Bamboo: A Socio-Material Approach to Past and Present Bamboo Cultures

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Abstract

Bamboo is regarded as the most versatile woody plant worldwide. It accompanied humans from prehistoric times and contributed much to the socio-cultural and technological development of many small-scale and large-scale societies in Asia, the Americas, and Africa. Moreover, bamboo is still essential for subsistence-oriented farmers and their bamboo-based or -related indigenous technologies and material cultures. Through the study of historical records and anthropological fieldwork, this book attempts to analyze past and contemporary bamboo cultures and interprets human-bamboo relationships from an epistemologically symmetric view that re-integrates things as part of the social. In so doing, this book reviews the debates concerning the human–thing relations and examines the redefinition of the social from an interdisciplinary perspective. Thus, following socio-material theories, such as practice theory and Actor-Network Theory, this work scrutinizes the interrelation of humans and bamboo by taking into account its elements' characteristic features and their contribution to the human-bamboo relationship: humans and their bodily and sensual involvement in the production and use of bamboo tools and mundane objects as part of everyday activities and bamboo as a forest product and plant, raw and construction material, tool, device, commodity, as well as its part in the human-made surrounding and immaterial value. It is argued that using a cross-disciplinary approach and an openness for nonhuman influence on the social sphere, a deeper understanding of bamboo's impact on peoples' lives can be attained.

Abstract (German)

Bambus gilt als das vielseitigste Nutzholz der Welt. Seit prähistorischen Zeiten begleitet es den Menschen und trug so wesentlich zur soziokulturellen und technologischen Entwicklung vieler Kulturen in Asien, Amerika und Afrika bei. Auch heute noch ist Bambus für Bäuerinnen und Bauern der subsistenzorientierten Landwirtschaft und ihre auf Bambus basierenden traditionellen Technologien und materiellen Kulturen von wesentlicher soziokultureller und technischer Bedeutung. Durch das Studium historischer Quellen und mittels anthropologischer Feldforschung versucht dieses Buch, vergangene und gegenwärtige Bambuskulturen zu analysieren und die Beziehungen zwischen Menschen und Bambus aus einer epistemologisch symmetrischen Sichtweise heraus zu interpretieren, und begreift dabei die nichtmenschlichen Entitäten als Teil des Sozialen. In diesem Zusammenhang greift dieses Buch aktuelle Diskussionen über die Beziehungen zwischen Menschen und Dingen auf und untersucht die Neudefinition des Sozialen aus einer interdisziplinären Perspektive. In Anlehnung an sozio-materielle Theorien wie die Praxistheorie und die Akteur-Netzwerk-Theorie wird in diesem Buch die Wechselbeziehung zwischen Menschen und Bambus untersucht, indem die charakteristischen Merkmale ihrer Bestandteile und deren Beitrag zur Mensch-Bambus-Beziehung berücksichtigt werden. Dazu gehören unter anderem: Menschen und ihre körperliche und sinnliche Beteiligung an der Herstellung und Verwendung von Bambuswerkzeugen und Alltagsgegenständen als Teil alltäglicher Aktivitäten; Bambus als ein forstwirtschaftliches Erzeugnis und Pflanze, Baumaterial, Werkzeug, Gerät und Ware; die Rolle des Bambus in der vom Menschen geschaffenen Umwelt; als auch sein immaterieller Gehalt. Hierbei wird dargelegt, dass mit Hilfe eines interdisziplinären Ansatzes und einer Offenheit für nichtmenschliche Einflüsse auf die soziale Sphäre ein tieferes Verständnis der Auswirkungen von Bambus auf das Leben der Menschen erreicht werden kann.

Preface

I have thought for many years that bamboo enriched material cultures and local pre- and non-industrial technologies throughout history and that its relevance for humankind's development and contemporary societies should be analyzed, discussed, and communicated more extensively using the perspectives and methods of the humanities, (social and cultural) anthropologists, and historians. In my view, only a boundary-crossing synthesis of different theoretical concepts, epistemologies, and methods would be able to provide a comprehensive study of bamboo and demonstrate bamboo's relevance for historical and present societies. It is estimated that bamboo has more than 1,000 different uses and still serves millions of people throughout the world as crucial raw and construction material. Moreover, bamboo is known as the fastest growing and the most versatile and diversely used woody plant in the world and, in recent decades, has acquired increasing importance as a sustainable resource and substitute for tree wood.

Trained as a sociologist, I was primarily taught to study the human being as a self-contained being and as the only bearer of the social. Yet, in contradistinction to traditional sociologists' anthropocentrism that commonly excludes nonhuman entities from the social, my entry point is bamboo and requires an epistemologically open approach in order to study the human-bamboo relationship and bamboo's material history and to disengage from a human-centered study.

In the beginning, thesis was originally planned as comprehensive work about the Vietnamese pre-industrial bamboo culture from the late nineteenth to the early twentieth century as well as to examine China's technological development related to bamboo. During my research, however, my studies went deeply into the sources that provide insights into bamboo's part in pre-industrial everyday life and material cultures in China, Japan, the Americas, and Africa. Simultaneously, I gained additional data based on my anthropological fieldwork related to small-scale societies' current bamboo-based material cultures in the Central Highlands of Vietnam. On the one hand, this re-orientation resulted in a work much broader in scope and scale since I discuss bamboo's material history across time and space, which consumed more time than originally planned. On the other hand, and due to this work's limited time and scope, I decided not to investigate bamboo's part in pre-industrial Vietnam due to the lack of data and compensated for this with my analysis of Japanese bamboo culture from the late nineteenth to the early twentieth century. Also due to lack of time, China's technological development related to bamboo is less prominently debated in this work but exemplified by two key inventions followed by a general discussion of bamboo's part in Chinese peasantry's everyday life.

My interest in bamboo and its technological possibilities developed while I was working with bamboo in 2010. At that time, I was part of a group of students who aimed to develop bamboo bicycles at the Technical University of Berlin, and I also worked on my own bamboo handicraft projects in my workshop. Simultaneously, I studied books about bamboo in a wide array of academic fields. As a result of my growing scientific interest in bamboo, I decided to do empirical research about traditional uses of bamboo and prepared my first stay in Vietnam, which lasted from March to August 2012 with short trips to Thailand and Laos.[1] During that time, I acquired an overall impression of the current state of the traditional use of bamboo by local people and gained insights into contemporary, *modern* uses of bamboo in the domain of architecture, modern arts, sustainable development, bamboo processing factories, or bamboo bicycle production.

My second trip to Vietnam from March to May 2018 opened new insights and solidified my first impressions from 2012. Overall, my interest and glimpse into many domains helped me gain crucial empirical data and to compile a comprehensive catalog of more than 2,500 photographs and 200 video files involving bamboo. Moreover, I had productive conversations with local craftspersons, botanists, architects, politicians, or peasants, who supported my interest in studying bamboo and who helped me to obtain additional information about bamboo.

My research interest during my stay in Vietnam was twofold. First, I opted to investigate bamboo's relevance and function in contemporary material cultures and study bamboo-based material cultures of ethnic groups living in the Central Highlands of Vietnam and how these groups exploit bamboo to meet their needs. Second, I attempted to gain more practical, first-hand experience about bamboo's inherent material qualities alongside techniques and methods of bambooworking through my observation of others working with bamboo and by my own experiences in the domain of bambooworking.

[1] During that time, I traveled mainly by motorbike, from Hà Nội to the western border region to Laos and then back to the coastal region. Afterward Huế southwards over the Tây Nguyên (Central Highlands) to Hồ Chí Minh City, followed by a short stay in Thailand and returning to Hà Nội and Vietnam's northeast region. In the following the places I visited are listed in chronological order. Vietnam: Hà Nội, Cát Bà, Xuân Lai (Bắc Ninh Province), Mai Châu District, Pù Luông Nature Reserve (Bá Thước District), Hà Nội, Thái Hòa (Nghệ An Province). Laos: Vientiane. Vietnam: Huế, Hội An, Kon Tum Province, Buôn Ma Thuột, Làng Tre Phú An (Bến Cát District), Hồ Chí Minh City. Thailand: Bangkok, Phitsanulok, Chiang Mai. Vietnam: Hà Nội, Cao Bằng, Hà Nội.

Due to fortunate circumstances, after a couple of weeks in Hà Nội in March 2012, I met Nicolas Saunié, a French engineer I first encountered during our collaborative work on bamboo bicycles in Berlin. With Mr. Saunié, I share a common interest in bamboo, and we decided to travel together through Vietnam in order to discover the contemporary uses of bamboo. Thus, with short interruptions, we traveled together for three months and began in April 2012 to work for three weeks in the bamboo handicraft village in Xuân Lai, Gia Bình District, Bắc Ninh Province (Vietnam), visited bamboo-related development projects in the border region to Laos, and stopped whenever bamboo crossed our path to study its uses.

Generally speaking, my observations and hands-on experience provided the necessary background knowledge that I integrated into the present book. In my view, it is a significant advantage to understand a material such as bamboo not only as a social scientist or historian but also as a carpenter or designer. Having hands-on experience of how bamboo *behaves* and *works* allowed me to analyze and interpret more quickly and effectively how a particular bamboo artifact is designed, which skills and techniques are required, how the human body is involved in modeling matter, and which tools are needed to work bamboo. Instead of just writing about bamboo on a theoretical level, I believe that hands-on experience and general understanding of how to work bamboo is a precondition for profound scientific research, especially if one is concerned with the relationship between humans and bamboo.

Towards the end of my first stay in Vietnam in 2012, I had the chance to meet Mr. Ẩn Nguyễn Ngọc, a resident artist in Kon Tum, who has a very comprehensive knowledge of ethnic groups and particularly of Bahnar people who live in the Central Highlands of Vietnam. Since Mr. Nguyễn Ngọc has a long-lasting friendship with a group of Bahnar people, he arranged a stay at their hamlets and helped me to realize my first fieldwork and to study Bahnar people's bamboo-based material culture. Then, in March 2018, I returned to Vietnam to gain additional, comprehensive data about the Bahnar people's traditional ways of using bamboo. Like in 2012, I was also able to improve my personal bamboo working skills in a bamboo workshop in Hoi An.

The present book is intended to provide a theory-driven approach to bamboo from a historian's and anthropologist's perspective and by taking into account bamboo's biological and physical properties. In summary, the focus of the present work is on the human-bamboo relationship, how bamboo affects people's social lives, and bamboo's versatile use in the past and present.

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I am also grateful to Nicolas Saunié; we had a unique experience in Vietnam and Thailand. Sharing a common enthusiasm for bamboo and following the ways of bamboo, we had the opportunity to encounter kind people encouraging our interest in bamboo. My thanks also go to the people in the bamboo handicraft village in Xuân Lai, Bắc Ninh Province (Vietnam), who allowed Mr. Saunié and me to work and learn from them the traditional and modern ways of bamboo processing.

My sincere thanks I would also like to give to Tân Võ, the founder of Taboo Bamboo Workshop in Hoi An (Vietnam), who allowed me to work at his workshop. I am grateful to his staff and particularly to Bảo Linh. It was a wonderful environment in which to improve my bamboo working skills. I would also like to thank the staff of the bamboo arboretum Làng Tre Phú in Bình Dương Province (Vietnam) for their support and advice and the staff of Tre Xu Thanh in Thanh Hóa Province (Vietnam) for providing insights into sustainable bamboo processing and cultivation. I am extremely indebted to Ẩn Nguyễn Ngọc for his countless suggestions and comments throughout my fieldwork and research. I would like to give special thanks to all the Bahnar people for providing me with a homely environment in the field and continuous support during my fieldwork.

Finally, thanks go to all those friends, colleagues, scholars, and acquaintances who helped during my research and who, over the years, have been generous with their ideas and support

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Of course, my heartfelt thanks also go to my parents, Emine and Necmi Erkol, whose generosity made my studies and later this now completed doctorate possible. Born in two small villages in Anatolia and growing up in a subsistence-based agricultural environment, both of you worked hard since childhood and later as migrant workers in Germany. Knowing that education is the key to knowledge and success, you encouraged my siblings and me to study. You also taught me, whenever we have been in Turkey during the holidays, about village life that helped me take a closer look at Vietnamese and Bahnar peasants' life—though regions differ, village life is determined by agricultural work and a community-based life. I am aware that I am very lucky to have parents like you. I hope to be able to give you back even a fraction of what you have done for me.

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Abbreviations

ANT – Actor-Network Theory

BEFEO – Bulletin de École Française de I'Extrême-Orient

CPV – Communist Party of Vietnam

EFEO – École Française de I'Extrême-Orient

FAO – Food and Agriculture Organization of the United Nations

GSO – General Statistics Office of Vietnam

INBAR – International Bamboo and Rattan Organisation (formerly International Network for Bamboo and Rattan)

MDF – Medium-Density Fiberboard

SCOT – Social Construction of Technology

ShiCu-network – Shifting-Cultivation Network

SPIDER – Skilled Practice Involves Developmentally Embodied Responsiveness

STS – Science and Technology Studies

TXT – Tre Xu Thanh

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1. Introduction

"There is not in the whole vegetable kingdom a plant which is so intimately bound up with the life of mankind as the bamboo. In India, Ceylon, China, Japan, the Malay Archipelago, and in the tropical forests the world over it is a servant-of-all-work" (Freeman-Mitford 1896, 27), as the British plant collector Algernon Freeman-Mitford declared in his seminal book *The Bamboo Garden* in the late nineteenth century. And indeed, wherever bamboo occurred naturally, it was instrumental for prehistoric and ancient civilizations, material cultures, and pre-industrial technologies.[2] However, in the past and present, bamboo is still of great significance. It is vital for traditional small-scale societies' local technologies, preserved as bamboocraft, and part of the built environment. Moreover, bamboo is experiencing a revival in modern architecture and undergoing an increasing economic use, as exemplified by the growing bamboo industry.[3] Overall, it is estimated that bamboo is one of the most used plants in the world and that it secures the livelihood for about one billion people in Asia, Africa, and the Americas (Liese 2000, 157).

As stressed by the *bamboo line hypothesis* (see chapter 5.4.3), early hominids' material culture in East and southern East Asia was based on bamboo tools rather than stone. In relation to the Stone Age, one could speak of a *bamboo age* since bamboo was the predominantly used material. Similarly, due to bamboo's pervasive and abundant utilization as something enmeshed with people's everyday life, one can speak of *bamboo civilizations* in connection with traditional material cultures in many large-scale societies (such as Japan, China, or Vietnam). Simultaneously, bamboo has been the chief material for many small-scale societies throughout Asia, Africa, and the Americas. Bamboo's crucial role for humans' socio-cultural and material life, the ecosystem, and wildlife is concisely pointed out by Judziewicz et al.:

> Wherever they [bamboos] are dominant components of the flora, bamboos play an important cultural role in the development of human societies, ministering to economic, ecological, and spiritual necessities. They are used in housing construction, paper making, furniture making, arts and crafts, traditional medicine, popular cultural belief systems and ceremonies, and the conservation of soils and watersheds, and they serve as food for both humans and their domesticated animals. Bamboos have been converted into materials that stimulate creativity,

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[2] In the following, I shall use the term *pre-industrial technology* to signify non-contemporary, historical technology, and the term *nonindustrial technology* to refer to current people's indigenous technologies.

[3] The term *tradition* is a problematic one. When I refer to it in this work, I neither want to simplify indigenous cultures nor do I intend to define any culture as something immutable—especially as distinct from the so-called *modern world*. Every society has evolved under unique circumstances and developed its own particular cultural, technological, or social features. Social, cultural, technological developments are never completed and are much more characterized by ongoing dynamic spatiotemporal processes of development. Societies change constantly rather than being immutable.

> nourish the spirit, develop human abilities, adorn the countryside, and provide economic benefits. (Judziewicz et al. 1999, 88)

On the whole, bamboo is a special kind of plant and material and a loyal assistant and companion of human history. Since prehistoric times, human dexterity and the human hands' capabilities and skills have developed working on and with bamboo. One is tempted to say that humans' relationship with bamboo has become part of human nature. As demonstrated by the various bamboo cultures throughout the world, wherever bamboos occur, there has always been an intimate interrelationship between humans and bamboo.[4] A relationship that involved the human body, skill, and creativity and, at the same time, was determined by bamboo's material properties.

Consequently, bambooic tools and everyday objects bear the marks of the hand that worked with and utilized them. The interaction with and handling of bamboo as a building material became a fundamental element of the history of the human body and humankind's socio-cultural and technological development. Therefore, human (mind and body) and bamboo (and its intrinsic biological and physical-material properties) in connection with the interaction, use, and handling of bambooic tools, devices, and objects laid the foundation for the human-bamboo relationship and the material history of bamboo—the study of which is the leading research interest of the present work.

By and large, this thesis scrutinizes the characteristics of bamboo cultures and pre- and nonindustrial technologies involving bamboo of historical and present small-scale and large-scale societies. In relation to the former case, I take a closer look at bamboo's decisive role in material cultures of ethnic groups whose livelihood was or is based on shifting cultivation. In relation to the latter case, I examine China's and Japan's historical bamboo cultures, the development and implementation of pre-industrial technology associated with bamboo, and bamboo's part in urban dwellers' and the peasantry's everyday life.

A study having bamboo as its starting point must be holistic if it claims to narrate its material history and relevance for humans alongside its connection to the ecosystem and wildlife. A holistic approach to bamboo must also take into account bamboo's polyvalent character as

[4] I define the word *bamboo culture* in conformity with the concept of *material culture*, which is primarily interested in studying the materials that form the basis of a society. In view of this, I use the term *bamboo culture* in two ways. First, to refer to material cultures in which bamboo is the most frequently used raw material. Second, I use it as an umbrella term that designates and revolves around different societies' and peoples' use of bamboo in various domains of life but without bamboo being the central building material of a society (see also chapters 5.4 for a broader definition).

bamboo belongs to the realm of the plant kingdom and the human-built environment. Thus, the next subchapter's goal is to describe bamboo's multifacetedness.

1.1. Approaching Bamboo's Versatility

A key feature of my research program is the emphasis I place on the fundamental and constitutive role of things and materials in everyday life. In my view, the animate and inanimate tangible and less tangible things, that is, the tools, artifacts, human-made material surroundings, animals, plants, wind, sun, soil, insects, human beings, and many more entities, all are in constantly shifting relationships and coalesce in unpredictable ways, determined by the contingencies of time and space. In this context, I hold that bamboo is part of many strata of human existence and beyond that. As mentioned above, bamboo is part of the human-made material and immaterial world, pre- and nonindustrial technology, the *social*, history, nature, and people's everyday life, activities, and practices. Thus, this thesis examines bamboo's multifacetedness and polyvalent *forms of existence* and identifies bamboo's general use and (dis-)advantages enrolled in its materiality and scrutinizes its part in the human-bamboo relationship. In view of this, the following perspectives are intended to represent the various ways in which bamboo can be viewed.

First and foremost, bamboo is a plant—or more correctly *bamboos* in the plural since the *Bambuseae* tribe encompasses more than 90 genera with over 1,500 species, which differ in shape, size, woodiness, hollowness, distribution, and the like.[5] As a plant, bamboo is integral to people's natural environments, landscapes, gardens, or ecosystems and vital for wildlife habitat and environmental conservation. Secondly, bamboo is a widely usable, renewable, plant-based raw and construction material with specific material properties. Thirdly, bamboo is used to produce countless (movable) bambooic things, tools, devices, goods, everyday objects and commodities, as well as (non-movable) constructions as part of the human-made built environment.[6] Fourthly, bamboo is attributed with positive qualities such as gentleness, modesty, or serenity and an integral element of many societies' immaterial cultures and part of the arts,

[5] Worldwide over 1,500 different bamboo species exist that belong to the subfamily *Bambusoideae*. Hence, in the following, whenever using the term *bamboo* (in the singular), I mainly refer to the subfamily *Bambusoideae* and I use this term interchangeably with *bamboos* (in the plural).

[6] Since there is no adjective of the word bamboo in the English language as there is for *wood-wooden* or *metal-metallic*, which would describe the material composition of a concrete thing made of bamboo, I use the word *bambooic* in the following to designate things made of bamboo.

poems, sayings, and rituals. Fifthly, during processing, creation, and utilization of bambooic things, a person's or group's activities and (social) practices (involving the human body and mind) are oriented toward, modified by, or attached to bambooic things.

To summarize, speaking of human-bamboo relationships in this thesis encapsulates the dimensions of humans and their (animate and inanimate) bamboo-related material surroundings involving biological, social, and material interrelations. As will be explained in chapter 1.3, drawing on an interdisciplinary approach, I attempt to find a deeper level of understanding of the human-bamboo relationship since each discipline provides certain insights into the multi-facetedness of this relation.

1.2. Research Object and Research Questions

Having a nonhuman entity such as bamboo as a starting point is challenging because the traditional anthropogenic disciplines such as history, sociology, or (social and cultural) anthropology provide less useful methods and concepts to study nonhuman entities. This is because their (traditional) methodological toolkit and theoretical postulations and hypotheses are confined to the human subject, human society, and human culture. As already indicated in the proper names of *socio*logy and *anthro*pology, these disciplines are anthropocentric in their scientific orientation. The term *anthropos* derives from Greek and means *human,* and *socius* derives from Latin and means *companion*, *sharer*, *partner*, or *associate.* Both terms are followed by the suffix -*ology*, which also derives from Greek *lógos* and means knowledge. Thus, both disciplines represent sciences interested in the human being.

During their academic institutionalization and trajectory, both disciplines and related disciplines such as history and philosophy became increasingly fixed on the self-contained human and, unsurprisingly, abandoned and ignored the nonhumans as part of human existence. Subsequently, their anthropocentric focus predetermined an artificial disconnection of humans and nonhumans as a fundamental prerequisite for the scope of their research interest, methods, or theories. Thus, based on their human-centered social ontologies, features such as social and intentional action and agency are limited to the self-contained human being.

Needless to say, studying bamboo and the human-bamboo relationship requires a different epistemological and (social) ontological approach and methodological openness. Such an approach comprises methods that afford a less anthropocentric approach to matter, and it calls for an extension of conventional concepts and definitions to obtain a comprehensive analysis of nonhuman entities' materiality and agency. Moreover, it entails a refocusing on the human and her/his bodily involvement, human activities and practices alongside humans' conflation with material things and her/his interaction with nonhuman entities.

Consequently, the (re-)integration of nonhuman entities into the realm of the social enables us to evaluate their relevance and (intentional or non-intentional) capacity for agency and, thus, their contribution to the social rather than seeking the social just as an effect of human activities. By implication, only by a redefinition of the *social* and a (re-)introduction of nonhumans to the arena of the social and human history can an untainted investigation of both elements of human-nonhuman relations in general and the human-bamboo relationship in particular be obtained.

The topics of the present work are presented by the six key topics (and their sub-issues) further below. After a descriptive exploration of bamboo's botanical and physical-mechanical properties and basic processing techniques, the first part evaluates and discusses socio-material theories' assumptions and symmetrical approaches in connection with human–thing relationships. A second part theorizes bamboo's involvement in material cultures, pre- and nonindustrial technologies, and indigenous knowledge. A third part is devoted to bamboo's relevance in connection with the shifting cultivation of an ethnic minority in contemporary Vietnam's Central Highlands. A fourth part examines bamboo's role in pre-industrial technological development as exemplified by China. A fifth part deals with the issue in terms of bamboo's contribution to material cultures in pre-industrial times—as exemplified by China's peasantry in the first decades of the twentieth century, Japanese material culture from the late nineteenth century to the early twentieth century, and past material cultures in the Americas and Africa. And a sixth part summarizes the research findings and gives an outlook on bamboo's near future related to traditional bamboo cultures.

While the first two parts are primarily considered with theoretical questions, the other three parts seek to obtain data that will help address the various forms of the human-bamboo relationship based on the theoretical chapters' findings. Now, having outlined the main subjects of this thesis, in what follows, I will depict the central research questions related to these parts in more detail and again in more detail in each chapter. In chapter 1.5 I will present the structural outline of this dissertation.

1) Theoretical Assumptions and Symmetrical Approaches to Human–Thing Relations (Chapter 5)

When studying the human-bamboo relationship, one core question is concerned with how to present and discuss human-thing relations. Since the traditional Western bifurcation differentiates between the human subject and the rest (including nature, technology, animals, plants, and the like), how does the Western notion of humans and nature affect our perception of ourselves and our environment? And how do Western dualisms determine analyses of human-thing relations if epistemological approaches are subordinated to the intentionally acting human? Do less anthropocentric and non-oppositional philosophies and approaches provide alternative frameworks to study the reciprocal relationship and multifaceted nature of a given human-thing relation? Are (re-)interpretations of nonhumans' agency and emphasizing their conflation with humans into heterodox hybrids helpful to analyze dialectic relationships between humans and nonhumans? If so, do socio-material theories, such as practice theory and the Actor-Network Theory (ANT), present the complexity of reality more accurately than conventional social theories and ontologies? A complexity that at least includes i) the (human) society, (material and immaterial) culture, and technology; ii) nature and the ecological surrounding; iii) human activity, (social) practices, and skill; iv) the bodily involvement of humans; and iv) animate and inanimate nonhuman entities' effects and actions. Or are socio-material theories' epistemological aberrations when they assign agency to nonhumans? As becomes clear, these questions tackle epistemological and ontological ideas and are concerned with metaphysics when they inquire about the nature of reality. Overall, these questions are helpful to find answers to these issues and to elucidate the various features of the human-bamboo relationship.

2) Bamboo in Material Culture, Technology, and Indigenous Knowledge (Chapter 5 and 6)

Since human life exists only in coexistence with the world of matter and since bamboo is an integral part of material cultures, another set of questions deal with the characteristics of material cultures and the scope of material culture studies. On the one hand material culture studies highlight the role of tangible things, as expressed by the word *material* in material cultures. On the other hand, since less tangible and nonmaterial inanimate entities or animate entities also influence the human-made tangible things and built environment, what are the shortcomings of material culture studies if they are limited to human-made things? For instance, a bamboo house's durability is determined by less tangible (e.g., wind) and nonmaterial entities (e.g., sun), starch-eating insects, or by the factor of time, amongst others. In view of that, should not material culture concepts encompass nonmaterial things and animate things too? Against this background, do socio-material theories with less hierarchical ontologies (like practices theory or ANT) provide a better approach to interpret the intertwining of entities with variable physicality?

As demonstrated in relation to traditional bambooworking, bamboo is primarily manually worked using hand tools. Considering this, I critically review the term technology, which in its current sense is associated with industrialization and industrial machinery, in contrast to *technē*, which highlights human-centric skillful manual work. In doing so, I elaborate on the definitions of pre- and nonindustrial technology and indigenous technology. What are the differences between human-centered processing of things compared with industrial technology that is based on artificial machines and rationality? How do both affect and modify human activities? And, given the rise of industrial technology on a global scale, can indigenous knowledge and indigenous technology be preserved and resist industrial technology and tools, or is technological development a one-way road guided by industrial development, as argued by advocates of unilineal development?

3) Bamboo in Relation to Shifting Cultivation (Chapter 7)

Many ethnic groups living in (sub-)tropical mountainous rainforests have developed a special relationship with their environment and with bamboo in connection with their agricultural system, namely, shifting cultivation. These mountain dwellers have created material cultures that are mainly based on bamboo and its multipurpose use. In this context, I take a closer look at the multiple layers of the human-bamboo relationship of indigenous people practicing shifting cultivation. In detail, based on my fieldwork conducted in 2012 and 2018 and my literature review, I examine Bahnar people who live in the Central Highlands of Vietnam. In so doing, my research is linked with the following questions: What characterizes the bamboo culture of Bahnar people? In which domains of life can one find bamboo? Which tools and objects are made of bamboo? How is the human body involved in bambooworking?

Further questions investigate if practice theory is helpful to determine social practices involving bambooic tools, objects, and the human body. At the same time, I clarify if ANT provides a methodological toolkit that helps to analyze to what extent heterogeneous actors come into play when analyzing the relationship between shifting cultivation and bamboo culture. Finally, I inquire if holistic ideas of well-being (such as the Buen Vivir concept) are promising alternatives to one-dimensional modernization theories.

Given the fact that the Bahnar people's traditional lives are affected by external factors, I attempt to identify them and to scrutinize how they conceived, conceptualized, and governed highland groups' lives in history, and how they currently affect Bahnar people's lives. Since Vietnam is a socialist country, I attempt to identify the major characteristics of a socialist striving for development and modernization and scrutinize its effects on the perception of ethnic minorities and shifting cultivation.

4) Bamboo's Role in the Pre-Industrial Technological Development of China (Chapter 8)

It is evident that Chinese people have benefited from bamboo since ancient times. In view of that, I attempt to illuminate how bamboo affected certain Chinese proto-industries and technologies. Since this is an extensive topic, I limited my focus to two outstanding inventions: papermaking and gunpowder (in connection with military technology). In relation to papermaking, my questions are related to the factors that influenced bamboo-based papermaking. Regarding the use of gunpowder as a means of military technology, my research questions are: How did bamboo's material properties influence Chinese military technological development? And how did ancient Chinese people exploit bamboo's natural cylindrical form, hollowness, stiffness, springiness, and abundance when they produced firearms and other weapons.

5) The Material History of Bamboo and Its Part in Material Cultures in China, Japan, the Americas, and Africa (Chapter 8, 9, and 10)

Bamboo has been of relevance for many small-scale and large-scale societies worldwide and in different epochs. Therefore, it is virtually impossible to portray the miscellaneous bamboo cultures at full length. In the same way, it is challenging to exhibit a particular bamboo culture sufficiently even when limited to a given time due to the multipurpose utilization of bamboo in many domains. However, by tackling and analyzing various bamboo cultures, one can decipher bamboo's function and relevance for material cultures, pre- and nonindustrial local technologies, and people's everyday lives and as well its material history.

With reference to the discussion of bamboo's botanical, physical, and mechanical properties in chapters 2–4, many questions revolve around how bamboo's properties, such as its hollowness, springiness, or tensile strength, were incorporated in bambooic things in various historical bamboo cultures. Thus, I question how different peoples, such as the Chinese peasantry, Japanese urban dwellers, and peoples native to the Americas and Africa, integrated bamboo in their material cultures and local technologies. What are the characteristics of bambooic things? How did bamboo affect the performance of everyday activities or agricultural work? And, if we regard the human as a tool-using animal, and given that the human being conflates with the tool and workpiece when she/he is using tools, is it promising to discuss a given human-bamboo entity as a hybrid entity instead of separate units? Hence, based on the methodological toolkits offered by socio-material theories, I will address this question.

6) The Future of Bamboo (Chapter 11)

If one understands bamboo's material history as part of people's socio-cultural, natural, and technological history and as a product of distinct human-bamboo relationships that are characterized by human ingenuity and creativity and bamboo's material properties, one can illuminate the role of bamboo from a trans-regional or even global perspective. In view of this, questions arise that revolve around the characteristics of bamboo cultures. What are the commonalities amongst various bamboo cultures? How did people in different regions and epochs use bamboo? And did various bamboo cultures develop separated from each other or by exchange?

1.3. Interdisciplinary Approach

Bamboo is the subject of various fields of natural sciences. For instance, civil engineers and architects are interested in bamboo's physical and mechanical properties and its strength and weakness as a construction material; biologists scrutinize bamboo's botanical aspects (such as its taxonomy, distribution, propagation, or its relation to the ecosystem); chemists explore bamboo's chemical composition; agronomists investigate bamboo's economic value and value chain for people's livelihood and bamboo industries; and climatologists study bamboo's benefit for climate change mitigation as a means of carbon dioxide fixation.

Despite its relevance for humans, however, bamboo has not been studied much in the humanities, history, or social and cultural anthropology, which, I believe, is related to the fact that these disciplines' scope is commonly confined to humans. This thesis, however, combines and considers various natural science disciplines' perspectives and findings related to bamboo with anthropogenic science theories and methods in order to examine bamboo's relatedness to humans. In the words of the French philosopher, anthropologist, and sociologist Bruno Latour, a holistic cross-disciplinary study requires "a multifarious inquiry launched with the tools of anthropology, philosophy, metaphysics, history, sociology" but equally of history of technology, biology, or architecture and engineering "to detect how many participants are gathered in a thing [or human-thing relation] to make it exist and to maintain its existence" (Latour 2004, 246). In view of this, my approach to study the human-bamboo relationship is determined by a methodologically open approach to both its components because only a symmetrical approach provides satisfactory answers and explanations about the characteristics of this relation.

Therefore, this work involves works of various disciplines, including archaeology, (social and cultural) anthropology, ecological anthropology, history and the history of technology, philosophy and the philosophy of technology, sociology, and material culture studies, as well as biology, physics, chemistry, architecture, geography, and civil engineering. By and large, natural sciences helped me to gain information about bamboo, its properties (as a plant, raw material, or building material), and to what extent bamboo's inherent material and mechanical characteristics determine the built environment and artifact production. In addition, anthropogenic disciplines offered useful methods and theoretical approaches to examine bamboo's material history and the human-bamboo relationship. Hence, in what follows, I briefly explain the main disciplines' contribution to my research.

As a branch of philosophy, metaphysics is concerned with the fundamental principles of how we perceive ourselves and our environment. Thus, a critical review of the shortcomings of Western thinking and, particularly, its dualisms (such as mind vs. matter, subject vs. object, or human vs. nonhuman) is crucial to pave the way for alternative ontologies and epistemologies that reject the orthodox bifurcation of the world into the sphere of humans in contradistinction to nature or technology. This critical reflection is essential for a less anthropocentric study and allows a wider openness to study the characteristics of the human-bamboo relationship.

Sociology, or rather critical unorthodox post-structuralist and (partly) post-humanist sociomaterial theories as part of an alternative sociological way, are of outstanding value to redefine the concept of the *social* and fundamental to re-evaluate human-thing relations and bamboo's part in people's lives. In this context, this works relates to various theories that originate from or are influenced by sociologists. Its theoretical part is therefore linked to sociology and related disciplines that study human behavior and culture.

History and the history of technology offer methodologies that were vital to study humans' bamboo-related history through historical records and additional secondary sources. The study of first-hand information helped me to reconstruct bamboo's use in the past and to clarify bamboo's relevance for historical societies. Yet, as argued by the philosopher Beth Preston, the history of technology (and the philosophy of technology which follows a similar strand) "focuses primarily on the cultural and social effects of industrial and post-industrial technologies" (Preston 2019, 1). Consequently, it operates with a limited conception of technology. Unsurprisingly, then, most research in the (discipline of) history of technology is limited to European or Western technology and concentrated on technologies that arose with the industrial revolution.[7] As a result, the rigid focus on the industrial revolution of (post-)modern societies ignores indigenous technologies and neglects the relevance of mundane artifacts in everyday life and their technical (skill-dependent) use. However, I argue for a history of technology that should have a trans-cultural, epoch-spanning view to acknowledge and analyze extra-European pre- and nonindustrial technologies.

Since this thesis examines the bamboo culture of ethnic minorities in the Central Highlands of Vietnam, the present work is also an anthropological work. Hence, anthropological discourses, definitions, theoretical assumptions, and methodological toolkits were essential to study the human-bamboo relationship of contemporary indigenous people. Moreover, it was fieldwork, as a genuine method of anthropology, that helped me to gain first-hand data from the field.

Material culture studies originally derive from archaeology and anthropology but nowadays are a broad interdisciplinary field including sociological, anthropological, archaeological, architectural, and historical theories and methods and fundamental for setting the framework of this work and studying bamboo in material cultures. Since material culture studies analyze and understand human society through its material environment, the emphasis on bamboo's part in

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[7] A literature review of the peer-reviewed journal *History and Technology* (first published in 1983) shows that most of its content is about topics associated with Western industrial and postindustrial societies such as: electricity, radiation, chemical industries, nanotech, airplanes, high tech, cybernetics, Cold War military technology, or about the invention of plastic, tomography, magnetism, the steam engine, patenting, the development of thermodynamics—all associated with Western science and industrial technology.

the material aspects of people's lives sheds light on bamboo's embeddedness in human activities, practices, and daily routines. In view of this, the present work is also an outcome of material culture studies.

To summarize, bamboo as its central theme, the present work employs a boundary-crossing interdisciplinary approach and comprises various academic disciplines and research fields and pieces together segments of a greater whole, for each discipline has its own view. On the one hand a conceptual bridging and disciplinary admixture will provide an interdisciplinary synthesis of various distinct theoretical concepts, ideas, methods, research traditions, and discourses and requires the scholar to go beyond each discipline's academic borders and overcome their atomization and specialization. On the other hand such an endeavor remains challenging due to the heterodox, contradictory, ambiguous, and inconsistent definitions and concepts within each and beyond the disciplines.

1.4. Methodology

As mentioned above, this thesis tries to compile cross-cultural data in time and space for a holistic approach to bamboo. In view of this, the work's main topics are related to the disciplines of history and anthropology, while its theoretical parts and discussions involve the former alongside philosophy, the philosophy of technology, and sociology. While the historical part of this dissertation is focused on past pre-industrial bamboo cultures, its anthropological part examines largely contemporary nonindustrial bamboo cultures. Against this background, by following the methods of history, the historical chapters' findings resulted from an evaluation, analysis, and interpretation of primary and secondary sources. And by following anthropological methods, I gained data from fieldwork alongside ethnohistorical methods encompassing other scholars' historical and ethnographic work. The combination of both with material culture studies has been crucial to address my research questions.

Overall, my methodological approach is based on the socio-material theories and concepts discussed in chapter 5 and 6. Since the various chapters are concerned with various subjects, I discuss my theory-driven approach and methodology and the relevant literature at the beginning of each chapter. Therefore, I advise the reader to look up each chapter for my methods rather than reiterating them at this point.

1.5. Structural Outline

After the present introduction that summarizes the general orientation and research goal of this work, chapters 2, 3, and 4 deal separately with bamboo's botanical aspects and material properties and processing techniques required for (traditional hand-driven and modern machine-based) bambooworking. Chapters 5 and 6 are devoted to the theoretical approach of this thesis. Chapters 7 to 10 address bamboo in connection with various societies. Chapter 7 deals with bamboo cultures in the context of shifting cultivation in the Central Highlands of Vietnam. Chapter 8 examines pre-industrial China's proto-industries and the use of bamboo by the Chinese peasantry in the 1920s. Chapter 9 is devoted to the bamboo culture of late-nineteenth-century Japan, and chapter 10 elaborates on bamboo cultures in the (pre-)Columbian Americas and (pre-)colonial Africa. The last chapter (11) summarizes the preceding chapters' findings, discusses a global perspective on bamboo cultures beyond time and space, highlights this work's limitations and shortcomings, makes some recommendations for further research, and ends with concluding remarks about the human-bamboo relationship. On the whole, the present work consists of eleven chapters, with a bibliography of about 320 books and more than 200 photographs and sketches, and two tables. All photos, sketches, and tables shown in this work are mine unless otherwise noted.

Since this thesis covers a wide array of fields, I will outline each chapter's structure, content, research goals, research questions, and methods in detail at the beginning of each section and I will link each chapter's subject to the other chapters in the thesis. Thus, in what follows, I only mention the central themes running through each section, except for the theory chapter, which requires a more detailed description to help the reader grasp my underlying theoretical approach from the outset.

Part A (Chapters 2, 3, and 4): The Anatomy and Processing of Bamboo: Botanical, Physical, Mechanical, and Chemical Properties of Bamboo and its Types of Uses

This part is divided into three chapters. Its first chapter (2) addresses bamboo's botanical aspects (such as its taxonomy, distribution, propagation, or relation to its ecosystem). The next chapter (3) deals with bamboo's anatomical structure and how this conditions bamboo's physical-material properties. Then, chapter 4 elaborates on the characteristics of bambooworking and how people form, shape, design, or transform bamboo.

Part B (Chapter 5 and 6): Theory

The underlying goal of Part B is to provide a theoretical foundation that should guide this dissertation's main assumptions, hypotheses, and approaches necessary to (re-)evaluate human-thing relations in general and the human-bamboo relationship in particular as well as to meet the content-related focal points of this work as comprehensively as possible. Against this background, this part is divided into two chapters. Chapter 5 elaborates various approaches to (social) practices, and materiality and chapter 6 discusses topics relating to indigeneity and development.

By and large, chapter 5 describes the complex interconnectedness of human activities involving things, such as bamboo, examines concepts of materiality, and is associated with a redefinition of the social by integrating nonhumans and their potential agency into the sphere of humans. After some introductory words in chapter 5.1, the following chapter (5.2) is devoted to ontological problems that emerge when studying human-nonhuman relations. Then, chapter 5.2.1 is concerned with Western dualistic conceptions of nature, technology, and society. The next chapter (5.2.2) examines nonanthropocentric approaches to these concepts and tackles questions revolving around the definition and conceptualization of the *social* and where to locate it. For this purpose, I elaborate on socio-material theories and Ingold's theoretic models concerning the social. To find adequate explanations, I first refer to practice theory (5.2.3), its underlying theoretical assumptions and refocus on practices, and second, in chapter 5.2.4, to the less anthropocentric and post-humanist approach and theoretical principles of ANT as well as its symmetric approach to and integration of nonhuman entities into the realm of humans. In chapter 5.2.5, I discuss Ingold's socio-material approach called *meshwork*, and his emphasis on the human individual's development in her/his interaction with things alongside Ingold's thinking about how we perceive ourselves and the environment. Then, by taking into account the strengths and shortcomings of practice theory, ANT, and Ingold's concepts, I conclude with my theoretical and methodological approach to the human-bamboo relationship.

Chapter 5.3 addresses the concepts of materiality by highlighting different notions of the terms *artifact* and *naturefact* (5.3.1) and *agency* in relation to concepts of *things* and *objects* (5.3.2). Following this, chapter 5.3.3 is devoted to the *becoming of things* and underlines, in contrast to Aristotle's hylomorphism, that matter matters in the generation of things and that things are produced as an outcome of a material's materiality and human creativity. With regard to this, chapter 5.3.4 examines the hybridity of human-thing entities, involving human skill, activities, the human body, tools, and the materiality of things.

Drawing on the previous chapters, I define concepts of material culture and bamboo culture in chapter 5.4. Next, in chapter 5.4.1, I outline the concepts of *material* and *immaterial culture*. I emphasize how different concepts of material cultures and epistemological interests in material cultures studies affect scholars' research objectives and methodological approaches and point out the advantages of material cultures studies that are not limited to tangible things but reflect the relationship between physical and less/non-physical entities. Then, based on my definitions of material culture in chapter 5.4.2, I propose my definition of *bamboo culture*. Given that the present work attempts to study bamboo's material history, chapter 5.4.3 is an excursion that is concerned with bamboo's use in prehistoric times.

The following chapter (5.5) deals with the characteristics of the terms *technē*, *mēkhanē*, and *technology* and highlights the transition of manual to non-manual work. Since the term *technology* is commonly associated with European Enlightenment and Industrialization, chapter 5.5.1 considers the subject- and human-centered term *technē* (involving human creativity, bodily involvement, techniques, and skillful handling of tools) in comparison with the objective, rational, and scientific nature of *technology* and examines how the latter's ascent played a determining part in the downfall of *technē*. Then, chapter 5.5.2 discusses briefly how industrialization and machine-based work in chopstick factories affect the way of working.

The discussion of the terms *technē* and *technology* is crucial for three reasons. Firstly, since this dissertation is devoted to technologies in pre- and nonindustrial contexts, it requires a critical review of the term *technology* since it is primarily associated with Western technological development and industrialization and often conceived as superior to techniques and methods that are not propelled by industrialization. Secondly, only a critical review of both terms (and *mēkhanē*) provides a foundation for my later reflection on indigenous technology as part of indigenous knowledge (in chapter 6.2) and how bamboo can be analyzed as part of local pre- and nonindustrial technologies. And thirdly, a critical review of the terms *technē* and *technology* is crucial to discuss theoretical assumptions on technological change, which is the subject of the next chapter (5.6). In this context, I outline some theoretical explanations of technological change, including diffusionism (5.6.1) and technological and social determinism (5.6.2). Lastly, in chapter 5.6.3, I conclude with my understanding of reasons for technological change.

Since this thesis is partly concerned with bamboo's part in an ethnic minority's material culture (namely that of the Bahnar people), chapter 6 is critically engaged with indigeneity and development. After a brief review of unilinear theories about cultural evolution (6.1.1), I critically review primordial and situationalist concepts of *ethnicity* (6.1.2) and concepts of *indigeneity* (6.1.3), followed by a discussion of the terms *indigenous knowledge* (6.2.1) and *indigenous technology* (6.2.2) in chapter 6.2. Then, in chapter 6.2.3, I elaborate on the multidimensionality of tools and point out that emphasizing the *simplicity* of a nonindustrial technology neglects certain other qualities, such as skillful sensory learning and tool use. After defining the basic principles of indigenous knowledge, I once again return to the concept of material culture in chapter 6.2.4 and point out both concepts' similarities and differences that guide this thesis in its approach to indigenous knowledge and material cultures.

Chapter 6.3 is once more engaged with a critical review of the concept of technology in the discipline *history of technology* and technology's relation to colonial and postcolonial power structures. Finally, chapter 6.4 critically discusses monocausal concepts of progress and modernity and is critically engaged with (sustainable) development and people's self-determination, and introduces holistic ideas of well-being (by the example of the Buen Vivir concept as formulated by Eduardo Gudynas).

Part C (Chapters 7, 8, 9, and 10): Historical and Contemporary Bamboo Cultures

Parc C is concerned with the analysis of human-bamboo relationships and bamboo cultures of different societies throughout space and time by interpreting bamboo's part in i) material cultures, ii) nonindustrial indigenous technologies, and iii) and everyday activities.

Chapter 7 elaborates on past and present bamboo cultures of people practicing shifting cultivation and is mainly concerned with that of Bahnar people amongst whom I conducted my fieldwork. After a brief account of the history of the Bahnar people and the Central Highlands (7.1.1), I briefly discuss ethnic groups in Vietnam (7.1.2) and give a brief introduction to the Bahnar people's cultural history, language, and area of habitation (7.1.3). Chapter 7.2 outlines my research design and research goal, field access and setting, and examines the previous research conducted in the Central Highlands of Vietnam. Given that the Bahnar people's agricultural method is integral to their lives, in chapter 7.3, I discuss the characteristics of shifting cultivation and bamboo's relatedness to it. After a short introduction of the local bamboo species distributed in the area of habitation of Bahnar people in chapter 7.4.1, chapters 7.4.2 to

7.4.7 describe the Bahnar people's bamboo culture. The purpose of chapter 7.5 is to outline bamboo's use by other indigenous people in the Central Highlands and Papua New Guinea. Then, chapter 7.6 examines the human-bamboo relationship from socio-material viewpoints. The last chapter (7.7) highlights bamboo's significance for highlanders, such as the Bahnar people, as something enmeshed with their agricultural system. In this context, this chapter also critically scrutinizes monocausal modernization theories and introduces the Buen Vivir concept as a promising alternative to one-sided developmental programs.

Chapter 8 addresses bamboo in Chinese history. After a literature review and introduction of my methodological approach (chapter 8.1), followed by an overview of bamboo's distribution in China and its link to the origins of Chinese bamboo-related material culture (chapter 8.2), chapter 8.3 scrutinizes bamboo in trade and economies in the early twentieth century. The following chapters are divided into three parts. The first part examines bamboo's multifaceted use and contribution to Chinese civilization (chapter 8.4). The second part (chapter 8.5) addresses how bamboo contributed to papermaking and gunpowder. And the third part (chapter 8.6) attempts to illuminate bamboo's part and use in the Chinese peasantry's daily life in early twentieth-century China.

Chapter 9 investigates bamboo's entanglement in Japanese immaterial and material culture during the Meiji era (1868–1912). It starts by introducing my methodology and a literature review in chapter 9.1, followed by a brief outline of Japan's history (9.2). Then, in chapter 9.3.1, I point out bamboo's cultural significance in the Japanese language, customs, aesthetics, and art and its role in the tea ceremony (9.3.2). Chapter 9.4 is devoted to the use of bamboo in Japanese everyday life, and chapter 9.5 ends with concluding remarks about bamboo's relevance for Japan's material culture.

Chapter 10 is divided into two parts. After a brief discussion of my methodology and a literature review (chapter 10.1), the first part (chapter 10.2), after providing a side note on bamboo's part in the discovery of the Americas (10.2.1), scrutinizes bamboo's involvement in the bamboo cultures of the Americas and which is subdivided into one section that examines the bamboo cultures of Native Americans in the United States and a second section that discusses bamboo as part of the material cultures of indigenous people in South America. The second part (chapter 10.3) briefly looks at bamboo in Africa. Then, chapter 10.4 concludes with remarks on bamboo's use in the Americas and Africa. Overall, chapter 10 is less comprehensive than the other chapters but attempts to illuminate bamboo's part in extra-Asian regions.

Part D (Chapter 11): Research Results and Conclusion

The last part summarizes my research findings (chapter 11) and gives a short explanation of the common features of bamboo cultures on a global scale (11.1). Then, chapter 11.2 discusses the limitations and shortcomings of the present work, gives recommendations for further studies, and concludes with an outlook in 11.3.

Part A: The Anatomy and Processing of Bamboo: Botanical, Physical, Mechanical, and Chemical Properties of Bamboo and its Types of Uses

2. Botanical Aspects of Bamboo

This work analyzes the function and relevance of bamboo for material cultures in history and present times. For a comprehensive understanding of these bamboo-related material cultures, it is of paramount importance to recognize bamboo's exceptional part in their emergence and development. Hence, one must consider the plant's biological aspects, material properties, and related processing techniques for two reasons. Bamboo's mechanical properties are determined by its anatomical structure, and at the same time, both determine the manner bamboo can be worked. Since every structural material has its strengths and weaknesses, it is essential to understand these aspects when planning to craft an object for daily use or immovable constructions such as houses or bridges. Only by understanding bamboo's specific characteristic (botanical and mechanical) features can one reveal the way it was and still is used, and simultaneously interpret its historical and present embeddedness in daily life, and scrutinize the human-bamboo relationship. In the following chapters, I will discuss bamboo's biological aspects, including its taxonomy, anatomy, propagation methods, distribution, some ecological factors, as well as pests and diseases that harm bamboos.[8]

2.1. Taxonomy

In each country or region, people classify bamboos based on their own observations and refer to them with their own vernacular terms. Western-based, systematic scientific studies on bamboo and its taxonomy started in the second half of the nineteenth century. One of the first and most comprehensive works was published by Auguste and Charles Rivière in 1879. However, the initial first (Western science-based) botanical descriptions date further back in time. One

[8] I will discuss further bamboo species and their main characteristics related to their use by Bahnar people in Kon Tum in chapter 7.4.1 and outline the three most valuable economic bamboos in late twentieth-century Japan in chapter 9.4.1.

example is Alexander von Humboldt and Aimé Bonpland's book *Plantes Équinoxiales* (published in 1817). Since then, many bamboos have been described, classified, or reclassified because of previous failures. Today bamboos' taxonomy is far from completed, and an ongoing process since the classification of bamboos is fraught with problems.

Since Carl von Linné's seminal work *Systema Naturae* (1758), the taxonomic classification and characterization of plants have been made by studying their reproductive parts' observable characteristics. In connection with bamboo, this method is a challenging task. In contrast to most plants, a significant part of bamboo species does not flower annually. Instead, some bamboos produce flowers in regular or irregular long temporal intervals that can last over one hundred years. For this reason, Floyd Alonzo McClure, a well-known American botanist who pioneered the research on bamboo and author of *The Bamboos. A Fresh Perspective* (1966), proposes alternatively that bamboo's entire vegetative system should be used as an indicator for its determination, such as the culm sheaths or branching habit (1966, 87) (the appropriateness of branches for taxonomic classification is discussed below).

In view of the irregular flowering, it is challenging to identify a given bamboo with unequivocal certainty, and despite the huge effort of various botanists, the exact number of bamboo species varies and depends on the classification methods and differs between the sources. According to Ohrnberger (1999, 8), there are worldwide 1,575 bamboo species, whereas Clark et al. (2015, 2) count 1,482. Depending on the scholars' classifications, not only the global number of bamboos varies, but also the subtribe to which bamboo species belong.

What is certain is that the bamboos, or with their scientific classification *Bambusodieae*, belong to one of twelve subfamilies of the grass family *Poaceae* (or *Gramineae*), to which also wheat, rice, millet, or barley belong. Bamboo shares some similarities with these plants, such as growth behavior, die-back after flowering, or the rhizome structure. On the other hand, bamboo shares similarities with trees, such as their size, hard wood, appearance, or property to lose leaves.

The subfamily *Bambusodieae* is divided into three tribes: *Arundinarieae*, *Bambuseae*, and *Olyreae*. *Arundinarieae* are endemic in North America's temperate climates, East and Southeast Asia, Subsaharan Africa, and occasionally in high elevations in the tropics. Due to their natural distribution, they are also called temperate woody bamboos. *Bambuseae* typically occur in the tropics of both the Neotropics and Paleotropics and are referred to as tropical woody bamboos. Classifying *Bambuseae* and *Arundinarieae* as *woody bamboos* refers to their solid wood that both bamboos develop as a result of lignification. The herbaceous *Olyreae* are mainly distributed in the Neotropic ecozone. They have no lignification and are, for this reason, of almost no economic interest and are only seldom used by craftspersons and in material cultures. According to Clark et al. (2012, 4), 546 bamboo species belong to the *Arundinarieae* tribe, 812 to the *Bambuseae*, and 124 to the *Olyreae*.

2.2. Anatomy

First of all, all bamboos' basic structure and growth habits are more or less the same. And the anatomical structure of their culms is relatively homogenous, particularly in comparison to tree wood. Liese and Tang write that "the culm consists of about 50 % parenchyma cells, 40 % fibers, and 10 % vascular bundles (vessels, sieve tubes with companion cells)," moreover "the percentage of fibers decreases from outside to inside, while the parenchyma increases" (2015, 229).

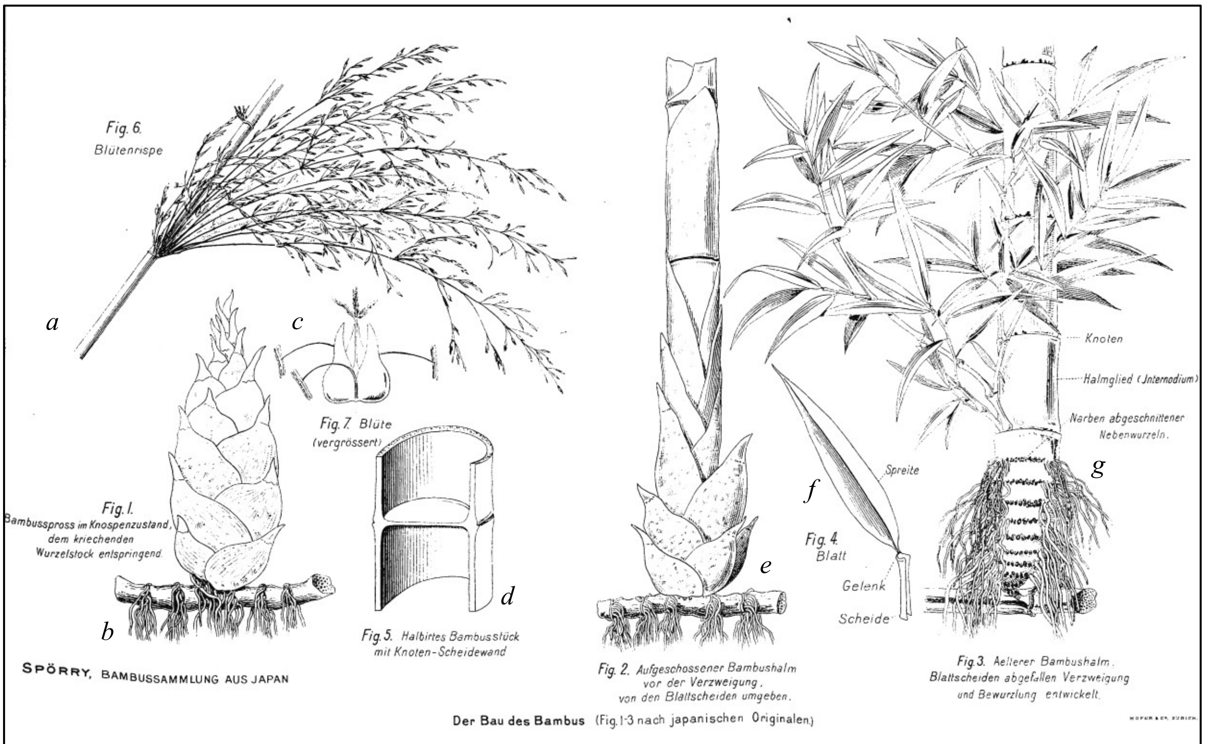

Figure 1 Structure of a bamboo plant and its vegetative parts. (*a*) Panicle (a much-branched inflorescence). (*b*) A young shoot before elongation, encompassed by its sheath leaves. (*c*) A specimen of a bamboo flower. (*d*) A half piece of a bamboo section including its diaphragm and node ridge (*e*) An elongating bamboo shoot, still without branches and leaves. (*f*) One bamboo leaf with a linear, lanceolate form (typical for bamboos). (*g*) A mature culm that has already developed branches and roots.
Source: Spörry 1903, 201

Concerning the bamboo plant's anatomy, one can differentiate between the following parts: rhizomes, culms, branches and leaves, culm sheaths, and roots. In this subchapter, I will briefly introduce these parts and their properties. But before delving into these issues, I shall briefly highlight the significance of holistic views regarding plants and other organisms. In this context, morphology (as a subdiscipline of biology) is of particular interest since it is related to the study of the structure and form of organisms. And functional morphology (as a branch of morphology) has a similar research field but with a particular focus on the relationship between the structure (or form) and function of morphological features. Both disciplines' underlying approach should help us to arrive at a holistic interpretation whenever analyzing the structural and functional aspects inherent to a plant or animal. Accordingly, functional morphology provides an opportunity in the analyses of various factors related to each other. This is, amongst other scientists, discussed by Gartner (ed.) et al. (1995) in *Plant Stems: Physiological and Functional Morphology*. In this work, biologists of various fields study the stem of plants and trees from several perspectives, including the roles of stem architecture in plant performance, the transportation and storage of water, or the relationship of stems and fire. Instead of a one-sided study of trees, Gartner proposes tree stems from being studied with holistic methods and encourages other researchers to explore "the stem in the whole-plant context" (ibid., 1995, xiii). In line with Gartner's statement and the functional morphology, this chapter aims to pave the way for the analyses and discussion of the relation of bamboos' structural composition and function and their morphological properties. Thus, this thesis studies bamboo in a whole-plant context and attempts to analyze and understand bamboo's main characteristics and how it behaves when working with it.

The bamboo stem is divided by nodes into internodes, the length of the internodes varying within the bamboo species. These vegetative sections are illustrated in sketches *a* in Figure 4 and *d* in Figure 1, and the right-hand photograph in Figure 6. As Liese and Tang (2015, 236) argue, the node plays not only an essential role in the growth habit of a culm but also for its structural function. The authors further note the following about the anatomical structure of bamboo's node:

> Most of the main axial vascular bundles pass directly from an internode through the node into the next internode. In the peripheral zone of the culm, they bend slightly outward while branching partly into the sheath. In the inner zone, they are connected with those in the diaphragm. In the upper part of the node, the bundles become larger in diameter, and vascular anastomoses develop intensively. At the upper edge of the diaphragm, many small bundles turn horizontally and twist repeatedly. (*ibid.*)

Due to the fact that the fibers are generally shorter at the nodal parts, the nodes have a significant impact on both the physical and material qualities of a bamboo culm. For this reason, as Liese and Tang (*ibid.*) explain, culms tend to break more often at their nodes than at other parts. Acre-Villalobos also claims that “the composition at any transverse section is determined by the shape, arrangement, size, and number of vascular bundles” (1993, 14). This observation is in line with Liese and Tang’s statement that since the “strictly axial arrangement of the vascular bundles is interrupted at the nodes, . . . species with long internodes . . . are preferred for furniture, splitting, and weaving” (2015, 227).

Although bamboos are commonly known to have a hollow structure, this is not true for all bamboos. Some bamboos, such as *pole* bamboo shown in Figure 41 or *Drepanostachyum suberectum* (sketch *b* in Figure 4), have a solid, thick wall with only a small hollow. It is self-evident that the culm’s wall thickness, material density, and hollowness interrelate with a culm’s mechanical properties and, as a result, with processing techniques and the way it can be used.

2.2.1. Rhizomes and Roots

Figure 2 Leptomorph and pachymorph rhizome growth determining the plant’s aboveground appearance. (*left*) A leptomorph rhizome’s growth habit of *Phyllostachys (Bambusa) mitis* indicating how the plant achieves horizontal dissemination. (*right*) A pachymorph rhizome’s growth habit of *Bambusa vulgaris* representing how new culms emerge from the mother plant and form a clumping aboveground appearance.
Sources: Rivière & Rivière 1879, 69 and 194

The rhizome (in Greek *rhízōma,* meaning *a mass of roots*) is a subterranean stem which develops dense, fibrous roots and new shoots from its nodes. In comparison to trees, bamboos have no central axis but are connected through their rhizome system, which plays an important part in relation to a bamboo plant’s structure. It determines the plant’s aboveground appearance, growth habit, stability and affects the way a bamboo plant infiltrates the soil. Concerning the evolution and distribution of bamboos from a functional morphological viewpoint, one can conclude that the interplay of the bambusoid grasses' subterranean rhizome system and their aboveground culm ensured the plants' survival until now and supports their distribution (Yu 2007, 15).

Figure 3 A bamboo clump growing close to a stream in Kon Tum Province, Vietnam.

The rhizome system is vital for the plant's structural features and serves as the main reservoir for nutrients and water and is a subterranean network to which each bamboo culm of the same plant is connected. And due to this connection, all culms are provided with the nutrients essential for their growth and health. Particularly young shoots, which have not yet developed leaves to produce photosynthesis, are protected and supported by the older culms and the rhizome network structure. The characteristic feature of the rhizome to store nutrients and keep the plant alive is effectively used for plant propagation (see chapter 2.3). A cutting, separated from the mother plant but including a rhizome, still has enough energy resources to survive and develop into a new plant. Supplying nutrients and energy to young culms through the rhizome system and ensuring that they grow protected by the mother plant along with the subsequent death of older culms is, in many Asian countries, often taken as a symbol for family solidarity and mutual support.

Bamboo's dense and fibrous roots have a cylindrical form and do not increase in diameter once they are grown. The roots usually grow out of the rhizomes and are seldom deeper than 70 cm below the earth's surface (Banik 2015a, 46). With the prolongation of the subterranean rhizomes, the roots enmesh compactly just below the soil and are considered beneficial for soil-water conservation, particularly on mountain slopes (ibid., 48). The right-hand photograph in Figure 2 illustrates the density of bamboo at its basal nodes.

In some cases, the roots can also be noticed in the culm's basal parts—a specific feature primarily occurring in pachymorph bamboos and illustrated in Figure 15. According to McClure (1966, 79), these aboveground roots fix the culm to the ground and have a stabilizing effect on the culm, while subterranean roots do not affect the stabilization. Furthermore, some bamboos have aerial roots at their nodes that have the shape and function of thorns (illustrated in Figure 7). In other cases, roots grow beneath branches, and a culm section, including roots and a branch, can be used for vegetative reproduction. This can be seen in both photographs of

Figure 9 showing a man cutting bamboo sections for later seedlings, and in the right-hand picture in Figure 7 that illustrates a section in its second year.

Concerning their growth habit and their effect on the aboveground plants' occurrence (clumping formation or open clumpers), two kinds of rhizome forms are distinguished. One is called leptomorph, which means *a thin form* in Greek, and the other one is called pachymorph, which means *a thick form.* Both growth forms are illustrated in Figure 2, and as McClure (ibid., 19) points out, both types also have significant variations. The leptomorph rhizomes are also referred to as monopodial rhizomes or running bamboo due to their rhizomes type. Their rhizomes tend to spread fast in a horizontal direction, have more distance between their culms, and are prone to be invasive. In contrast, the pachymorph (or sympodial and clumping) bamboo have a caespitose growth because their rhizomes turn upward and form a high density of culms around the mother plant (ibid., 24–25).

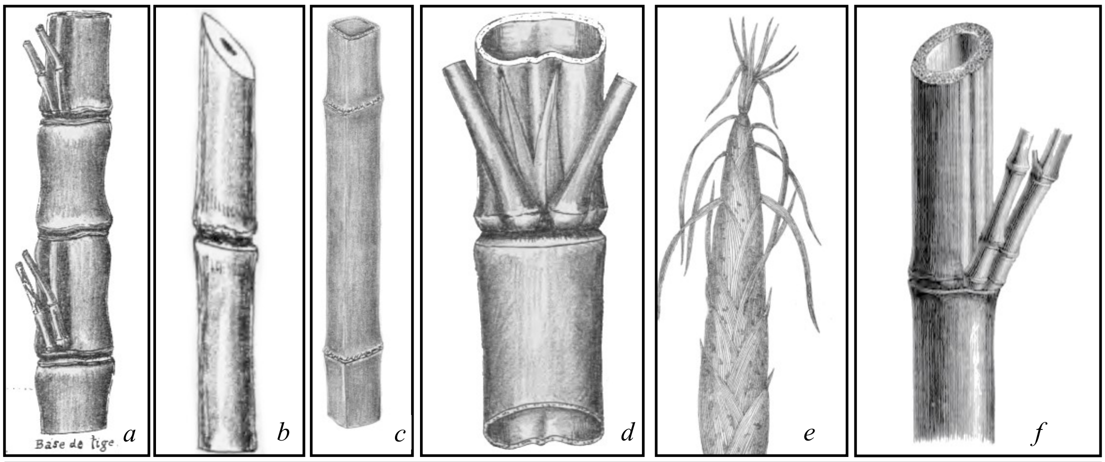

Figure 4 Various bamboo species and their culm forms. (a) Phyllostachys aurea, (b) Drepanostachyum suberectum, (c) Chimonobambusa quadrangularis (Fenzi) Makino, (d) Phyllostachys pubescens, (e) a shoot of Phyllostachys pubescens, and (f) Phyllostachys (Bambusa) mitis.
Sources: (*a–e*) Camus 1913 (33, 24, 16, 26, 33), and (*f*) Rivière & Rivière 1879, 89.

Despite these two growth principles, each plant's aboveground formation depends on a species's individual rhizome system's property. Accordingly, some rhizome systems combine pachy- and leptomorph rhizome characteristics in one plant. The coexistence of both in one structural unit is called amphipodial, which stands for *amphi* (Greek ἀμφί for *different*) and *poda* (Greek πούς for *foot*) (Crouzet 1998, 12). As McClure (1966, 34–36) explains and differentiates, bamboos with short-necked pachymorph rhizomes can grow as a dense clump, and pachymorph rhizomes with an elongated neck can develop to a less compact culm density. Furthermore, some bamboos' leptomorph rhizomes can result in a more diffuse growth with open space between each culm. In this case, the bamboo groves resemble forests. In contrast, the culms of long-necked pachymorph rhizomes appear as freestanding culms. Amongst bamboos with amphipodial rhizomes are *Arundinaria, Pseudosasa, Shibatea,* and *Sasa* (ibid.). In this context, Judziewicz et al. (1999, 65) write that a single bamboo can cover many hectares and may be one of the most abundant living organisms existing on earth when considering its rhizome mass. In other words, a bamboo grove that gives the impression of a *bamboo forest* or thicket may be the outcome of an expansion of a single individual plant.

Besides its inherent growth habit, anthropogenic interventions can modify a grove's aboveground appearance, particularly by removing a clump's shoots and culms. Hence, a pachymorph bamboo's natural culm density is modified by thinning out culms. As a consequence, the culm density lessens, reminiscent of bamboos with leptomorph growth. And *vice versa*, a leptomorph bamboo can grow denser when its rhizomes are confined to a specific radius.

Bamboos adapt to both above- and underground conditions. They can fill gaps where other plants need more time to grow and are generally known as plants having a very expansionist and invasive growth that not only overcomes obstacles but even splits stone or brick walls. In addition to their fast growth and high renewability of plant parts, bamboos (and particularly clumpy bamboos) tend to close free spaces through a gradual consolidation by their aboveground stems that results in an inaccessible biological frontier for other plants and organisms (ibid., 71).

On the one hand, bamboo rhizomes are like wickerwork, fixing and binding the soil and serve as a protection against erosion. What is more, bamboo's growth habit is also conditioned by the rhizomes' anatomical structure that is marked by "the presence of large air canals in the cortex of several species," which as a consequence results in many bamboos' "ability to grow along flooded river bands, contributing to their soil stabilization" (Liese and Tang 2015, 242). A fact also confirmed by Kuehl, who writes that "bamboos are most effective in areas prone to runoff such as slopes, riverbanks, or degraded lands" (2015, 108).

On the other hand, the control of bamboo growth is sometimes necessary for economic, botanical, agricultural, or decorative reasons. In pre-industrial Japan, for example, bamboo's excessive expansion occasionally led to quarrels and conflicts between neighbors when a neighbor's bamboo emerged in one's own garden and threatened garden plants. For that reason, the late nineteenth century Japanese Civil Laws regulated the responsibilities related to bamboo groves and their rhizome control in the Japanese Civil Code (for a more detailed discussion about that topic, see chapter 0). In the domain of shifting agriculture, bamboo's growth habit plays a decisive role in the cultivation of farmland. Like every other plant, bamboo competes for nutrition, water, and light with other plants and quickly fills gaps in the plant cover. As a result, it can harm crops, but at the same time provides bamboo shoots and crucial construction materials. If managed well, its positive effects outweigh its problematic effects caused by its rapid growth.[9]

2.2.2. Shoots and Culms

Figure 5 Collecting bamboo shoots in Pù Hu Nature Reserve, Tanh Hoá Province. (*left*) A man who removed a culm from a clump near the road detaches bamboo shoots from the rhizome system using a machete. (*right*) Collected bamboo shoots lying on the ground after harvest.

The subterranean bamboo develops for several months under the soil before elongating in the rainy season. During this subterranean growth period, the young shoot stores water and valuable nutrition, its development depending on the mother plant's age, size, and equally weather and soil conditions. As mentioned above, a new, elongating shoot has no leaves and does not participate in the plant's photosynthesis. It depends on the older culms' support and the rhizome system to be nourished and supplied with water. Sketch *e* in Figure 4 and the right-hand picture in Figure 6 represent elongating shoots' above-ground appearance, and the right-hand sketch in Figure 2 illustrates a bamboo shoot's subterranean appearance.

A bamboo's length growth is comparable to the extending of a telescopic antenna. Like a series of interlocking tubular pieces, a bamboo culm has interlocking sections called internodes that divide the culm into partitions of different lengths. A subterranean shoot is, therefore, like a lowered telescopic antenna, as indicated in the right-hand photograph of Figure 2. Accordingly, the young shoot's size determines the later mature culm's length, size, or diameter. Moreover, on account of this underground formation and structural composition, bamboo's length

[9] Bamboo's aggressive growth habit in relation to shifting cultivation and its influence on biodiversity is discussed in more detail in chapter 7.3.

growth is remarkably fast. Even giant bamboos of thirty meters or more complete their culm's length growth in less than three months. "Moso bamboo," as Fu notes, "can grow up to 119 cm (47 inches) in 24 hours and 24 m (78½ feet) high in 40 to 50 days. Its culm diameter at 1.3 m (51 inches) above the ground is 6 to 18 cm (2.3 to 7 inches)" (2001, 5). Because of its extraordinarily fast length growths, bamboo is conceived as the world's fastest-growing plant. Some bamboos, like *Dendrocalamus giganteus,* even develop a culm length between 25–30 m (or up to 35 m) and a culm diameter of 15–25 cm (and sometimes 30 cm) (Ohrnberger 1999, 285). One specimen is illustrated in Figure 6 and expresses best why these bamboos are also called giant bamboos. In contrast, many *Sasa* (meaning *dwarf* in Japanese) have culm diameters of one centimeter and a height of less than one meter.

Figure 6 A *Dendrocalamus giganteus* clump in Queen Sirikit Botanic Garden in Chiang Mai, Thailand. (*left*) These species can develop large stems that reach 25–35 meters. (*right*) Young bamboo shoots developing protected by the mature culms. The young elongating shoots have a pinkish color first, turn green, and later change to brow-grey.

During its sprouting and even at the end of the elongation period, the young culms store a lot of water necessary for their fast length growth. On account of their high water content, young culms have tender, soft tissue and wood, making them a suitable material for basketwork and temporary constructions due to their flexibility and easy workability. Only later, through the process of lignification, do woody bamboos develop a hard, woody tissue. Bamboos of three to five years are commonly preferred for long-lasting structural purposes (such as houses and bridges) because immature bamboos of one or two years shrivel up when losing their water content. Accordingly, immature culms are of no use in durable construction works due to their weak mechanical properties.

In terms of bamboo culm forms, McClure writes that "they vary from strictly erect, erect with pendulous tips, or ascending, through broadly arched to clambering . . . and from nearly straight to strongly zigzag" (1966, 36). For instance, the culms of *Guadua angustufolia* or

Dendrocalamus giganteus are strictly erect. And the culms of *Bambusa ventricosa* or *Phyllostachys pubescens var. Heterocicla* have bulbous forms (for the latter, see Figure 129). Figure 4 shows some varieties of culm and branch forms of some other bamboos.

A common feature of all bambusoid grasses is that all taper from the culm base above ground to the tip. However, as McClure (ibid., 42) states, the manner of tapering varies from species to species. While smaller bamboos diminish in diameter more gradually, the culm base and lower part of big bamboos are more or less the same in diameter. In contrast, some giant bamboos taper more abruptly in the last third part of the culm (ibid.). The bamboo's tapering also relates to the internodes' lengths, which differ amongst all bamboo species. As the term *inter*node already indicates, the internode is a chamber between two nodes. According to McClure's observation, "bamboos have longer internode lengths in the middle part and shorter internode lengths in lower and upper parts of the culm. Furthermore, the internode lengths of most bamboo increase faster in the lower part, while decreasing more slowly in the upper part" (ibid., 42–45). The internode length plays an integral part in the processing of bamboo. Bamboos with a long internode length have fewer nodes and, therefore, fewer diaphragms. This property is vital in the crafting of many tools and devices. So, for instance, bamboos with long internode lengths are chosen to craft blowguns, drinking straws, or water pipelines. For the same reason, "base and middle portions with long internodes are utilized generally for construction work, furniture, mats, and boards" (Liese and Tang 2015, 228).

Since the color of a young shoot and a mature culm differs, the change of a culm's color is also a helpful indicator for taxonomic classification and culm age determination and, at the same time, of ornamental value in many Asian countries. The *Dendrocalamus giganteus* culm's color change is demonstrated in the right-hand photograph in Figure 6. While the elongating shoots have a violet color, young culms have a slightly greenish appearance, and older ones have an olive-green color. One famous bamboo that is known to change its color is the Chinese Moso bamboo. Its young culms have fresh green color and turn gradually yellow when getting older.

Another method of age determination besides the culm's color is to tap a culm with the spine of a machete blade and to listen to the sound that the tapping generates. Since mature bamboos have dry and hard wood, their sound is higher pitched than young bamboos that contain more water and, for this reason, sound duller. The principle of age determination is vital since mature bamboos have different material qualities compared to young or too old ones and require specific processing techniques and a craftsperson's skill when working on them. Indeed, estimating a culm's age by color and resonance is a skill itself and shared by many Bahnar people who use bamboo for every sort of construction.

What is more, bamboo shoots are a favorite food in many East and Southeast Asian countries. Since the shoot includes important vitamins, minerals (e.g., calcium, copper, iron), and little protein, it is considered beneficial for health and desired for its delicious flavor. Nevertheless, not every bamboo shoot is tasty or edible, but as Banik (2015b, 164) notes, over five hundred bamboo shoots are still estimated to be comestible.

2.2.3. Leaves and Branches

Like any other plant, bamboo does photosynthesis on the strength of its foliage leaves, which have a similar appearance amongst all bamboos. As depicted by Banik, bamboo "leaves are usually linear, lanceolate or oblong-lanceolate in shape; they usually have a short petiole into which the base, which is frequently unequal [*sic*] cut, extends; the point is usually long acuminate, often scabrous; and the side is glabrous or softly hairy" (2015a, 57). While some species develop large leaves, others form smaller ones, but the size depends much more on the leaves' location on the culm and the surrounding habitat and moisture content (ibid.). Therefore, small bamboos (like the *Sasa* tribe) may have the same leaf size as giant bamboos.

After a specific time, bamboo leaves change their fresh, green color and turn brownish or greyish when getting dry and falling to the ground. As the botanists in Làng Tre Phú An explained, the foliage leaves are naturally transformed into worthwhile nutrients and are considered a natural fertilizer due to their natural decomposition. For this reason, bamboos are considered to support their own growth by fertilizing themselves with their leaves. However, unlike deciduous plants and trees, which periodically lose all their leaves, bamboos only lose part of their leaves since they are indeciduous plants. In contrast to deciduous trees, bamboos stay green throughout the winter.

In temperate zones, bamboo's renewing of its leaves usually takes place during spring. During this period, the leafage is colorful and covers the ground surface as foliage. The Japanese consider this natural phenomenon as the bamboo plant's autumn (Crouzet 1998, 16). Throughout East Asian countries with periodic snowfall, such as Japan and both Koreas, bamboo's vital, green leaves during winter symbolize freshness and are considered as a manifestation of bamboos' resistance against cold, harsh weather conditions.

Figure 7 A culm with sharp thorns and vegetative propagation. (*left*) The *Kram ơrăk* bamboo (vernacular term of Bahnar people in Kon Tum Province, Vietnam) develops sharp thorns at its culm nodes. (*right*) A two-year-old bamboo clump that is cultivated and growing from a section of *Bambusa macroculmis*.
Source (sketch): Rivière & Rivière 1879, 119

Concerning bamboo's branching system, Banik states that they are more complicated than ordinary grasses and that lateral branch buds develop on the nodes after a shoot reaches its complete size. Banik (2015a, 55) also notes that branch buds emerge just above the nodes and on opposite sides of the mature culm. Since branch buds develop simultaneously during the length growth, they press themselves into the elongating culm's soft surface and form a *sulcus* (a furrow). Depending on the envisaged work and design, a *sulcus* is sometimes a hindering property, such as in the creation of flutes, or beneficial, such as in the joining of bamboo.

While all bamboos share the branch position on the culm, the branch development order differs amongst the bamboos. As McClure (1966, 49) writes, some bamboos develop their branches *acropetally* (like *Arundinaria gigantea*), which means from apex to culm base. Others do it the opposite way, from the culm base to the apex (like *Bambusa textilis*), which is called *basipetal*. In contrast, a third group generates the branches in the middle of the culm and then extends to the ends of the culm (like *Semiarundinaria viridis*). Although most immature bamboos have buds at each culm node, mature bamboos typically do not evolve branches in the lowest part (ibid.).

As mentioned above, the taxonomic classification of bamboo is difficult due to bamboo's irregular flowering. Since the branch growth of various bamboos differs, its analysis is a useful indicator for bamboo classification.[10] As McClure (ibid.) writes, some bamboos tend to develop

[10] As McClure (1966, 51–53) notes, the branch complement in the lowest part and highest part often differs from the middle part. Moreover, the branch complement in the middle part has specific characteristics helping to identify a particular species. Some species, such as *Sasa* and *Phyllostachys* have a precise number of branches. While *Sasa* bamboos have one single primary branch, *Phyllostachys* have two almost similarly strong branches with a smaller third beneath both, which sometimes emerge. Other bamboos have one strong main branch with smaller axes around that branch, and in other cases, the first emerging branch is surrounded by more or less equal branches.

a primary axis that looks much the same as their culm: a characteristic that is most clearly visible in bamboos with pachymorph rhizome systems. The presence of roots at the lower parts of some species' branches is another striking feature and is depicted in Figure 15. As McClure (ibid., 58–60) further writes, small, sharp branches, which look similar to thorns and occur in the lower part of the culms, are typical for some other species, such as shown in the left-hand photograph in Figure 7.

2.2.4. Sheathing Organs

As mentioned above, bamboos develop protective sheaths for their vegetative axes to protect themselves against harm and stiffen them during their length growth. As McClure has observed, there are six different sheaths protecting bamboo's vegetative parts: "culm sheaths, branch sheaths, leaf sheaths, rhizome sheaths, neck sheaths, and prophylla [or bractlet]" (ibid., 61). On each node of a young shoot is a culm sheath, which protects the young culms' sensitive surface. According to my own observations, the sheaths differ in form, color, size, surface texture, or shape amongst different species. Moreover, as the botanists in Làng Tre Phú An stated, culm sheaths are also helpful in terms of taxonomy.

As the inner surface of culm sheaths is smooth, the internodes are subjected to less friction while they grow (ibid., 62). On account of their smooth skin, the culm sheaths have an ornamental value in Japan and are used as packaging paper for presents; and due to their stiffness and water-resistance, the sheaths were also used to fabricate large hats in China and Japan (see chapter 8.6.7).

2.3. Cultivation and Reproduction

For the development of the plant and the achievement of the maximum possible height, growing conditions like climatic factors (e.g., rainfall, temperature, and sunlight), as well as the quality of the soil, are essential. As Banik (2015b, 113) states, bamboo grows under different ground conditions but prefers well-drained soil with plenty of water. A high amount of organic material facilitates the rhizome's growth, while solid earth with insufficient water permeability reduces the growing speed (ibid.). In general, bamboos prefer humidity and frequent rainwater for optimum growth. In this context and regarding the Chinese Moso bamboo's optimum growth, Fu

(2001) examines the required amount of humidity and rainwater for Moso. He considers that for Moso, the optimum rainfall lies between 400 and 600 mm and is best during the plant's shooting time from March to May and concludes that "in the Moso bamboo central distribution zone, the rainy season, the time of shooting and new culm growth coincide" (ibid., 5). After the first emergence and elongation of the shoots in the months between July to September, the rhizomes start to grow, Fu's text states. And, as a result of less rainfall and droughts, the rhizomes' growth slows down, and they build fewer shoot buds (ibid.).

Bamboo plant propagation is achieved through two different methods: generative plant propagation using seeds and vegetative propagation using plant parts by applying different methods. Since many bamboos have a long flowering interval, they only seldom produce seeds, and propagation by seeds is hardly possible. In this case, vegetative reproduction is usually the method chosen to obtain new plants. In the following, I shall discuss both methods in brief.

2.3.1. Generative Reproduction and the Phenomenon of Flowering

Depending on the species, three general flowering behaviors can be determined. First, a regular flowering occurring almost every year; second, a gregarious and periodic inflorescence; and third, an irregular flowering (Brandis 1906, 22). While the first two cases have a determinate inflorescence, the third case has an indeterminate inflorescence. Hence, the flowering process can occur after a long phase in the vegetative life cycles of a bamboo plant, which may last "15–60 years in tropical bamboos and 60–120 years in bamboos of [the] temperate region" (Banik 2015b, 117). The general rule is that bamboos' flower period usually occurs at intervals of more than one year (McClure 1966, 85).

The large-scale flowering of a bamboo species followed by a complete die-off of the plant is a peculiar commonality shared by various bamboo species and, until now, an unsolved mystery. In biology, this characteristic feature is defined as a gregarious, monocarpic flowering, which means that all plants from one species flower at the same time (gregarious) and die after bearing their fruit once and producing seeds (monocarpic). Although flowering can occur simultaneously, it can develop differently in some clumps of a given area. As Banik writes, "some clumps may remain alive for a few more months in producing mature seeds," and the harvest of "these clumps is to be delayed till the mature seeds are produced and fall on the ground" (2015c, 223).

Figure 8 A bamboo panicle. This type of inflorescence is characteristic of many bamboos.

In some cases, all bamboos of the same species are affected, independent of where the single bamboo is located on earth. In the years 2002–2005, for instance, all clones from *Fargesia nitida*, which was introduced from West China to Europe at the end of the nineteenth century (Ohrnberger 1999, 141), started to flower simultaneously within a couple of years from China to Europe. In this case, the flowering cycle took 120 years, and the whole plant died after flowering, including the vigorous rhizome system and the mature culms. Only seeds could renew the dead plants.

Many scientists from different fields discuss possible explanations for the gregarious flowering with a subsequent die-off. Judziewicz et al. (1999, 75) summarize five general ideas that may explain the gregarious inflorescence: predator satiation, parasite avoidance, gap creation, wind pollination, and energy partitioning. *Predator satiation* means that seed-eating predators are sated by the mass flowering and mass production of seeds. This claim is based on the idea that compared to a single flowering that produces just a few seeds, a certain number of seeds would be unseen and undiscovered by the predators due to massive quantities of seeds covering the soil and, as a result, would survive and grow to new plants. According to the idea of *parasite avoidance*, the complete destruction of the aboveground culms and subterranean rhizomes deprives parasites of their basis of existence. The *gap creation* idea assumes that large-scale flowering causes a distribution of seeds in close vicinity to the gradually dying mother plants and claims that the new seeds can fill the gap left by the dying bambusoid grasses before other plants could do it. The theory of *wind pollination* supposes that large-scale flowering increases the chance of pollination. Finally, the *energy partitioning* hypothesis suggests that energy is somewhat bundled in a new reproduction phase after bamboo's long-lasting aggressive vertical and horizontal growth (ibid.).

The gregarious flowering and the subsequent dieback of the whole plant profoundly impact humans' living conditions, the surrounding forest and ecology, and wildlife habitat for multiple reasons. On the one hand, the bamboo plant is a plant amongst others, part of its natural environment and interlinked with other organisms. On the other hand, the bamboo plant is part of human life and expresses one part of the human-bamboo relation. Therefore, changes in the bamboo plant's vegetation that are induced by mass-flowering and die-back have consequences for humans and nonhumans, and exemplify the fragile interconnectedness of nonhumans' and humans' very existence.

Some aspects are discussed in the following: (1) Flowering can decrease the available amount of bamboos and forces people to replace them with other resources (other plants, trees, or bamboos). Moreover, bamboo industries relying on few bamboo species may face economic problems when their primary bamboo source is lost. (2) Dieback of bamboos with edible shoots may decrease the food supply with shoots and can cause economic problems to peasants selling shoots for monetary income. (1) and (2) are especially problematic in the case of *Phyllostachys edulis*, which is currently the main species growing in China (Liese et al. 2015, 338), and whose shoots are traded globally. (3) As Liese et al. (ibid., 305–307) note, bamboo produces either small, thin, light, inconspicuous seeds that share similarities with wheat or corn grain. Or else, bamboos produce fruits that are round and large and resemble indehiscent fruits. The inconspicuous seeds are harvested and used like rice but also attract rats (ibid.). In the former case, seeds are an additional and vital food supply, while in the other case, they contribute to an increase of the rat populations. This abrupt population growth, in turn, may cause an infestation of rats, which may threaten or attack staple foods, granaries, or settlements. (4) After a gregarious flowering, not only does the population of granivore animals (e.g., birds and rats) increase due to the high amount of seeds, but so does the population of predators, which rely on the granivore animals, which has an influence on local biodiversity. (6) A mass die-off of bamboos results in large gaps in the vegetative cover and is only gradually recovered by bamboo or other plants. In any case, it is a massive disturbance of the surrounding nature and affects the environment's structure. (7) The dieback of bamboos also has a deep impact on wildlife and leads to a loss of habitat. The herbivorous giant panda bear, whose diet consists mostly of bambusoid grasses, is nowadays endangered due to habitat loss induced by humans. According to Tian et al., "as a slowly reproducing species, giant pandas cannot maintain themselves when massive staple-food bamboo flowering occurs in fragmented habitats" (2019, 186). Besides affecting giant pandas' lives, mass flowering would equally affect other animals such as the bamboo lemur or red panda. (8) Although bamboo is considered to grow very fast and sometimes aggressively, according to Bystriakova et al. "more than 400 bamboo species are potentially threatened by the destruction of natural forest cover" and are even threatened with extinction

(2003, 7). Their human-induced decline and vulnerability, however, “is increased by the simultaneous flowering and subsequent death of entire populations in cycles of 20–120 years” (ibid., 8). Consequently, some bamboos species are at risk of extinction and can be lost when not protected.

2.3.2. Vegetative Reproduction

While a propagation by seeds offers a new composition of the genetic make-up and an adaptation to environmental conditions, the conventional vegetative propagation does not modify the genotype at all. So, the mother and daughter plants are syngeneic without any modification of their phenotype, which is why they have precisely the same characteristics. Vegetative reproduction is either realized through conventional vegetative propagation or a newer method known as micropropagation.

Conventional propagation is achieved by the division of plant parts and their roots. Cuttings or seedlings commonly include a mature culm and rhizomes attached to them. From a vegetative viewpoint, the seedling is still intact and alive. While the aboveground culm continues to perform photosynthesis, the subterranean rhizome will supply the culm with water and nutrients. Another conventional propagation is affected by using a section of branch culms that have the property to develop new roots and rhizomes if cut and planted. This method is illustrated in Figure 9, which shows a man cutting such sections from green bamboo, and by the sketch in Figure 7, which displays the growth of a two-year-old bamboo seedling.

While conventional propagation is a traditional way to multiply bamboo clumps and parts based on local people’s knowledge and techniques, micropropagation duplicates a mother plant’s clones based on plant tissues and requires a scientific apparatus and expertise. It is self-evident that the former method allows the propagation of only a few seedlings, while the latter method offers the chance for a large-scale reproduction due to fast plant breeding. Compared with micropropagation, the conventional method enables local people to choose and cultivate bamboos themselves. This propagation method is quite simple and applied, for instance, by local farmers in Vietnam, who plant bamboo on mountain slopes as a protection against erosion, as food and material supply, and to reduce the distance between their houses and the nearest bamboo clumps or groves.

Figure 9 Treatment of bamboo seedlings through vegetative propagation. Both photographs are taken in Pù Luông, Thanh Hoá Province. (*left*) A man is cutting bamboo sections for vegetative propagation with a machete. (*right*) The sections consist of a part of the culm and a branch. The same photograph also shows the presence of roots at the lower part of the twigs, which are essential for that type of propagation.

2.4. Age Determination of Bamboo

The age determination of a bamboo grove (not culm age as discussed above!) is complicated and depends on one's approach. According to my own observations and discussions with botanists and local people, the determination of a plant's age could i) be based on an estimation of the culms' ages and observation and evaluation of a clump's appearance; ii) relate to the initial reproduction by seeds; iii) relate to human-induced plant propagation; and iv) be achieved by backtracking a plant's origin to its mother plant.

The first approach examines both the appearance of culms and the entire bamboo clump since the plant's form, shape, density, or size together with the culms' diameter, color, and other indicators provide valuable information for age determination. Moreover, the amount of woody, dry, and dead culms reveals further details about a plant's age because older bamboos remain as deadwood in the grove when disconnected from the supply of nutrition and water by the plant. Needless to say, this method can only result in an approximate rather than an exact age determination. Another way to determine the age of a bamboo clump is to take account of the last inflorescence since (as discussed above) many bamboos reproduce themselves through seeds. A third way considers the cultivation or planting of a plant by vegetative reproduction. If the planting date is transmitted, it sheds light on the age of the cultivated clump but provides no information about the age of a seedling's mother plant. Accordingly, backtracking a clone's origin is another method to determine the age of a bamboo plant and reveals further information about a clump’s taxonomy and is helpful to estimate further flowerings, as mentioned above in my remarks on the flowering of *Fargesia nitida*.

2.5. Bamboo’s Distribution

Figure 10 Thick bamboo groves cover the mountain slopes in Pù Luông Nature Reserve, in Tanh Hoá Province.

Bamboos grow naturally in various soil conditions and landscapes and occur in valleys, mountain slopes, and higher altitudes such as the top of hills. However, bamboo seldom occurs as the only vegetation in a given region but mainly grows in forests together with other trees and plants.

Bamboos derive originally from the tropics but gradually “evolved to cover a wide range of climates from tropical areas to temperate zones, from plains to high mountains” (Yang et al. 2010, 33). They are endemic in all continents except for Europe and Antarctica and were able to adapt to many ecosystems and climatic conditions. As mentioned in chapter 2.1, woody bamboos grow mainly in (sub-)tropical and temperate zones, while their habitat is also related to their rhizome system. As a general rule, bamboos with pachymorph rhizomes (e.g., *Bambusa, Dendrocalamus, Gigantochloa, Guadua,* and *Oxythenanthera*) grow mainly in the tropical regions, whereas bamboos with leptomorph rhizomes (e.g., *Arundinaria, Fargesia, Melocanna,* *Phyllostachys, Schizostachyum,* and *Semiarundinaria*) grow in temperate zones (Liese 2000, 157).

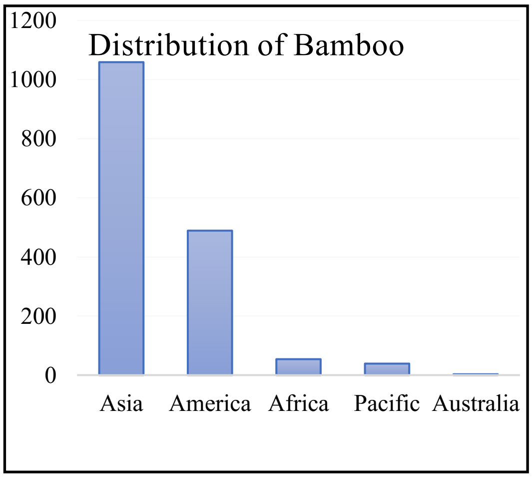

Figure 11 The distribution of bamboo species throughout the world. The figure is based on the data from Ohrnberger (1999, 11).

As Ohrnberger (1999, 11) has found, bamboo's distribution reaches from the 47" parallel south in South America up to the 46" parallel north in East Asia, with an altitudinal range that reaches from sea level to more than 4,000 meters. Although bamboo is found in many regions, it is mainly concentrated in East and Southeast Asia and South and Central America. Yet the highest concentration of bamboo species diversity is found in "the monsoon-belt of Southeast Asia with southern China, and coastal regions of the Atlantic side of South America" (ibid.). This thesis discusses mainly bamboo in material cultures of East and Southeast Asia and partly in the Americas and, to a lesser extent, in Africa. Following this thematic priority, I shall deliberately neglect a detailed list of bamboo species in Africa for reasons of space. What is more, to avoid redundancy and repetition regarding the distribution of bamboo, I shall provide a detailed account of bamboo's distribution throughout specified regions in the respective chapters dealing with local and transregional bamboo cultures.

According to a study by the FAO and INBAR, bamboo covers over thirty-six million hectares all round the world, of which approximately two-thirds grows in Asia. The distribution of bamboo in Asia is as follows: India has around 30 %, China 14 %, Indonesia 5 %, Vietnam 2 %, Myanmar 2 %, and Japan, Thailand, Cambodia, among other countries, have less than 1 % of the total bamboo resources in the world (see also Figure 14).

As the study also points out, India is considered to have the most bamboos in Asia (about 50 %). It accounts together with China for 70 % of all bamboo occurrences in Asia. What is more, both countries increased their bamboo plantation area between 1995 and 2005 by about 10 %. The same report also indicates that the second-largest bamboo area with about ten million hectares is to be found in Central and South America, followed by Africa with only 2.3 million hectares (Lobovikov et al. 2007, 12–14).

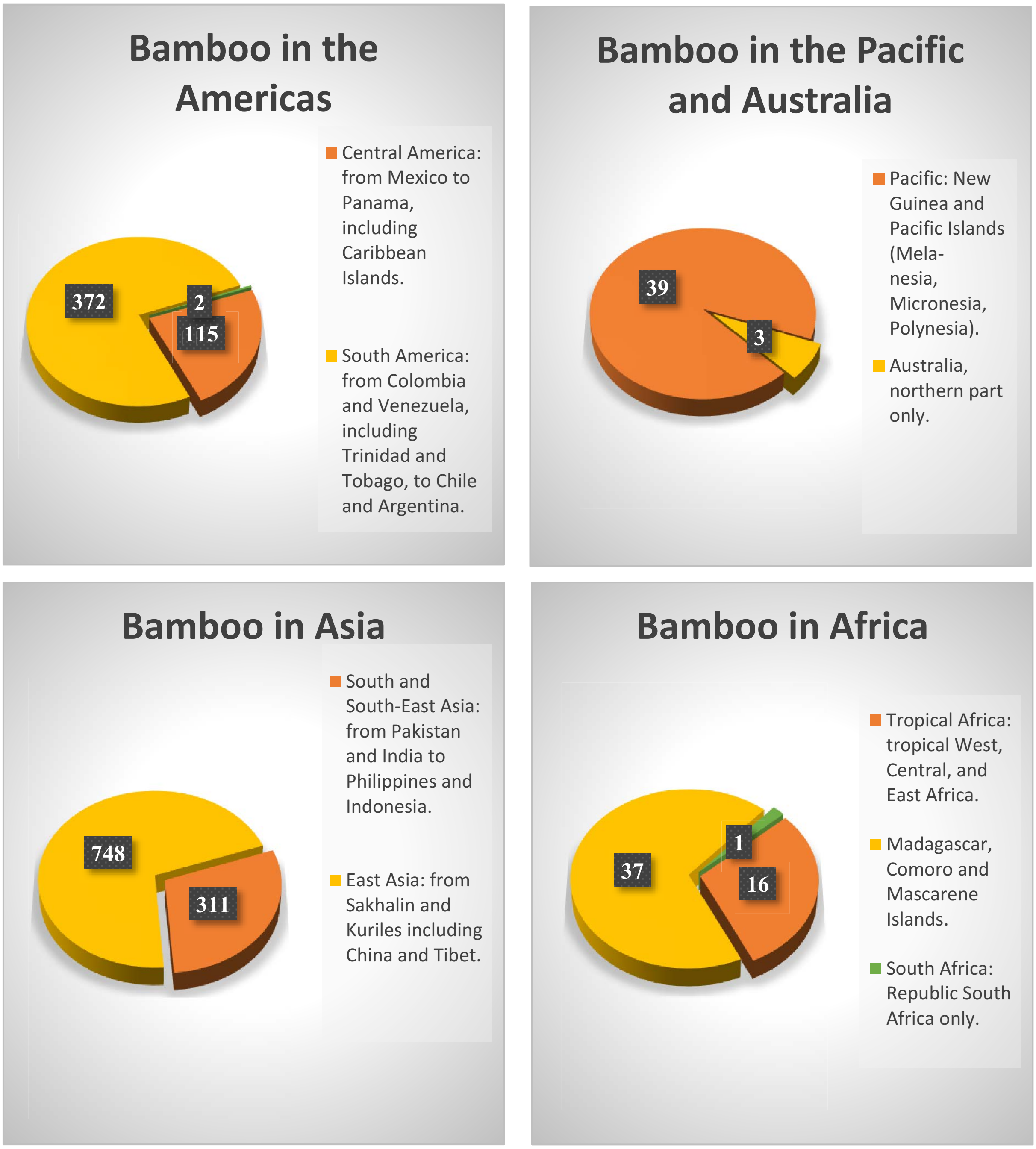

Figure 12 Natural distribution of bamboo in the continents by region and number of bamboo species. The figure is based on the data from Ohrnberger (1999, 11).

Concerning definitions of bamboo's distribution, it is worthwhile to examine various definitions considering bamboo as part of forests. First of all, the term *forest* remains problematic since there is no standardized definition at all, but many ones with alternating criteria. A general description of the term forest conceives it as a "complex ecological system in which trees are the dominant life-form" (Encyclopædia Britannica 2000). Other definitions are related to the intentions of administrative units, the land cover type, or land use type (Lund 2014), as well as plant diversity, economic interests, or local definitions. Moreover, the international classifications of forest vary for developing and developed countries because of diverse national meanings of forest (Schuck et al. 2002, 15–16).

Figure 13 A bamboo clump's leaf canopy in Pù Luông Nature Reserve, in Tanh Hoá Province.

The FAO has a clear definition of criteria that determine a forest. According to the FAO, a forest is a "land spanning more than 0.5 hectares with *trees* higher than 5 meters and a *canopy cover* of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use" (2012, 3). As regards bamboo, the FAO states that forests can also include "areas of bamboo and palms provided that land use, height and canopy cover criteria are met" (ibid.). The FAO further notes that bamboo is "an integral part of forestry, but it is also widely spread outside forests, including farmlands, riverbanks, roadsides and urban areas" (Lobovikov et al. 2007, xi), as indicated in Figure 10, showing how thick bamboo groves cover the mountain slopes in Pù Luông Nature Reserve, in Tanh Hoá Province.

In contrast to the FAO's definition and inclusion of bamboos in tree forests, the Japanese National Forest Inventory uses a different term for bamboo forests. In their view, a bamboo forest is a "forest that does not fall under 'forest with standing trees' but is mostly covered by bamboo" (ibid., 15). Bamboo's dense leaf canopy is vividly illustrated in Figure 10 and Figure 13, which show bamboo's resemblance to tree forests in this respect.

2.5.1. Bamboos in Asia and the Americas

The distribution or, more specifically, the amount of bamboo areas is no reliable indicator for the diversity of (endemic or cultivated) bamboo species. For example, India has the highest amount of bamboo area worldwide, but China has the highest diversity of bamboo species in the world. In the year 2000, Japan (153,000 ha/bamboo), Malaysia (592,000 ha/bamboo), and

Myanmar (963,000 ha/bamboo) had together around 1.64 million hectares of bamboo in contrast to India, which had 11.36 million. However, each of the former three countries had a similar diversity of native species to India, which has 119 native species, Japan has 139, Myanmar 97, and Malaysia 92 (ibid., 12, 29). Thus, a country's size and its total bamboo areas do not directly correspond to bamboo diversity. Japan has less than two percent of India's bamboo area but at the same time twenty bamboo species more than India. What is more, a richness in bamboo diversity is not necessarily associated with the sophisticated traditional use of bamboo. For instance, the Bahnar people's bamboo culture is based only on a few endemic bamboos (see my discussion chapter 7.4.1); the bamboo technology of the Awa people of Papua New Guinea equally rests on the skillful use of some superior bamboos (as explained in chapter 7.5.2), and the same thing can be stated for pre-industrial Japan (see chapter 9.4.1). In other words, if people have only a few bamboos with extraordinary material qualities at hand, they are capable of creating countless things based on those species.

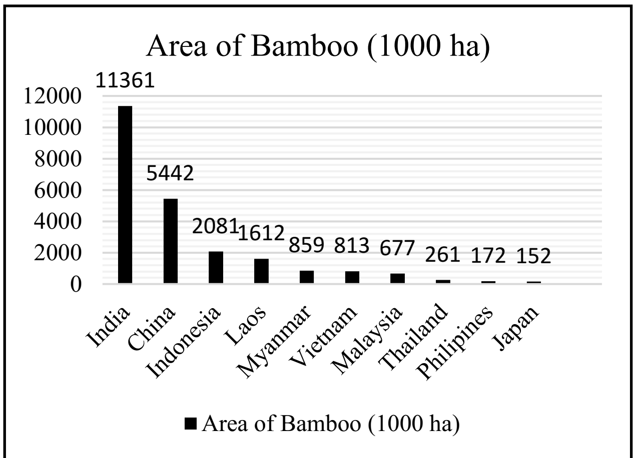

Figure 14 Distribution of bamboo in East and Southeast Asia. The figure is based on the data from Lobovikov et al. 2007.

Bamboo's distribution is not only irregular on a global scale but also in the same country due to different climate zones or ecosystems to which bamboo is well adapted. This issue is demonstrated by the distribution of the Chinese bamboos that can be grouped according to the following five geographical areas: "1. monopodial bamboo area in northern China; 2. mixed bamboo area south of the Yangtse River; 3. mountainous bamboo area in southeast China, with a predominance of mountainous monopodial bamboo; 4. sympodial bamboo area in southern China . . . ; and 5. Hainan and Yunnan provinces, with several climbing sympodial bamboo species" (ibid., 15). The same is also true for Vietnam since the country comprises many climatic zones due to its topography and shape and the monsoon's circulation that creates a dry but cool winter and warm but wet summer (Sterling et al. 2006). While southern Vietnam has a tropical climate with a tropical monsoon (rainy and dry season), northern Vietnam has four distinct seasons—and these climatic differences influence the distribution of bamboo species.

In the last decades, the increasing demand for timber and bamboo has led to further plantations and management of bamboo forests not only in China but throughout the world. For preventing a possible imbalance between global demand and supply of bamboo as raw and construction material, countries have increased their total area of bamboo. For instance, China increased its Moso bamboo plantations by a factor of one and a half from the 1950s until 2005 (Lobovikov et al. 2007, 15). On the ground of its extraordinary material qualities and outstanding mechanical performance, Moso is the most desired species for the Chinese bamboo industry. It currently accounts for about 70 % of China's total bamboo distribution (ibid.). This economic concentration on Moso bamboo does not correlate with an increase in bamboo biodiversity or the preservation of other bamboo species endemic to China.

Historical accounts of bamboo's distribution in Latin America were made, amongst others, by Alexander von Humboldt and Aimé Bonpland.[11] Considering *Guadua angustifolia* they note that it mainly occurs in the mountain of Quindiu (in Colombia) and that it forms forests of several miles in expanse, and tends to prefer high places with mild temperatures; while it also descends into very hot valleys, it is never seen in the high mountains (1806, 66).[12,13]

The work of Judziewicz et al. entitled *American Bamboos* (1999) studies and discusses the distribution of neotropical woody and herbaceous bamboos. According to this study, South America has the richest diversity of woody bamboos species compared to North and Central America (see also chart *a* in Figure 12). The authors also state that throughout the Americas, twenty-one genera occur naturally. These, in turn, are divided into approximately 430 species of woody bamboos, nearly 40 % of which belong to the *Chusquea* genus. The neotropical bamboos occur in the temperate regions (in the southeastern parts of the United States to southern parts of Chile) and the tropical dry habitats (like deciduous forests or desertic grassland) of Mexico and Central America. Since bambusoid grasses prefer a high moisture content in the

[11] In his personal narratives, Humboldt makes a comment on the loss of bamboo and palm trees due to land scarcity in Havanna (Cuba) from 1800–1801 to 1804 and writes: "Those palm trees round the Havannah, and in the amphitheatre of Regla, on which I delighted to gaze, disappear by degrees. The marshy places which I saw covered with Bambousacees, are cultivated and drained. Civilization advances, and the soil, more stript of plants, scarcely offers any traces of its wild abundance" (1818, 12).

[12] Original in French: "est surtout dans la montagne de Quindiu [in Colombia] … et forme des forêts de plusieurs lieues d'étendue, et paroît se plaire dans les endroits élevés qui offrent une température douce: il descend aussi dans les vallées très-chaudes; jamais on n'en voit sur les hautes montagnes" (Humboldt and Bonplant 1806, 66). For a more precise description of the distribution of *Guadua angustifolia* at the turn of the eighteenth to the nineteenth century in South America see Humboldt 1817, 48pp.

[13] Since the scientific description and taxonomy of bamboo was in its infancy, Humboldt and Bonpland classified *Guadua angustufolia* by mistake as *Bambusa guadua* and as a subtribe of *Bambusa*—this false classification was later corrected by Kunth, who reclassified *Guadua angustifolia* as its own genus (Young and Judd 1992, 738).

air, they reach their highest generic diversity in humid lowland tropics with average rainfall. Such humid lowland tropics are to be found in the Amazon Basin, which is why the core centers of bamboo diversity in the Americas are in Brazil's Atlantic Forests (Judziewicz et al. 1999, 55–63).

About the distribution of bamboo, Judziewicz et al. (ibid.) further write that bamboo occurs naturally in the Andes (including Venezuela, Peru, Bolivia, Ecuador, and Colombia), where 130 species are recognized as endemic. Of these, sixty are to be considered endemic to Colombia, making Colombia the country with the highest diversity of bamboos in the Andean region. Central America, on the other hand, still has seventy-three (herbaceous and woody) bamboo species. Bamboo also flourishes well in montane cloud forests of Central America, Venezuela, Colombia, and Peru, by benefiting from the high condensation of atmospheric water caused by rainfall, clouds, and fogs (ibid.).

Like the Chinese bamboos, the bamboos in the Americas are distributed unevenly and scattered through forests rather than creating bamboo forests. Nevertheless, three genera of bamboo, namely *Guadua*, *Etytrostachys*, and *Arthrostylidium*, can build some kind of thickets in the vast Amazon rainforest (Bystriakova 2003, 16). And young erect culms and fallen branches can produce an almost impenetrable barrier in the forest understory and dominate the lower portions of *terra firma* landscapes in parts of southwest Amazonia, including valleys and relict river terraces but usually not on plateaus (Daly and Mitchel 2000, 400).

2.5.2. Historical Exchange and Introduction of Bamboo

Although most bamboos derive from nature, some have been cultivated by humans and exchanged with or introduced to other regions and countries. Asiatic bamboos have been planted and cultivated in Europe and the Americas, American bamboos have been planted in Asia, and African species have been introduced to Asia and America, and the like. For instance, the well-known Chinese "Moso bamboo was introduced into Japan in 1736, in Europe 1880, and in the United States about 1890" (Fu 2001, 5). The first bamboo introduced to the West was a *Phyllostachys* genus, planted in England in 1827 (Ohrnberger 1999, 225).

Guadua *angustifolia*, native in the Neotropic ecozone from Mexico to Argentina, was first cultivated in Panama and then distributed to other Latin American countries (Londoño 2001, 20) and due to its superior properties, it was introduced into China, India, and other countries

(Benton 2015, 38). In Argentina, for instance, only five genera and thirteen species are endemic, and several Asiatic bamboos were introduced in the late nineteenth century (Londoño 2001, 4). And even the most economically important and frequently used bamboo species in bamboos in late twentieth-century Japan were introduced from China and contributed significantly to the establishment of the Japanese bamboo culture (see chapter 9.4.1).

On the other hand, as Young and Judd (1992, 738pp) point out concerning the taxonomic history of the genus *Guadua*, it is difficult to retrace a bamboo's origin and initial distribution.[14] Indeed, in many cases, the historical introductions, dating back a long time, complicate the distinction between endemic and introduced bamboos, particularly when no reliable data is available.

Besides a transatlantic or -pacific exchange of bamboo, inter-regional exchanges and introductions have taken place for ages. On account of this, the exchange of bambusoid grasses must have been more frequent on a local scale than on a global scale. Bahnar people, for instance, plant bamboos that they consider to have superior qualities close to their hamlets and villages and so contribute to the distribution of local bamboos.

On the whole, bamboo diversity is manipulated by humans' introduction of non-endemic species, and some bamboos have become essential for local bambooworking, such as Moso in Japan. In the Americas, bamboo was introduced during the colonial era or by subsequent new settlers migrating from overseas (Takahashi 2006, 5) and complemented the native woody bamboos due to their distinct material properties. Of the introduced bamboos, the most frequently occurring ones are *Bambusa*, *Dendrocalamus*, *Phyllostachys*, and *Giganthochloa* (ibid.). Replacement or complementing by new bamboos was especially crucial in the Caribbean Islands, such as Jamaica. According to Rashford (1995, 1–3), the first bamboos were introduced to the island in 1774 and since then cultivated as valuable raw and construction material. Thus, the introduction of bamboo species did not only modify the local flora and fauna but equally the material cultures of people in the pre-industrial era.

In other cases, bamboos were introduced for scientific research in the field of botany or engineering, or for the opportunities they presented in terms of economic development, as proved by the following statement:

[14] *Guadua* was first described by Humboldt and Bonpland in 1806, and later by Carl S. Kunth in 1822, Munro in 1868, and Hackel in 1887. While McClure in 1973 classified *Guadua* as a subgenus of *Bambusa,* later studies by Soderstrom and Londoño (1987) reclassified *Guadua* as a distinct genus (Young and Judd 1992, 738pp).

> The United States Department of Agriculture (USDA) began an ambitious program in the early l900's to promote the use of exotic bamboos in industry and manufacture in the United States, and to aid development in the Caribbean basin. Little of economic importance was ever done with these bamboos and the program was terminated. What did not fail, however, were the bamboos themselves. (Edelmann et al. 1985, 43)

Nowadays, bamboo is the subject of scientific research in many domains, such as architecture, biology, design, or civil engineering. Bamboo has also been the subject of developmental or governmental programs, highlighting bamboo's economic significance for local people's livelihood. Moreover, native or introduced bamboos are cultivated in bamboo nurseries and bamboo arboretums which have become internationally linked and contribute to the study, exchange, or improvement of bamboo cultivation methods.

2.6. Ecological Aspects of Bamboo

Figure 15 A bamboo stem after harvest. Since the remaining stem is not crosscut close to the node, it is not yet decomposed, and its hole is filled with rainwater that provides a breeding ground for mosquitos and other ovipositing insects.

The importance of bamboo is not only determined by its value for humans as a construction material and food. Bamboo is also indispensable for its environmental surroundings. Bamboo is always connected to biodiversity, offering important space, shelter, and cover for wildlife and organisms. Many animals and organisms are specialized in bamboo, and in some cases, their existence depends on the persistence of bamboo clumps and groves. Judziewicz et al. emphasize the specializations of animals and insects on bamboo. They state that many animals and insects are "inhabiting bamboos for protection from predation, parasitism, and inclement weather; eating the leafy bamboo vegetation, tender new shoots, or abundant seed crop; building nests with tough bamboo leaves and twined branches and thorns; and ovipositing on bamboo" (Judziewicz et al. 1999, 76). Mosquitos, for instance, oviposit in bamboo *stems* and fallen bamboo culms filled with rainwater. Figure 15 shows bamboo stems after the harvest of the culms. The stems are filled with rainwater, and hundreds of mosquito larvae live in them. To restrict the breeding ground for mosquitos, my respondents in Làng Tre Phú An reported that stems should be crosscut close to a septum to reduce rainwater filling the remaining space of the internode.

Because of its adaptation to different ground conditions, bamboo can grow rapidly and densely in marginal lands and has remarkable features with regard to stopping soil erosion, stabilizing riverbanks, and improving the condition of its surrounding environment (Tadesse 2006, 18). Local indigenous people have known that for a long time and planted bamboo to improve soil conditions. Nowadays, bamboo is used to neutralize and revitalize acidic soils with low pH values up to pH 3.5, particularly if the soil has been contaminated by industrialization (Banik 2015b, 113).

2.7. Pests and Diseases of Bamboo

Bamboo is, like every other plant, a desirable source for insects and organisms, which occasionally weaken parts or the whole plant by causing infectious diseases. As my respondents of TXT (Tre Xu Thanh)—a bamboo processing and sustainable agriculture research and development company in Thanh Hóa, Vietnam—reported, a human-made monocultural bamboo plantation is much more endangered by diseases than a natural diversification of bamboo. While in natural circumstances, the distance between bamboo clumps functions like a natural border for pests and diseases, bamboo plantations with short distances between bamboo culms or clumps grant easy access to insects and diseases. In contrast, natural diversification implies a greater variety and number of enemies of insects that feed on bamboo (Shu and Wang 2015, 176).

As a general fact, one can distinguish between pests and diseases occurring on the living plant or felled culms required as raw material and bamboo products. Mohanan writes that "a total of 440 fungi, three bacteria, two viruses" (1997, 8) are noted regarding bamboo. Nevertheless, only a few have a severe effect on the growth and health of bamboos. Foliage diseases (e.g., leaf spots, leaf blight, and leaf rust) and culm diseases (e.g., bamboo blight and culm rust) are reported to have adverse effects on plant growth and health, with young culms suffering much more from diseases than mature culms (ibid. 2002, 17–21). The photograph on the right in Figure 16 shows the fruit bodies of a fungus that grows on a culm, which is part of a larger construction and reveals the stem's decay.

According to Shu and Wang (2015, 175), insects' impacts on bamboos are even worse than diseases. They state that there is a large variety of bamboo insect pests, which "can be differentiated as bamboo shoot and culm borers, defoliators, branch and culm pests, bamboo seed pests, and postharvest pests according to the injury period and damage parts of bamboo" (ibid., 2015, 178). So far, about 800 insect species have been counted on Asian bamboos (Wang et al. 1998, 15).

While most of these insects have no profound impact on the growth and health of bambusoid grasses, approximately one hundred might cause severe damage, and less than one hundred can cause considerable economic losses (ibid.). In the latter case, it is primarily the wood-boring beetle, *Dinoderus minutus* (as shown on the left in Figure 16), that is responsible for a large amount of damage. Since *Dinoderus minutus* is attracted by the high amount of starch in bamboo culms, it infests and destroys raw materials and bamboo products (ibid.). That beetle enters a bamboo culm through cracks and holes and bores tunnels into the tissues. As a result, the culms become defective, porous, and powdery, and finally useless. And moreover, *Dinoderus minutus* leaves holes on bamboo's surface that enables humidity and other insects to penetrate a culm or bamboo product and cause further damage (Plantwise 2020).[15]

Figure 16 Insects and fungi harming bamboo culms. (*left*) A *Dinoderus minutus* feeding on bamboo starch. (*right*) The fruit bodies of a fungus growing on a bamboo culm indicate a bamboo culm's advanced decay.

[15] Accessed July 13, 2017, https://www.plantwise.org/knowledgebank/datasheet/19035.

3. Material Properties of Bamboo

Since this work focuses much more on the traditional and historical utilization of bamboo than on industrial bamboo processing technologies, this chapter primarily gives a general introduction to bamboo's material properties for a discussion of questions related to the traditional workability of bamboo.

As indicated above, except for the herbaceous bamboo subtribe, all bamboos share basic botanical principles related to their material properties. Therefore, bamboo is not only classified in terms of biological aspects but also its material properties. Each bamboo species and each culm of a given bamboo species has its own behavior if exposed to stresses and strains. Accordingly, whenever working with bamboo, one must consider every single bamboo's specific form (e.g., size, diameter, wall thickness, form, age) since its material properties affect the way bamboo is used. This chapter briefly describes some essential properties like the weight, strength, and flexibility of bamboo. This short introduction will shed light on further analysis and explanation concerning the question of how bamboo *works* and how bamboo workers can work on bamboo. In other words, this chapter questions how bamboo's materiality is related to the methods humans apply to craft things with bamboo.

First of all, there are objective visible factors, like a stem's age, size, diameter, or wall thickness, which determine the use of bamboo and simultaneously the methods of how bamboo is processed. The culm's age, for instance, is of significant importance since older mature bamboos develop a wood that is hard and less flexible compared with younger culms, which are soft and flexible. "During a lifetime," as Liese and Tang write, "the culm undergoes an aging process, especially during its maturation period of 3–4 years, but also still later," and "this process changes certain structures and, consequently, it influences properties and utilization" (2015, 242). As a result, mature culms are used in cases whenever hard, strong, and durable wood is needed. In contrast, the young culms are frequently used for basketry, wickerwork, or temporary makeshift constructions due to their flexibility and easy workability.

Criteria such as durability, workability, or access to local or super-regional bamboo resources affect the choice of bamboos as well. Compared to tree wood, bamboo wood is less durable. It decomposes fast when exposed to sunlight, rain, and moisture. For that reason, traditional bamboo houses, bridges, and other bamboo-based constructions and objects have a relatively short lifespan, particularly in comparison to other durable materials such as stones, bricks, and timber. For the same reason, bamboo-based constructions and objects are naturally recycled through natural decomposition, especially if they are exposed to the sun and monsoon rain in (sub-)tropical regions. Hence, from an architectural point of view that tends to construct long-lasting constructions, bamboo's fast decomposition can be considered a weak point. In contrast, from an environmental viewpoint, the natural decay of bamboo products and constructions can be beneficial because they are naturally recycled without harming the ecosystem. An abandoned Bahnar bamboo stilt-house, for instance, such as shown in Figure 49, is gradually recaptured by the surrounding environment.

3.1. Water Content and Fire Resistance

According to my respondents of the arboretum Làng Tre Phú An, the moisture content in a bamboo culm is related to its age, the (rainy or dry) season, and soil condition and differs within a bamboo's section, that is, between its lower/higher and inner/outer part. Moreover, the moisture content is the lowest in the dry period, while it is at its maximum at the end of the wet season. Generally, one can say that the amount of water in a bamboo plant influences its use since the moisture content correlates with bamboo's mechanical and physical properties, including a culm's tensile strength, compression strength, material density, flexibility, or durability (Dunkelberg 2005, 72; Liese and Tang 2015a, 259). As a rule, the water content decreases with the age of a bamboo culm. On account of this decrease, young bamboos (having a higher water content) are easier to work than old, mature bamboos. As a consequence, the material properties of a bamboo stem have a profound impact on bambooworking.

The water content of bamboo is not only linked to its material properties but also its fire resistance. As a matter of fact, bamboo has a less effective burning behavior than tree wood, and young bamboos especially burn insufficiently and slowly due to the high moisture content that hinders their flammability. Another reason for bamboo's fire resistance is its outer silicified skin that protects the inner wood of bamboo and reduces its flammability (Dunkelberg 2005, 77).

Dunkelberg analyzes bamboo's fire resistance and writes that "in accordance with DIN 4102 (behavior of building materials and components in a fire), bamboo would be classified as a combustible, specifically as a flame-retarding building material" (2005, 82).[16] This property

[16] DIN stands for *Deutsches Institut für Normung e.V.,* which is translated in English as the *German Institute for Standardization* and is concerned with the standardization of issues in many fields.

is well known by Asian populations who benefit from it in the construction of houses. As Dunkelberg (ibid.) mentions, a burning house whose vertical roof battens consist of bamboo gives its inhabitants a little more time to act and escape than a similar building made of timber. Dunkelberg (ibid.) further points out that a bamboo house's skeletal structure (including the bamboo posts and parts of the roof) will remain after catching fire, whereas houses made of timber will be destroyed.

Bamboo's flame-retardant ability is also helpful for a bamboo clump's fire resistance against natural fires. Its moisture content prevents its culms or the entire clump from catching fire. In case of a destructive fire that causes severe damage or a total loss of the leaves and culms, the subterranean rhizomes, however, will keep the plant alive and support its regrowth. A bamboo's regrowth after a total loss of its aboveground plant parts is illustrated in Figure 20.

Another interesting aspect in this context is the way a bamboo section reacts if exposed to fire. Since bamboo sections enclose air, fire increases the air pressure inside the culm and results in an explosion accompanied by a loud noise similar to firecrackers. This bursting and its reverberation are widely thought to have given bamboo its name. Since the explosion of a culm's section causes a loud bang, it is onomatopoeically rendered as a *bam* and its reverberation as a *boom*. Thus, both noises combined result in the word *bamboo*, deriving from the Malay word *bambu*. According to my respondents in the Bahnar hamlet, a bamboo culm's explosion also functions as a warning signal. In the case that a clump catches fire, bursting bamboos warn peasants to look after their houses and prevent them from catching fire.

Fire resistance is also crucial when cooking with bamboo containers, for which primarily young and green bamboo are chosen due to their large water content. For the preparation of bamboo containers, a section of the culm is cut off, opened at one end, its remaining diaphragm is removed, and then filled with food. In the next step, the container is put on the fireplace and turned around. Bamboo's natural water content and its silicide surface prevent the combustion of the cooking pot during cooking. Such a cooking container is presented in Figure 66 and shows an opened bamboo-section filled with cooked rice.

3.2. Physical and Mechanical Properties

Bamboo is considered a construction material with superior material-technical properties in matters of weight and strength properties. This feature is exploited for different purposes and is best demonstrated in the production of kites, whose structural integrity is based on bamboo's light weight and exceptional strength. And, in combination with various connections methods, people can build stiff, stable, and robust structures, such as scaffolds.

Figure 17 Bamboo supply for the bamboo craft village Xuân Lai, Bắc Ninh Province. Since a bamboo culm has a light weight, a single person can lift and carry it.

Since bamboo is a material of relatively little weight, especially in comparison to tree wood, a single person can carry a single or even a bundle of freshly harvested culms, whereas a tropical bamboo with a height up to thirty meters and a diameter up to thirty centimeters requires many more people for transportation. After felling, the bamboo is transported by the human workforce to the nearest road, or waterway for longer distances, as seen in Figure 85, showing bamboo rafts in early twentieth-century China, and Figure 86 illustrating bamboo rafts in Quan Hóa Province, Vietnam—or nowadays also by trucks (as in Figure 17).[17] As a general rule, a culm's weight is determined by the bamboo species, its diameter, height, age, wall thickness, and water content; the bamboo culm's weight shrinks soon after cutting due to its loss of moisture caused by drying.

Discussing bamboo's mechanical properties in the following sections is essential for the present thesis for several reasons. Firstly, a general understanding of bamboo's mechanical properties is essential when analyzing the range of processing techniques. Secondly, understanding bamboo's properties is helpful in analyzing and shedding light on the development of material culture related to bamboo and indigenous bamboo technologies. Thirdly, by recognizing the material properties manifested not only in bamboo as a raw material but also in all the things made of bamboo, one can make statements about things' utilization, functioning, or mechanical properties.

A bamboo product's material quality is related to the part of the culm it originates from. As Hidalgo-López states, "the central section, which has the longest internodes, is the strongest in [terms of] tension; and the lower section of the culm, in spite of its larger diameter and wall thickness, has the lowest mechanical properties of the whole culm" (2003, 85). Concerning a

[17] Bamboo transportation via waterways is discussed again in chapter 8.3.

culm's weakest point, Hidalgo-López (ibid.) compares the bamboo culm's structure to a metal chain. According to him, each internode is comparable to a metal chain link since each internode has specific strength properties. The moment a culm is exposed to loads, it will withstand the pressure only as much as its weakest internode can bear the weight.

A culm's material property, in turn, is also related to the chemical compound of bamboo, which is mainly tissue but also cellulose, hemicelluloses, and lignin (Liese and Tang 2015a, 244). The chemical composition determines how bamboo can be used, and it differs depending on species, ground conditions, age, or the like. The starch content and the amount of silica, for example, "influence certain properties such as the taste of shoots and pulping and cutting properties" (ibid., 248–249). And according to Dunkelberg, "the highly variable chemical composition of the bamboo material within the cane explains the difference in the physical and mechanical-technical properties between the zones within the material" (2005, 91). Consequently, each culm has its own specific properties. As mentioned above, the taxonomic identification of bamboo is difficult. Its chemical composition facilitates a botanical identification, however, and "has an influence on deciding what kinds of bamboos with which kind of material in combination is suitable for the utilizations" (Liese 1985, 23).

The mechanical properties (such as elasticity, bending, compressive, tensile, and shear strength), in turn, are related to the anatomical structure and chemical composition of bamboos and play a decisive part in the utilization of bamboo. Accordingly, the different strength properties discussed in the following paragraphs should not be regarded as isolated from each other because they are interrelated.

Compressive strength: Compressive strength is the resistance of a material against the crushing of its fibers. Bamboo has a high compressive strength related to its low material density and low weight, making bamboo a sophisticated material for a plethora of temporary and durable constructions. Bamboo's nodes are essential for its compressive strength, especially when exposed to vertical loads. Concerning bamboo, Dunkelberg reports that "if a load is imposed perpendicularly to the fiber, the strength at the nodal points is 45 % higher than that of the tube sections without nodes" (2005, 85), whereas a load parallel to the fiber reinforces the bamboo culm only by about 8 % (ibid.). The compressive strength, in combination with bamboo's elasticity strength, makes bamboo a superior material for earthquake-proof constructions. That is why traditional bamboo houses withstand much more shaking than houses made of brick. However, considering bamboo's compression capacity, one must distinguish between the compressive capacity of the hollow bamboo culms and split materials, such as strips or slats. Since both have distinct geometric forms, they behave in a different way when they are under pressure.

Tensile strength: In comparison to trees, bamboos have a higher tensile strength that is comparable to steel, some bamboo species even having tensile strengths superior to steel. Thus, bamboo is a preferred material wherever high tensile strengths are required, as in the case of semi-permanent and temporary bridge constructions across streams in rural areas. A traditional bamboo bridge that is still common in Thanh Hoá Province in Vietnam and that combines bamboo's tensile strength and bending strength is illustrated in photograph (*c*) in Figure 27.

Bamboo's remarkable tensile strength results from its long fibers and its silicified outer skin, which, compared with tree wood, is harder and denser. According to Liese and Tang, bamboo's fibers "amount to about 40 % of the mass and to 60–70 % of the weight of the culm" (2015, 230). In this context, Dunkelberg points out the tensile strength of "slender canes are superior to thicker tubes in relation to their cross sectional areas" (2005, 87).

Elasticity and bending strength: The elasticity strength is the resistance of a material against deformation and its ability to return to its original shape after being compressed or stretched. The bending strength is defined by a material's behavior when affected by a load perpendicularly to its longitudinal axis. The elasticity strength of a bamboo culm is related to the high density of fibers in the silicified epidermis. These fibers not only strengthen the material against deformation but are also crucial for bending strength (ibid.). In this context, Arce-Villalobos mentions that the "fibers contribute indirectly to the tangential strength because they change the 'texture' of the crack path. The more fibers the crack trajectory encounters, the more energy is needed to fracture the material" (1993, 98). Accordingly, the moment a culm is bent, its lower part gets compressed while its

Figure 18 Bending a semi-circular section of a bamboo culm at the Taboo Bamboo Workshop in Hội An, Quảng Nam Province. (*left*) After preparing the notches, (*middle*) the workpiece is fixed with a clamp and heated by a blowtorch. (*right*) After cooling, the material remains bent.

outer part gets expanded. Bamboo’s remarkable bending strength and behavior can be recognized when watching a bamboo plant resisting strong winds or snow load on the branches.

Another aspect that has to be taken into account when bending bamboo is connected to the nodes’ materiality, which affects a culm or semi-circular section’s bending qualities. As shown in Figure 18, the semi-circular workpiece is slightly bent beneath the node for improved bending properties. The same figure also shows that notches were cut into the workpiece to prevent too high tensile strength in the process of bending that could cause cracks. In contrast, bamboo culms with small diameters can be slightly bent without removing their septae or split into strips or slats. The photograph in Figure 19 shows a man bending or, more precisely, straightening thin culms over a coal fire. To prevent the culms from burning, he rubs them with a cloth soaked in water, which simultaneously cools the culm and helps to maintain its shape.

Figure 19 Bending thin bamboo culms over a coal fire in Xuân Lai, Bắc Ninh Province.

Shear strength: Bamboo and tree wood have one main characteristic structural difference. That is the absence of radial cells and fibers in bamboo culms in comparison to tree wood. Since radial cells strengthen the shear property parallel to the axis, bamboo has a weak shear strength parallel to its axis, and bamboo’s nodes have almost no influence in this regard (Hidalgo-López 2003, 92). For one thing, bamboo’s low shear strength is a disadvantage in certain types of construction since bamboo tends to break parallel to its axis. For another thing, the absence of radial cells and its hollow structure enable the manufacturing of various joints and the splitting of bamboo into strips required for basketry or other work (ibid.).

Fracture: The way a bamboo culm fractures depends on which structural point a load or impact hits the culm. Bamboo absorbs the effects of a fracture in the way that “cracks are immediately diverted in the direction of the fibers, thereby impairing the strength of the critical point to a lesser extent” (Dunkelberg 2005, 89). On the other hand, if a node is hit, the impact causes a crack in the axial direction since “the strain of the material across the fibers is exceeded” (ibid.), and thereby the nodes reduce further cracking.

Bamboo's inherent way of cracking is exploited in the manufacture of traditional bamboo floors. In this case, a single bamboo culm is laid on the ground, and then using a mallet, the bamboo culm is hit on its nodes. As a result, cracks occur in the axial direction, and the culm loses its hollow shape. After hammering on the nodes, the remaining node pieces are removed, and the culm flattened. Several of these flattened culms laid down with their softer outer skin upright form a smooth floor. Such a bamboo floor is shown in photograph *f* in Figure 27 and Figure 52.

4. Processing of Bamboo

Working with bamboo involves the use of various tools that minimize the effort to prepare and manufacture bamboo products. It is, therefore, essential to discuss these tools in brief. Depending on the given people's livelihood and economy, people either used hand tools exclusively or, more commonly nowadays, machines. While in the past, no electrically operated machines were available, in contemporary Vietnam's bamboo carpentries or bamboo manufacturing, for instance, more and more modern machines (e.g., jigsaw, drilling machine, grinding machine) and other tools are common. In contrast, indigenous people in the Central Highlands, such as the Bahnar people whose material culture is discussed in this book, rely solely on hand-driven tools. In general, and as I noticed during my research in Vietnam, local peasants or craftspersons tend to use modern tools for economic reasons whenever possible and suitable.

First of all, each bamboo culm has its own physical-mechanical characteristics that must be considered when working with it. This is especially the case in traditional bambooworking. Traditional techniques implicate a detailed perception of a culm's form (straightness or bending), culm diameter, length, age, culm wall thickness, and the like. Only by considering each culm's characteristics can the craftsperson work on it and craft the things she/he desires. In the context of traditional material cultures and indigenous technologies, bamboo's round and hollow structure are of great importance, and many objects and constructions take bamboo's natural form into account. Needless to say, a craftsperson's skill and bodily involvement is also part of the production techniques and plays a vital role in bambooworking—an aspect I shall discuss in chapter 7.6.1 with relation to the Bahnar people's bodily involvement in their work on bamboo. Contemporary bamboo industries, in contrast, do not use bamboo by applying traditional hand-based processing techniques. For these market-bound industries, each bamboo's unique shape and irregular dimensions are an obstacle to mass production of bamboo-based commodities. Accordingly, these industries attempt to find ways for standardized and automatized production by means of large machines. One way is to use prefabricated pressed and glued bamboo. Pressed bamboo consists of bamboo strips (of various lengths and widths) and chemical polymers and is used for the fabrication of cutting boards, floors, ply bamboo, kitchen utensils, and the like. Therefore, the industrialization of bamboo manufacturing has resulted in a fundamental material transformation of bamboo from a hollow and circular shape to a flat, glued workpiece. In this light, industrial bamboo products could be described as engineered bamboo wood.

It can be argued that there is a *material turn* related to bamboo, which is similar to the industrialization of tree wood, whose processing was mechanized beginning in the industrial revolution using new machines and technologies. In the end, tree wood's natural structural character has been modified in many cases to a uniform material needed for automatized production. This change is vividly illustrated by medium-density fiberboard (MDF), which not only offered new designs but also improved some negative features of tree wood. Therefore, the bamboo processing industry is to be expected to make further (technological) developments in the next decades. Hence, bamboo's material history, which was related to traditional techniques and a craftsperson's skill, will also change fundamentally in the next decades.

In this chapter, I shall discuss bamboo chiefly in connection with traditional bambooworking and only in brief as part of modern bamboo carpentry and industry. I first discuss bamboo's harvest, preservation, and drying methods (chapter 4.1), which are essential for the methods and techniques applied to work on bamboo (chapter 4.2) and to create joints (chapter 4.3). Then (in chapter 4.4), I will discuss modern tools and machines and how their use affects the production process as well as the products deriving from bamboo. And lastly (chapter 4.5), I will compare tree wood with bamboo wood, as both are significant materials which are occasionally used together.

4.1. Harvest, Preservation, Drying of Bamboos

The harvest method, harvest time, felling method, and transport of bamboos are related to the bamboo species (and its biological characteristics), the time-related usage of bamboo for long- or short-term use, and the underlying economic interest or purpose. As for bamboo's exploitation, one can differentiate between various domains such as the bamboo industry (e.g., the chopstick factory), bamboo manufacture (e.g., bamboo handicrafts), or bamboo as part of indigenous people's material culture (e.g., the bamboo culture of Bahnar people).

Given the ecological crises, bamboo's benefit for climate mitigation and its role as a sustainable substitute for tree wood is much discussed.[18] Scientists point out bamboo's relevance in climate change and rural livelihoods and advocate paying more attention to bamboo's ecological potential and economic value for local industries and rural people (Lobovikov et al.

[18] See, for instance, Lobovikov (2011), Schoene and Yping (2012), or Liese (1985).

2011). Since bamboo is processed for many things, including paper, pulp, flooring, fences, kitchenware, tools, furniture, and the like, producing them using bamboo can help reduce the pressure on tree forests and timber and simultaneously contribute to the sustainable management of mixed forests.

Much of bamboo's benefit is based on its biological features and growth habit, which differs from that of trees. The felling of a tree usually results in a complete die-off of the whole organism. If felled, a fifty-year-old tree will need approximately the same time to be replaced by a new tree. Consequently, chopping down a single tree and wood harvesting of forests have severe effects on the ecosystem, and it requires many years for a recovery. Bamboo, in contrast to trees, has the advantage that the whole bamboo plant stays alive even after cutting a certain quantity of culms. The reason for that benefit lies in the structural composition of bamboo. Each bamboo culm is connected through a network of rhizomes to other bamboo culms. Thus, if a single bamboo culm is cut, it does not affect the entire cluster because the remaining culms continue to perform photosynthesis, and they still receive nutrients and water from the rhizomes. Even if almost all bamboo culms from a single cluster are cut, and the photosynthesis stops, the energy remaining in the rhizomes will help the plant to recover. This regrowth on the strength of bamboo's rhizomes is illustrated in Figure 20, which shows how new branches emerge after cutting bamboo culms.

Figure 20 Regrowth of new bamboo culms after a total cut-off of the aboveground plant parts. Although all parts of the aboveground clump were removed, new branches emerge from the remaining culm stem since the rhizome is still vital and provides the remaining plant with water and nutrition.

Depending on the different bamboo species and their (monopodial or sympodial) growth habits, almost one-third of the mature, woody culms can be harvested each year without harming the cluster and its growth (Dunkelberg 2005, 92). In this context, Banik notes that new thin and tender culms will develop one or two years after a completely clear cut from the rhizomes and that simultaneously the remaining buds, dormant at the bamboo stump, will develop leaves. However, only after five to six years will a bamboo clump develop culms of average size and good quality (2015b, 195).

The best season for the bamboo harvest is considered to be the time from late spring until the end of the rainy season as the starch content is the lowest during this time, which in turn, correlates with less attraction of starch-feeding insects (ibid., 194). As Banik states, bamboo's starch content is also related to the daytime because bamboo starts to transport starch during the morning when the sun rises when the plant starts with its photosynthesis, while the starch content decreases during the night. On account of this variation, Banik (ibid.) recommends felling bamboos between midnight and six in the morning, a period when the starch is to be found more in the leaves and rhizomes. Accordingly, bamboos harvested during nighttime tend to be less attractive to insects, dry faster, and have less weight, making them easier to transport (ibid.). Consequently, bamboos that are harvested during the summer months and daytime will decay quicker.

Another aspect related to the selection and harvesting of bamboos corresponds to the required products people want to craft. As Banik (ibid., 195) argues, bamboo of three to five years is recommended for the construction industry, whereas for various crafts, bamboos less than three years old are recommended. Bamboos older than six years, however, develop very hard wood and are more likely to be infested by insects.

The harvesting of bamboo is traditionally done with a heavy knife, such as a machete, and normally not with a saw. As my respondents in the bamboo arboretum Làng Tre Phú An explained, machete harvesting supports the decomposition of the remaining bamboo stump while saw harvesting decelerates its degradation. As a result, machete harvesting supports the development of new shoots because it opens free space for new bamboo shoots due to the faster decomposition of older *stumps*. An aspect one should consider when cutting bamboo is that the culm should be cut directly above a node. Otherwise, the remaining cylinder gets filled with rainwater, which is favorable for mosquito larvae, especially in humid and rainy regions, as illustrated in Figure 15.

According to my respondents of TXT, depending on local customs, bamboo's leaves and branches are immediately removed after felling, but in some other cases, a bamboo is left vertically after cutting without taking away its branches and leaves. Afterward, the felled bamboo stays there without touching the ground for some days, allowing the culm to reduce its moisture and starch content caused by the continuing photosynthesis.

Another vital aspect to consider when harvesting bamboo is related to the inflorescence of bamboo. The flowering period results in the production of seeds and is accompanied by reducing the starch content in bamboo's sap. Accordingly, "flowered bamboo has a higher resistance to beetles because the starch is depleted when bamboo flowers," but simultaneously, "these bamboos are brittle and, so usually, not used for any construction works" (ibid., 223).

Figure 21 Open-air drying of bamboos in Xuân Lai village, Bắc Ninh Province. The oblique, conical stacking of bamboo culms allows good air circulation.

The preservation of bamboo supports the protection against climatic effects, insects, and fungi. While some methods use chemical or nature-based oils and varnish, others are based on traditional knowledge and rely on simple techniques. In any case, if one wants to preserve bamboo durably, one must have a good knowledge of bamboo's anatomical structure. The outer silicified skin, for instance, prevents any penetration by applying simple treatments, such as immersion in a liquid (Liese and Tang 2015, 279). At the same time, the bamboo's silicified epidermis is already a kind of protection itself. Hence, surface treatment is only necessary when a bamboo culm is exposed to weather conditions for a long time. As a general rule, bamboo poles can (depending on the species) remain exposed to rain and sun for about two to three years before the first severe damage occurs as a result of bamboo's decomposition.

If bamboo is abundant and readily available, the cost to rebuild a bamboo-based house, for instance, is lower than the costs and preservation efforts—as exemplified by the abandoned house of Bahnar peasants shown in Figure 49. On the other hand, simple protections help to extend the durability of bamboo very effectively. For instance, traditional bamboo houses of Bahnar people commonly have cantilevered roofs that protect the other house elements such as bamboo walls and bamboo terraces from rainwater and sunlight and effectively increase bamboo's lifetime. Photograph *c* in Figure 25 illustrates such a Bahnar house, and the right-hand photograph in Figure 25 likewise shows the thatched roof's protective function of a bamboo makeshift house. In order to increase a house's lifespan, bamboo houses are also often erected on stones to prevent them from constant contact with water in the soil or on the ground surface.

A widespread traditional method to reduce the moisture and starch content of bamboo, which I observed in many places in Vietnam, is to immerse bamboo poles in the water of small ponds or rivers for some weeks. After a while, "the nourishment for the beetles (starch, sugar and other water-soluble substances) is removed" (Dunkelberg 2005, 95), and the culm has a higher resilience against the attack of insects, especially against boring beetles. The soaking of bamboo is related to the natural diffusion occurring "mainly in axial direction, less in transversal whereby radial is slightly better than tangential" (Liese and Tang 2015, 283). After that immersion, the soaked bamboo culms are set up vertically to dry and exposed to the ambient weather conditions without a shelter. In the background of the photograph in Figure 21, one can see an artificial lake segmented by footbridges in which the inhabitants of the bamboo handicraft village soak their bamboos. Soaking bamboos in boron salt solution is another method to reduce the culm's attractiveness to insects, as illustrated in the right-hand photograph in Figure 22 taken in Xuân Lai village. As the photograph also shows, the soaked culms must be weighed down by stones, bricks, or concrete piles due to bamboo's natural buoyancy.

According to the bambooworkers in Xuân Lai village, the reduction of the culm's water content is essential for the durability of bamboo products. The higher the moisture content, the lesser the material's strength, and the lesser the fibers' mechanical resilience. However, the drying process can cause damage to the culm, since the dry shrinkage of bamboos increases as the moisture content decreases. This can lead to tensions in the culm and provoke cracks, particularly if a culm dries too fast. Cracks, in turn, occur because the loss of moisture correlates with the culm's shrinkage, and during that shrinking process, the outer part gets smaller, while simultaneously, the inner part is stretched. At the same time, the shrinkage relates to the enclosed air in the internode, which also expands and leads to more tension causing further cracks. However, cracks do not always cause severe damage to the whole culm, and culms with cracks are still useful in many ways. On the other hand, when using a whole culm, a crack is an open door for insects and fungi, which can cause great harm to the culm over time.

The drying of bamboo culms is commonly achieved through air-drying, as can be seen in Figure 21, or kiln drying, as illustrated in the left-hand photograph in Figure 22. The air-drying method, as Liese and Tang explain, "is the process of removing moisture from bamboo by exposing them to atmospheric conditions. By proper stacking for air circulation, culms can be dried with no need to add energy above the capacity of the ambient air" (2015, 289). According to the respondents in Xuân Lai village, the air-drying of bamboo culms, as shown in Figure 21, ranges from six weeks to three months. For good results, the traditional air-drying is done in the dry season and in clear weather, using the sun's heat for drying and air circulation caused by the wind. Nonetheless, since the weather conditions change constantly, air-dried bamboo may be harmed by varying atmospheric conditions. For instance, long-lasting, strong sunlight can cause cracks, whereas long-lasting rainfall, along with high moisture content in the air, can cause an infection by fungi. Despite its deficiencies, air-drying is an economical and sustainable way of drying, although this method exposes the culms to a higher risk of harm. Instead of drying the whole bamboo stem, and whenever slats are required, bamboo is split before drying. For instance, this is done in the crafting of bamboo floors for traditional bamboo-stilt houses of the Bahnar people, as Figure 52 illustrates.

Figure 22 Kiln-drying and soaking of bamboos in Xuân Lai, Bắc Ninh Province. (*left*) A chamber made of bricks in which bamboos are laid inside and smoked. (*right*) To remove the starch content in bamboos, culms are put into boron salt solution to soak for several days.

Kiln-drying, in contrast, allows better control of "the temperature and relative humidity needed in the kiln to dry bamboo with a minimum occurrence of degrades and in the shortest time possible" (ibid., 290). While modern drying methods, using drying chambers or ovens, need electricity, traditional kilns use renewable materials. In Xuân Lai village, for instance, in addition to the above-described method of soaking and drying, the craftspeople also use kilns which are made of bricks and ca. 6 m in length and 1.5 m in height and width (see photograph on the left in Figure 22) to dry bamboo. After putting layers of bamboo into it, the kiln is heated by burning rice stalks for a couple of days. While the heat dries the bamboo, the burning rice stalks additionally cure them due to smoke production within the kiln. According to the craftspeople in Xuân Lai village, the smoke provides additional protection for the culms. This claim is in line with Liese and Tang's statement that "the build-up of deposits from smoke such as carbon and its derivatives forms a protective layer preventing physical and probably chemical contact of the culm material with fungal spores as well as beetles" (ibid., 275). Hence, this method not only dries the bamboo pole in a more cautious and controlled way and prevents the bamboo from being attacked by starch-eating insects, but smoked bamboos are also prized for their aesthetic value.

4.2. Traditional Tools and Bamboo Treatment

Bamboo's structural composition offers a wide range of methods to manipulate the culm. Culms are bent, split, peeled, drilled, engraved, or polished and transformed into new raw materials such as semi-circular tubes, planks, laths, or strips. In turn, these materials are used in the domain of furniture making, tool production, architecture, basketry, artwork, and other everyday objects.

In general, the variety of tools that are used to work bamboo is few and relatively simple. For Bahnar people, for instance, the most significant tool to work on bamboo is the machete (also referred to as a long knife or jungle knife). This tool is widely distributed in Southeast Asia's remote mountainous regions (such as Thailand, Laos, Vietnam, or Cambodia) but also throughout the world. The machete's shape differs from region to region, but its functionality and handling remain the same, and it needs some practice to become accustomed to it and handle it perfectly. The machete, common in Vietnam, has a heavy, long, and thick blade with handles that are made of softwood, hardwood, rattan, or bamboo rhizome. By using a machete, a bambooworker can, amongst other things, cut bamboo to length, shave bamboo's outer skin, split slices, or flatten slats. Depending on the machete's blade length and weight, the bambooworker can also work on large diameter bamboos with ease (see Figure 23). Some of its uses are exemplified by the photographs in Figure 23, Figure 75, and Figure 76, and two kinds of machetes are illustrated in Figure 45. As I observed among the Bahnar people and as McClure notes, even entire constructions like "a bamboo house . . . [can] be built with no more tools than a machete [but] wherever the use of bamboo is to be refined or elaborated to any extent, additional tools are required" (1953, 44). Indeed, while the Bahnar mainly utilize bamboo for most of their bambooworking, a wide range of tools was required in pre-industrial Japan's sophisticated bamboo workshops. A list of these tools is compiled by Spörry and discussed in chapter 9.4.2 and likewise by McClure, as shown in Table 1. In the domain of furniture making or traditional handicrafts, craftspersons use alongside the machete also a mallet, different types of chisels, and other tools for drilling, splitting, or shaving the culm material.

Tool	Uses	Recommended specifications
Machete	Miscellaneous: felling and trimming culms, and cutting them to lengths; removing fragments of diaphragms from bamboo boards; etc.	Preference of the user decides the type of blade selected; long, fairly heavy blade recommended.
Hacksaw	Felling culms, removing branches, cutting culms to length.	Large size; ample supply of molybdenum steel blades, with 18 and 25 teeth per inch.
Tripods and trestles	Elevating culms and holding them firm for sawing to length, cracking nodes.	May be local, following the pattern locally preferred.
Ax	Cracking the nodes at large culms to make boards.	Light-weight ax with a narrow but thick, strongly wedge-shaped bit.
Hatchet or small ax	Cracking the nodes of smaller culms for making boards.	Similar to the ax, but smaller in size and fitted with a short handle.
Whetstone	Sharpening edged tools.	Garborundum; coarse-grained on one side, fine on the other.
Spud	Removing diaphragm fragments and excess soft wood at basal end of bamboo boards.	Long handle; broad blade set at an angle to operate parallel with surface of board.
Adz	Removing diaphragm fragments and excess soft wood at basal end of bamboo boards. Spud is more convenient, but the adz is generally more available.	Standard design; best-quality steel.
Gouge	Removing diaphragms to make troughs and drain pipes from split or opened culms.	Curved (front bent); 1-inch and 1.5-inch bits.
Chisel	Making holes in culms to accommodate lashings for end ties.	Best steel (molybdenum steel is available); 3/4-inch bit.
Drill	Making holes to accommodate bamboo pins or dowels.	Hand- or power-driven drill; metal drilling bits, best steel, assorted sizes, 1/8-1/2 inch.
Wood rasps	Leveling prominent culm nodes.	Large size, with one flat side, one convex; coarse, medium, and fine teeth.
Splitting jig	Facilitating the splitting of whole culms or sections into several strips at once.	. . . [a cross of iron bars, or steel wedges fixed on hardwood of different sizes, A.E.]
Splitting knives	(a) For splitting small culms. (b) For making bamboo withes.	(a) Short handle; broad blade. (b) Long handle; blade beveled on one side only; to be specially made.
Rods of reinforcing steel	Breaking out the diaphragms of unsplit culms.	Suggested minimum: one each of ¾ inch by 10 feet and ½ inch by 10 feet. Other dimensions to meet special needs. Hardwood or bamboo pole may be substituted.
Wire pincers	For handling wire used for lashings.	Conventional type with long, narrow jaws and wire-cutting feature.

Table 1 Tools required for the processing of bamboo (Source: McClure (1953, 44–45).

When cutting bamboo into lengths, a saw with fine, sharp teeth is more suitable than a machete or knife because it prevents fibers from fraying when cutting. For the surface treatment of bamboo, tools are used for scoring, carving, or sanding. The surface treatment by sanding or removing parts of the upper layer can increase the friction between the culms and is often applied to create specific handicraft products. Or else for tight connections since bamboo's smooth skin and round shape can cause slippery connections.

Since electrically powered machines and tools were not common until the early 1950s, all work procedures in the domain of bambooworking were based on traditional hand tools. Moreover, for a long time, electricity was restricted to industrialized, urban areas and was barely introduced to rural regions. Traditional bambooworking tools, used in the second half of last century, are compiled by McClure. His compilation, reproduced in Table 1, represents the typical traditional tool kit necessary to work on bamboo both in the past and present. Figure 137 shows a sketch of the Japanese carpenter's toolkit in the late twentieth century and provides additional data about the design and function of some tools mentioned in Table 1.

Many parts of the bamboo plant are useful materials needed for different kinds of purposes. Bamboo branches, for instance, can be used for wall constructions, and bamboo leaves serve as a watertight material in making hats. Nevertheless, it is the bamboo culm which is the most used part of the plant, and most bambooworking techniques are based on its manipulation, of which some are described below.

Figure 23 Fabrication of a bamboo lamp by splitting strips of a bamboo culm using a long machete at the Taboo Bamboo Workshop in Hội An, Quảng Nam Province.

In many cases, such as roof construction or bridge building, bamboo's cylindrical structure remains almost unmodified, whereas splitting bamboo extends the ways bamboo can be used. As Yu writes, the bamboo weaving is an "important branch of bamboo utilizations . . . in which bamboo works not only as the functional structural element, but also represents a high aesthetic value" (2007, 28). Woven bamboo baskets with different shapes, designs, and purposes, as well as wickerwork and other woven tools and objects, are discussed together with weaving techniques in this book's ethnographic and historical chapters. As a general fact, craftspersons and bamboo are both co-creators of bambooic things. This argument and view, emphasizing a material's role in the process of creation and form-giving in contrast to former views that overemphasized the human subject's role, is thoroughly discussed theoretically in chapter 5.3 and again by way of examples of Bahnar peasants' bambooworking skills and techniques in chapter 7.6.1. As a matter of fact, "the traditional bamboo crafts show a high level of harmony of both sides: the natural structure and the human initiative in the bamboo handicrafts" (ibid.) and reflect the human-bamboo relationship.

Splitting bamboo culms into splits of different shapes and sizes is essential for many constructions and used to create walls, floors, doors, fans, animal enclosures, hen cages, chopsticks, springs, or the like. As mentioned earlier, young green bamboos are easier processed than dry, woody bamboos, and due to their higher flexibility are primarily used for weaving and basketry. Moreover, bamboo is easy to split parallel to its axis due to the length of its fiber, which "is long and thin with an average length of 1.4–2mm . . . and [so] belongs to the category of medium or long fiber" (Hidalgo-López 2003, 444).

The material property of the bamboo culm differs according to its structural composition—the silicified outer skin has much more fibers and a higher material density than its inner, soft culm wall—and depending on the intended purpose, the epidermis or endodermis are removed if needed. In general, a longitudinal split, including the outer skin, has better strength properties than a split without the skin. Young bamboos (up to eighteen months), for example, are peeled to obtain bark strips, which then are used as ties, or when woven, as strings or ropes (Dunkelberg 2005, 108). Depending on the craftsperson's needs, each split has a peculiar form and fits best for a specific purpose. As Dunkelberg writes, "the unlimited capacity of the bamboo cane wall to be split longitudinally within its segments [internodes] . . . results from the parallel orientation of the constituent fibres" (ibid., 69). Therefore, splits can be quadratic, rectangular, flat, or of triangular shape, and other splitting patterns are used, for instance, to cut tapered sections for lathing, complete tangential segment, or a strip radially and tangentially behind the epidermis (ibid., 68–69).[19]

[19] Japanese bambooworking techniques and required tools in late twentieth-century Japan are described, amongst others, by Spörry and discussed in chapters 9.4.2 and 9.4.3.

4.3. Joints

The making of joints is a part of bambooworking that basically puts together bamboo pieces (or bamboo and wood) and relates to the desired purpose, different applied bambooworking techniques, and material compositions. By means of joints, craftspersons can create small objects or large constructions with greater complexity, durability, or safety. As a result, a plethora of joint concepts has evolved by exploiting bamboo's natural structure. This section will briefly discuss traditional joint methods based on bamboo or other organic materials and exclude industrially fabricated joints employing adhesives.

Figure 24 A bamboo scaffold enclosing a large building under construction in Chiang Mai, Thailand.

The design of traditional joints is linked to the processing techniques, including drilling, cutting, splitting, bending, and connections through ropes made of hemp, bamboo, or rattan. Since bamboo's hollow structure and irregular dimensions precondition its use for joints, its natural structure is sometimes adverse. Therefore, taking bamboo's characteristics into account is crucial in the creation of firm and durable joints. In general, joints improve the natural characteristic of bamboo and enable stable and durable connections. Accordingly, if two bamboos are attached to each other, they can bear more loads than a single bamboo could do.

Connections often employ the use of bamboo strips and ropes that mainly include the outer skin of the bamboo culm's wall due to its higher tensile strength compared with the inner walls. Photograph *d* in Figure 25 illustrates how two bamboo culms are connected through a green bamboo strip, while photograph *e* in Figure 25 shows how the various elements of a waterwheel are connected using bamboo strips. Other organic materials that are used for joinings are rattan, cotton, hemp, and in recent decades, also industrially fabricated materials such as wire (*b* in Figure 25), metal nails (*h* in Figure 25), plastic ropes, or recycled bicycle tubes (*f* and *g* in Figure 25). Other joining methods include a bamboo (or else wood and iron) dowel or pin to reduce friction and secure connections. A large wooden dowel is used, for instance, in the roof construction shown in photograph *b* in Figure 25, and metal nails are used to fix bamboo slats

Figure 25 Various joining methods. (*a*) A bamboo bench assembled of smoked bamboo, fixed using bamboo pins and metal nails. The specimen shown is not yet polished and painted. (*b*) A bamboo-based roof structure fixed on a wooden pole with wires fastening the culms. (*c*) A traditional Bahnar house's walls are fastened by bamboo strips. (*d*) Two bamboo poles are attached by a strip of a bamboo's outer skin. (*e*) A bamboo waterwheel whose structural elements are secured by bamboo strips. (*f* and *g*) Bicycle inner tubes are recently used to fix bamboos. (*h*) Nails are used for connecting bamboo laths. Since nails do not remove any material when penetrating the bamboo wall, they cause cracks.

for fence making (*h* in Figure 25). The left-hand photograph in Figure 26 shows a makeshift construction that uses two techniques and involves a bamboo culm's outer skin, and a bamboo dowel rammed into the bamboo column.

Joining techniques are best illustrated in house construction, traditional bamboo furniture making, makeshift constructions, or fences. One simple means of bamboo joining is applied in the construction of roof covering in a Roman tile fashion, as shown in the photograph (*b*) in

Figure 27. In this case, the bamboo is cut into two half shelves, and after removing its remaining diaphragms, the half shelves are used as shingles and fixed to the ridge. The length of shingles and the number of layers can vary, but the way that roof covering type works are always the same. In some cases, two layers of half culms are put on bamboo slices so that the curvature of the half shelf at the lower layer points downwards, whereas the half shelf of the upper layer (which covers the lower layer) points upwards. In other cases, as illustrated in photograph *b* in Figure 27, the curved part of all bamboo shingles is directed upwards. The construction is held in position by bamboo's own weight and additionally stabilized by horizontal bamboo and bindings. This simple but efficient roof covering is typical in many Asian countries, and it is probably one of the earliest techniques used by humans for shelter.

Figure 26 Simple bamboo joints. (*left*) Several bamboos are laid on each other, while the lowest is inserted into the bamboo post and reinforces the bamboo lashing. (*right*) A makeshift house construction thatched with palm leaves and a bamboo fence that is made of long horizontal culms that are inserted through the openings of the vertical posts.

Joints are also used to build large constructions such as bridges, roofs, or scaffolds. A bamboo bridge in Thanh Hoá Province, Vietnam (*c* in Figure 27) and the large scaffold encompassing a concrete building under construction (Figure 24) illustrate the effectiveness of bamboo joints.

Bamboo also plays a decisive part in agriculture for irrigating fields. And probably the most impressive example of exploiting bamboo's hollow structure is the creation of bamboo water pipelines. The connections of bamboo water pipelines are, in principle, uncomplicated and cheap since, in most cases, bamboos are easily stuck together. For a precise connection, either the hole is adapted to receive the end of the bamboo to be inserted, or the end of the bamboo to be inserted is adapted to fit the hole. Due to bamboo's hollowness, only the culm wall must be removed to obtain a tube for water conveyance.

Contrasting with its simplicity is the relatively short lifespan of about three years. In pre-industrial Japan, for instance, sophisticated irrigation systems of several hundred meters were erected to transport water over long distances, and today bamboo is still used to transport water in rural areas of Vietnam from waterwheels to the farmland.[20]

Figure 27 Various uses of bamboo. (*a*) A bamboo truss roof construction in Quảng Nam Province. (*b*) A bamboo roof cover made of semi-circular culms in the Ethnographic Museum in Hanoi. (*c*) Bamboo bridges built to cross a river in Mường Lát District, Thanh Hoá Province. (*d*) A man crafting a bamboo fan with thin bamboo strips in Bá Thước District, Thanh Hoá Province. (*e*) A bamboo enclosure for animals in Tân Lạc District, Hòa Bình Province. (*f*) Bamboo flooring, partition walls, and railings in a house in Tanh Hoá Province.

[20] The design and use of bamboo water pipelines in Japan before industrialization reveals much about bamboo's importance for water transportation and is addressed in chapter 9.4.3.

Joining bamboos by sticking them into each other requires precise holes and involves two traditional methods. One is to remove a culm's outer wall using a chisel or alternatively a heated iron bar. The latter is heated over natural fires and pressed into a culm. Due to the heat, the iron bar penetrates bamboo's silicified skin without much effort and simultaneously seals the culm and protects it from further fraying. In contrast to the first method, however, the iron bar's diameter predetermines the hole's diameter and thereby the bamboo that would fit.

Drilling bamboo poles using electrically driven machines is a relatively new method and was not applied until recently. Drilling is necessary particularly if the craftsperson operates with screws. In contrast to drilling, screws (or nails) do not remove a culm wall's material when inserted into a culm. They penetrate the culm wall and separate its fibers, and can cause cracks in the axial direction—as exemplified in photograph *h* Figure 25.

4.4. Industrial Tools and Machines

On the one hand, new materials, such as plastic, iron, steel, or concrete, have replaced bamboo in many fields in Vietnam: in house construction, corrugated sheet metal roofs replaced bamboo roofing; concrete bridges substitute bamboo bridges; bamboo household goods, commodities, and furniture are now often made of plastic, which sometimes even replaces the most basic and omnipresent bamboo chopsticks. On the other hand, the industrialization of bamboo, which is a relatively new phenomenon, has profoundly impacted the maintenance of traditional techniques and methods of bambooworking. Furthermore, the industrialized fabrication of bamboo is much more linked to bamboo's economic value and optimization of bamboo-based products' value chain. Needless to say, one-sided economic interests and exploitations of bamboo differ, for instance, from bamboo's socio-cultural and material embeddedness in peasant's traditional life.

Nowadays, as Yu rightly comments, "industrialization gives bamboo a new chance to be used as a material in industry. But in this way of industrializing, bamboo also loses its structural advantages: through the industrial processing, the original tube structure of bamboo is destroyed and pressed into a solid material" (2007, 3). Not surprisingly, in recent decades, pressed bamboo products, such as bamboo flooring, furniture (e.g., chairs, tables, wardrobes), or kitchen tools (e.g., cutting boards, cups) have found their way to the global market and become part of material cultures in regions where there is no bamboo plant.

In contemporary Vietnam, many bamboo manufactories and bamboo workshops have replaced parts of their traditional tool kit with new tools. Some of these replacements took place, for instance, in the workshops of the bamboo craft village in Xuân Lai. Currently, people only seldom use a chisel to make holes in a bamboo culm, but Forstner bits attached to a bench drill are used for this purpose. The workers only occasionally use bamboo dowel pins to fix joints, but more often, metal nails that are shot by an electric nail gun. The handsaw has also been replaced by a circular sawing machine. And sanding, formerly using organic materials and stones, is today mainly done by industrially fabricated sandpaper and grinding machines. The above photograph in Figure 28 of a workshop in Xuân Lai village shows a bench drill machine required to drill holes into culms. The lower photograph in Figure 26 shows a circular saw (required to cut bamboo tubes to length) and a sanding machine (used to smoothen a culm's surface or taper a culm).

Figure 28 Electric power tools as part of the tool kit in the bamboo craft village in Xuân Lai village. (*above*) A drill press needed to drill holes for the joints. (*below*) A circular saw and sanding machine.

Based on their research about the traditional and modern techniques in the domain of bamboo furniture and carpentry, Wu and Ho point out that in contrast to traditional bamboo furniture making, the modern carpentry of bamboo furniture increasingly utilizes laminated bamboo and also mortise and tenon joints and that new techniques have a profound impact on the traditional production (2015, 986). Regarding the different materiality of the hollow bamboo in contrast to the laminated bamboo, the authors conclude that "the styles created from bamboo and laminated bamboos are different. In other words, the styles are not just created based on function, but also on the characteristics of the materials" and that "the style of traditional bamboo furniture emphasizes more on culture, whereas modern bamboo furniture focuses more on design" (ibid., 989). Wu and Ho summarize the traditional working steps in the domain of bamboo furniture making as follows: "1) Picking bamboo, removing the knots, removing the oil, drying, and preserving; 2) Cutting, sawing, carving, gouging, heating, inserting, gluing, assembling, nailing, and painting; 3) decorating, such as polishing, painting, inserting flower ornaments and other materials" (ibid., 986). A traditional bamboo bench, which my colleagues and I crafted in the workshop in Xuân Lai village, is illustrated in the photograph *a* in Figure 25. As mentioned above and in line with Wu and Ho's summary, creating a bamboo product, such as a bench, is an elaborate but hand-made product. Its creation is less machine but hand-dependent and requires the craftsperson's personal skill and knowledge. At the same time, the traditional bamboo bench represents traditional bamboocraft and symbolizes traditional Vietnamese furniture styles, though involving modern tools.

Figure 29 A chopstick workshop in Tanh Hoá Province, Vietnam.

Chopstick manufacturing is another vivid example of the industrialized processing of bamboo. A part of such a chopstick workshop in Than Hóa Province in Vietnam is shown in the left photograph in Figure 29 and its final products in the right-hand photograph of the same figure. The manufacturing process is primarily machine-based and can be briefly summarized with the following steps. After removing a bamboo culm's septum, the culm is crosscut into sections of the same length by using a saw bench. In the next step, an operator splits the circular culm into two semi-circular pieces with a splitting machine's aid. Then, these semi-circular sections are used by another operator to supply another splitting machine that produces the final chopsticks, and which is shown in the left photograph in Figure 29. Needless to say, for the purpose of productivity enhancement, it is not only bamboo that is well adapted to optimized work steps but also the human operators who are geared to the industrialized production process, including labor division, repetitive monotonous work tasks, predefined working hours, and the like. With regard to bamboo's material history, as a material involving human intelligence and skill, bamboo is detached from its socio-cultural context in the domain of machine-based bamboo processing. Thus, in the domain of industrial market-bound production, the operators are alienated from the means of production in Marx's sense. What is more, the present professionalization and industrialization of bambooworking will increasingly impact the way bamboo is processed. And analogous to tree wood's industrial processing, it is most probable that bamboo will go a similar way, and new industrially produced bamboo commodities based on bamboo as a standardized pressed raw material will be developed.

4.5. Similarities and Differences between Bamboos and Trees and Their Woods

In this section, bamboo is discussed in comparison to tree wood because both share a common destiny in terms of their meaning and function in human history. Bamboos and trees, however, share not only many characteristics concerning their use and their wood properties but also some fundamental differences. Speaking of bamboos and trees in a general way, on the other hand, one should not neglect the fact that bamboo and tree species also differ within their own botanical subfamilies. The wood of pine trees, for instance, has other properties than that of oak trees, and the thick-walled culms of *Guadua angustufolia*, for instance, differ from those of the thin-walled *Pseudostachyum polymorphum*.

In some cases, tree wood is superior to bamboo, but in other cases, bamboo is superior to tree wood. Tree wood is often used where bamboo is not preferable or less readily available. On the other hand, bamboo is preferred due to its easy workability, especially for temporary constructions. Nowadays, bamboo is getting more and more important for many reasons. One reason is that the world population is increasing, and far more people than ever want to achieve a higher living standard. Thus, the demand for lumber and tree wood products is increasing, as is the pressure on forests. Using bamboo as raw material reduces the pressure on forests while simultaneously benefiting from bamboo's sustainable features. As a result, the production of industrially fabricated bamboo products has increased in the past few decades. This process is accompanied by scientific research and experiments in various disciplines, aiming to improve bamboo's industrial processing.

Some similarities, differences, advantages, and disadvantages of bamboo compared to tree wood are shown in Table 2. At this point, in what follows, I shall outline these aspects in brief.

1) Trees and bamboos are distributed in many regions of the world, but trees are more common than bamboos. 2) Both have a comparable strength property (except for shear strength).

	Trees	Bamboos
Botanical aspects	A tree is an individual organism. Its roots only nourish the tree itself.	Bamboo is a plant, not a tree. A bamboo clump consists of several culms. Each bamboo culm is connected to other culms through their rhizome network, which supplies young and old culms.
Distribution	Trees are spread worldwide, except for regions with arctic climates.	Bamboos are endemic in all continents except for Europe and Antarctica and grow primarily in warm and moist tropical and warm temperate climates.
Growth	Trees have primary growth (causing elongation) and secondary growth (causing thickening and annual rings).	Once a shoot has developed into a mature culm, bamboos neither elongate nor thicken anymore.
Harvest	Once a tree is felled, the remaining stem does not regrow to a new tree. It takes many years to replace a chopped tree.	Bamboos can be harvested each year. It is possible to cut up to 30 % of the mature culms of a clump without affecting the whole plant.
Processing: Weight / Transport	Depending on size and age, a felled tree is too heavy to be carried by one person.	Depending on size and age, a single bamboo culm or multiple culms bound together can be carried by a single person or just a few people.
Processing: Tools	Basic structures may be realized by using a single tool such as an ax, but a wide range of tools (e.g., saw, chisel, plane) is needed to build more complex constructions or to obtain specific products.	In many cases, a machete is sufficient for bambooworking, but a variety of other tools allow more precise work with bamboo.
Processing: Workability	Tree wood has a compact material density. It cannot be easily split into slices, and processing methods require saws.	Bamboos have long fibers and usually a hollow structure. They are easily split lengthwise and provide fast and easy workability.
Processing: Joints	Joints made of wood take advantage of wood's compact material density.	Making joints of bamboo must consider bamboo's hollow structure, which is both advantageous and disadvantageous.
Durability	Wood is a relatively durable organic material, and wooden constructions can last many decades or even longer when protected well against weathering.	Bamboos are a less durable organic material and need adequate protection against weathering but endure decades when used indoors.
Material composition	The inner part of wood (heartwood) is harder than its outer part (sapwood).	The outer skin (epidermis) of bamboo is harder than its inner part.
Mechanical properties: Strength properties	Wood is a strong and hard material but simultaneously light and flexible. Due to its strength properties, wood is used for countless constructions and products.	Considering bamboo's structure and strength properties, it is favorable for countless constructions and products.
Structure	Wood is an anisotropic material. It has different properties in different directions (axial, radial, tangential), which is why it is much stronger parallel to the fiber than across it and why it is easier to split it in a longitudinal direction along the grain.	Bamboo is anisotropic, but due to its material composition and its long fibers, it is easier to penetrate its material in the axial direction.
Firewood	Wood has good flammability and fuel value.	Due to its low material density, bamboo has a low fuel value.

Table 2 Similarities and differences between tree wood and bamboo wood.

3) Since both are organic materials, they decompose when exposed to climate conditions and are less durable than other construction materials, such as stone or brick, and both are infested by insects. However, bamboos decompose faster than trees. 4) Tree wood and bamboo wood require various tools, with tree wood processing necessitating a more advanced tool kit than bamboo wood due to its greater material density. 5) The techniques and tools needed to work on wood or bamboo are well adapted to both material and mechanical properties. 6) The most striking difference between tree wood and bamboo wood is their material composition and structure. While wood is a compact material, most bamboos have a hollow structure.

To sum up, tree wood and bamboo wood have specific material qualities, and each has its strong and weak points. Hence, considering both materials' basic characteristics, craftspeople can combine both to compensate for the other's weakness, as demonstrated by many devices, tools, and buildings. An illustrative example in which the strength properties of wood and bamboo are combined is a wooden-bambooic waterwheel. Waterwheels are essential devices in the domain of agriculture and water irrigation and are commonly used to transport water from a river through bamboo pipelines to paddy fields. Such waterwheels are still used in the northwest of Vietnam, for instance, and illustrated in photograph *e* in Figure 25. Concerning their material composition, the wheel, water chamber, blade, shaft, piping, and strips connecting its structural elements are made of bamboo and hence particularly exploit its hollow structure and easy workability. On the other hand, the bearing is made of tree wood due to its dense and compact material composition, which is more suitable than bamboo, which is less resistant to radial pressure.

Part B: Theory

5. Approaches to Practices and Materiality

5.1. Introductory Words and Structure of This Chapter

From the first emergence of the anatomically modern human to the present time, people in each epoch have been surrounded by the ideas their predecessors had elaborated. These ideas are their legacy to their successors. What they did and produced had and still has a lasting effect on our entire life. Their inventions, technological choices, or cultural habits have been shaping our society, knowledge, skills, perception, technology, and the like. As Marx wrote, "men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly found, given and transmitted from the past" (1978, 595). Marx's apodictic statement is not only true for our epoch but also for the antecedent and the successive eras alike. All the things our antecedents built are linked to our way of living through the very material character of these things and our conflation with the material world. Moreover, each time people use those things transmitted from the past, they reinforce social structures through these things. In their totality, tools, devices, artifacts, or constructions influence human life—regardless of being complex or simple, special or ordinary. The way we produce and live through and with things reveals many insightful aspects of our economy, identity, culture, society, or technology.

In the same manner as with other things, people used bamboo. Ancient societies had begun working with bamboo long before the Neolithic, and they had started to shape their material and natural environment using bamboo. It is likely that bamboo was of enormous importance for early arrivals in Asia and that bamboo influenced their way of living and was fundamental for establishing material cultures. By and large, people found and discovered the different technological possibilities that bamboo offered them, and today bamboo is still essential for contemporary societies. In short, bamboo has a remarkable material history and is linked with human sociality by providing a material constitution and matrix for human existence. In this light, my entry point into the examination of people's bamboo-based material culture was to follow the human-bamboo relationship.

Yet bamboo cultures—as a subset of broader material cultures—are by no means immutable and rigid but dynamic and affected by a slow or fast change and development, just like every other material culture. Each technological advancement and improvement always exerts an influence on a social group's material culture. Changes in ideas, technical know-how, tools, and materials had and still have a profound impact on subsequent technological choices and innovations. In this sense, our predecessors' activity is linked to our activity. This is, in the words of Schatzki, most vividly expressed by the "artifacts and built structures [that] determine or condition [our] present activity" (2003, 85).

For that reason, history can no longer be understood or interpreted as the outcome of human activity alone. Historians must reconsider their underlying assumption concerning the realm of actors and agency in favor of a concept that sheds more light on the relevance of nature and technology in history (ibid., 82). Thus, Western-based technologies, indigenous technologies, material cultures, and (more specifically) bamboo cultures—all transmitted from the past to the present—continue to affect our lives, alongside nature and humans themselves.[21] Things, therefore, are related to social relations and "give endurance and solidity to the fundamental ideas and practices that pervade . . . culture and social organization" (Lemonnier 2012, 127).

This work is both historical and anthropological. It is concerned with bamboo's contribution to historical material cultures and pre-industrial technologies and bamboo's relevance and function for contemporary people's traditional use in everyday life. Thus, it is open to all aspects related to bamboo. It addresses bamboo as i) a plant, ii) a mundane artifact in everyday use, iii) a technical device and tool, and iv) part of the built environment, that is, the human-made material surroundings as the product of human labor (consisting of houses, bridges, fences, water supply systems, farmlands, and other things). For another thing, I question how bamboo's very materiality is related to ways of manufacturing, production, use, and consumption and how the human body and skill are involved in these activities. In other words, I scrutinize bamboo's entanglement in human activities and practices. For this purpose, I assume that bamboo is part of all strata of human existence since bamboo is part of the material and immaterial world, technology, society, nature, and everyday life of people throughout the world. In

[21] Western, Western-based, Western culture, or Westernized are terms that are associated with ideas, methods, way of living, technologies, and practices that originated in Europe.

this way, it connects humans with both human and nonhuman entities through its very presence and symbolic meaning in daily activities and practices.[22]

A study that encompasses bamboo's various appearances requires, of course, an affiliation of diverse disciplines' perspectives on bamboo related to (indigenous) technology, processing techniques, bamboo's materiality, and bamboo's effects on the social. Because of that necessity, my research questions crosscut many disciplinary boundaries to find appropriate answers about the parameters of the human-bamboo relationship and how (indigenous) bamboo technologies and bamboo artifacts permeate human activities. Such an approach is, of course, less human-centered than bamboo-centered and does not separate human society from nature or technology *a priori*. From my point of view, technology and nature are equally entangled with the course of human history. As Schatzki argues, through technology, one can conceive of human history as a "social-natural history [that] takes form and advances" (2003, 82). Following this view, the history of bamboo is less a history of bamboo's materiality alone than a history of its conflation with the human being.

Another point that is significant in this context is that the history of bamboo evolved outside of Europe for the simple reason that there was no bamboo in Europe. It is a history that existed long before the rise of European empires and their domination over the non-European world. Hence, bamboo's history and its contribution to technological development evolved long before the beginnings of the Industrial Revolution and the spread of Western-based technologies. Therefore, investigating bamboo's part in pre-industrial and pre-colonial as well as in colonized and postcolonial societies must consider bamboo's meaning to those societies in question and the influence of bamboo on their technological choices.

Accordingly, when writing about bamboo culture and non-respectively pre-industrial technology, the Western-based understanding and coining of the term *technology* must be reflected, and space must be provided for a reflection of the non-European history of technology since each society has a different approach to technology. For instance, Needham and Wang (1956) have proven that people in ancient China had other methods, concepts, and strategies for handling technology in comparison to people in Western countries. According to them, Daoism as well as Confucianism, conceived of as a "combination of philosophy and religion, also

[22] Using the term non*human* implites some sort of anthropocentrism due to the term *human* as part of its composition but still is worthwhile because it has less restriction of agency contrary to the terms subject (active) and object (inert).

incorporating 'proto'-science and magic," are essential "for the understanding of all Chinese science and technology" (1956, II, 33).

In the following chapters, I shall try to depict theoretical assumptions that are useful to describe the complex interconnectedness of social practices involving bamboo, since the analysis of such kinds of relationships constitutes my principal research question. Accordingly, my approach aims to underscore the interaction, connectedness, mutuality, context, and agency of the human-bamboo relationship. Therefore, my conceptual model is elaborated based on the theoretical presumption in this chapter, which seeks to scrutinize how nonhuman actors such as bamboo—as entities of nature, technology, and the human-made world—form humankind. Such an approach means probing the interaction of bamboo with the human. How did bamboo's very materiality affect the bamboo culture that humans developed? Is it possible that mundane objects (such as bamboo baskets or containers) or bamboo constructions (such as bridges or houses) *act* or *inter*act with humans and nonhumans? In this context, I shall analyze and discuss concepts of materiality and their relation to human creativity, perception, work, identity, society, and activity. In doing so, I am in agreement with Ingold, who holds that "to understand materials is to be able to tell their histories—of what they do and what happens to them when treated in particular ways—in the very practice of working with them" (2012, 434).

Outline of this chapter

In this chapter, I shall discuss various issues that are, in my view, essential and indispensable in order to discuss the human-bamboo relationship thoroughly. In this light, this chapter's versatile discussions and findings regarding the properties of human-thing relations or human-bamboo relations were fundamental for my (anthropological and historical) search for commonalities underlying people's bamboo cultures. What is more, throughout the chapters of *Part C: Historical and Contemporary Perspectives on Bamboo Cultures,* I will draw on, modify, and enhance my findings and discussions elaborated in this chapter by referring to my empirical observations and literature analysis.

Overall, this chapter (5) critically examines Western dualisms and their underlying dualistic concepts of nature vs. society (technology or culture), notions of materiality and technology, and issues related to the repositioning of the social. Chapter 5 thus forms the necessary background knowledge to permit an extensive discussion about the characteristics of the human-bamboo relationship as well as collectives, including humans and nonhumans. At the same time, I claim that only a less Western-tainted, anthropocentric analytical approach concerning the characteristics of pre- and nonindustrial societies' material culture, technology, or indigenous knowledge can one analyze and interpret human-thing relationships. Consequently, chapter 5 will provide the theoretical basis for my further discussion of indigenous knowledge, indigenous technology, sustainable development, and alternatives to unilineal views about development and well-being in chapter 6.

In what follows, I will outline the main topics of this chapter and their relevance regarding the subject of this dissertation. Yet, concerning the structure and topics of this chapter, it should be said that these chapters complement the other chapters in this work.

After my abovementioned introductory remarks concerning my research perspective (5.1), chapter 5.2 will address ontological problems that emerge when studying a particular human-nonhuman relationship as done by this work. In doing so, in chapter 5.2.1, I will first take a critical look at Western philosophy and science's dualistic concepts of nature, technology, and society. This will lead to Immanuel Kant's philosophy because his idea, emphasizing the epistemological limitations inherent to humans, had a major impact on succeeding scholars in the humanities, philosophy, and social sciences. Then, I shall critically discuss humans' uniqueness and how Western conceptions of ourselves relate to how we perceive ourselves and the nonhuman animate and inanimate world. After briefly emphasizing how human history is shaped and mediated by nature and technology rather than by the self-contained actions of humans alone, I shall present non-oppositional perceptions of nature, technology, society, or culture (5.2.2).

Accordingly, chapter 5.2.2 is concerned with the question of how to define, conceptualize, and where to locate the *social*. After emphasizing the deficiency of classical social theories in giving an appropriate description of the social, I will point out alternative socio-material approaches that attempt to include the nonhuman entities as part of human sociality in their epistemological approaches to the social. In brief, I will describe my approach to both practice theory and ANT alongside Ingold's theoretical models concerning the social and explain how I took advantage of their theoretical assumptions for a discussion of the traits of humans and nonhumans, or more precisely, the intricacies of humans and bamboos. In doing so, however, instead of seeing these approaches only as theories, I highlight their methodological advantage for my practice-oriented material studies from anthropological and historical viewpoints.

After this first introduction, I will explain the individual theories once again in more detail. Thus, in chapter 5.2.3, I briefly summarize how the *cultural turn* affected scholars and led to paradigm shifts that contributed to post-structuralist theories and, finally, to new ways to study human practices—yet without preconceived assumptions, as in traditional social theories with their narrowing notion of culture. In this context, I introduce the principles of practice theory as a social ontology. After the elaboration of practice theory's attempts to redefine the *social* (5.2.3.1) and their refocus on practices (5.2.3.2) following the example of Andreas Reckwitz's and Theodore Schatzki's notions of *practices*, the second part of this chapter (5.2.4) is concerned with the Actor-Network-Theory (ANT) and its symmetric approach to and integration of nonhuman entities to the realm of humans. Since ANT's symmetric approach contrasts traditional anthropocentric views, it has faced harsh criticism, and some of its critiques will be discussed at the end of the same chapter.

The next chapter (5.2.5) discusses Ingold's socio-material approach that he calls *meshwork* and in which he emphatically recommends acknowledgment of the process of a human individual's development in her/his interaction with matter. Ingold discusses the meaning of the concept of environment and questions whether the human being is a self-contained being or an organism amongst other beings and, in doing so, questions the principles of human sociality. Simultaneously, following Ingold, I address how the human being, in view of its cognitive and bodily abilities, conflates with material agency, and elaborate on humans' dialectic interaction with matter—both the discussion of the concept of environment and the bodily involvement in doing things provide a profound understanding of human-thing relationships in general and are of outstanding importance for my approach to the human-bamboo relationship.

The purpose of chapter 5.3 is to reflect on the characteristics of materiality as one part of the human-thing relationship. Accordingly, I start with an elaboration on the differences between the problematic categorizations and dualistic concepts of artifact vs. naturefact (and their relatedness to intention) in chapter 5.3.1. The subsequent chapter (5.3.2) is concerned with different notions of the terms *thing* and *object,* how both express action differently, and how both are related to agency. After a brief introduction to Martin Heidegger's concept of the term *thing*, I shall portray Tim Ingold's and Bruno Latour's interpretation of Heidegger and how both define their concepts of things and objects. This discussion is followed by a comparison of Aristotle's concept of *substances* with ideas of the *new materialism* and subsequent interpretations of (human and nonhuman) agency. This discussion's underlying goal is to achieve more profound and versatile access to the agency of nonhuman things as one integral part of human-thing relationships.

In the second part of chapter 5.3, I shall address the becoming of things. I begin with a critical outline of Aristotle's hylomorphism concept and its shortcomings and compare it with alternative ways of how matter and form may be conceptualized, namely, as mutually integral to each other (5.3.3). In this view, I shall devote attention to Deleuze and Guattari's understanding of matter and form-giving and their notion of how craftspersons and things encounter and interact. In this context, the next section (5.3.4) discusses human-thing entities by referring to Ingold's well-known example of *basketry weaving* and Malafouris's *potter's wheel* to exemplify the mutual interaction of a human's bodily skill and a material's property—as vividly expressed by Malafouris's concept of a *brain-artifact-interface*.

The next section (5.4) is concerned with the concepts of material culture and bamboo culture and bamboo's material history. Hence, in chapter 5.4.1, after introducing the concept of *material* and *immaterial culture* and the significance of the embeddedness of things in the context of human action, I shall discuss the characteristics of material culture studies and describe some of its deficiencies that come to the foreground if *material culture* is construed only in terms of tangible things and, as a result, neglects the semi-tangible and nonmaterial things. Therefore, I shall illustrate the mutual relationship between physical and less/non-physical entities, which will later be the subject of my analysis of the intertwining of humans and nonhumans from the perspective of ANT in chapter 7.6.3.2. What is more, since things are also assigned with symbolic meaning, I shall briefly outline various approaches addressing the symbolic meaning of things. These previous discussion threads permit, on the one hand, to study bamboo and its intertwining in human activities from different points of view and, at the same time, to propose my definition of *bamboo culture* (in chapter 5.4.2) by referring to the material culture concepts mentioned above.

Since this thesis also attempts to study bamboo's material history, chapter 5.4.3 is concerned with bamboo's use in prehistoric times. Here, I shall first outline the so-called *Movius Hypothesis* that gives some explanation concerning the distribution of bifacial stone tools in the Paleolithic Old World—based on the fact that stone tools are less common in East and southern East Asia compared to the rest of the pre-Columbian world. And then, thematically based on the *Movius Hypothesis*, I shall point out the *Bamboo Hypothesis* and its attempt to explain why stone tools were less common in East and southern East Asia.

In the next chapter (5.5), I comment on the Western-based term *technology* in contrast to its origin *technē* and describe how technology emerged in conjunction with industrialization and later anticipated the downfall of skillful manual work. After portraying the ancient Greek meaning of *technē* and its relatedness to handicraft, and how the relation of tools and machines evolved in the course of the history of humankind, and how the relation to nature changed with industrial development, I shall introduce some definitions of the term technology related to Western industrialization (5.5.1). The second part (5.5.2) of chapter 5.5 will provide a glimpse into labor division and alienation of work associated with industrialization and machine-based work by reference to a bamboo chopstick factory in Vietnam. This issue's main objective is to discuss how bamboo is transformed from an artisanal, manually processed raw material into an industrial raw material in contemporary times and what consequences this transition implies for the workers.

Chapter 5.6, then, addresses the principles of technological change as part of a human-nature history as processual and dynamic rather than as a unilineal development. For that reason, I introduce, with critical remarks, three theories of technological change: diffusionism (5.6.1), social determinism, and (to a lesser extent) technological determinism (5.6.2), and finally conclude with my understanding concerning the *explanans* of technological change in chapter 5.6.3.

One last thing to note here in accordance with my approach to the *social* is the following dilemma. Although I principally argue for critical approaches of Western dualisms and even though I pledge for a non-dualistic approach and language, I could not avoid terms such as *technical*, *social*, *natural*, or *cultural* for lack of adequate alternatives. Accordingly, my use of these terms and categories should be regarded as useful analytical instruments for describing my and other scholars' thoughts rather than as clearly distinguishable categories belonging to separated domains.

5.2. Theories About the Social

Having the human-bamboo relationship as one's subject matter gives rise to questions about the traits of this relationship. According to the conventional social sciences' and humanities' view, humans are the only bearers of the social. If that is so, what is the role of nonhuman entities? And what then is the role of bamboo in the human-bamboo relationship? As will be proven by the chapters of *Part C*, which take a closer look at bamboo's part in small-scale and large-scale societies, it is evident that bamboo plays a crucial role in people's everyday activities and affects people's actions. If this is the case, can agency be attributed to bamboo? And if bamboo is intricately interwoven in people's lives, does it take part in the social? If this is the case, where to locate bamboo? In the realm of nature since it is a plant? In the realm of technology or material culture since bamboo is part of local (indigenous) technologies and involved in creating and using countless tools, devices, and things surrounding people. Or can bamboo be found in the arts, literature, or oral stories due to its symbolic meaning? Regardless of whether these questions are answered positively or negatively, discussing a human-nonhuman relationship leads to ontological issues concerned with questions about our very existence, how we live, act, and perceive ourselves, the world we are living in, and the things surrounding us. "Ontologically," as Costantino puts it, "reality is relative, multiple, socially constructed, and ungoverned by natural laws" (2008, 117). Hence, scrutinizing the intimate relationship between humans and bamboo leads to the question about the definition and concepts of society, nature, or technology and how these are related to each other.

It should be emphasized once again, according to the traditional Western view, humans (as rational beings) constitute society as opposed to the natural world; the society and the social are conceived as detached or free from nature, and nature is considered as distinct and extraneous to rational human beings. Therefore, in the first section of this chapter, I shall place special emphasis on the problematic Western dualism of nature versus society and how this dualism leads to problematic conceptions of ourselves and our environment in social sciences and the humanities. In the second part, I shall discuss post-structuralist and post-humanist theories that do not draw a clear distinction between humans and nature, subjects and objects, or humans and nonhumans. These theories, in turn, are of significant analytical relevance for my subject matter concerning the human-bamboo relationship and essential for a discussion of the concept of society, to question what constitutes society, and how nonhuman entities like bamboo can be regarded as part of constellations that include humans and nonhumans and thus how nonhuman entities become part of the social.

5.2.1. Western Dualisms and Other Concepts of Nature

Since the European Enlightenment, nature in Western thought has been considered as a sphere that conditions human existence. It is taken for granted that life without nature would not exist; simultaneously, it was the mechanical concept of nature that has paved the way for the domination of nature. This view resulted in a desubjectification and disqualification of nature and a conception of nature as a resource that can be exploited in any way and, in essence, serves human interests (Görg 1999, 20). What is most striking is that however the Western concept of nature may be defined, it is always defined in contradistinction to society, culture, or technology (ibid., 17). In the same way, in the classical Western view, technology appeared as the product of human beings' rationality. Its primary purpose seemed to be the control and exploitation of the natural world for social benefit. Accordingly, since the world's industrialization, the application of new technologies has depleted the local and global environment's biodiversity and resources. At the same time, technology is still seen as a means to mitigate environmental stress.

First of all, as a result of a dualistic conception of nature opposing society, the social sciences' and humanities' primary subject matter was to study human society detached and independent from nature and other nonhuman entities. In Max Weber's thinking, for instance, sociology is the science "concerning itself with the interpretative understanding of social action" (ibid, 4). Weber's (ibid.) main interest was concerned with the individual, subjective meanings that human actors ascribe to their actions in their mutual relations within specific socio-historical situations. Thus, Weber (2019, 8) speaks explicitly of action as the *human* behavior that takes account of the behaviors of other humans. In doing so, Weber's *a priori* limitation of sociology to humans' actions stems from Kant's anthropocentric assumption postulating a sharp dividing line and demarcation between human and nonhuman animals (Görg 1999, 23). In contrast to humans, nonhuman animals do not *act*, because they have no free will and are not morally capable. As a result, the role of agency was constructed one-sided and confined exclusively to the (intelligible) human being, as a result of which nonhuman animals became the biologists' research field.

In short, Kant's theoretical philosophy is fundamentally based on his statement of human's epistemological limitation. According to Kant, humans cannot transcend their own minds' limitations due to the limits of the human senses. In Kant's view, our mind is subjective and conditions from the outset how we perceive and experience objects in space and time and the world (as expressed with Kant's *thing-in-itself*):

> In fact, if we view the objects of the senses as mere appearances, as is fitting, then we thereby admit at the very same time that a thing in itself underlies them, although we are not acquainted with this thing as it may be constituted in itself, but only with its appearance, i.e., with the way in which our senses are affected by this unknown something. Therefore the understanding, just by the fact that it accepts appearances, also admits to the existence of things in themselves, and to that extent we can say that the representation of such beings as

> underlie the appearances, hence of mere intelligible beings, is not merely permitted but also inevitable. (Kant 2004, 66)

Consequently, Kant's emphasis on the mind's role as an *a priori* conditioning separates the world into the *appearance-for-us* and the *things-in-itself* (Görg 1999, 23). Hence, Kant's concept of nature results in two views of nature. One *nature* exists as such, and the other is mediated by the human mind. As Christoph Görg (ibid., 24) notes, Kant's concept(s) of nature reflect(s) the debate between constructivism and realism: Do we construct and create a *nature-for-us* based on our mind and social categories? Or can we attribute specific characteristics to a *nature-in-itself*, a natural world that exists independently of our conceptual scheme?

Needless to say, the Western distinction of nature and human society is by no means universal but a singular way of thinking about our world. For instance, pre- or nonindustrial indigenous and Western societies have their own particular epistemology, understanding of nature, technology, and society. Therefore, one has to understand each worldview and perception of the environment in its uniqueness and, at the same time, not as diametrically opposing each other. To give an example, contrary to the Western view, in many hunter-gatherer societies or parts of pre-industrial agricultural societies, as Ingold (2000, 45) argues, people perceive and understand themselves as part of their environment/ecosystem and broadly speaking also of nature—and *vice versa,* the surrounding world as part of them. A clear division between nature, technology, culture, or society is not present in such cases. The Bahnar people, whose material culture I studied, for instance, do not perceive themselves as strictly different from the environment surrounding them (see my discussion of Bahnar peoples' perception of their environment and themselves in chapter 7.7). Their technologies are oriented towards sustainable ideas that ensure the conditions needed for their livelihood rather than toward unrestrained exploitation of nature. Such an interconnectedness with nature challenges Western anthropocentric objections that put an emphasis on the uniqueness of humans, though the human being is part of nature and stitched into the fabric of its ecological and material environment.

Moreover, human history is not the history of humans alone; or a history of humans plus the material things humans made. A view that is supported by Schatzki, who writes that "nature mediates all face-to-face interactions among humans and, in conjunction with the physical properties of technology, all interactions among people" (2003, 87). Nature and technology are intermingled with human existence. To put it in some other words of Schatzki: "animals, plants, and climatic or geological phenomena, . . . have always been integral to human coexistence" (ibid.). Thus, humanity and humans' technology, society, and material culture developed in association with nature or animals.[23] Since the beginning of time, humans have made use of animals' physical strength and simultaneously fabricated and consumed goods derived from them (such as meat, milk, or leather). As these examples illustrate, humans' history relies in part on the exploitation of nonhuman animals. The latter are part of our history, as we are part of their (individual and societal) history. Considering humans' development as the outcome of humans' agency alone is anthropocentric and should be handled critically to broaden our perspective and create a better basis for further discussions. If we categorize nonhuman animals as nature and human animals as socio-cultural beings, we bisect a unified whole into two distinct parts.

5.2.2. Nonanthropocentric Approaches to Nature, Society, and Technology

Many classical social theories in the humanities and cultural and social studies, particularly sociology as the scientific study of human society, try to explain the social or fundamental considerations about what constitutes the social. The vast majority of the work in this area has been focused on human-centered sociability, and few attempts have been made to investigate the role of (animate and inanimate) nonhuman entities. One primary rationale for this lack of interest is rooted in anthropocentric ontological assumptions. In general, the traditional understanding of the *social* is limited to humans and rules out nonhuman entities. Therefore, Latour asks polemically, "there is a *social* sociology but where is the *physical* sociology" (2000, 121)? Indeed, many efforts were made by sociological theorists to explain the social through human agency, but they excluded everything nonhuman: nonhuman animals such as chimpanzees, donkeys, dogs, or insects; the human-made things such as baskets, guns, shoes; plants and trees; and as a result of that any material agency.

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[23] Even if human beings have a special role among all animals, especially due to their mental skills (high level of self-reflection), there is, in my view, only a gradual difference between humans and animals. On the one hand, humans have created complex technologies, material cultures, and language. On the other hand, humans still are animals. For instance, the commonality of our locomotor, digestive system, or sexual organs with other animals is obvious. Simultaneously, anthropocentric views confining intentionality, creativity, and self-awareness to humans alone remain questionable. In the present times, animal psychologists, biologists, zoologists, primatologists, though self-contained in their academic disciplines' biased views for a long time, have increasingly revealed insights concerning how closely related humans and animals are. In this light, and to close the gap of the orthodox Western view that distinguishes between the superior humans and the inferior animals, anti-speciesists propose using the less discriminatory terms human and nonhuman animals. In principle, I agree with this demand, but for the sake of linguistic practicability, I shall largely dispense with this differentiation in the thesis and speak further of humans and animals, keeping in mind, however, the criticisms made at this point.

Unsurprisingly, then, although social scientists were first in line to define the social, they achieved partial truths on account of a reductionist perspective on what constitutes the social. Hence, many traditional scholars are locked in a stalemate on the grounds of their binary construction of human existence (such as nature vs. culture or subject vs. object) and their inconsistent theoretical assumptions that widen the gap between theory and practice. One could claim that the significance of everyday life and practices was ignored in favor of complex theoretical structures (e.g., Talcott Parson's structural functionalism or Niklas Luhmann's system theory), which, as grand theories, were developed to find satisfactory explanations about the social realm. Nonetheless, traditional assumptions that proclaim dualistic ideas (nature/culture, subject/object, thing/agency) and an exaltation of the (intelligible) human to the nonhuman's detriment remain unpromising.

In that this work analyzes the human-bamboo relationship, it contrasts sociocentric and anthropocentric viewpoints. In doing so, it is not in accordance with Émile Durkheim's view that the unity of nature and society is in the social (intermediated by humans), that is, in the language (Görg 1999, 18) or communication between humans because this view excludes all nonhumans. Therefore, this work disagrees with an epistemic unity of nature and society, according to which the logical and terminological systems with which humans try to determine and classify nature are formed according to the pattern of (human) social relations and hierarchies. In general, these anthropocentric views contributed much to the constitution of humans' uniqueness and sociability in the humanities and social sciences and gave less intention to people's material culture, the agency of nonhumans, or animal societies, and their underlying material culture.[24]

Supposing scientists want to refocus on both the significance of the human-made material environment and the agency of nonhumans, they must dispense with the Western anthropocentric assumption of the human being as a self-contained one and as the most superior lifeform on earth—wherein the reflexive intelligence is considered as an exclusion criterion. Paying attention to other agents (animate or inanimate) besides the human being raises the question of

[24] See McGrew, W. C. (1992) and its discussion of the material culture of the chimpanzee. Among other assumptions, two arguments relating to material culture are interesting: Firstly, every population of chimpanzees has its specific behavior and customs; and secondly, a new technical innovation by a chimpanzee group requires a traditional reproduction of knowledge to become customary. Thus, the specific utilization of tools for a particular purpose—for example, using a hammer and anvil to open a nut of an oil palm tree—is nothing innate and static, but rather a socially biased learning (McGrew 1992, 13–14). See also Schaik van et al. (2003), who describe the geographic variations of orangutan behavior, arguing that geographic distance correlates with cultural variations.

humanity's uniqueness and the definition of agency. Understanding human beings as one species amongst other species, however, changes the view on the vexed question of what the human is. Nonetheless, my viewpoint does not neglect humanity's outstanding features compared to other organisms. Humans have unique (cognitive and bodily) qualities. And on this account, they have a transformative capacity that empowered them to shape their environment using tools and develop sophisticated and increasingly complex technologies.

In view of this fact, a reorientation makes it possible to overcome Western binary oppositions to the benefit of mutualism, as postulated by non-essentialist socio-material theories pursuing holistic perspectives. As Bolter argues, "posthumanist theory claims to offer a new epistemology that is not anthropocentric and therefore not centered in Cartesian dualism" (2016, 1). Instead, as advocates of posthumanist theories—and (poststructuralist) practice theories—emphatically have proven, the realm of humans is inseparable from (natural or artificial) nonhuman entities. At the very moment when human and nonhuman entities, or in terms of the standard Western definition when *subjects* and *objects*, are involved in practices, analyses based on the Western bifurcation concept fall short. In (social) practices, the human *subject* and the nonhuman (material) *object* are not separable. That being the case, instead of separating both and studying them dissociated from each other, this work attempts to analyze their reciprocity.

In doing so, I follow Ingold (2000, 2012), ANT, and most prominently Latour (2004), and advocates of practice theory such as Schatzki (2001, 2003) and Reckwitz (2002), who (from different perspectives) hold that humans are part of a network (or socio-material assemblage) in which the human develops and interacts directly or indirectly with other organisms, things, or the (natural and artificial) surrounding environment. Moreover, animate and inanimate entities of various materiality play a decisive role in the performance of social practices and are instrumental for social action. Accordingly, reflecting on nonhumans and how humans deal with them raises questions about the agency of nonhumans and how nonhumans *act* upon human actions. This view, in turn, enables analysts of the social to make statements about the material aspects of practices and is one central part of this chapter. For instance, examining pairs of entities as in the case of the compound of the cab driver and the automobile, the soldier and the military uniform, the bambooworker and the machete, or the hunter and the bamboo trap reveals insights into the mutual relations and interdependences of such compounds.

Since this dissertation takes a nonhuman and an inanimate thing (bamboo) as its research interest, it is concerned with ontological and epistemological alternatives to the Western dualisms and hence with socio-material theories that provide a more integral and holistic way of viewing human existence and the role of nonhumans, namely, the abovementioned: ANT, practice theory, and Ingold's theoretical assumptions. In what follows, I shall briefly explain their principal ideas, how I combined their theoretical frameworks and different perspectives for the purpose of defining my research objectives, and how their different concepts framed my methodological approach when analyzing the role and agency of bamboo in relation to human practices and relational networks. In the next subchapters, and in the main chapter of the present work, I shall discuss their principles in more detail and in relation to the main chapter's topics.

Following the practice theory approach, I consider that (social) practices necessarily consist of at least two materials: the human body and the (semi-)tangible object. Thus, the human-material relations offer many points of association incorporated in people's daily activities. In view of this, I explore the question of how the human body, human skill and knowledge, and things (or, in my case, bamboo) relate to each other to carry out practices. Accordingly, practice theory's endeavor to refocus on mundane objects, people's tool use, and the human body reveals many insights into humans' everyday lives and their conflation with matter. Yet, despite practice theory's rejection of an overemphasis of theory to the disadvantage of unbiased empirical access to the field and its fundamental assumption that reality creates truth and not theories, one unsolved problem remains. This is practice theory's anthropocentric approach, which, despite practice theory's worthwhile contribution to a discussion of human-material relations, deliberately limits its scientific scope to the *homo agens*.

Accordingly, the human subject is practice theory's starting point of its reflection on reality, the social, and likewise the human-bamboo relationship. As a result, this restriction provides some advantages but also disadvantages in terms of the interpretation of people's lives. Overall, by following the principles of practice theory, I was able to scrutinize the bamboo-based material world of people, such as the Bahnar people, and how daily practices involved the use of bambooic tools and objects. Moreover, and following Schatzki, I consider "social life" as something that "transpires as part of nexuses of human practices and material arrangements" (2003, 84). Concerning this matter, practices are an association of human and nonhuman entities, in the sense of *a human-using-tools*, a *human-living-in-a-house,* a *human-cooking-food,* a *human-using-a-fishing-rod*, or other compositions. Each arrangement encompasses human and animate or inanimate nonhuman entities. In this light, related to the bamboo culture of Bahnar people in chapter 7, I identified certain practices of Bahnar people that I categorized under the term *profession* (such as a basket weaver, farmer, musician, hunter, gatherer, fisher, architect, engineer, technician, artist, and the like) since these activities are purposeful and require specialized knowledge and skill.

At the same time, practice theory's approach, having the human practitioner in its focus, allows insights into the material counterpart of the human-bamboo relationships both in ancient and contemporary societies since bamboo was essential to carry out many activities in a wide array of domains of life. For instance, through my theory-driven examination of historical sources, I was able to reveal insights on how Chinese farmers in pre-industrial times handled plows and describe how they amalgamated with the plow and other entities into a hybrid entity by depicting it from practice theory's (and ANT's) view. In this view, practice theory provided a general understanding of how people of various epochs and places approached, utilized, and conflated with bambooic tools and objects through which they shaped their material surroundings.

Another more critical view to the fragmented Western perspective on human life is given by ANT. Instead of partializing the indivisible world into self-contained segments, ANT considers every individual as enmeshed in a specific web that consists of countless mutually dependent aspects. As argued by Latour, if we conceive that "nature assembles non-humans apart from the humans" for one thing, and, for another thing, that "society collects humans apart from the non-humans," the human social world and nature exist in different spheres (2005, 164). In contrast, ANT maintains that agency is produced through associations in a network in which neither nature, culture, technology, nor society exists independently, for these categories are socially constructed and intermingled with each other in real life (ibid., 75). One could say that technology (or nature) creates culture (or society), as much as culture (or society) creates technology (or nature). For instance, technology is in no way neutral; it shapes our world and opens new possibilities. It has bearings on the way we act as much as on what we do as social beings.

Accordingly, due to the decentralization of the human actor or the human practitioner as the core center of practices and its symmetric approach based on a flat ontology and its analytical openness for nonhumans (and nonhumans' potential agency and ability to build associations within a network), as claimed and promulgated by ANT, further and other mutual independencies (which the human is not necessarily part of) can be found, analyzed, and described. Thus, in comparison to practice theory, ANT also allows us "to connect practices to the wider network of practices," which methodologically also means to follow "the actions of network-builders instead of following the practitioner" (Alhonnoro 2014, 21, 23).

Yet, these views imply two questions I briefly want to address. What is meant by nonhumans, and "what does it mean to say that nonhumans have agency" (Sayes 2014) in ANT's methodological framework? Proponents and opponents of ANT controversially discuss ANT's symmetric approach, its integration of nonhumans into the sphere of the social, and its attribution of agency to nonhumans. As Sayes points out, the concept of nonhuman has varied in the development of ANT and now encompasses tools, objects, animals, insects, artifacts and naturefacts, tangible and semi-tangible things, as well as natural phenomena and ideas (ibid., 136). I will follow this comprehensive understanding of the concept of nonhuman and Sayes's differentiation of four senses of ANT's nonhuman concept, which I elaborate on in chapter 5.2.4. And by having a very broad concept of the nonhuman, my definition of agency attributed to the nonhuman is, in the words of Sayes and in the sense of ANT, "decoupled from criteria of intentionality, subjectivity, and freewill" (ibid., 141).

In view of that, ANT provided fresh impulses in my analysis of human-thing hybrids and actor-networks. One actor-network that I was able to observe and identify during my fieldwork at the Bahnar people emerges as a result of a reciprocal relationship that develops around the Bahnar people's shifting cultivation and their bamboo culture (understood as the material surroundings, including tools, objects, and the human-made material environment). Rather than having the human being in the core center of the network, the study of a wide array of entities (human or nonhuman, animate or inanimate, and tangible, less tangible, or nonmaterial) revealed much about the characteristics of this network.

For a better illustration of the insights offered by ANT-driven ethnographic approaches, in what follows, I shall briefly summarize the relatedness of humans and nonhumans as part of the actor-network revolving around shifting cultivation and Bahnar people's bamboo culture: In general, the preparation, cultivation, and protection of agricultural land by Bahnar peasants depend on the interplay of human activities, the involvement of tools, and other nonhumans. These nonhumans, understood in their comprehensive variant, can be tangible, semi-tangible, or nonmaterial in their material consistency. For instance, fire is a semi-tangible thing but essential in the transition of forests to agricultural land during the burning process as one step of shifting agriculture. The burning process, in turn, relates to another semi-tangible thing, namely the wind that affects the direction and strength of fires. Time is another intangible factor since climate conditions (rainy and dry season or temperatures and global warming) influence the growth of seedlings and harvest time. In some cases, such as in the competition of various plants and weeds with the rice grain for sunlight and nutrition, a certain kind of nonhuman-nonhuman relationship emerges. In this mutual relationship, the various nonhuman entities (plants) influence each other's very existence and are also influenced by the sun, rain, or soil conditions necessary for their growth. At the same time, undesired plants and weeds *force* Bahnar peasants to weed them out since they would limit the growth of rice plants and, so, diminish the rice yield. In other words, nonhumans evoke a human action, namely, weeding.

Moreover, the rice variety's characteristics are also crucial because they determine a plant's growth habit and resistance to harsh weather conditions and insect or fungal infestation. In this light, nonhumans of various origins and material consistency are intertwined and cause effects in the network. Concerning bamboo, the Bahnar people's bamboo technology, their use of bambooic (agricultural) tools, and the preceding creation of these tools is the necessary backdrop for agricultural work, and lastly, the principles of shifting cultivation and the actor-network encompassing the abovementioned entities.

To summarize, every entity is in one way or another connected to the network, and these entities' agency results from their relatedness to the network. At the same time, each entity contributes to the creation, emergence, and stabilization of the network and, so, profoundly impacts the success of farmland management. In a similar manner I shall describe, for instance, the various human and nonhuman entities' roles in relation to the Japanese tea ceremony in chapter 9.3.2 and identify some possible viewpoints of how the latter might be studied from ANT's perspective.

To sum up, practice theory and ANT significantly diverge on the question of where to locate the social. For practice theory, the practice is the smallest part of the social, and the human practitioner is the carrier of practices. Using ANT's material-semiotic approach, however, the social cannot be placed into human actions but is part of a network and the output of the movements of associations of such a network. The social emerges as a result of the interplay of all entities, whether they are humans or not. Consequently, practice theory and ANT epitomize different empirical approaches and access to society. Practice theory offers the chance to study social practices involving bamboo but simultaneously has a human-centered focus; ANT does not shy away from explanations of the social that explicitly includes nonhumans. At the same time, both are anti-essentialist in their views and process-depicting in their analyses, and claim that the social is reproduced rather than fixed somewhere. In doing so, both defy traditional social ontologies and monocausal explanations related to methodological holism or methodological individualism.

By and large, both theories' strength is the inclusion of the material foundation of human life, while ANT goes a step further in its inclusion of various actors. On the other hand, ANT's overemphasis of heterogeneous actors invokes vague boundaries in its analysis, and practice theory's overemphasis on practices, as associated and assembled through the *individual*, unnecessarily restricts their respective scientific research. But taken together, both can compensate for the other's shortcomings and weaknesses, allow the examination of the relationship between humans and bamboo from different perspectives, offer ways to understand bamboo's relevance in various fields, and contribute to a mutually complementing reflections on whether bamboo is part of the *social*. In this sense, I was able to relate my practice theory-driven interpretation and findings of the various *professions* of Bahnar people with my observations of the actor-network revolving around shifting cultivation and bamboo culture. Combining both provided a more detailed insight into the practices and the broader network in which the practices took place and also provided an analysis of entities that are not directly related to human practices. Moreover, both theories taken together were also helpful in depicting other parts and components of the human-bamboo relationship and other forms of associations such as the network evolving around the Bahnar bamboo stilt house as discussed in chapter 7.6.3.2, where I once again describe how various entities of semi-, tangible, and nonmaterial appearance come into play.

Tim Ingold (2000, 2012) also seeks to overcome the constraints that emerge with the Western dualistic view, particularly with the dichotomy of humans and nonhumans and devotes his attention to many issues, including our perception of the environment, the conception of body and mind, the conceptions of ecology, how humans interact and develop through matter as sensuous beings, how individuals develop personal skills, and contests the binary between art and technology. In doing so, the issues tackled by Ingold overlap with practice theory and ANT but provide further significant insights that make it possible to scrutinize certain issues from another perspective. Moreover, Ingold develops his own concept in contrast to the material arrangement (practice theory) and actor-networks (ANT), which he calls *meshworks* and in which Ingold examines the human-material conflation of activities and things as emergent from a mutually interdependent process.

Overall, Ingold's thoughts provided a distinct and insightful approach to the social world and human development. To give an example, in relation to my analysis of the creation of a bamboo sheath for a knife, I benefited from Ingold's theoretical assumptions related to the becoming of things and human skill to interpret the human-thing conflation as part of human actions in the process of doings and making things. Ingold's critical ideas to form-giving (as will be discussed in contrast to Aristotle's hylomorphism model in chapter 5.3.3) underscore the human being's multi-sensory approach to a material's materiality at the very moment of activity. As Ingold (2012, 432) states, the human individual, the applied tools, and the raw material collaborate not figurately but literally. Thus, a bambooworker in action is always a bambooworker plus tool plus bamboo and becomes a hybrid being that involves many entities in its activities. And this fact demonstrates that the mind should not be conceived as the predetermining factor that gives shape to any material, even though human intentionality, intelligence, rationality, and abstract reasoning are involved (ibid.).

Concerning my methodology, all three theories (and others), and their distinct empirical approaches, were of outstanding value in analyzing the scope of socio-material associations and reinterpreting the characteristics of the human-bamboo relationship by taking account of their guiding principles. Consequently, all theories were helpful in choosing, developing, and deploying methods for my anthropological work and ethnographic approach (as discussed in chapter 6.3) and in conducting a socio-material and theory-driven textual and non-textual analysis of primary and secondary sources (including texts and photographic images, sketches, drawings, and paintings of bamboo objects from various periods) and to position the various issues of each chapter in connection with the general subject of this thesis.

In conclusion, instead of separating society from nature or technology, emphasizing their reciprocity is indisputably of ontological and analytical interest. In this context, this work proposes hypotheses in view of principles of the abovementioned theories and their distinct socio-material approaches. Overall, this work attempts to identify the material aspect of human action and practices concerning bamboo and is thereby a materialistic approach that reintegrates the nonhuman as a constituent part of a network (material arrangement or meshwork) alongside the human.

What is more, even though I have discussed the fundamental characteristics of ANT and practice theory, in chapter 7.6, I shall again discuss and use both concepts in my attempt for a social ontological flat approach to and explanation of the human-bamboo relationship based on the bamboo culture of peasants practicing shifting cultivation—since both concepts draw our attention to distinctive categories of the social and, in doing so, provide different analyses to trace humans' relationship with bamboo.

5.2.3. Practice Theory

Induced by the linguistic turn and cultural turn, many aspects of prevailing findings and truths of humanist and modernist thought were challenged and led to fundamental changes in elementary ideas and thoughts. The studies of the philosopher Ludwig Wittgenstein (1953) and of the linguist Ferdinand de Saussure (1916) (sign system, signifier, signified) on language, carried out in the early twentieth century, provided the foundation for further analysis of language. Both scholars' studies emphasized that language determines human beings' very existence, and their ideas had a lasting effect on the later generations of philosophers and scholars in the humanities. For instance, Saussure's sign system gave birth to structuralism.

The cultural turn could be conceived as a further development of the linguistic turn, insofar as it expands the realm of language to other communication aspects. It has raised questions about the definition of culture as something structurally unified, symbolized, and systematic.

Finally, due to the linguistic and cultural turn, Western science's pillars become shaky and resulted in paradigm shifts that altered underlying ontological and epistemological assumptions and scientific interpretations that initially led to the development of constructivist social and cultural theories. These theories, however, focused less on materialistic than on cultural or discursive constructivist aspects of the social. Later, scholars attempted to abandon the dualistic assumptions and criticized the anthropocentric focus of previous social constructivist theories—their emphasis on the coexistence of humans and nonhumans paved new ways to understand human life and humanity. As a consequence, posthumanist theories seek "to undermine the traditional boundaries between the human, the animal, and the technological" (Bolter 2016, 1).

Accordingly, instead of the deductive method, which uses theoretical concepts and categories as a sort of template which the data about the real world must fit in, scholars of different disciplines have shown that assumptions of social living should not be geared to previous theoretical premises. One should gain data the other way around, namely through empirical observation. For that reason, some theorists debated on the intricate question of what *really* happens in the *real* world and made this question their primary research topic. Their leading question discusses the activities in which humans are involved, and by responding to that question, they strive to close the gap between practice and theory. Because of their theoretical assumptions, these scholars turned their attention to empirical and material analyses and were less confined by preconceived expectations than a normative cultural concept as in holistic or structuralist explanations. Their theory, which is a compound of many diverse theoretical hypotheses, became known as *practice theory*. It is a specific theory of practice that inclines to define culture with reference to the practice as part or outcome of the individuals rather than external to them and has its roots in science and technology studies (STS).

Culture in practice theory is conceived as dynamic and context-dependent rather than static and timeless or abstract in the sense of a system of symbols. Culture, conceived as a product of practice, is reproduced through social actions. In turn, practices are equally dynamic and stable and are related to countless activities, which is why there is still no generally accepted definition of the term *practice*. However, since practice in practice theory is materialistic—for (at least) two material entities, the human body and the nonhuman entity (tool, thing, artifact, objects, etc.), encounter in practices—any division between culture and materiality is obsolete for post-structural practice theorists. As a result, practice is thought to be embodied. Thus, "the forms of human activity," as Schatzki finds, "are entwined with the character of the human body" (2001, 11). At the very moment when our body is part of a practice, it is a prerequisite and a materialization of the practice itself. Accordingly, the practice theorists' approach to culture cut across the formulation to the extent that they "recognize the co-existence of alternative practices within the same cultural milieu, differing conceptions of or perspectives on the same practices, and ongoing contestation and struggle over the maintenance and reproduction of cultural norms" (Rouse 2007, 506). Being capable of observing the same practice from different angles allows insights into causal relationships of its components that would otherwise remain secret.

5.2.3.1. Redefining the Social

The commonality of practice theories is their attempt to redefine the *social* and, in doing so, they are in opposition to classical sociologists, which underscore the significance of the social structure related to the collective and contrast social theories that put special emphasis on the individual's actions and activities but, generally speaking, highlight the relation between agency and structure. Accordingly, practice theorists re-evaluate the traits of human sociality, social phenomena, and the characteristics of agents and agency. They question what the *social* is about, where to locate the social, and due to its study of the nature and principles of the social world, practice theory is a socio-material theory since it takes into account the human being, the human body, and the material surroundings as part of practices into account. Moreover, it is a social ontology, which is, generally speaking, the study of the essence of social facts, that is, "the study of the social realm, where the latter is taken as comprising those phenomena whose coming into being and/or continuing existence depends necessarily on human beings and their interactions" (Lawson 2014, 11)—yet, practice theory puts a special emphasis on the material things that humans' practices involve. Pursuing the abovementioned questions, practice theorists gain another, more fundamental access to the essence of human living and society—yet without adding a further explainability of the purpose of human existence or the purposiveness of nature. Overall, practice theory reflects anew on the essential questions with which early sociologists were concerned. Nevertheless, rather than finding a coherent theoretical explanation and consensus about its subject matter, practice theory synthesizes multifaced theoretical conceptions based on a dynamic and open research basis to avoid preceding essential and timeless explanations (Schatzki 2001, 12). Accordingly, and as mentioned above, the practice in practice theory allows distinct access to and interpretation of what determines the social. As Nicolini argues with relation to Reckwitz's modeling of the humanities and social sciences' view concerning human beings' underlying social role and determination: "while *homo economicus* is conceived as a (semi) rational decision maker and *homo sociologicus* is depicted as a norm-following, role-performing individual, *homo practicus* is conceived as a carrier of practices, a body/mind who 'carries,' but also 'carries out,' social practices" (2013, 4; citing Reckwitz 2002, 256).

Classical social theories such as the structural-functional theory, the rational choice theory, the social conflict theory, or symbolic interactionalism neglected the significance of nonhuman entities concerning humans' everyday practices. Despite their insightful contributions to theory building and analytical interpretation of society, each theory's models and concepts are fraught with problems, particularly in conjunction with the question of where and how to locate the social.[25] In sum, these theoretical models represent the discussions between methodological

[25] In the following, I briefly introduce the major theories about the social. According to the structural-functional theory, society is a sort of system. Metaphorically often exemplified as an organism, in which all parts are interconnected to each other and setting the entire system in motion and functioning through a mutual relationship of

individualists at one extreme on this issue, and methodological holists at the other extreme. It is a debate between the explanation of social phenomena on a micro-level (methodological individualism) and macro-level (methodological holism), in other words, with a focus on the features of the actors or the structure.

The methodological holism and structure-functionalist models give priority to the whole system. They point up the independence of its parts from the whole. In contrast, methodological individualism claims that individual actions are the reason and outcome for social phenomena. Poststructuralist practical theorists contradict these objectivistic narratives about social phenomena, in which underlying theoretical assumptions are preconceived, and seek to find insights through their relatedness to multiple practices. In this sense, practice theory's iconoclastic texts are against Durkheim's normativism and against his scientific endeavor to find explanations or rules for sociality (or social facts) by highlighting social regularity at the cost of context-dependent practices just as physical or biological patterns of bodily and thing-related performance of the human activity.

In sum, the outstanding achievement of advocates of practice theory is their endeavor to refocus on mundane objects, the human body, and the significance of everyday life. They deny the assumptions of traditional social constructivism and linguistic constructivism because both preclude the nonhumans or reduce all phenomena with dependence on language. And they contradict logocentric models of agency that emphasize the mind in its role as the regulating and ordering power prior to life. Seen from this angle, practice theorists provide an alternative view on society in relation to traditional culture theories in which culture as a phenomenon is exclusively a product of our mind. Therefore, they are in opposition to the idea of structure and locate the social itself in the practices and not in the mind. Hence, the individuals play a decisive role because they engender culture through practice alongside nonhuman entities. By and large, on account of their critical thoughts, practical theorists have given new impulses to sociology and social sciences on a theoretical, methodological, and analytical level.[26]

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its components. While the structuralist theory highlights the importance of the whole system or structure, the rational choice theory emphasizes the individuum as the bearer of decisions and agency. As such, it as a micro-theory that attempts to model how individual rationality and action as initial factors conflate and contribute or instead produce the social. Social conflict theories scrutinize the principles for the inequality of societies that generate conflicts. Symbolic interactionism, in turn, is primarily preoccupied with the significance of language and symbolism for social living and attempts to figure out how we interact with other humans as well as with the world we are living in. It is a social-constructivist theory, for it presupposes that reality is socially constructed.

[26] The representatives of practice theory redefined or introduced new concepts for their social ontology that would allow the humans' and nonhumans' properties to be described in a similar way, and so paved the way for the practice turn. Some prominent advocates are Pierre Bourdieu (habitus, capital, field), Anthony Giddens (theory of

As to the shortcomings and criticism of practice theory, one may identify several issues. As Warde explains, these are practice theory's "theoretical imprecision, its methodological eclecticism, its potential political conservatism and the difficulties with its application of policy" (2014, 11). Others are related to the overestimation of agency, philosophical definitions concerning the relation of "mind, body, things, social context, and action" or the "scope of theories of practice" (ibid.). I have already discussed some aspects of these problems in the previous chapters. Despite all possible deficiencies, practice theory approaches, as I hope to prove below, develop valuable concepts and models that allow a detailed examination of nonhuman things such as bamboo.

5.2.3.2. Refocus on Practices

Given that practice is the core element of practice theory, I shall elaborate on different notions and concepts of practice in the following. As Reckwitz (2002, 244) argues, Wittgenstein, and to a lesser degree, Heidegger—both provided important impulses to the concept of practice—were concerned with the refocus on practices as part of the everyday culture and action. In his *Philosophical Investigations* (1953), Wittgenstein, as discussed by Rouse (2007, 502), came, in his critical discussion of rule-following, to the conclusion that rules are not deterministic but allow deviant behavior. Human action, therefore, is not as consistently in conformity with rules depending on ideas or norms but is practice-dependent. The principle of interpretation, as Rouse states, is also discussed by Heidegger in his seminal work *Being and Time* (1962)—first published in 1927 as *Sein und Zeit* in German. "For Heidegger," as Rouse writes, "interpretation is involved whenever one interprets something 'as' something, . . . or by making explicit assertions about it" (ibid., 503). In brief, for Heidegger, "interpretation is governed by a general sense of what brings it to fulfillment or completion" (ibid.); it is, in Heidegger's words, "the expression of the existential *fore-structure* of Dasein itself" (1962, 195).

As in the famous example of Heidegger's hammering (ibid., 98), a prior understanding of the hammer's qualities and its potential uses is essential to be in charge of using a hammer as a

structuration, agency), Michel Foucault (structure and power and social control), Theodore Schatzki (practices, doings and sayings, nexuses), Bruno Latour (human and nonhuman agents, actor-network), Charles Taylor (incorporation of agency) (for a brief introduction of advocates of practice theory, see also Schatzki 2001, 10–11). All are considered as poststructuralists and reject structuralism and its explanation of human culture based on language, although still assuming that language is essential and that language forms and shapes reality. However, they do not think that language alone is genuinely useful to explain reality.

hammer. “Only because equipment has this ‘Being-in-itself,’ and does not merely occur,” as Heidegger puts it, “is it manipulable in the broadest sense and at our disposal” (ibid.). Underpinning Heidegger’s notion, Rouse (2007, 503) states that a prior understanding is essential for interpretation and makes this assumption evident by the example of carpentry and the required equipment and things: “One must already understand the general context of carpentry (the relation between hammers, boards, nails, buildings or furniture, and the various purposes they serve), one must have a sense of how to proceed (hammers must be picked up to be used, held by the handle, swung rather than thrown, hit the nail on the head rather than the shaft and so forth)” (ibid.). Heidegger notes on that issue that “to the Being of any equipment there always belongs a totality of equipment, in which it can be this equipment that it is,” which is the reason why “there lies an *assignment* or *reference* of something to something” (1962, 97). Thus, an interrelation of things constitutes our world. In sum, for Heidegger (1962), it is the practical approach of the human being to the environment that is primordial and, therefore, is much more essential than a merely theoretical approach. In this sense, my approach to bamboo is also a practical as well as theory-driven approach. It was only through my observation of the use of bamboo in practice that I gained an appreciation and awareness of its broader context.

In practice theory’s theoretical approach, the smallest part of the social is located in practices, constituted by the doing, saying, thinking, acting, performing, feeling, and perceiving of individuals in interaction with other humans and nonhumans. There are a variety of practices such as practices of consumption, practices of ceremonies (funeral, cremation, or anniversary celebration), or practices of artifact and tool use. Moreover, these practices could be everyday or occasional practices; they might be profane or spiritual, and commonly known and accepted, or elite and unaccepted. “Applications of the practice idiom,” as Rouse puts it, “extend from the most mundane aspects of everyday life to highly structured activities in institutional settings” (2007, 499). A further aspect of practice is that its performance either is ephemeral and belongs to a particular place and time or else, its performance pattern might be stable and longstanding (ibid.). In any case, the sum of all individual everyday actions or practices re-creates society, culture, and history anew.

Instead of finding an explanatory approach of social phenomena in the socially acting human individual, in practice theory, more entities besides the human being are participants and enmeshed together to engender sociality. Moreover, in practice theory, the whole human being with its body, that is, with its sensuous and physical capacities (sense of touch, hearing, seeing, smelling, tasting), is involved in each practice where it encounters the material world. Thereby, practice theory avoids the antagonism of mind and body or the antagonism of mind and matter. In one sense, practice is bound to the human body, but in another sense, it is concerned with networks of materials on which human agency depends. "Practice theorists," as Rouse argues, "understand human bodies as both the locus of agency, affective response and cultural expression, and the target of power and normalization" (ibid., 512). Analyzing the patterns of performance demands elaborating on the things involved, the material environment, and the material culture. Day by day, we encounter various things such as pencils, nail scissors, shoelaces, fish traps, blending machines, escalators, fridges, computers, or bamboo flutes. In handling, using, and negotiating with these everyday artifacts, *the practice* in practice theory is revealed. The entanglement of these things with human life is, in many cases, not explicitly orally expressed but is tacit and takes place in secret.

Therefore, it is not just the physical nature of material things that practice theory is concerned with, but also its conflation with human agency and their embeddedness in action conceived as a social practice. The very instant humans and nonhumans encounter, they begin conflating due to their mutual interaction—what we have is a *human-and-thing-in-action*. As assumed in previous constructivist theories, the nonhuman other is not a solely cultural or symbolic coded material representative *other* but an entity in a certain kind of practice. The nonhuman other is part of what Heidegger called *referential totality*, according to which "individual entities are derivative of the total referential system" (Harman 2002, 168). This view broadens the perspective on our lives and challenges the prevailing Western dualism and its inherent antithetical principles. The world, then, cannot be separated into two opposing parts any longer. A bipolar world, in which the rational human subject (as the acting being) opposes the inert inorganic object, remains problematic. Such a division is averse to the conceptions of practice theory.

Matter matters and things are significant and do not exist as merely symbolic things. Things play their part and contribute to the realization of practice, and it is this circumstance that endows them with relevance. Only when a bamboo blowgun is put into action does it refer to its property to hunt birds, and only then is the blowgun provided with significance—and not as a solely symbolically coded thing. Besides an entity's relation to action, however, one should devote attention to the underlying manufacturing technique, a thing's use, manipulation, but also to its users. This approach, then, means "that the actor," as Lemonnier has put it, "is being reintroduced into the study of techniques" (2012, 19). Therefore, studying bamboo in this dissertation's notion reintroduces people and how they work and produce things.

Practice in everyday life is a skillful or skill-dependent practice, which means that most things we do are related to an antecedent learning process or mental and cognitive incorporation. Skill depends on our body and its involvement in practice. Apart from that, practices are close to the meaningful use of things, making practical performance possible because things generally enable or constrain human activities. Against this backdrop, all humans are skillful artists, for we embody countless skills and abilities that shape the way we live.[27] Each human is a kind of storage for each human memorizes what she/he already has learned and experienced through things, their use, and their modification.

Reckwitz's Practice Approach

According to Reckwitz, "a 'practice' (Praktik) is a routinized type of behavior which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (2002, 249). For Reckwitz (2002, 250), these elements form a *block* on the grounds of their reciprocity. They are the practice and bring forth the practice and can by no means be reduced to one element. Hence, the manner Bahnar people cook, hunt, fish, play music, and build their houses can be understood as practices involving the mentioned elements: human body and mind, things, and humans' purposeful, emotional actions. In this way, a Bahnar peasant is "a bodily and mental agent" who "acts as the 'carrier' (Träger) of a practice—and, in fact, of many different practices" (ibid.).

In Reckwitz's praxeological view, "a social practice is the product of training the body in a certain way" that equally involves mental activities that "imply certain routinized ways of understanding the world, of desiring something, of knowing how to do something" (ibid., 251). Practices are, therefore, bodily performances entailing practical know-how, interpretation of others' behavior (be it human or nonhuman), and intuition. Ingold's (2012, 437) term *organism-as-a-whole*, as discussed in chapter 5.2.5, conceives the human being as an organism-person who perceives her/his environment through her/his body and not as an achievement of the mind,

[27] We can find these skills in many fields such as teaching activities, housework, or administrative processes. All of these activities and tasks involve ordinary everyday practices such as reading or writing, driving or assembling a car, riding a bicycle, going to the market, preparing food, or preparing an evaluation report. Moreover, the practice could be related to a profession, when working as a dentist, fireman, or housekeeper, for instance.

and equally underlines the reciprocity of body and mental activities. In truth, there is no absolute distinction between the body and mind. They are inseparably connected and overlap as components of human activities and, accordingly, of the social. While the human body is one part of the human-material arrangement, things are complementary and coexistent of practices and stand out through their constitutional relationship of the social. Or, in Reckwitz's words, "the stable relation between agents (body/minds) and things within certain practices reproduces the social" (2002, 253). Hence, things are not conceived as passive or symbolic references; what is of empirical and analytical interest is their contribution to practices.

What Reckwitz means by *background knowledge* becomes clear if we are to understand this kind of knowledge to be tantamount to the way of "understanding the world" (ibid.). A way that necessarily includes that other humans are capable of interpreting certain practices as what they are. Customs, taboos, or religious purposes, for instance, are linked to such background knowledge. To give one example of such a custom as a collective understanding, according to traditional Bahnar beliefs, a baby is not yet fully human and "is only considered a larva" and only becomes a member of its community after the "ear blowing ceremony" (Đao et al. 2011, 67) when getting a name. The ritual performance of ear blowing becomes understandable to only those Bahnar people who share this custom.

In the practice theory approach, it is the entire assemblage in its individuated unit. For its part, this unit is expressed by the human being as the carrier of social practices. From this view, Reckwitz concludes that "the social world is first and foremost populated by diverse social practices which are carried by agents" (2002, 256).

Bourdieu's *habitus* expresses best how an individual embodies skill, habits, or dispositions and exemplifies clearly how "instituted . . . patterns of behavior provide the background that makes possible rule-following and other complex normative activity," by making "the human body the crucial intermediary in the transmission, acquisition, and reproduction of social practices" (Rouse 2007, 512).

Schatzki's Practice Approach

As mentioned above, practices are in one way or another often related to recurring everyday activities, daily routines, and ordinary rituals but are also marked by transformation. On the one hand, practices are compliant with social rules and norms and function as structuring frameworks of everyday activities. Moreover, on account of practices, certain unchallenged and almost monotonous activities take place over and over again (drinking coffee in the morning, brushing one's teeth, or having breakfast). On the other hand, practices are unstable, variable, polyvalent, and changeable. They are adaptable depending on the situation, especially when new problem-solving strategies are required. When peasants change their agricultural method from shifting cultivation to permanent agriculture, for instance, they also change their daily, cultural, or ritual practices.

In any case, every practice is the outcome of previous practices, and its uniqueness characterizes each practice. A definition of practices that considers the factor of time and space is given by Schatzki. He writes that practices in his view are "open spatially-temporally dispersed sets of doings and sayings organized by common understandings, tele-affectivities (ends, tasks, emotions), and rules" (2015, 32). Practice, according to Schatzki's definition, is a performance that refers to the human actor who actualizes and carries out the practice, with agency being attributed to the human, who as the *practitioner* is thought of as the "integrator of the elements of practice when performing practice" (Alhonnoro 2014, 21, 22).

As indicated above, there is no human activity in which things are not included. Practices require the material realm in order to be realized. Furthermore, due to each practice's uniqueness, each relationship with all its elements is also unique. Schatzki describes this relationship of humans with the nonhuman world as the interrelation of practices and arrangements, and asserts that:

> practices transpire at particular arrangements, require particular arrangements, change because of specific arrangements, and establish and modify arrangements; arrangements, meanwhile, secure and require certain practices, lead to changes in practices, and house particular practices. Saying that social life inherently transpires as part of nexuses of practice and materiality means that all human coexistence takes place as a feature of, or by way of, such nexuses. (Schatzki 2003, 84)

The nexus, or practice-arrangement nexus, is the place where social existence arises and is denominated by Schatzki as the *site of the social* (ibid., 85). It is the framework that reveals the setting of human coexistence as "the place where, and as part of which, social life inherently occurs" (2002, xi). In such a nexus or arrangement, agents of the social, such as "bodies, organisms, artifacts, and things of nature" (ibid., 2015, 32), are intertwined in time and space and endowed with social efficacy. "Human coexistence," as Schatzki puts it, "transpires as and amid an elaborate, constantly evolving nexus of arranged things and organized activities" (2002, xi). Thus, the relationship between practices and arrangements is characterized by dynamism and openness rather than being static and linear. It is the synergy of practices and arrangements that, in Schatzki's terminology, form *bundles* "in that (1) practices affect, alter, use, and are directed toward or are inseparable from arrangements; while (2) arrangements channel, prefigure, and facilitate practices" (2015, 32). On the strength of his considerations, Schatzki states that practices and arrangements are marked by six different types of relation: "causation, use, constitution, intentionality, constraint, and prefiguration" (ibid.).

Schatzki specifies his concept of bundles in which not only practices correspond to arrangements but practices to other practices and arrangements to other arrangements—furthermore, these bundles vary in complexity: from i) a simple couple of practice and arrangements to ii) a link of multiple practices and arrangements or iii) even more multifaceted as a link of a combination of several practices and arrangements, which Schatzki calls *constellations* (ibid.). A birthday celebration, as a recurring ritual, illustrates the first case. In this example, material things (e.g., invitation card, birthday present, birthday cake) conflate with ritualized actions (e.g., singing the birthday song, blowing out the candles, sending birthday wishes) while having the person whose birthday is being celebrated as the center of the whole event. Carpentry, for instance, illustrates the second example and involves the raw materials, skillful procuring, the workbench, tools, and the like. Finally, on a higher level of complexity or scope are domains (or, in Schatzki's terminology, *constellations*) such as nature or economy.

Another aspect of the conflation of practices and arrangements is that they are cross-situational and expand in time and space for each factor, such as activity, rule, the material things, or purposive action as parts of social phenomena (which are the practices, arrangements, and their bundles); the practices and arrangements determine merely a unique local setting and singular situation (ibid., 32–33).

In sum, arrangements—and ANT's concept of networks or collectives, which will be discussed in the next section—are neither situated only on a micro-level nor macro-level. These concepts are suitable to intermediate between both spheres because of the conflation of the elements that constitute them. Now, returning to the question of how to define the social, Schatzki (ibid., 33) criticizes the classical separation between individuals and structures (system, or institutions) in social theory and claims that it is common ground in practice theory that individuals and structures are the results, products, components, and aspects of the practices, that is, the bundle of practices and arrangements. Following these considerations, Schatzki explains where to locate the social and why the division between micro- and macro-level is insufficient:

> What's more, the objective spatial-temporal spread of the plenum of practices and arrangements defines the boundaries of the possible objective spatial-temporal extensions and shapes of social phenomena. Hence, as Bruno Latour argues, there is nothing social, no level of social phenomena, 'above' this mass: no structure or system that collects, encompasses, holds, or determines practices, arrangements, bundles, and constellations. What there is to social life is entirely played out in the practice-arrangement plenum. Hence, social life does not admit levels. Or rather, it encompasses just one level: the plenum of practice-arrangement bundles. It also follows from these considerations that 'macro' and 'micro' cannot designate distinct levels of society. (ibid.)

Using the categories of technology, economy, society, or nature for a discussion of technological or societal change is troublesome when considering Schatzki's and other practice theorists' objections. The interrelationship and situation-dependence of practice-arrangement bundles are far more useful to trace back how entities of different realms conflate and contribute to societal or technological development. Human history is then a social-natural history in which technology occupies a central position (ibid. 2003, 90–91). Accordingly, and contrary to the deterministic views discussed in the previous chapter, Schatzki (ibid., 91) emphasizes the mutual relatedness of technology, practice, and material arrangements and says that they all determine social life. Consequently, due to the interrelationship of its diverse parts, changes in one part provoke changes in the other.

5.2.4. Actor-Network Theory's Post-Humanist Approach to the Social

One other prominent and promising theoretical approach that seeks to overcome Western dichotomies and attempts to rethink human and nonhuman entities' relationship is the Actor-Network Theory (ANT). ANT's material-semiotic approach to the social derives its origin from STS. By examining laboratories as the place of scientific practices, ANT provided evidence that findings of scientific work are not exclusively human-made but that artifacts (also called hybrids) have a key function in a certain way. The artifacts in the laboratories were not considered as simple inert technical instruments but as one element of a more comprehensive network that maintains and transforms the network and also, as a consequence, scientific insights (Latour 1993, 137).

ANT asserts that in a variety of ways, everything in a social and natural world is connected by a relational network, or in other words, through a network of associations. Moreover, ANT attempts to redefine the *social* through networks or associations in which the *interaction* between human and nonhuman things (human beings, symbols, ideas, etc.) takes place. The actor-network in ANT is, for Latour, an "assemblage . . . of heterogeneous associations that includes human and nonhuman elements" (1999, 165). Yet, as stated by the ANT, neither the individual nor the society—as a kind of super-structure alone—is representative for what goes on in the world, but rather a plurality of differing components (human and nonhuman entities), the collective that explains how different agents converge and act as a whole (ibid., 2005, 74–75)—Latour replaces the *old* word of *society* with his concept of the *collective* (ibid., 75). The network consists "of a host of elements" that are commonly labeled as "technical, social, natural, political and so on" and "that are juxtaposed in the building of networks" (Murdoch 1998, 360) and might involve texts, institutions, rules, laws, everyday objects, ideas, humans, nonhuman animals, the sun, water, and the like.

In ANT's perspective, agency is not fixed to an individual but is "spread around the network" (Ingold 2008, 210). In comparison to Schatzki's (anthropocentric) concept of arrangements or other practice theorists, the idea and concept of the actor-network structure extend agency to objects and understand a network itself as a practice in which agency is understood as an emerging effect. It is not the human individual that is the core center of interest, pulling all strings. In ANT, agency is produced through humans' interconnectedness with nonhumans, that is, subjects with objects. In Schatzki's model of practices and arrangements, humans are *a priori* defined as the starting point of investigation. Such focus, however, has analytical shortcomings concerning nonhuman agency. Following the practice theory principles, it is hardly possible to interpret nonhumans' actions, their influence on other actors, and their role in a given network. Thus, it would hardly allow an analysis of objects, such as a bamboo fence. Yet, being analytically open for literally everything, as argued by ANT, one might determine, for instance, the impact of the bamboo fence on other entities such as animals. Indeed, even though not acting willingly or intentionally, and even though the bamboo enclosure is a human-made thing, it influences animals' movement and foraging since it is a physical barrier. And as such, the bamboo fence is a placeholder for humans, protecting their crops and securing their livelihood.

"Agency," as van der Leeuw puts it, is further "located among different actors . . . decoupled from subject-object distinctions and representing the collective capacity for action by humans and non-humans"; it is "not located in any one place and is multitemporal" (2008, 222). As a result, the classical dichotomies (nature vs. culture, subject vs. object) are associated together rather than standing in opposition to one another. However, and as Latour states, all attempts to overcome the subject-object dichotomy, or "to reuse it positively, negatively, or dialectically have failed" (1999, 294), which resulted in his coining of new terms such as hybrid entity, actants, humans, and nonhumans.

The decentralization of the human individual is then the main difference between practice theory and ANT. While the former focuses on the human individual in its approach to gaining data about the practices, in ANT's view, the center is not located in a single human actor but throughout the network. It is the network concept, in which all are "woven together in order to ensure the durability of the consolidated relations" (Murdoch 1998, 60). As a consequence, ANT is less fixed on *social* relations since such human-centered relations are held together by the very material aspects of long-lasting and resilient materials that produce durable networks (ibid.). Since ANT's underlying ontology is flat, it takes into account the material surroundings and the things' agency—this epistemologically free approach is what distinguishes ANT from other socio-material theories, such as practice theory, the most. A Japanese tea ceremony, for instance, is constituted by various entities: humans as participants of the gathering, the material equipment (such as the tea bowl, tea caddy, bambooic tea scoop, or bambooic tea whisk), the tea, the clothing (wearing the kimono), and the tea room. Chapter 9.3.2 briefly discusses the various entities' roles in the Japanese tea ceremony and mentions some possible viewpoints on how the latter might be studied with relation to ANT's view.

By questioning the nonhuman others' ontological status, the door has been opened wide, which, in principle, allowed the objects to enter the subjects' realm. For this reason, and as mentioned above, Latour (1999, 295) replaced the indissoluble oppositional concept of subjects vs. objects with the concept of humans and nonhumans in order to follow practice in the first place instead of being directed by theory. According to ANT, intentionality, freedom, and psychological inwardness are no longer regarded as necessary characteristics of an actor (Belliger and Krieger 2006, 35) who comes into being in connection with functional correlations. Within the framework of a network, an actor is enrolled in a specific role.

In their earlier works, Callon and Latour defined an actor as "any element which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own" (1981, 286). In the terminology of ANT, the assignment of roles is called *translation*, a term that Latour uses with reference to Serres and "to mean displacement, drift, invention, mediation, the creation of a link that did not exist before and that to some degree modifies two elements of agents" (1994, 32). As mentioned at the beginning of this chapter, the combination of humans and nonhumans results in hybrid entities (but not every hybrid consists of a human-nonhuman entity).

Things shape a person's role and action. Latour exemplifies the interplay of humans and nonhumans, amongst others, by the hybrid consisting of a citizen and a gun. According to him, a citizen carrying a gun becomes a *citizen-gun* or *gun-citizen*. Thus, one becomes "a different person with the gun in . . . [one's] hand" (ibid., 32–33), a notion outlined by Latour as follows:

> If I define you by what you have (the gun), and by the series of associations that you enter into when you use what you have (when you fire the gun), then you are modified by the gun—more so or less so, depending on the weight of the other associations that you carry. This translation is wholly symmetrical. You are different with a gun in hand; the gun is different with you holding it. You are another subject because you hold the gun; the gun is another object because it has entered into a relationship with you. The gun is no longer the gun-in-the-armory . . . . What is true of the subject, of the gunman, is as true of the object, of the gun that is held. (ibid., 33)

Thus, the conflation of the gun and the gunman constitute a hybrid actor. Accordingly, agents can be humans and nonhumans alike.[28] This mutual translation means that neither the citizen nor the gun acts alone, but that a new actor emerges that acts. This actor, in turn, is not only a hybrid actor, but it can also be conceived as a network itself that might encompass countless things and other networks (Callon and Latour 2006, 78). Belliger and Krieger (2006, 43) emphasize in this context that ANT is a fractal model and that no final elements related to the social or to nature can be defined once and for all. They conclude then that reality is hybrid and that this explains why ANT, instead of describing subjects or objects, attempts to describe a network of hybrids. Accordingly, an actor such as a bamboo fence is a hybrid entity consisting of nature (since its building materials are of organic origin and their decomposition follows natural laws), it is a cultural thing (to shield oneself from the neighbors' view), it is of economic value (when protecting one's farmland against animals), and the like. In ANT's perspective, an actor, such as a bamboo fence, ties together "scattered elements into a chain in which they are all indissociably linked" (Callon and Latour 1981, 289). In order to encompass these various elements for reasons of simplification, ANT uses the term *black box*, according to which all its members are integrated into a single whole (Stalph 2019, 3).

Due to its integration of nonhuman actors (as a component of a collective), ANT was accused of anthropomorphism due to imputing intentionality to all nonhuman entities—as vividly illustrated by ANT's advocates' studies of microbes and scallops (Blok 2007, 73). Indeed,

[28] In the terminology of ANT, the term actor or agent is often replaced by the term actant since it is unusual to refer to nonhumans with the term agent.

contrary to the classical anthropocentrism of humanism, ANT, as a post-humanist theory, seeks a balance of power between all entities that engender the heterodox mixture of the social. It methodologically encompasses all entities with which we share a common destiny and existence and which are involved in the practice. Hybridity, then, is an essential collective term in ANT and represents how culture, nature, technology, or society are intimately linked, similar to the heterodox mixture of the world we live in. In this context, Latour pinpoints that "action will rarely consist of human-to-human connections . . . or of object-object connections, but will probably zigzag from one to the other" (2005, 75). ANT's affirmative attitude towards materiality demonstrates its attempt to give voice to the voiceless material thing since both humans and nonhumans contribute equally to the network and create social circumstances. In this context, ANT questions if a given entity has the capacity to manipulate the unfolding of events, and if the answer is yes, ANT seeks to integrate such entities (like the microbes and scallops) into the social sphere (Blok 2007, 73).

In his analyses of ANT's concept of the nonhuman, Sayes differentiates between four senses of nonhumans: "as a condition for the possibility of human society (Nonhumans I) . . . as mediators (Nonhumans II), as members of moral and political associations (Nonhumans III), and as gatherings of actors of different temporal and spatial orders (Nonhumans IV)" (ibid., 2014, 135). Except for the third sense (nonhumans III), which is linked to new industrial technologies, devices, tools, and apparatuses, which entail moral and political associations, the other senses can be found in pre-industrial societies. In the first sense, nonhumans (I) are "necessary stabilizers of the human collective" (ibid., 137). An argument that is in accordance with practice theory's approach, intimating that things are the material foundation for activities and practices. Second, nonhumans (II) are not only passive, indifferent spectators but, when regarded as mediators, they are "adding something to a chain of interaction or an association" (ibid., 138); they effectuate something including the activities of humans and nonhumans. Third, nonhumans (IV) "are seen as gathering actors from other times and other spaces . . . suggested by the very notion of an actor-network: the assembling together of a network of actors of variable ontologies, of variable times, and of variable spaces" (ibid., 140). In summary and in the words of Sayes, it can be said that for ANT "agency is decoupled from criteria of intentionality, subjectivity, and freewill" (ibid., 141).

In line with Clifford Geertz's (1973) *thick description,* according to which the cultural is not to be found in the mind of individuals but by referring to the symbolic value of objects and also encompasses patterns of behavior (Reckwitz 2002, 248), ANT is in the first place a scientific *description* rather than a scientific *explanation* of the social, cultural, economic, political, or technical dimensions of its subject matter. ANT offers, to some extent, much more a methodic than a unified theoretical approach. Since there is no coherent theoretical approach that can be followed, similar to practice theory, ANT represents various heterogeneous ways and interpretations. Nevertheless, what primarily concerns ANT is that agency is not located in an entity but in the associations of entities. As Latour objects, "if action is limited a priori to what 'intentional,' 'meaningful' humans do, it is hard to see how a hammer, a basket, a door closer . . . [or other things] could act" (2005, 71). In the classical sociological view, the latter entities are non-social, for they are in principle part of the material world through their materiality that distinguishes them from human beings. Latour's conclusion on the issue of the relational influence of one agent to another agent is that "*any thing* that does modify a state of affairs by making a difference is an actor—or, if it has no figuration yet, an actant" (ibid.).

Criticism of the ANT

Unsurprisingly, ANT also encountered harsh criticism due to its symmetric approach, and its representatives were accused of not taking account of *intentionality*. The provocative idea of a symmetrical approach to humans and nonhumans is worthwhile as it attempts to overcome the Cartesian bifurcation. And indeed, in ANT, the subject is no longer the active and creative part in opposition to the inert object in which the latter is formed by the former. Both are part of one association and contribute equally or symmetrically to the collective. Through their close intertwining, agency unfolds in their association. Accordingly, ANT delocalizes agency from the individual subjects or the structure to the associations within a collective, and claims that agency is distributed throughout the network and that it evolves through the connection between humans and nonhumans (ibid., 72). In this view, agency is nothing which entities are endowed with, but is produced through processes in the network.

However, as maintained by Ingold (2012, 430), the symmetrical attempt of ANT is unpromising for two reasons. First, ANT still emphasizes humanity's uniqueness, and second, it highlights a unilineal evolutionary development from the simple to the complex (from foragers to modern society or from nonhuman to human animals). It is argued that ANT, by virtue of its anthropocentric view, self-ascribes a hierarchy between humans and nonhumans and that it is—despite its statements of symmetry—still asymmetric, although it declares that it "deontologizes the division between the human and the nonhuman" (ibid.). Rethinking materiality and bringing back things is hardly possible in the wake of such a differentiation. Society and history in ANT, as Ingold demonstrates, appear as the sole outcome of human action, with nonhumans playing a subordinate part (ibid.). Latour, addressing such critiques, defends ANT's usage of the term symmetry. He states that his and his colleagues' intention was primarily that the idea of symmetry was to prevent the preclusion of nonhuman in advance (2005, 76). In Latour's words, "to be symmetric, . . . simply means *not* to impose a priori some spurious *asymmetry* among human intentional action and a material world of causal relations" (ibid.).

Contrary to ANT, which asserts that agency is distributed equally in the network, is the assumption that action is unequally spread in a network, for instance, when it comes to the ability to act willingly. In this context, "agency," as argued by Ingold, "must make allowance for the real complexity of living organisms as opposed to inert matter" (2008, 214). Instead of locating agency in every entity and postulating a symmetry between the different entities, as done by ANT, Ingold proposes that any conceptualization of agency must satisfy the needs for the explanation of the complexity of living organisms as opposed to inert matter (ibid.). The comparison of a whale with a boat concerning agency, for instance, is problematic. In the understanding of ANT, both are part of a network and are endowed with agency through their connectedness to a network. In fact, and following Ingold's objection, both have different qualities of agency. While the whale decides over its movements, a boat cannot move on its own, it has no individual will and thus remains inert matter. I generally agree with Ingold's critical remark. There are different qualities of agency when considering an entity's intention or will. On the other hand, agency (as discussed above) can exist detached from intention, which leads to the question of how nonhuman entities shape other entities' actions. For Latour, anything that makes "a difference in the course of some other agent's action" (2005, 71) is of interest. For instance, a virus is a submicroscopic infectious agent without any intentional agency; however, it causes an action on various levels: from the single individual to a global scale. By implication, if agency is limited to intention, the effects of the severe acute respiratory syndrome coronavirus 2 or SARS-CoV-2 that has profoundly impacted humankind since 2019 could not be fully understood.[29]

[29] For further definitions and characteristics of agency see chapters 5.3.2 and 5.3.4.

5.2.5. Tim Ingold and The Perception of the Environment

In contrast to the traditional hylomorphic and anthropocentric Western view related to how humans enforce form upon inert matter or attribute symbolic meaning to things, and as a response to ANT's network concepts' shortcomings, Tim Ingold responds with his theory-driven approach, known by the acronym SPIDER (Skilled Practice Involves Developmentally Embodied Responsiveness) or also named *meshwork*, in which he emphasizes "the co-responsive movement of occurrent things along their manifold lines of becoming" (2012, 437). Ingold's endeavor is to turn the spotlight on the bodily acquisition of skills. In Ingold's SPIDER model, as bearers of agency, entities are not just assembled as parts of a network through dematerialized relation, but it is their material relation (or as Ingold says *lines*) through which entities move, act, and perceive their world (ibid., 2008, 211). Every entity, be it a human or nonhuman, or be it inert matter or an animate being, is much more the result of its interconnection. As Ingold defines it, this meshwork is not the collective of everything as in the network of ANT "but a tangle of threads and pathways" in which action "emerges from the interplay of forces that are conducted along the lines of the meshwork" (ibid., 212). In other terms, SPIDER turns much more attention to the becoming, evolving, developing of agents and how they constitute an agency by their particular properties and relational parts of a web or meshwork (ibid.).[30]

Ingold, who debunks the misconceptions that structure the human sciences, addresses fundamental questions concerning human existence and human beings' embeddedness in the world surrounding them. In doing so, Ingold's approach to the human being as one living organism amongst others is of particular interest in terms of developing, learning, and becoming. In brief, Ingold's key argument is that humans develop and become who they are through learning. In other words, a human's individual development is geared to individual learning, namely the incorporation of skill through repetitive practices in a given (human-made and natural) environment (2000). In this view, then, each human's individual development is shaped by biological as well as cultural factors.

Overall, Ingold brings these and other issues about the very human existence into focus and discusses them in his recent works and particularly in his essay collection *The Perception*

[30] Instead of modeling reality as a network (as in ANT) or meshwork (as in the SPIDER model), one can also combine both models into a mesh network, as in the models of computer science. In a decentralized mesh network, then, "information is passed on between nodes in a many-to-many fashion and in a flat hierarchy" (Büttrich 2006, 2). Such a mesh network (or meshnet) consists of plural connections in which each node (or participant) is connected to several others and, through this connection, contributes and maintains the network. In this sense, each participant can be part of multiple dynamic and non-hierarchical networks.

of the Environment (2000) based on his texts written from the late 1980s to the late 1990s. Trained as an anthropologist, Ingold crosses many scholarly boundaries and presents an unorthodox way of approaching the Western concept of environment. Amongst other things he is concerned with the philosophy of perceptions, which leads him to the fundamental question of whether we experience the environment or preconfigure it in our minds. In short, Ingold's (2000, 20) conclusion is that as living organisms, we experience our surrounding environment and develop in it and have, just like other nonhuman animals, definite requirements, desires, and take our decisions against this backdrop.

An aspect that Ingold shares with ecological psychologists is "that perceptual activity consists not in the operation of the mind upon the bodily data of sense but in the intentional movement of the whole being (indissolubly body and mind) in its environment" (ibid., 166). But what aspects are implicated by the environment? Ingold's (ibid., 20) attempt to conceptualize the *environment* has three implications. First, the term environment has by no means an absolute but relative meaning and relates to the being that lives in the environment in question. Second, the environment is at no time finished but is dynamic and evolves continuously. Third, environment and nature differ from one another insofar as nature is something that exists apart from humanity, and broadly speaking, the environment shapes us as we shape the environment (ibid.). Ingold finally concludes that our Western relation to the environment, in contrast to nature, is of such kind that we see ourselves as integral parts of our surrounding environment, as "beings *within* a world," but as a non-integral part of nature, which exists independent of us and in which we perceive ourselves as "beings *without* it" (ibid.).

Moreover, Ingold (2012, 437) attempts to resolve the problems that come with the dualistic view, particularly with the opposition of humans vs. nonhumans, and discusses the notion of embodiment. Subsequently, he pays special attention to the conception of the body as something which is not merely an organism. In contrast to conventional psychologists' assumption that our head constructs the world we are living in—similar to the processing system of computers—Ingold proposes, with reference to Gibson, that perception "is not the achievement of a mind in a body, but of the organism as a whole in its environment" (2000, 3).[31] Ingold believes that "in the living, dynamically centered body, person and organism are one. The body is the organism-person" (2012, 437). In this context, both humans and nonhuman animals are likewise

[31] Ingold's own thoughts are influenced by James Gibson's work, *The ecological approach to visual perception* (1979).

organisms-as-a-whole. The idea of "the synergy of organism and environment" allows an alternative conception of human existence as part of nature and additionally helps us "to regain a genuine ecology of life" (ibid., 2000, 9). Such an unorthodox understanding of beings is contrary to the anthropocentric and mechanistic Western view that the human being is—by virtue of his/her extraordinary cognitive capacity—a self-contained being and the sole being endowed with agency. What is of significant interest here is that an understanding of humans as organism-persons allows us to "provide the link . . . between the biological life of the organism in its environment and the cultural life of the mind in society" (ibid., 3). Accordingly, this approach offers models for a critical reflection on the division between (civilized, modern, and cultural) human beings as socio-cultural beings in opposition to nature.

To summarize, Ingold's abovementioned emphasis on learning and developing constructs a perception of our environment that takes account of our bodily sense, action, and perception of ourselves as organisms or beings; and how we become who we are through the interaction with human and nonhuman others. As sentient beings, we perceive our environment through movement, which characterizes our individual development as like that of other creatures. "The growth and development of the person," as Ingold argues, "is to be understood relationally as a movement along a way of life, conceived not as the enactment of a corpus of rules and principles (or a 'culture') received from predecessors, but as the negotiation of a path through the world" (ibid., 145). Learning means that being a human or becoming who we are should be considered as a process rather than something ready-made. It is through development that we become what we are. And it is not that our biological features determine our progress; rather they condition the framework in which we evolve. Our body is not tantamount to a preconfigured entity, as in the idea of form in Aristotle's hylomorphism (as discussed in chapter 5.3.3).

And what is valid for humans is also valid for animals. A puppy, a calf, a human newborn or toddler are by no means ready-made but develop in their environments. One could argue that we evolve through the physical presence of matter, together with the material things. Life, as Ingold (2012, 431) infers, is determined by the process of development and becoming in an environment. This notion contrasts with the perception of life as something that has to be accomplished or to become accomplished.

A guide dog is trained to lead blind persons, which involves a long learning process in which the dog must learn how to move carefully in human-made surroundings. Male nightingales learn from their male conspecifics how to sing numerous strophes through practical repetition. A toddler learns how to pile a cone-shaped tower of blocks through the behavior of matter. As these examples demonstrate, learning and development are attributes we share with other nonhuman animals. Becoming is a process that is realized through the mediation of nature.

Figure 30 A basket boat maker at work on Cẩm Kim Island in Hội An, Vietnam.

In this light, personal skills are the outcome of individual development through repetitive practice and hence are subjective and represent appropriated knowledge. No craftsperson is born a master but develops into a professional with years of antecedent learning. The learning process or acquisition of a particular skill or ordinary activities, in turn, implicates the involvement, understanding, and use of things and tools. We learn to write using a pencil and paper. We can weave a bamboo basket because we have already experienced bamboo's bending properties and how to handle the machete to split bamboo culms. Accordingly, a woodworker or bambooworker develops her/his skills during years of practice—simultaneously, she/he might have no experience in other tasks such as pottery.[32] Against this background, the importance and originality of this dissertation lies in its considering of human cognitive and bodily abilities and practices in the interaction with bamboo or in the field of bambooworking.[33] This entanglement, for instance, is represented by the basket boat maker in Figure 30. The boat maker bends and interweaves the bamboo strips using his hands and feet to create the basket boat (*thuyền thúng*). Each of his movements depends on the materiality of bamboo. The finished bamboo boat is

[32] In chapter 5.3.4, I shall provide a more detailed definition of the term skill in relation to practical and cognitive experiences or the material and human-thing entities.

[33] Bambooworking, analogous to woodworking, comprises skillful activities in carpentry, architecture, weaving, furniture making or joinery.

thus an outcome of a human-material *interaction* in which the human shapes the material while the material influences the way the boat maker can create things from it.

Schatzki, just like Ingold, draws our attention to the alliance of humans and nature. He proposes that “human action and coexistence were born both amid and from nature, and they have remained inseparable from it ever since” (2003, 87). Our human bodies, for instance, are nothing else than natural things, and through these natural entities, we embed ourselves in social connections and act in this world. We perceive our world and encounter all the other things that exist as natural entities through our human body.

The vexed question of the social raises the question of the concept of human sociality. The American philosopher, sociologist, and psychologist George Herbert Mead discussed, amongst other things, the sociality of human and nonhuman animals in his seminal book *Mind, Self and Society* (1934). Influenced by Wilhelm Wundt, one of the founders of psychology, Mead (1972, 32) argues that the division between the physical world and consciousness reaches its limits. He, therefore, rejects the division of body and mind. For Mead, “minds and selves are essentially social products, products of the social side of human experience” (ibid., 1). Thus, the human’s physical involvement with its surrounding environment is of vital interest when considering each individual’s history or biography. In Mead’s view, “individual experience and behavior are . . . physiologically basic to social experience and behavior” (ibid., 2).

Being against the antagonism of mind-matter or mind-nature, Mead formulates an understanding of sociality as a key term of his social psychology. The phenomenon of sociality in Mead’s account is something that is shared by all living organisms, as the following quote shows:

> The behavior of all living organisms has a basically social aspect: the fundamental biological or physiological impulses and needs which lie at the basis of all such behavior . . . have social implications, since they involve or require social situations and relations for their satisfaction by any given individual organism; and they thus constitute the foundation of all types or forms of social behavior, however simple or complex, crude or highly organized, rudimentary or well developed. The experience and behavior of the individual organism are always components of a larger social whole or process of experience and behavior . . . There is no living organism of any kind whose nature or constitution is such that it could exist or maintain itself in complete isolation from all other living organisms, or such that certain relations to other living organisms (whether of its own or of other species)—relations which in the strict sense are social—do not play a necessary and indispensable part in its life. All living organisms are bound up in a general social environment or situation, in a complex of social interrelations and interactions upon which their continued existence depends. (ibid., 227–228)

What is of interest here is that each organism has its peculiar access to its environment and that each organism’s development is irrevocably tied to other organisms and the interaction with other forms of existence. Human sociality is not an outcome of self-contained human beings with merely human-human interrelations but emerges from a host of interrelations of overlapping strata or realms of all kinds of things. Another aspect of interest here is that sociality rather than the term society sheds light on the processual character and continuation of human existence. In my definition, human sociality considers the dynamic entanglement of humans in a variety of fields with entities of all forms while experiencing the world, rather than confining it–as the traditional notion of (human) society does– as the sole result of human actions and activities. Humans' actions affect and are affected mediately or immediately by other entities' actions, whether or not they become visible and manifest as such.

5.3. Materiality and the Becoming of Humans and Things

As already indicated in the previous chapter, human life exists only in coexistence with the world of matter (the realm of the human-made artificial world) and the ecological environment surrounding us (the realm of nature). Being a human is constituted in a confrontation with and through things that belong to these two realms. Accordingly, things—in the sense of objects, artifacts, tools, devices, and the like—are intimately meshed with human society and are part of our culture and history and can be found in every corner of human existence. Moreover, things (just like humans) are entangled both with each other and with humans and affect both nonmaterial and material aspects of human society. Given that for many societies throughout the world and human history, bamboo was and still is *a* and not seldom *the* elementary construction material and resource of incomparable value, this work is concerned with material aspects of life that are based on or related to bamboo and thus, in analytical concepts that assist in exploring the material *bamboo* and its uses. Moreover, since the present work is concerned with the human-bamboo relationship and, thus, human-thing relations, in what follows, I shall discuss the various meanings and concepts of things, including artifacts, naturefacts, things, objects, hybrid compounds, and the like.

5.3.1. The Continuum Problem: From Artifact to Naturefact

Preston (2019, ch.1, par.2), analyzing the philosophical definition of the term *artifact*, points out that its standard definition includes three aspects. Firstly, artifacts are made with intention;

secondly, artifacts are modified materials in opposition to naturally occurring things; and thirdly, artifacts are made for a special purpose. This typical definition of an artifact (or thing) is problematic for at least the following reasons. Discussing the intersection of humans and nonhumans, particularly with a focus on artifacts (as human-made things), involves the question of intention and mind. Do things exist independently of our minds? Or is our mind the antecedent force of perceiving and structuring things? As a mental activity that involves planning, intention is not confined to human beings, and not every artifact must be the result of an intentional purpose. Preston (ibid., par.3–4) illustrates this by exemplifying that beavers intentionally build their constructions, whereas spiders produce their webs very likely with less intention.[34] Hence, artifacts are not exclusively the products of human beings' actions.

There are further difficulties in the conception of artifacts in differentiation to naturefacts. While a (human-made) artifact is shaped with a particular design, the naturefact undergoes (in the first instance) no manipulation of its materiality. While the former's production is related to (human) intentionality and an envisaged purpose in the very beginning, the latter is something that occurs naturally. Although having different origins, both could be used intentionally and for a specific purpose.

Furthermore, and as Preston (ibid., par.10) correctly states, a naturefact changes (gradually) its materiality when it is brought into use. This fact, in turn, gives rise to the question of whether one can speak of a naturefact when a natural thing's materiality changes in virtue of its use. This problematic issue is the case, for instance, when a human or a chimpanzee uses naturally occurring things such as wooden sticks and stones in order to crack nuts. At the very moment when the wooden stick (as a tool in the function of a hammer) strikes the nut (or workpiece) or accidentally the stone (functioning as an anvil), it changes its surface. Consequently, depending on their material properties, the wooden stick, the stone, and the nut change their naturally given shape. As a result, one could say that gradual changes transform a naturefact into an artifact. Another example that illustrates the ambiguity of naturefact and artifact is the bamboo grove when used as a fence. In this case, the bamboo plant is both an organic and

[34] The pioneering American anthropologist Lewis H. Morgan (1868), for instance, studied the beaver's habitat, anatomy, and the materials employed for constructions and thus, how beavers form their environment and how their artificial erections (that is, the tangible forms) represent the beaver's architectural skill (1868, 18). Whether intentional or not, the beaver is a designer, builder, architect, and craftsperson. His remarkable abilities are impressively demonstrated by his techniques and the structures and constructions he builds. These are, for instance, "the dam, the lodge, the burrow, the tree-cutting, and the artificial canal; each testifying to his handiwork, and affording us an opportunity to see the application as well as the results of his mental and physical powers" (ibid.).

natural entity and an artifact in its function as a fence. In sum, a clear definition of artifacts and naturefacts is problematic in terms of materiality and function.

With reference to Dan Sperber's work (2007) about seedless grapes' biological and cultural functions, Preston (ibid., par.12) identifies a *continuum problem*. In the case of seedless grapes, scientists changed the plant's biological property (the production of *seedless* grapes), and in doing so, endowed it with cultural wants, making it a *mixed* or *hybrid entity.* Other mixed entities that are both natural and artifactual are, for instance, quills (which is a composition of a bird's feather and ink), landscapes (which are both natural and modified by humans), or even dogs and cows (which are natural beings but shaped by humans through selective breeding).[35] As a result, and as exemplified by the latter cases, maintaining a rigid nature-culture, nature-society, or nature-technology dichotomy is problematic because there is no clear demarcation line between these realms. One attempt to solve these classical oppositional conceptions is proposed by Schatzki, who proposes integrating the one into the other and claims that "instead of either X or Y, the logic is now X plus Y" (2003, 87). This composition of two distinct parts into one unit resembles the concept of dualism of Yin and Yang in Daoism, according to which opposite forces may at the same time be complementary to each other. Instead of seeking a clear differentiation, as done in the Western theoretical thought that ends in segregating nature from society (or culture and technology), emphasizing the interrelatedness of these concepts or categorizations helps bridge the gulf between them and overcome problems attached to dualisms.

5.3.2. Things, Objects, and Agency

Now that I have discussed the difficulties concerning the term artifact and naturefact, I shall elaborate on the various notions of the terms *thing* and *object* and how their definitions impact how we perceive and handle these things in the world, and why some scholars attribute a certain kind of agency to nonhuman entities.

There is a plethora of other delineations and conceptualizations of defining a thing (or artifact, nonhuman entity, material, object, etc.). Some scholars use the terms objects and things synonymously. Others like Latour introduced their own terms, such as quasi-objects, hybrids,

[35] The description of nonhuman animals as mixed entities at this point serves only for a definitional analysis. It is not intended to eclipse their subjectivity and capability to act.

immutable mobiles, actants, or human and nonhuman actors (Roßler 2007). And Ingold (2012, 436), providing an overview of Heidegger's phenomenological reflection about the key terms *object* and *thing* as two contrasting entities, differentiates equally between objects and things. The object, so Ingold outlining Heidegger's view, "is closed in upon itself and stands before us complete and ready-made. . . . To touch it, or to observe it, is to bring the movements of our own being into close correspondence with those of its constituent materials" (ibid.). Accordingly, in line with Heidegger, Ingold (ibid., 235) writes that there is no doubt that our standard definition of an object relates to something accomplished, something that is already designed and fabricated, and that waits for an opportunity to be used. In opposition to the *object* is the *thing*, which is, for Heidegger, "a gathering of materials in movement" (ibid.). Given this difference, Ingold (ibid., 435) challenges the misconception of objects as something finished with relation to an object's biography and states that an object's life does not end with its production and consumption but rather is part of multiple relations and continuously unfolds in later periods of its existence. For that reason, Ingold (ibid.) criticizes material culture studies for mainly exploring the ways *completed objects* are embedded in the social lives of humans and thus neglecting their becoming and further stages of existence along with further encounters. Therefore, Ingold suggests conceiving the object as a non-finished "sample of material" (ibid.) in order to emphasize its capability of continuously unfolding in a variety of ways. Indeed, instead of approaching things with an intention only to highlight their passive aspects, one should take a closer look at how they actively express action. Instead of merely gazing at them, interpreting their meaning, and discussing their exchange value, one should center the attention on the materiality of things and how these things are made, fabricated, manipulated, and the like.

On the basis of a critique of Immanuel Kant's philosophy, Latour states that "reality is not defined by matters of fact. Matters of fact are not all that is given in experience . . . [and] are only very partial" (2004, 232). Following this criticism, Latour discusses (just like Ingold) the definition of the term *thing* with regard to Heidegger by referring to the latter's comments on the etymology of thing. Latour argues that "a thing is, in one sense, an object out there and, in another sense, an *issue* very much *in* there, at any rate, a *gathering*" (ibid., 233) with numerous human and nonhuman participants. In this case, the term thing refers to its Germanic origin *Ding* in the sense of *meeting* or *assembly*. Yet Latour (ibid., 233) criticizes Heidegger's *unjustifiable* oppositional conception between *Gegenstand* and *Ding*, that is, for instance, between an industrially fabricated object (*Gegenstand*) and a handmade thing (*Ding*). According to

Latour's (ibid.) statement, this bifurcation reinforces different realms in which an object, such as a plastic comb or plastic basket, is an outcome of technology and science; whereas a thing, such as a handmade bamboo comb or bamboo basket, requires human creativity and skill. In this vein, the division between the term *thing* as the counterpart to the term *object* appears counterintuitive, which is why Latour (ibid.) (like Ingold) emphasizes the importance of bringing back objects into the realm of things.

Aristotle in his *Physics* also addresses the issue of how to conceptualize things considering the question of whether something exists by nature or artificially. For him, solely human and nonhuman animals and plants are *substances* because they occur naturally and because their changeability originates in themselves. Each naturally occurring thing, Aristotle argues, "has within itself a principle of motion and of stationariness (in respect of place, or of growth and decrease, or by way of alteration)" (Aristotle Physics, Book II, ch.1, 192b12–192b23). In contrast, Aristotle categorizes artifacts as non-natural substances based on the fact that their materiality depends on external forces without any inherent stimulus or inducement for modification. In other words, non-natural things are condemned to persist until an external agent comes on the scene and alters their way of being (ibid.). Hence, Aristotle downgrades artifacts when he speculates that things rely on independent substances (Preston 2019, ch.2.1, par.1).

Contrasting with Aristotle's view is *new materialism*, which developed based on an academic refocusing on the fundamental role things play. Advocates of new materialism, such as Jane Bennet or Manuel DeLanda, conceive and conceptualize matter with more independence from human activity. Jane Bennet, for instance, speaks of *thing power* as "the lively energy and/or resistant pressure that issues from one material assemblage" (2004, 365). For Bennet, the inherent power that things have is part of a broader realm, a collective of humans and nonhumans alike (ibid.). Against this background, her primary goal is not to prove that a thing exists solely on its own apart from human interference but to emphasize "the not-fully-humanized dimension of a thing as it manifests itself amidst other entities and forces" (ibid., 366). For DeLanda, new materialism "is based on the idea that matter has morphogenetic capacities of its own and does not need to be commanded into generating form" (2012, 43). Accordingly, things may evolve on another timescale in contrast to the timescale that humans commonly can conceive. The bamboo plant, for instance, developed its physical, biological, and chemical properties over millions of years *by its own efforts.* This development has been accompanied by bamboo's reaction to other *entities* and *forces*, such as harsh weather conditions (e.g., strong winds, coldness, drought), fungi, starch eating insects, or poor soil conditions. In order to withstand harsh weather conditions, for instance, the bamboo plant has developed a hollow structure, a partialization by its internodes, and a firm anchoring in the soil by its underground rhizome system. It is the interaction of these various entities and forces with bamboo's own morphogenetic capacities that shaped the structure and design of bamboos from which people benefit.

Studying the mutual relations of human and nonhuman entities raises the question of the definition of agency. According to the standard definition of agency, "a being has the capacity to exercise agency just in case it has the capacity to act intentionally, and the exercise of agency consists in the performance of intentional actions" (Schlosser 2019, 3). Generally speaking, "an agent is a being with the capacity to act, and 'agency' denotes the exercise or manifestation of this capacity" (ibid., 1). From a human's perspective, the latter statements are quite understandable, and such an agency can be described as an *intentional agency* (ibid., 4). On the other hand, the term *agency* can be regarded as an open concept, and its definition varies depending on what a scholar wants to explain by using it. "Agency," as Malafouris puts it, is "not an innate and fixed attribute of the human condition," but "a temporal and interactively emergent property of activity" (2008, 35). Thus, according to Malafouris's view, agency is not restricted to intentionally acting humans alone and, as posthumanists argue, should not solely be explained with reference to "causally efficacious mental states and events" (Schlosser 2019, 1).

ANT, aiming to dissolve the oppositional concept of human subject versus nonhuman object, also attributes agency to nonhuman inanimate or animate entities since they have the capacity to influence other entities. A traffic light, for example, serves as a reliable signal to draw the attention of road users. Its color creates something in the road user and causes a particular action or non-action. Moreover, agency is also often contingent. A packing blanket that my neighbor once unintentionally left in his garden became a favorable material for a squirrel for its nest building. A dog that suddenly crosses the road has an immediate effect on the actions of other road users. If a car hits the dog, a tragic accident takes place. If the driver reacts and brakes or avoids the dog, it can lead to other accidents. In every respect, the driver's action is influenced by the dog's initial action. And the driver's action influences the survival of the dog. Thus, one actor's unintended action can cause an unexpected effect on another actor.

5.3.3. The Becoming of Things

So far, I have mainly discussed the conceptualization of materiality and things (artifacts, naturefacts, objects, etc.). In one sense, materiality and things are related to a given physicality. In another sense, they are associated with human action and how humans use raw materials to create, make, and produce certain things that they endow with (symbolic) meaning, as well as how humans use these things. In the following sections, I will pay attention to how things are generated on the grounds of a human-material interaction and how human and nonhuman entities conflate.

In Aristotle's philosophy, a thing is a compound of matter (*hyle*) and form (*morphe*) and is put together in a creative process—a task that Aristotle named as *hylomorphism*. In the hylomorphic model, "making," as Ingold puts it, "begins with a form in mind and a formless lump . . . and it ends when form and matter are united in the complete artifact" (2012, 432). In the view of hylomorphism, the matter is passive, and a particular type of activity of a material is not of concern. Accordingly, *giving form* to something appears as a result of a preconceived idea in a human actor's mind.

In its current versions, the hylomorphism model is still part of Western modernity and serves as a bedrock for our definitions of culture and nature. Commenting on this, Ingold argues: "Culture furnishes the forms, nature the materials; in the superimposition of the one upon the other, human beings create the material culture with which, to an ever-increasing extent, they surrounded themselves" (ibid., 433). But rather than reinforcing the divergence of culture and nature (or mind and matter), wherein the humans impose their mind on nature or the raw material, substantiating their conflation is of vital interest—especially when discussing how a form is generated in connection with matter and not, as Aristotle's hylomorphism postulates, as an imposition upon it. As Ingold sees this issue, this infliction is *the* weak point of hylomorphism and is constituted by Aristotle's "assumption that the origination of things is reducible to the imposition of preconceived abstract form on inert matter" (ibid., 432–433). Long after Aristotle, not only things but metaphysics itself was downgraded for its speculative character and geared to the facts of the natural sciences, and "ordinary objects had to be eliminated from our ontologies" (Preston 2019, ch.2.1, par.3). This circumstance explains why many disciplines had difficulties integrating nonhuman entities in their scientific focus and why they devoted less attention to ordinary objects in everyday life. For instance, philosophical idealism hypothesizes that the objects of knowledge and our reality are mentally constructed, and it sees the mind in opposition to the body. On the contrary, human existence is attributed to a conflation of mind and matter. Instead of separating what is indissoluble, one should seek imbrications.

As Ingold (2012, 435) points out, one main problem of the conventional theory of the hylomorphic model is its reduction of matter to something passive and inactive instead of perceiving material in a continuously becoming. *Ergo*, a material must be experienced in the process of making. Or, as the philosopher Gilles Deleuze and psychoanalyst Félix Guattari write, matter is "in movement, in flux, in variation" (2005, 409). Deleuze and Guattari, whose works gave fresh impulses to the postmodern theory of the social and political, also examine the deficiency of Aristotle's hylomorphic model and discuss the relation of matter and form in the process of creation and stress the interaction of both, as follows:

> to the formed or formable matter we must add an entire energetic materiality in movement . . . and combine [it] with processes of deformation: for example, the variable undulations and torsions of the fibers guiding the operation of splitting wood. [And] . . . to the essential properties of the matter . . . we must add *variable intensive affects*, now resulting from the operation, now on the contrary making it possible: for example, wood that is more or less porous, more or less elastic and resistant. At any rate, it is a question of surrendering to the wood, then following where it leads by connecting operations to a materiality, instead of imposing a form upon a matter: what one addresses is less a matter submitted to laws than a materiality possessing a *nomos.* (ibid.)

As this example illustrates, a craftsperson's manual activity depends on the wood's materiality. Giving form to matter is neither an expression of external energy that forces matter to take a particular shape nor a result of a preconceived idea of shape and form on the raw material. Giving form is by no means a means of imposition. It results from an interaction with the craftsperson's tools and physical force and the working material's properties (such as wood's elasticity, softness or hardness, or its compressive and tensile strength). And what is valid for wood is valid for bamboo. There is no universal law embedded in matter that would guide the craftsperson's hand to bring a matter to a specific end and form. Giving form is much more something that is experienced and unfolds during the process of making, in which the materials, tools, and the craftsperson are all involved. Thus, there is no reason "to sustain the distinction between form and substance" (Ingold 2000, 345). And there is no reason to conceive matter as solely passive or amorphous.

Additionally, Deleuze and Guattari stress that the *movement of matter* means that the "matter-flow can only *be followed*" (2005, 409), and they illustrate this by the example of a woodworking craftsperson, who follows the matter at several places. For one thing, the artisan does not leave her/his workbench to carry out certain operations, that is, "an artisan who planes follows the wood, the fibers of the wood, without changing location" (ibid.). For another thing, the artisan must literally follow the wood into the forest to "find the wood where it lies, and to find the wood with the right kind of fibers" (ibid.). In this context, the bambooworker (or Bahnar peasant) intending to make a bamboo object (such as a sieve, a bamboo pipe, or a rod) must equally follow the bamboo into the forest to find the appropriate bamboo species, for each bamboo culm and species has different properties required for various work. In a second step, the bambooworker must choose the right bamboo culm based upon the question of what the particular bamboo culm *can do*. In other words, the bambooworker questions which possibilities of making are ruled out or opened up by the bamboo culm? Which things are manufacturable with a given culm? And which processing techniques are at hand and required? All these questions relate to and must consider bamboo's very materiality. The way a bamboo culm is split, for instance, is determined by the hollow structure and long fibers of bamboo. From this point of view, processing techniques are interrelated with bamboo's materiality rather than only depending on the craftsperson's ingenuity and intelligence alone. On the contrary, the craftsperson engages in a dialogue with bamboo if she/he desires to manipulate her/his workpiece. Finally, in a third step, the bambooworker cuts the culm brings it back home for further work (e.g., curing, cutting, varnishing), and so forth. At the immediate moment of each encountering with bamboo, be it in the form of a bamboo plant or a prefabricated culm, the bambooworker follows the flow of bamboo (or matter). Searching for the right bamboo culm and creating things made from it should be considered as an intuitive process, or in the words of Deleuze and Guattari, "to follow the flow of matter is to itinerate, to ambulate. It is intuition in action" (ibid.). Therefore, human productivity does not mean the imposition of one's ideas on materiality but is a developmental process in a field that encompasses various forces and entities, as illustrated in Ingold's well-known example of basketry:

> Basketry . . . involves the bending and interweaving of fibres that may exert a considerable resistance of their own. Indeed the basket holds together, and assumes a rigid form, precisely because of its tensile structure. In short, the form of the basket is the result of a play of forces, both internal and external to the material that makes it up. One could say that the form unfolds within a kind of force field, in which the weaver is caught up in a reciprocal and quite muscular dialogue with the material. (Ingold 2000, 342)

Hence, things evolve in a mutual interchange between the human embodied skill and the material's properties. Whenever human beings encounter the material world with their senses, that is "in the attentive touching, feeling, handling, looking and listening . . . in the very process of creative work . . . technical knowledge is gained as well as applied" (ibid., 316). In this sense, agency is not so much hierarchically conceived and attributed to the human alone as it is emergent in activities involving the nonhuman other. In comparison to weaving, as argued by Ingold, making determines that the idea of a form is already fixed in mind. In contrast, weaving emphasizes that things become in a process in which persons and their bodily abilities are involved in some way or other (ibid., 346).

5.3.4. Human-Thing Entities

While the becoming of things is defined partially by the material properties of their underlying materiality alongside human creativity, they are also *explanans* of human-thing entities. In this context, then, Lambros Malafouris discusses the relationship between human and material agency and depicts the human-thing relation as a *brain-artifact interface* or *bio-interface*, which he exemplifies by the potter's wheel, in which "the potter and the task-environment display a dynamic coupling between mind and matter that looks like a dance of agency" (2008, 22, 24). In Malafouris's view, agency is the result of a causal entanglement of humans and things, a space in which "*brain, body and culture conflate,*" or as in the example of the potter's wheel, create a "brain-body-clay-wheel" (ibid., 22). Just like bamboo, clay has its own specific material qualities and peculiar characteristics. Skillful working with clay consequently requires an overall previous practical and cognitive experience about clay's materiality to know which and how certain things can be realized with clay and others cannot.

As discussed in chapter 5.3.4, learning is not something that solely happens in our minds; it requires the physical world and practical bodily experience. It is through the connection of body senses and their movement that an organism meshes with its environment. Skill, then, as an ability to perform specific tasks with know-how based on repetitive tasks, results from body movement and perception. It is not built up from nothing. Skill is something that develops alongside the development of the organism through an adaptation process to its world. Drawing on his theoretical inverting of making and weaving, as exemplified by basket weaving, Ingold (2000, 347) points out that artifacts (as products of creative practice) also evolve alongside a person's skill. Related to this contention, Ingold defines three aspects of skill:

> First, the practitioner operates within a field of forces set up through her/his engagement with the material; secondly, the work does not merely involve the mechanical application of external force but calls for care, judgement and dexterity; and thirdly, the action has a narrative

> quality, in the sense that every movement, like every line in a story, grows rhythmically out of the one before and lays the groundwork for the next. (ibid.)

As Ingold clarifies with his definition of skill, skill is the ability of a person to do something well but likewise is an action in which materiality is involved. The term *field of forces* depicts such human-material involvement as part of human actions and emphasizes that things unfold in the process of creation, production, or making. The field of forces in the domain of bamboo basketry, for instance, underlines an interrelated process wherein a person's handling of the bamboo strips is related to both human physical force and dexterity and the material qualities (bending properties, tensile strength, shape, and length, etc.) of a bamboo strip. This human-material interplay is illustrated, for instance, by the boat maker mentioned in chapter 5.3.4. Moreover, in the case of traditional bamboo house construction (see chapter 7.4.4.1), each working task must acknowledge bamboo's physicality anew.

By and large, each bamboo culm has its unique material qualities and material attributes: bamboos differ in shape, diameter, age, material density, or internode length. Forging—to give another example—is similarly an action in which the materiality of the wrought iron (that is, its melting quality, hardness, brittleness, and the like), the tool's quality (a hammer's shape and weight), and human physical force are intermingled.

Consequently, instead of separating society from nature or technology, emphasizing their reciprocity is indisputably of ontological and analytical interest. As DeLanda suggests, scrutinizing "what categories are used dualistically" (2012, 44) may assist in the search for overlapping aspects rather than avoiding dualities as such. In contrast to monistic assumptions (such as philosophical idealism) that develop and affirm dualistic categories, DeLanda's suggestion urges us to find ways to negotiate between these two categories.

In sum, the human mind should not be conceived as the predetermining factor that gives shape to any material, even though human intentionality, intelligence, rationality, and abstract reasoning are involved. Simultaneously, form giving is achieved by a human being's multisensory approach to a material's materiality at the very moment of activity. Thus, the human individual, the applied tools, and the raw material collaborate not figuratively but literally. A bambooworker in action is always a bambooworker plus tool plus bamboo and becomes a hybrid being that involves many entities in its activities, such as a *human-using-tools*, a *human-driving-a-car,* a *human-playing-a-bamboo-flute*, or a *human-using-bow-and-arrow*.

5.4. Material Culture and Bamboo Culture:

5.4.1. Material Culture Studies Beyond Artifacts and Less-Tangible Material

The main issue of human science studies is to comprehend the nature and functioning of human societies. Scholars differentiate in the first instance between two main key terms that constitute human culture to debate the question of the properties of human culture. On the one hand, there is material (or tangible) culture, and on the other hand, immaterial (or intangible) culture. Both terms refer to culture, which is exceedingly difficult to define, for it is a catchall term that encompasses ideas, lifestyle, social behavior, customs, and other habits.[36] Immaterial culture includes intangible aspects (or the physically nonpresent) such as belief systems, cultural values, and norms, to which the human being has no access through the human sensory apparatus. Material culture encompasses tangible things (or the physical present) and—conceived as the relationship of things, human culture, and society—emphasizes how *things* are core components of human existence. Things could be considered, first, from the subject's position, that is, how the human subject perceives the nonhuman thing, or secondly, from the thing's standpoint without necessarily including the (human) subject's view. The first viewpoint is represented by advocates of philosophical idealism (most prominently represented by Kant), according to which our mind constructs reality, where materiality is defined in opposition, as, for instance, in the antagonism of mind and matter. The second viewpoint is represented by adherents of philosophical realism, which postulates that things exist independently of human perception, thought, or categories—a hypothesis represented by supporters of materialism and socio-material theories who argue that materiality is the key factor that constitutes human existence.

The influential role of material culture as part of human social living has received increased attention across several disciplines in recent years. One underlying question of material culture studies is why and how people make and use things and how the material conditions social and cultural life. By examining the relationship between the physical world and the social, however, materiality itself becomes a research object, its definition depending on epistemological and ontological questions. In some instances, it meshes with human culture and society, while in

[36] For a comprehensive discussion of the concept of culture, see the well-known monograph of Kroeber and Kluckhohn (1952) *Culture: A Critical Review of Concepts and Definitions.* In their book, the authors discuss the semantic history of the term *culture*, its theoretic significance, and analyze and present various definitions.

other cases, materiality is seen to determine cultural and social aspects. The discussion about the denotation of material culture, its precise delineation, and material culture studies' subject matter is far from complete. Almost three decades ago, Johansen (1992, 6–7), for instance, suggested using the term *materialized culture* instead of material culture to indicate that culture is not *per se* embedded in objects because our culture is *materialized* through a process. Accordingly, the word *materialized* implicates material cultures' developmental and dynamic character—nothing is ready-made but evolves through a development.

As demonstrated by the Latin word *tangere* (in English "to touch") as in *tangible culture*, our physical environment encompasses, first of all, every *thing* that is *tangible*—independently of its origin. As material bodies, things are part of our reality independently of whether they were created by human activity or occur naturally, as long as they consist of matter. In any case, the tangible world is part of human social relationships and everyday practices and essential to meet one's needs. Studying the material world must therefore be associated with its context, the social, cultural, or technological aspects in which it is entangled. Simultaneously, such a study must point up "the dialectical and recursive relationship between persons and things: that persons make and use things and that the things make persons" (Tilley et al. 2006, 4). That is why the study of material cultures must involve both the tangible material aspects of things in the context they are embedded and human action (production, processing, using, consumption, etc.) that is intertwined with these things.

In view of the fact that the concept, interpretation, and understanding of both materiality and thing is exceedingly versatile, Tilley et al. (2006, 4) compile a list of both key terms on the basis of multiple works from different disciplines and, in doing so, provide a conceptual foundation for material culture studies. Amongst other things, they highlight that matter and things are composed entities with specific origins. They further write that things relate to nonmaterial aspects such as ideas, value systems, emotions, intention, and individual and collective identity and simultaneously may go beyond them—not everything we do that involves matter is related to our consciousness. Furthermore, Tilley et al. (ibid.) argue that things are indicators of history and tradition, social change, and relate to space and place, and to how people conceptualize them. Finally, the authors note that things also relate to the human body, which in turn may also be conceived as both a culturally shaped thing and as a sensuous organism in its environment.

A general aspect of material culture studies is their openness and broader scope compared to traditional studies that neglect the material aspects of human existence. However, material culture studies have been mostly restricted to the tangible objects and things alone and reinforced an asymmetry in which "society and history are rendered as exclusively human achievements, brought about by way of the enrollment of objects and things" (ibid., 431). Therefore, Ingold criticizes material culture studies for the anthropocentric conceptualization of their subject matter, "that focuses on the artifactual domain at the expense of living organisms" (2012, 428). Instead of a symmetric approach that would consider all living beings as what they are and more equally as one part of the world alongside humans, as argued by Ingold (ibid., 431), many theorists of material culture studies replaced nonhuman animals with the term artifact. This view inevitably contributes to a dualistic approach which unwittingly "omits the entire gamut of lifeforms, along with the sunlight, moisture, air, and soil on which all life depends. Included in the category of the nonhuman are only those material objects and artifacts thanks to which some humans are able to assert their wholly exceptional way of being in the world" (ibid.).

In recent years, however, material culture studies have increasingly attempted to integrate nonhuman animals and less tangible things into their scientific focus. This integration is essential since the common orthodox perspective on culture and society—wherein the human is the only protagonist of a *social* world due to an antecedently existent mind—must be critically examined. At least, such an antagonism, wherein the human (and her/his culture and society) is regarded as contrasting with other beings, leads to further oppositions (immateriality vs. materiality, mental vs. physical) and other definition problems. If material culture studies rely on such an anthropocentric conception of culture, the gulf dividing humans (as culture-beings) and nature (related to the rest of the world) is not bridged. In contrast, this work tries to overcome the orthodox view of dualism for the benefit of the reintegration of human and nonhuman entities as members of the same world by addressing the issue of the human-bamboo relationship.

What is more, rather than being focused on the tangible physical things and objects alone, one should broaden the scope to encompass those things that cannot be directly experienced haptically due to their semi-solid material quality or ephemeral material character. Against this backdrop, a Bahnar bamboo house is an illustrative example of an interplay of *solid, tangible* things (such as the bamboo floor and wall), *less tangible* things (such as smoke, air, and fire), and organisms (humans and insects). Each Bahnar house has an open hearth and a continuously smoldering fire. This fireplace does not only serve as a cooking place and heating but also as insect control. It constantly produces smoke, which then fills the entire house and hinders insects (particularly mosquitoes) from entering the house and attacking its residents. Since bamboo stilt houses have no windows, the air circulation is guaranteed by how the bamboo floor and walls are made, namely, from split bamboos with hundreds of openings due to the floor's lamellar structure. In sum, fire, smoke, the mosquitos (repelled by the smoke), the bamboo wattlework (allowing the air to circulate), and the humans (residing in the house) are all part of a little *arrangement* (Schatzki 2015) or network (Latour 1999) (the theoretical discussion of the entanglement of humans with nonhumans received comprehensive attention in chapter 5.2). In brief, the Bahnar people's house is a vivid example of a multifaceted interplay of humans—this interplay and its underlying network character are illustrated in Figure 81 and Figure 82—the ecosystem and the tangible and semi-tangible world. It is this composition that challenges a one-sided concentration on material things.

Any analysis of the realm of matter must also consider that a thing's relevance, use, and meaning changes depending on time, and more than that, the surroundings in which it is placed. Furthermore, the practical day-to-day use of mundane things characterizes their everydayness. In this sense, everydayness must also be conceived as relative and in a state of flux. Consequently, material culture is not solely linked to already existing things but also the production and use of things. It mediates the material relationship of people to their surrounding natural and artificial world. Humans are connected with their social group or society's material cultures. The latter are versatile and differ in time and space and between people. Foragers, in comparison to industrial societies, for example, have a less comprehensive material culture. Their toolkit is geared to their hunting and gathering technology and includes knives, axes, spears, bows, baskets, and the like. For their part, industrial societies have a much broader material culture that could encompass cell phones, bicycles, cars, televisions, books, water boilers, light bulbs, or nanotechnology. Furthermore, material cultures differ not only amongst different societies but within a given social group or subgroup. People do not share the same material culture in every case. Differences in tool and artifact use or applied technologies occur as a result of gender, age, skill, or profession (Lemonnier 2002, 19).

On the whole, material cultures are marked by "all the physical objects that a contemporary society produces or retains from the past" (Scupin and DeCorse 2016, 230). These objects could be moveable artifacts or immovable things such as paths, traffic lights, fences, buildings, or statues. Hence, even though material culture studies mainly reflect the human-made material environment in its present shape, they also allow a glimpse into the past and near future of a social group. A far-reaching definition of material culture would also encompass things that are not, in any case, human-made and exist independently of human action and intention. These things could be trees, plants, animals, rivers, or mountains, as well as semi-tangible and non-material things such as the sun, the rain, or bacteria.

In view of this, the studies of material culture have to take into account a plethora of different aspects if they genuinely seek to describe the embeddedness of humans and things. Besides this material involvement, however, symbolic aspects are also part of the mutuality of different entities, as highlighted by Lemonnier in the following manner:

> On the one hand, the human actors, sources of energy, tools, raw materials, gestures and mental procedures involved in a given action aimed at obtaining some material result generally fit together physically, or are at least more or less mutually compatible, otherwise no tangible result would derive from their systemic interaction. On the other hand, besides their material function, in most instances some of these elements, *as well as* their various uses, also cohere and play a role in some symbolic aspect of social life. (Lemonnier 2002, 4)

As Lemonnier's words illustrate, social, cultural, technological, and natural aspects are interrelated through, but also independently of, the material world. Hence, it is challenging to precisely demarcate and define a thing's realm because things similarly intersect social, natural, technological aspects and are symbolically loaded. For instance, a shell can be regarded as a calcareous covering of an animal or, as in the case of shell money, as a medium for exchange. Other mundane objects, such as the Vietnamese bamboo pipe used to smoke strong tobacco (Vietnamese *thuốc lào*), vividly illustrate the object's symbolic representation. Besides its functional aspect of enjoyment and consumption, the bamboo pipe transmits aspects of class and gender relations. Known as *điếu cày* (in Vietnamese) or *farmer's pipe* in English, the bamboo pipe symbolizes, already with its etymological reference, which social group originally and principally is thought to use it, namely, farmers. In present-day Vietnam, the *điếu cày* is most commonly used by peasants and workers rather than wealthy people. Moreover, smoking tobacco in general, and using the *điếu cày* in particular, represents gender relations. While male persons are commonly seen to smoke in public, far fewer women smoke or even use the *điếu cày* because smoking is considered improper behavior for a woman.

In sum, any definition of material culture is only one of many that are possible, and depends on the scholar's epistemological interest. Material culture studies generally have different understandings, conceptualizations, and categorizations of tangible products. Moreover, the meanings and concepts vary amongst different disciplines, much the same as within one discipline, and are related to a discipline's approach to materiality.[37] And finally, the traditional view of material culture studies retains an ontological division of material and immaterial culture. In contrast, other socio-material concepts (as discussed in chapter 5.2) underpin the relational association and interdependence of human and nonhuman actants as part of a network or assemblage.

Overall, the advantages and disadvantages of the concept of material culture elaborated up to this point will be critically integrated into my consideration of the bamboo subject and human-bamboo relationship. Simultaneously, the concept of material culture is also reflected in my definition of bamboo culture in the next chapter. Moreover, though not explicitly discussed in this chapter, my concept of material culture is related to practice theory's and ANT's key terms, theoretical assumptions, and methodological approaches, which provide a more profound analysis of nonhuman things as members of the social. Finally, since the concept of indigenous knowledge and material culture share many commonalities, in chapter 6.2.4, I shall once again elaborate on my understanding of material culture and bamboo culture vis-à-vis indigenous knowledge and indigenous technology respectively.

5.4.2. Bamboo Culture

So far, I have discussed the concept of material culture and materiality alongside the definitions of things and objects and their implications. In what follows, I shall revisit how bamboo might constitute people's material culture. Needless to say, bamboo is *only* one (albeit very important) part of a given material culture since other materials (such as stone, bone, wood, plastic, or iron) are also used frequently. Keeping this in mind, using the term *bamboo culture* in this work, analogous to material culture, primarily focuses on and encompasses all the things associated with bamboo; it deliberately neglects, to a certain degree, other non-bambooic materials or tools but implicates the different appearances and natures of bamboo. Firstly, as a plant, and therefore as an organism like trees and other plants. Secondly, as a plant-based material resource and construction material with specific material properties. Thirdly, in its appearance as a

[37] For archaeologists, in comparison to historians or anthropologists, for instance, any remains of ancient cultures are relevant and are conceived as sources that impart information about a social group. Remains such as fragments of bones or pollen are of substantial interest but would hardly attract attention in other disciplines. That being the case, archaeologists speak of a biofact (or ecofact) when they refer to organic material (plant seed, wood, bones, charcoal, etc.) and consider artifacts as those things that are intentionally made by humans (tools, building materials, textiles, etc.).

materialized and moveable thing, such as a tool or object for daily use. Fourthly, in the form of less movable or immovable human-made surroundings (houses, bridges, fences, pipelines, etc.). Fifthly, as a motif in art and literature and a symbolic entity in feasts and customs. And lastly, in its relation to means of production and individual skill.

Classifying a social group's or a society's techniques, technologies, products, and ways of production involving bamboo under the frame of a bamboo culture, is useful for discussing bamboo's general characteristics and connection with humans. The term bamboo culture reflects on the human-bamboo relationship or how the human (as an observer, designer, user, or consumer) and bamboo (in its appearance as a plant, building material, artifact, or as an element of the built environment, and a symbol) are enmeshed together. For the purpose of a general openness towards the empirically observable and accessible, and by following the concept of practical theory and ANT (as reviewed in chapter 5.2), my approach to bamboo cultures does not intend to predetermine what is a (vital) part of bamboo cultures *a priori*. On the contrary, my approach attempts to consider relations and contexts in which bamboo contributes to unfolding human actions and practices with as much openness as possible.

Accordingly, this open method permits the examination of bamboo's application in various practices and domains independently of the intensity of bamboo's use in such fields. On this account, I conceive bamboo in domains such as house construction, bridge building, irrigation construction, or furniture manufacturing as one aspect and part of a broader bamboo culture or broader material cultures. On the other hand, a bamboo culture can also be determined by bamboo's salient role for a specific society and its material culture—as, in the case of ethnic groups in the Central Highlands of Vietnam, bamboo is the most frequently used material. In any case, the intensity of bamboo's use varies from one place to another gradually. This is illustrated, for instance, by bamboo's use as construction material in traditional Vietnamese boatbuilding. Until today, bamboo remains an appropriate material for shipwrightry in Vietnam and is used to build different boat types for rivers, lagoons, or the open sea (see Pham et al. 2010). In some cases, bamboo is the primary material for boatbuilding, as in the construction of woven bamboo rafts or bamboo hull boats (shown in Figure 30 and the lower photograph in Figure 31). In other boat constructions, bamboo is used in combination with other construction materials (shown in the above and middle photographs in Figure 31).

Figure 31 Two different bamboo boat types. (*above* and *middle)* Boat types in Thuận An in Thừa Thiên-Huế Province. These boats are made of wood, bamboo and styrofoam, as the photograph in the *middle* shows. The basket boats in the *lower* photograph are made entirely of bamboo.

What is more, bamboo is always one part of a more comprehensive network, which (in the case of bamboo boats) may encompass shipwrightry, fishers, navigators, modern marine equipment and instruments, the state of the sea and climate conditions, or maritime life.

Overall, a *bamboo-centric* approach pays more attention to the question of how bamboo intersects with human agency in social practices. It queries bamboo's part in human evolution, technological development, and contemporary societies' daily life while not maintaining a rigid dichotomization of nature and society. Concerning the definition of the term *bamboo culture*, bamboo cultures can either be locally and temporally defined and confined, as in the case of Bahnar people in contemporary Vietnam. Alternatively, the term *bamboo culture* can be understood as a catchall term that subsumes the variety of regional and superregional material cultures and technologies in time and space on the strength of their use of bamboo. Such a cross-cultural interpretation provides the opportunity for significant insights into the human-bamboo relationship. However, and despite the fact of epoch-spanning similarities among bamboo cultures, particularly in the production of bamboo artifacts and their uses, each bamboo culture must be understood against the background of the society, culture, economy, technology, availability of endemic bamboo species, and the environment with which it is interrelated. Their uniqueness marks each bamboo culture and its corresponding bamboo technologies, and any approach to it must devote attention to this fact. Speaking of a homogenous Chinese or Vietnamese bamboo culture, for instance, would be a misleading definition in light of the fact that there was and still is no coherent bamboo culture on a national scale. The material cultures, bamboo technologies, and bamboo's implications in mountain dwellers' daily activities and valley dwellers in pre-industrial and contemporary Vietnam, for instance, have been different and still are marked by many differences. The Vietnam Museum of Ethnography in Hanoi, for instance, displays various architectural styles and everyday objects of the ethnic groups in Vietnam and offers insights into the diversity of bamboo cultures in Vietnam.

5.4.3. The Bamboo Line Hypothesis

Since this thesis is partly concerned with the material history of bamboo, in what follows I attempt to outline some hypotheses concerning early humans' adaptations to their environment in East and southern Asia and their development and utilization of bamboo-based tools in contrast to stone tools in the rest of the Paleolithic Old World.

Against this background, the archaeologist Hallam L. Movius (1948) draws a theoretical line across northern India that separates the Paleolithic Old World into two distinct parts on account of the distribution of superregional prehistoric tool technologies, namely, the Acheulean bifacial hand axes. Movius's view is based on bifacial Paleolithic stone tools' appearance in Africa, Europe, and southern India in contrast to East and southern East Asia, where such tools are hardly found. His postulation of this geographical boundary through bifacial handaxes' distribution subsequently became known as the *Movius Line* (Brumm 2010, 8).

On the one hand, the absence or presence of bifacial tools proved lithic materials' existence and provided information about their part in prehistoric material cultures. On the other hand, Movius believed that the evidence of lithic materials constituted *advanced technology*, leading Movius to his presumption that prehistoric East and southern East Asia could not be regarded "in any sense 'progressive' from a cultural point of view" (Movius 1948, 411). In other words, and in accordance with the view of Movius, the presence of bifacial tools testified to the technologically advanced toolkits of the Stone Age, according to what stone was extensively used for the manufacture of tools with a cutting edge, a tip, or a percussion surface, if compared to "more crudely made and less standardized tools of Far East" (Pope 1989, 51). Later, however, scholars criticized Movius's one-sided view concerning human development and a monocausal explanation of progress and simultaneously pointed out that Movius ignored the relevance of nonlithic materials and their contribution to prehistoric (regional) technologies (Brumm 2010, 8).

Nowadays, it is widely believed that the adaptations of early humans to the prevailing environmental conditions in East and southern East Asia significantly influenced the development and use of sophisticated organic tools and, above all, the use and development of bamboo tools (West and Louys 2007, 515-517). Against this background, Kathy D. Schick (1994) (an American archaeologist and paleoanthropologist) extends Movius's rigid view concerning the presence and absence of stone tools by underlining bamboo's importance, formulated in her *bamboo hypothesis*. "The key tenet of the Bamboo Hypothesis," as Brumm puts it with reference to Pope (1998), "is that early eastern Asian hominins adapted to a stable rainforest environment that determined the nature of the associated toolkits; handaxes were unnecessary, and constraints on tool optimality in rainforests resulted in the long-term production of technologically simple, morphologically undifferentiated stone artifacts" (Brumm 2010, 8). It is also argued that plant materials stimulated hominids in developing plant-based technologies to meet their needs and adapting to their surrounding environment (ibid., 10). According to West and Louys, "among the theories developed to explain this enigma, . . . the theory of bamboo use has undoubtedly proven one of the most enduring" (2007, 515). Moreover, and as Pope emphasizes, "the distribution of naturally occurring bamboo coincided almost perfectly with the distribution of chopper-chopping tools" (1989, 53).

Nonetheless, one question remains unsolved, namely, "why early Southeast Asians would switch to a predominately bamboo technology, given the superiority of stone blades" (West and Louys 2007, 516). According to West and Louys, reasons for bamboo's use instead of stone may be due to the fact "that bamboo knives replaced their bifacial counterparts … [or] that the nature of the rainforest environment precluded the use of large, heavy duty tools" (ibid., 517). Indeed, compared to stones, bamboo is very light, easy to transport, and omnipresent in many rainforests. Therefore, Brumm argues that the rainforest environment "determined the nature of the associated toolkits" (2010, 8) in which bamboo (as well as rattan or liana) was a vital resource and an appropriate material to construct efficient tools (Pope 1989, 53–54).

Against this background, the British archaeologist Desmond Clark (1992, 210) reinterprets the *Movius Line* as a *bamboo line*, marking an ecological boundary line according to which bamboo is much more common and widespread in the Far East than stone tools. The *bamboo hypothesis* remains the most accepted concept to reevaluate and explain the *Movius Line* (Brumm 2010, 10). At the same time, the *bamboo hypothesis* is criticized, for instance, for presuming that complex stone technologies do not suit rainforests even though scholars have proved that stone technologies could likewise be adapted to the requirements of the rainforest (ibid., 12). Another issue raised by the bamboo hypothesis is the relationship between hand ax assemblages and rainforests, as bifacial assemblages are absent not only in tropical rainforests but also in northern regions of China in which rainforests do not exist (ibid., 13).

Schick and Toth (1994), discussing the discrepancy of prehistoric technologies in different world regions, stress the role of bamboo as an essential material used by early humans in East and southern East Asia in the following manner:

> During prehistoric times, much of eastern Asia had bamboo woodlands and forests. Bamboo is unusual in that when split it produces incredibly sharp edges that can be used for a wide range of cutting, hacking, and scraping activities, as some societies in the world still do today. For this reason, stone technology may have taken on a reduced or even secondary role for those hominid groups, giving them less incentive to develop or maintain elaborate and more sophisticated stone tool types. (Schick and Toth 1994, 278)

Thus, in a sense, one can think of bamboo's use in prehistoric times as a *bamboo age*, similar to the Stone Age. What distinguishes stone and bamboo from each other, except for their material property and their intended use and applicability, is their preservability and persistence in terms of their distinct decomposition. Needless to say, due to their mineral composition, stones endure for a long time compared to organic materials like bamboo, which decompose relatively fast. Unsurprisingly, bamboo artifacts do not persist in the archaeological record, and, as a consequence, bamboo's prehistoric usage and occurrence may be undervalued (Westergaard and Suomi 1995, 677).

Against this background, information about bamboo's prehistoric relevance can only be obtained by indirect means, such as archaeological studies of excavation sites, anthropological studies of contemporary bamboo cultures, or, as Westergaard and Suomi (1995) propose, by studying the use and processing of bamboo by primates, which could reveal some insight into bamboo's part in the technological development of prehistoric hominids.

Another method is to reevaluate how bamboo tools could be crafted using stone tools and to study the bambooic tools' workability and handling by carrying out practical experiments. This is done by Clark, amongst others, seeking to gain empirical data and first-hand experience. In his conclusion, Clark claims that "flaked stone tools … [are] fully adequate for carrying out all the tasks necessary for preparing the many pieces of equipment made … from bamboo" (1992, 210). A similar study is realized by Bar-Yosef et al. (2012), who question how efficiently and effectively bamboo tools could be produced with stone choppers and flakes. For this purpose, they worked on and chopped bamboo with stone tools and crafted bamboo knives, and split thin bamboo strips and came to similar findings to Clark. In this context, I shall discuss the use of bamboo knives by Native Americans in pre-industrial North America (chapter 10.2.2.3) and by Awa people in Papua New Guinea in the 1960s (chapter 7.5.2) and shall provide further information about the utility of bamboo knives before the advent of iron tools.

To sum up, the bamboo line hypothesis—developed on the ground of Movius's findings—assumes the significance of bamboo for prehistorical humans in East and southern East Asia and their distinct toolkit based on bamboo, which, in turn, resulted from and was adapted to people's environment and requirements. Although the technological development of bamboo technologies from prehistoric history to the present cannot be traced without gaps or doubts, the spread of bamboo and its use until recent times suggests that bamboo has always accompanied humans wherever they encountered it. By implication, bamboo has become part of humans' material surroundings and contributed much to people's material culture and toolkit.

5.5. *Technē* and Technology: From Manual to Non-manual Work

As described in the preceding chapter, humans live their lives in a world of things and through material cultures that differ from time to time and place to place. In some cases, the tangible world includes industrially manufactured equipment, such as refrigerators, ticket vending machines, electron microscopes, or aluminum canoes. In other cases, none of these things are part of people's everyday life, which includes different things, such as water wheels, bamboo houses, or dugout canoes. On any account, a group's or society's world of things is a multilayered complex that is always permeable to things from other worlds of things. This is the case, for example, when nonindustrial societies adopt new industrial farming methods, plants, goods, or tools. Or when postindustrial societies adopt new technological devices such as computers and cell phones or nonmaterial things such as the internet. In any case, and above all, most things are the immediate outcome of a certain kind of technology and are inextricably linked up with human existence, regardless of whether these things originate from industrial technology or nonindustrial indigenous technology.

Since bamboo is discussed in this dissertation in relation to pre- or nonindustrial societies' technologies, and since the concept of technology epitomizes a range of contexts in which Western technology for a long time was and sometimes still is thought to be superior to preindustrial technologies, I have chosen to analyze the Western term technology critically. Thus, in this chapter, I shall briefly outline the development of the term *technology* (associated with the European Industrial Revolution) and how technology was detached from its roots in arts and crafts (*technē*). On the one hand, this brief description sheds light on the issue of when and how industrial technology changed people's association with manual work and how non-manual work changed society. It also draws attention to the distinctive categorization of industrial technology and pre-industrial technology. On the other hand, a critical review of the term technology is intended to prepare the basis for further specifications of the term technology related to indigenous knowledge, power relations attached to the term technology, and the Western notion of progress and development in chapter 6. This discussion is vital because the human-bamboo relationship, marked for centuries by self-determination, self-awareness, creativity, and autonomous control of the tools, is in danger of becoming a monotonous, alienated, and depersonalized subset of industrial production.

The relationship between science and technology and the discussions on whether technology is subordinate to science—particularly in terms of professional knowledge acquisition—or should rather be understood as a sovereign field of knowledge production are not elaborated in this text. What matters here is when and how the initial link of technology to the arts and crafts fell away; and how machines and industrial processes superseded the creative means of production to such an extent that the industrial revolution brought forth continuously new machines and devices. And finally, how, together with industrialization and technological development, the use and meaning of technology changed. These aspects are of particular interest because bamboo, as discussed in this work, is primarily related to pre- and nonindustrial use rather than industrial technology.

5.5.1. From Technē and Mēkhanē to Technology

Our current use of the term technology is an outcome of Western modernity and industrialization. Similar to culture, it has eclectic meanings and different conceptualizations and understandings in history, philosophy, anthropology, engineering, or everyday language. Accordingly, each theoretical concept of technology implicates particular epistemological access. Therefore, and since technology is a catchall term, it includes a wide variety of things, and it is hardly possible to precisely specify the term technology. Our Western understanding of technology and what it refers to is by no means universal. It is not transferable to pre-industrial or nonindustrial societies without problems, for they had and still have their own particular theoretical concepts of nature, society, and technology—if they differentiate between these categories at all.

Before I delve into the conflation of technology and industrialization, I will discuss technology's roots and meaning. The origin of the term technology stems from two Greek terms. The first is *technē*, often translated as *art*, *craft*, or *skill*, and the other term is *logos*, which means *word, speech, reason,* or *principle. Technē* is about the knowledge of principles employed in the making and creating of things, and it is bound to individual practical skills in the very creational process of making. Furthermore, it underlines humans' capability as one rational and logically thinking being together with the human body's interaction with the tool and workpiece in each work step. As Richard writes, for Aristotle, who coined the opposition of "*epistêmê* as pure theory and *technê* as practice," *technē* is associated with "knowledge because it is a practice grounded in an 'account'—something involving theoretical understanding" (2014, 1). In the philosophy of Aristotle, the knowledge of a craft and the craftwork combines practical work with imaginative skills. And *epistêmê* would be the present-day science or scientific knowledge. From a contemporary Western view, the craftsperson dedicates her- or himself to the act of making while the resulting *creative* work is nowadays labeled as art and is the artist's domain. It is a way of making opposed to the monotonous, mechanized working of operators in factories. The tasks of the latter depend much more on the machine than on personal abilities. In contrast, machine operators appear to have lost their autonomy, creativity, and control over their tools.

Unlike English, *technē* still exists as *technique* in French or *Technik* in German. In both languages, *technē* is used in addition to technology in the meaning of know-how and dexterity. Moreover, *Technologie* in German is commonly used to signify advanced or high-tech technologies. Apart from that, *Technik* denotes both industrial engineering and the medieval concept of *artes mechanicae.*

The term *technique* in English derives from the French *technique* and is related to individual skills. A skilled pianist has developed a flawless piano technique, or a skilled bambooworker has excellent bambooworking techniques. *Technē,* in this conception, describes an individually acquired experience that enables a person to perform a particular activity with skill and thought. *Technique* is both necessary to produce certain things, and it is a knowledge base required to use those things. Therefore, to be meaningful, things require someone with the "know-how how to use them, repair them, design them and make them" (Mackenzie and Wajcman 1985, 3). It is for this reason that an artifact without a user is strictly speaking useless (Grübler 1998, 20). A bamboo blowpipe without a skillful hunter using it is senseless. And a book without someone capable of reading it is equally useless.

In ancient Greece, *technē* was opposed to *mēkhanē*, which meant *engine*, *contrivance*, or *machine*. Since ancient Greece, however, countless machines have been invented and developed together with human history and significantly influenced the course of human history. The ascendancy of industrialization, the mechanization of industrial crafts, and the onset of capitalistic economic growth have meant that in modern societies, "the technical has joined the mechanical" (Ingold 2000, 295–296).

Yet, before machine use, tools were a prevalent part of human work. In a general understanding, the tool is a device with a specific purpose set into motion by human agency that enhances human physical properties. Its human-dependency is a distinguishing feature of tools in contrast to machines. The former depend inherently on human action, whereas a higher autonomous working principle characterizes machines. Underpinning this notion, Mumford gives the following definition of the difference between tools and machines:

> The essential distinction between a machine and a tool lies in the degree of independence in the operation from the skill and motive power of the operator: the tool lends itself to manipulation, the machine to automatic action. The degree of complexity is unimportant: for, using the tool, the human hand and eye perform complicated actions which are the equivalent, in function, of a well-developed machine; while, on the other hand, there are highly effective machines, like the drop hammer, which do very simple tasks, with the aid of a relatively simple mechanism. (Mumford 1934, 10)

For Mumford, the pivotal difference between tools and machines is automatism. While a tool requires human power, a machine can be driven by nonhuman power (water, wind, electricity, animal power, etc.). As Ingold (2000, 294) comments, tools are not so bound to technology in pre-industrial societies but are much more related to a craftsperson's work, practice, and skill than technological production in the machine age. Similarly, Mumford argues that "technics," in the sense of *technē,* "was related to the whole nature of man and that nature played a formative part in the development of every aspect of technology; thus, technics at the beginning was broadly life-centered, not work-centered or power-centered" (1966, 310). Compared with industrial technology, bamboo's traditional use still requires a creative and active engagement of the individual and her/his skills, know-how and implicates a bodily involvement. It can be described as art in opposition to machine-based production related to industrial technology.

The relation of tools and machines is also discussed by André Leroi-Gourhan, a French archaeologist, paleontologist, and anthropologist who produced insightful philosophical reflections about human behavior and cultural development. In his seminal work, *Gesture and Speech,* Leroi-Gourhan (1993, 242–249) discusses human manual activities and portrays an evolutionary process in which the hand gradually becomes liberated and replaced by tools and machines. As Leroi-Gourhan explains (ibid.), the evolutionary process, from manual work to rudimentary machines and complex automatization, is marked by five stages. In the very beginning, the hand is the tool itself, and only in the next step are human-made tools powered by hand the hand's action. The third stage is characterized by indirect mobility and force transmission, with simple mechanical devices like a lever, pully, or other hand-operated machines becoming widespread. These tools' commonality is to change the direction of human power induced by the hand. The use of extra-human power sources (such as water, wind, animal muscle power, or steam power) marks the fourth stage, in which an automotive machine, once set in motion, works independently of the hand. Finally, the last and ongoing stage is marked by the transition from the rudimentary machines (like the early steam engines) to fully automatic machines, wherein the hand plays a minor role and is primarily required to start a preconfigured and preprogrammed process (ibid., 242).

In contrast to the first three stages, the last two changed the relationship between humans and nature, and this relation changed even more drastically at the moment when the utilization of water and wind (as natural automotive sources) was substituted by the steam engine (ibid., 246). While rivers and winds are naturally occurring resources, the steam engine, releasing the energy of fuels as its primary source, has much more of an artificial character. However, and despite the technological development, for Leroi-Gourhan, "the complex operations of grasping, rotation, and transmission . . . characterize *handling*" and are still existent in the simple and complex machines and signify an "exteriorization of the motive force" (ibid., 243, emphasis added). Nowadays, machines have substituted hand-operated tools and devices, and workers have been marginalized while the fundamental working principles have remained practically unmodified.

An initial significant influence on our notion of the term technology was made by the German scholar Johann Beckmann (1739–1811). He described and coined the term technology in his book *Anleitung zur Technologie* (first published in 1777) as follows:

> Technology is the science that teaches the processing of natural materials or the knowledge of crafts. Instead of merely pointing out in the workshops how to comply with the master's

> (or foreman's) rules and habits in the fabrication of goods, technology provides in a systematic order comprehensive guidance on how to come to the final end, on the basis of true principles and reliable experience, which is to find the means and to explain and use the phenomena appearing during the processing (1802 [1777], 20, own translation).

Beckmann's early conception of technology underscores the process of industrialization and mechanization in his day and the desire for a close relationship between technology and science as well as a process of manufacture that is scientifically proven, rational, and objective. In his definition, Beckmann contrasts the subjective experience of a worker with the *true principles* of precise and systematic technology. This contrasting juxtaposition considers a master's subjective experience (gained through skill) to be of little value compared to *reliable experience* attached to technology. Beckmann's definition of technology illustrates the subject's decentralization from the core of activity and emphasizes the machines' and technology's independence from the human being. The acquisition of knowledge became a field of study detached from the practical application of knowledge, skill, and experience at the workbench. And the explanations of the findings and phenomena were manifested as codified knowledge in the form of a compilation of technical information in written records. In the end, knowledge of the first kind was enhanced to the disadvantage of the second kind since technical knowledge was linked to scientific professionalizing and training.

Today, technology is generally understood as a technical design resulting from scientific observation and thought that enables the methodical and exact repeatability of processes with the aid of tools and machines. This definition of technology was of no use in pre-industrial times and did not appear in the Anglo-Saxophone language world until the eighteenth century. Its spread is linked to the transformation of Western cosmology, from being entrenched in Christianity towards a mechanistic view grounded on the natural sciences; and in this regard, technology appears as the implementation of nature's mechanical character (Ingold 2000, 294–295) and could be considered as the fundamental basis for industrial development. As Salomon states, technology evolved "with mechanization, the industrial revolution, the development of professional schools in which engineers were given a scientific training, and the gradually narrowing gap between science and technical arts" (1984, 128).

An extensive definition of technology that encompasses several aspects is proposed by Robert E. McGinn (1978). According to him, "technology is a form of activity that is fabricative, material product-making or object-transforming, purposive (with the general purpose of expanding the realm of the humanly possible), knowledge-based, resource-employing, methodical, embedded in a sociocultural environmental influence field, and informed by its practitioners' mental sets" (1978, 190). McGinn's emphasis on technology as a *form of activity* underscores its social value in view of the fact that each technology must be understood in its relation to the society in question. Additionally, McGinn's definition highlights the performative character of production and the involvement of the individual's action with the material world and the theoretical and practical know-how. In this sense, and with relation to the subject of this thesis, I assume that technology can only be fully understood in terms of the relationship between people and things, that is, by acknowledging the material aspect of that connection.

Further insights about the origins, definitions, and differences of technique and technology are also given by Salomon, indicating that "technology is *more* and *other* than technique . . . [and] implies both laboratory and factory" (ibid., 1984, 127). Salomon, then, defines technology in contradistinction to technique, as:

> a product of rational knowledge rather than ability, the work of scientists (researchers and engineers) rather than craftsmen and technicians, it [technology] would not exist without the industrial environment through which it is stimulated and which it in turn transforms. The objects which it creates or upon which it acts are not only physical goods, but also intangibles. (ibid., 127–128)

In his definition, Salomon illustrates the rational and scientific nature of technology and emphasizes the Industrial Revolution as a midwife to its birth. Technology replaced technique; more specifically, the new industries' scientifically based machine operations replaced the skill-dependent manual labor in specialized factories. Unsurprisingly, the ascent of technology and non-manual work is associated with the downfall of technique or skill as the primary means of production. The characteristics of technology and technique (or skill) and their relationships to human subjectivity are discussed by Ingold, as follows:

> technique is embedded in, and inseparable from, the experience of particular subjects in the shaping of particular things. In this respect it stands in sharp contrast to technology, which consists in a knowledge of objective principles of mechanical functioning, whose validity is completely independent both of the subjective identity of its human carriers and of the specific contexts of its application. Technique thus places the subject at the center of activity, whereas technology affirms the independence of production from human subjectivity. (Ingold 2000, 315)

In Ingold's view, technique is interrelated with self-experience in the course of making. A person is not only creating something, but she/he also is creating her- or himself through knowledgeable handling of the material world in each production process. In doing something, self-awareness and self-experience, just like the experience of identity, come to the foreground. A skilled craftsperson is aware of her/his abilities as part of her/his particular identity. Skill (or technique), for Ingold, "is at once a form of knowledge and a form of practice" (ibid., 316), and in contrast to technology, it is acquired and applied. While skill relates to personal learning and experience from and together with others, access to technology or technological knowledge is achieved through written records independently of its context (ibid.). While the former requires human being's bodily involvement in the process of learning, the latter is less associated with a haptic perception and exploration of the tangible world. In conclusion, "technology is indifferent to the personhood of its operators, techniques are active ingredients of personal and social identity"; from which it follows that "the very practice of a technique is itself a statement about identity; there can be no separation of communicative [or social] from technical behaviour" (ibid., 318).

5.5.2. Industrialization and Machine-Based Work in Factories

After decades of technological development and industrial expansion, the relationship between the producer and the product changed totally. Standardization, division of labor, capital intensive production, and continuous mechanization led to mass production, flooding people with countless new commodities. The modern division of labor brought forth a further separation of design and construction. As Ingold (ibid., 295) remarks, this division is typified by the architect in opposition to the builder. While the former has much to do with the design of a house, the latter's task is reduced to the construction of the house. Rationalizations put a further process of replacement in motion wherein machines play a substantial role, and due to "mechanisation, arts and crafts were no longer the extension of the hand, they replaced the hand with machines which made other machines and thus transformed production" (Salomon 1984, 129). So, individual creative and skill-dependent work was replaced by a worker as a quasi-mechanical entity. To say it using the well-known slogan related to mass production: *the skill is built into the tool*—skill, thus, is depersonalized. In the further course, the factory owner could expand his power, for he had the means of production in his hand; his desire for economic growth depended on a working class and technology. Accordingly, technology and economy conflated inseparably.

In Marx's theory of alienation, the worker became alienated from the means of production. Marx's concept of alienation, as Drohla (1985, 168) explains, is related to the characteristics of capitalistic means of production. It manifests itself in the fact that the results of human activity are separated from their creators and become independent powers, which are no longer under the control of the workers and develop into powers dominating social classes and groups. These powers, in turn, produce their effect on human beings in not only unforeseen but also destructive consequences. As the term *alienation* indicates, Marx was interested in the socio-economic conditions of production but only paid little attention to the practice of making, in which techniques (or skills) and the very materiality of things, tools, and machines are intermingled (Leopold, 2018).

In sum, the notion of technology in its Western sense detached itself from art. Today, technology and art belong to two separate fields of production and creation. However, this distinction is much more a social construction than an immutable condition. Industrial production changed, or in Ingold's (2000, 289) perspective, transformed the worker's relationship and the means of production from the individual to the objective, namely, from a worker's skills to the mechanical devices. For Ingold, this "transition, in the history of human technicity, from the hand-tool to the machine, is not from the simple to the complex, but is rather tantamount to the withdrawal of the producer, in person, from the centre to the periphery of productive process. It is a history, . . . not of complexification but of externalisation" (ibid.).

Our present technologies are, *au contraire*, far from being simple. They are multifaceted, sophisticated, and hard to grasp and handle. What Ingold means by his critical remark is that the human as a creative worker has ended up in such a way that she/he no longer produces things with her/his physiological and psychological abilities. Many (office) workers and operators do not necessarily use their bodily and mental capabilities creatively. The operator is much more a part of a machine and depends on the rhythm of the latter. What results is a concept of engineers or technicians who, just like technology, are geared to mechanical devices and their digital extension. On the contrary, in nonindustrial societies' bamboo cultures, such as that of the Bahnar people or in pre-industrial Japan, the handling of tools and individual technical skills are pivotal to ensure a livelihood and an essential ingredient of daily activities and individual identity.

What is more, bamboo accompanied humanity for hundreds of years and helped to create unique bamboo cultures. From the very beginning, humans' ability to make things was enmeshed with bamboo. Yet, as Mumford assessed more than half a century ago, humanity is in danger of losing its creativity: "Instead of functioning actively as a tool-using animal, man will become a passive, machine-serving animal whose proper functions, if this process continues unchanged, will either be fed into a machine, or strictly limited and controlled for the benefit of depersonalized collective organization" (1966, 303). Mumford's prediction is still relevant today and, unfortunately, an essential aspect of capitalist production. Concerning bamboo's industrial use, one must indeed accept Mumford's dark prospect. For instance, in present-day Vietnam, the artisanal use of and creation with bamboo in bamboo workshops has more than ever been absorbed by the factory system and replaced the craftsperson's particular work steps with a depersonalized mechanization. Labor division and the working steps in the chopstick-factory, for instance, are characterized by a machine-paced work in which the operators metaphorically feed the machine with bamboo (Hillebrandt 2014, 33). With capitalist means of production, workers are still forced to move their bodies inside the factory to make industrial labor possible. Instead of obtaining a bamboo product due to individual creative making, the operators are part of a semi-automatic manufacturing process (see discussion in chapter 4.4 and the illustration of a chopstick manufactory in Figure 29). Under such circumstances, which tend to optimize workflows, labor is tied to the increase of productivity rather than improving the operators' individual dexterities or training them as skillful bambooworkers. My observations of chopstick factories in Vietnam show that the operators are inextricably linked with machines. They produce bamboo chopsticks collectively, but their entire work is depersonalized. No single task affords unique skills or creativity. The work is dictated by the rhythm of the machines. Hence, the chopstick factory is a typical example of how an industrialized production and the spread of machines affect the division of labor, human creativity or skill, and lastly, human life in its entirety. In this context, Mumford (1966, 314–315) raises the question of whether humanity's self-made mechanical system with its externalization of power and control is worth being maintained or whether humanity should adopt an alternative, humane path.

Since this dissertation's research goal is to scrutinize bamboo in the context of non-European pre-industrial or nonindustrial societies, it refers to a technology in a nonindustrial setting. By and large, a technology that rests on bamboo is typically an applied technology and part of everyday life. It is transmitted orally and experienced in practice rather than based on written records (as a sort of data that is science-based or scientifically proven). Furthermore, and in contrast to Western dualistic thought, technology in a pre- or nonindustrial context is less separable from people's (subsistence) economy, environment, society, culture, and everyday life. In this case, technology is not something that exists independently of practices and activities but was and is an integral part of pre- and nonindustrial societies. This being so, I shall take a closer look at technology through a holistic approach when I scrutinize the human-bamboo relationship and ask how things and humans are intertwined. Moreover, and from a social-ontological standpoint, technology means practice and has social dimensions, which is why I examine technology as the outcome of human-nonhuman relations.

5.6. Technological Development

Since this work examines many large-scale and small-scale societies' proto-industries or indigenous technologies throughout history, a discussion of some theoretical assumptions considering the characteristics of technological development is essential for a plethora of reasons. In this view, this dissertation is a comparative study describing bamboo cultures of present and ancient societies. The various chapters address people's interrelation with bamboo in disjunct places and separated by time. Thus, to analyze the material history of bamboo on a global scale, it is worthwhile to compare bamboo cultures that evolved—as most vividly illustrated by the separation of bamboo cultures of the Americas compared with Asia—separately from other bamboo cultures, but still developed similar ways to use bamboo. Against this background, discussing theoretical assumptions concerning technological development will be essential to discussing how bamboo cultures in different regions evolved and how bamboo contributed to the technological development of local proto-industrial technologies—as exemplified by China's long technological history.

After a brief outline concerning stages attributed to technological development, I shall discuss characteristics of technological development on the basis of diffusionism, technological determinism, and social determinism. Following this, after a short comment of Schatzki about the conflation of technology, society, and nature as the *explanans* of technological development, I will conclude with my view on technological development.

One central aspect that is related to technological development is the question of how the process of technological development develops. First of all, technological evolution is, as Grübler points out, "*uncertain, dynamic, systemic* and *cumulative*" (1998, 21). It is, strictly speaking, a non-linear and complex process with myriad possibilities and the very reverse of simplicity (ibid.). Moreover, new technology cannot appear out of thin air. In this view, the eureka moment as the seemingly sudden ingenious insight of a scientist or engineer is always constituted on the available technology and preceding scientific findings of a given society.

Technological development is much more processual, with step-by-step changes that draw on available technological know-how and is much more a recombination or reconfiguration of the prevalent technology (Mackenzie and Wajcman 1958, 10).

To put it another way, "existing technology *is* . . . an important precondition of new technology. It provides the basis of devices and techniques to be modified and is a rich set of intellectual resources available for imaginative use in new settings" (ibid.). The worldwide modern bamboo architecture, for instance, is a combination of Western-based architectural design and thought and the pre-existing know-how of local traditional bamboo house construction. Another example is the modern bamboo industry that combines Western-based industrial wood fabrication with traditional bamboo handicrafts and skills.

Regarding the different stages that technological development undergoes, Roland (1992, 83–84) defines the following four stages. He describes the first period, the *Age of Materials,* related to the control of organic and inorganic materials (woods, ceramics, and metalworking). The *Age of Technique* follows this stage, in which people improve and elaborate their techniques using human capital together with (nonhuman) natural resources. The third era, the *Age of Power*, is characterized by the expansion of power both in waterpower and cannons. The fourth stage, the *Age of Machines*, is linked to the rise of steam power and steam engines' exploitation for industrial development. Roland's classification conforms with Leroi-Gourhan's description of humans' evolutionary development, which I discussed in the preceding chapter. In as much as both scholars contribute to a general understanding of humankind's progress, the main features of their ideas can be transferred to non-European cultures also. Considering bamboo's use by many societies, the *Age of Bamboo* is linked to Roland's Age models. The *Age of Materials* is related to the general use of bamboo. The *Age of Technique* is related to the various technical uses implicating bamboo, while the *Age of Power* indicates the use of bamboo to exploit waterpower or wind power—most vividly illustrated by water and windmills. Bamboo is also partly involved in the use of steam power as expressed by the *Age of Machines* since bamboo has been used as pipelines for steam extraction (as detailed in the drawing in Figure 153 illustrating an apparatus for producing camphor).

5.6.1. Diffusionism

One prominent theory attempting to explain technological advancement and the dissemination of ideas is diffusionism, which attributes the technological development to distribution. According to the diffusionist model, technology and technical devices were transmitted throughout history from one to another place; locality is emblematically the place of birth of a certain technology, idea, or technical device. Leo Frobenius (1873–1938), a German anthropologist and archaeologist, conceptualized the model of cultural diffusionism and stated that members within a social group, as well as between distinct groups, exchange ideas, thoughts, technology, language, art, and similar things—through diffusionism cultural, societal, or technological development is explainable (Gaillard 2004, 44).

In the opinion of diffusionists, inventions disseminate largely unidirectionally, from the place of discovery to other places. Such a unilinear view of technological progress was claimed during the colonial period when technologies circulated from the centers of production to the periphery; that is, from the European motherlands to the colonies and from the urban centers to the countryside, the periphery (or colony) thought to provide *only* natural resources (Arnold 2005, 98). Today, technologies are far more complex, and new inventions evolve on a global scale with numerous actors involved.

One undeniable problem with the diffusionist model is the emergence of similar inventions in different world regions. In the past, people came independently of each other to similar (technological) insights and solutions on account of the materials they had to hand. Concerning bamboo, one could argue that peoples of the Americas and peoples of Southeast Asia made use of bamboo in similar ways. They used bamboo to make arrows, houses, pipes, fences, baskets, bridges, and other things without knowing of each other's existence. The occurrence of bamboo blowguns in different parts of the world is another vivid example. For the British anthropologist John Hutton, the invention of bamboo blowguns in separate regions relates to human intelligence. He sees the blowguns as a piece of evidence that "similarities . . . arise from the application of human intelligence to the solution of difficulties" (1944, 3). This comment is valid, but it neglects bamboo's materiality and, in particular, its hollow structure, which is a prerequisite for constructing blowguns. In fact, the intimate interplay of human intelligence, skill, technical knowledge, and bamboo's structure brought forth such inventions as the blowgun. Emphasizing human intelligence alone as the prevalent factor for inventions is anthropocentric and gives a one-sided view of human evolution and technological development.

One other problem with diffusionism arises if one considers that ideas, thoughts, devices, or the like were transferred from the origin of the invention to another place in the remote past or over long periods, making it difficult to trace the origins of certain things. For instance, many Western scientists claimed that seminal inventions first originated in Europe, and they neglected the history of essential inventions, which stem from non-European societies. Indeed, various inventions, such as gunpowder and the compass (to name only two examples), came to Europe a long time ago. Eurocentric scientists, however, knowing less about the origins of particular inventions, ignored other world regions' contributions to technology. That is why, as Arnold (2005, 98) rightly states, works like that by Needham on ancient China's technology represent a counterweight to Eurocentric diffusionism and are helpful to reconfigure the long-lasting technological exchange and diffusionism.

Indeed, pre-industrial China's technological development had a profound impact on the extra-Chinese world and material cultures. Many inventions originating in China reached the extra-Chinese world through diffusionism—and in many cases, bamboo played a significant part in the invention of specific technical devices and contributed to technological problem solving and innovations in China. Accordingly, technological exchange from China to Europe has been essential for Europe's technological development, industrialization, and the constitution of European societies. From this standpoint, diffusionism helps to find explanations of how inventions, technological solutions, and ideas spread on a global scale through cultural and economic exchange, for example, through trade routes such as the Silk Road. Needless to say, a Sinocentric approach to technological development is equally problematic.

5.6.2. Technological Determinism and Social Determinism

In what follows, I will introduce the main ideas of social determinism after briefly summarizing the basic ideas of technological determinism. Advocates of technological determinism underscore technology's impact on society. For them, changes in society (and culture) result from technology or rather technological development. Moreover, they underscore technology's independence of society and claim that changes in social structures are, first and foremost, the outcome of technological development. According to them, "technology impinges on society from outside the society," and "change in technology causes social changes" (Mackenzie and Wajcman 1958, 4). Because of the *a priori* exclusion of technology from the social sphere that, in consequence, does not allow mutual interrelationships to be revealed and discerned, I consider the concept of technological determinism and its analytical approach as problematic.

Social determinism stands in stark contrast with technological determinism, and its advocates argue that technological development has social causes. When focusing on technology's effect on society (as done by technological determinists), technology appears to be something outside society and independent. Yet by scrutinizing the social impact on technology, technology becomes, just like our economy, part of our social world. It becomes something less independent of us, something integrated and interrelated with society (ibid., 3). Accordingly, in this view, technology lacks an independent existence; it is merely a tool whose use depends on social decisions.

"Technical relations," as Ingold puts it, "are embedded in social relations, and can only be understood within this relational matrix, as one aspect of human sociality" (2000, 314). An instructive example of how people shape technology is the scientific community. Scientists are members of the society they live in, and their assumptions are influenced by the latter's supra-individual common thoughts and ideas, its underlying technology, religion, or culture, and the like. As a result, what the scientific community declares to be true or false is linked to a general consideration of the world they are part of.

Prominent advocates of social determinism and co-founders of a social constructivist theory known as the *Social construction of technology* (SCOT), like Thomas P. Hughes, Wiebe Bijker, and Trevor Pinch, emphasize the social reasons for technological development and are against a rigid dualistic perspective on this issue. Accordingly, Bijker and Pinch assess that "structure and agency become much more complicated when dealing with technology" and to say "where human agency ends and some sort of nonhuman agency begins is not always clear" (2012, x). Being against a rigid division between technology and science, Hughes critically examines the view that "technology was usually defined as the technical artefacts; science as knowledge" (1986, 282). Such a dichotomous approach inevitably leads to self-contained and contrasting categories and problematic conceptual separations.

As maintained by SCOT, technological development is primarily a multifaced social process rather than a technological one-way street. "In SCOT," so Bijker and Pinch, "the developmental process of a technological artifact is described as an alternation of variation and selection . . . [and] results in a 'multidirectional' model, in contrast with the linear models" (2012, 11–44). This view is illustrated by Bijker and Pinch (2012) through a description of the bicycle's technological development and implementation, which is inextricably linked with social factors.

At first glance, SCOT's approach offers an openness for the interpretation of technological development—especially by comparison with essentialist theoretical concepts that would most likely neglect or reject technological strains. Overall, SCOT is an appropriate method to develop a hypothesis of technological development with the involvement of social groups. At second glance, however, and since SCOT is an anthropocentric *social* constructivist theory, it reduces its scientific approach to humans, neglecting other (nonhuman) aspects. Lastly, SCOT's anthropocentric argumentation manifests the dichotomy between the human subject and the nonhuman object once again. Such an approach leaves almost no space for the nonhuman entity's characteristics or sphere of action. Any attempt to describe technological development or innovation, or an object's technological development, such as the bicycle, must instead consider the invention's materiality.

Therefore, referring to Bijker and Pinch's scrutiny of the bicycle's development, one is inclined to ask why both authors insufficiently consider the material used for the construction of a bicycle. The early precursors of bicycles, such as the *draisine* (around 1820), were made of wood, and only later were wooden bicycles substituted by metal ones. However, both wood and cast iron have different material properties that affect the bicycle's durability, riding quality, or shape, and they require different manufacturing processes. Thus, at the time of industrial mass production, wooden bike production was much more labor-intensive than those made of cast iron. The very materiality of a (wood or cast iron) bicycle was intermingled with technological development and industrial production processes. As a result, the evolution of bicycles should neither be understood as a solely human-induced social process nor as a technological outcome, but as a process in which material, social, and technological factors were involved. In this context, it is worth mentioning that bamboo was also considered an appropriate material to construct bicycles. The first bamboo bicycle was introduced in England in 1894, but like wooden bicycles, bamboo was also less suitable for mass production compared to cast iron, and its further development stopped until very recently.

5.6.3. Technology, Society, and Nature as the *Explanans* of Technological Development

Hitherto, I introduced and discussed several indicators that influence technology and theories that seek to solve the question of what generates technological development. It has become clear that change in technology results from many rationales and that one should be critical of one-sided explanations. Lemonnier also casts doubt on technological choices as being simply a product of technological behavior and stresses that "social logics unrelated to technology may weigh heavily on the evolution of technological systems" (2002, 2). It has also become clear that neither social nor technological determination are genuinely useful in explaining technological choices and development. Their reductionism eclipses the interplay of society, nature, and technology and how this intimate interplay contributes to societal or technological development.

Another critical remark, questioning the reasons for technical choices, comes from Marafouris (2008, 23). He points out that decisions do not exclusively depend on the human subject but rather result from an interplay of several factors (humans and nonhumans). This statement is also supported by Schatzki, who argues that "the history of technology" is not "simply that slice of the total realm of human activity that is tied to technology" (2003, 83), but rather "technology is integrally woven with the nexuses of practice and materiality through which people coexist" (ibid., 90). Neither the view of science and technology as something that lies outside society and determines humans and society nor the view of a nature that is shaped according to human and societal concepts corresponds with the empirical observations.

Studies of technology, just like material culture studies, must consider the material aspect of the human-thing relationship. Hence both the nature of the human body, along with the materiality of technology and the material world, must receive adequate attention. In my understanding of technological change, therefore, it is neither the humans as the sole bearer of agency, nor any independent technological structure as in the definition of technological determinism, nor the laws of nature that determine technological change. Quite the contrary, if the technology of pre- and nonindustrial societies changed, the motives should be sought in an interplay of all the entities coming together: the tangible things of the material realm, including the artifacts, tools, and other material aspects of technologies; the semi-tangible things such as climate conditions, wind, or water; the intangible things such as skill and knowledge; other nonhuman entities such as plants and nonhuman animals; the human, understood as an organic being; and lastly human culture and society. Any modification in one of these domains directly or indirectly impacts society, economy, nature, culture, or technology. In consequence, technological change is a multidimensional development and emerges as an effect due to the interplay of all mentioned domains.

6. Indigeneity and Development

Since the present work's anthropological parts are concerned with indigenous people's bamboo culture in various epochs and places, I shall discuss topics concerned with the definition of indigenous knowledge and indigenous technology and how both are related to indigenous people's socio-cultural and technological development. And, as mentioned in the introduction of the last chapter, this chapter's topical scope is thematically related to my discussion of the concepts of technology, society, nature, and culture in the previous chapter. At the same time, I shall provide a critical review of how to conceptualize the term indigeneity and ethnicity since both are essential core concepts when discussing pre- and nonindustrial small-scale societies and their use of bamboo.

Thus, the first part (6.1.1) of this chapter begins with a presentation of early anthropologists' unilineal explanation of human history and development (exemplified by Lewis Morgan's *stage model*) and their deficiencies in contrast to Franz Boas's contribution to *cultural relativism* as a further developed and unbiased approach to the study of social groups. Following this, I will address the issue of the definition of *primordial* and *situational concepts* of ethnicity (6.1.2) and refer to concepts of indigeneity and indigenous people (6.1.3). Since this dissertation's anthropological part is mainly concerned with the bamboo culture of an ethnicity, namely, the Bahnar people, a critical discussion of the origins and meanings of the terms *ethnicity* and *indigeneity* is essential to clarify both terms' shortcomings and, based on this critical discussion, to outline the term *indigenous knowledge* (6.2.1). Against this backdrop, I once again debate the definition of technology, this time in terms of its role for pre- and nonindustrial indigenous people, and develop my definition of *bamboo technology* (6.2.2).

As already indicated in chapters 5.2.5 and 5.3, I reiterate the point of skillful sensory learning regarding indigenous knowledge (and technology) and the fact that emphasizing the *simplicity* of a technology neglects certain other qualities, and discuss critical comments on this issue (6.2.3). Taking into account the definition of material culture (in chapter 5.4.1) and indigenous knowledge (in chapter 6.2.1), I elaborate on differences and commonalities between the two concepts and define them in more detail (6.2.4).

In chapter 6.3, after a brief review of the discipline *history of technology* and its framing of technology and an examination of the extent to which Western technology and colonialism were intertwined during the colonial period, I highlight the contribution of postcolonial and anthropological studies to the critical study of technology.

Following this, in the next chapter (6.4), I briefly debate the shortcomings of market-driven, unilineal developmentalist ideas by reference to Vietnam and their effects on the livelihood of indigenous people. This is followed by a short discussion of the term *sustainability* and how sustainability is linked with bamboo and people's self-determination. Given that people throughout the world are threatened by globalization and one-sided notions of modernization, I shall introduce holistic ideas of well-being (by the example of the Buen Vivir concept as formulated by Eduardo Gudynas), which provide alternatives to pressing questions concerning various aspects such as how (indigenous) people can preserve, defend, or promote their life-styles, (indigenous) knowledge, cultural heritage, or the surrounding ecosystem. What is more, even though it has a different background, I shall indicate that Buen Vivir is (partially) in line with socio-material theories when opting for re-assembling of the social, namely, to understand people's life not in Western dualisms but through holistic approaches.

6.1. From Early Anthropology to the Present: Definitions of Ethnicity, Indigeneity, and Indigenous Knowledge and Technology

Throughout the world, bamboo cultures are based on different forms of knowledge, culture, religion, technologies, social organization, ontologies, epistemologies, the nature surrounding people, and the like. Bamboo cultures have been and still are maintained by many indigenous peoples or ethnic minorities (or groups) in many countries throughout the world—and particularly by many ethnic groups residing in the highlands of Southeast Asia. Since I studied the bamboo culture of an ethnic group (Bahnar people) in Vietnam, I shall critically discuss the emergence and use of the notions of *ethnicity* and *indigeneity* in socio-cultural anthropology in order to analyze and understand the traits of indigenous people's nonindustrial technology (as one subset of indigenous knowledge) and their socio-cultural, economic, and technical embeddedness with their environment. This approach allows us not only to explore bamboo's use in contemporary nonindustrial societies but also is a linking part in the analyses of historical bamboo cultures discussed in the historical chapters of this dissertation.

6.1.1. Unilinear Theories About Cultural Evolution

In its beginnings, anthropology, as an academic discipline developed in the nineteenth century in Europe, tended to study extra-European cultures by applying its specific method (fieldwork). In doing so, early anthropologists analyzed and understood the entire socio-cultural lives of non-Western people as a unique self-contained whole unit. Accordingly, *traditional societies* were believed "to be structurally simple and culturally homogenous" in contrast to *complex industrial societies* represented and, as a result, "studied in their entirety as discrete wholes" (Munasinghe 2018, 2). Still in the beginning and before anthropology was established as an academic discipline, pioneering anthropologists like Edward Burnett Tylor and Lewis Morgan had argued for a unilinear idea of cultural evolution as a progressive change and unidirectional evolution of societies over the course of time: from simple to modern civilization. This interpretation resulted in the formulation of evolutionary stages models. For instance, Morgan (1877, 3) emphasizes humanity's gradual development and classifies societies as in a state of savagery, barbarism, and civilization, whereby each stage is linked to the other logically and in the sense of progress. The early anthropologists' perspective was in line with the zeitgeist, and to some extent, in accordance with Charles Darwin's seminal theory of biological evolution by natural selection. Morgan, much the same as Tylor, tried to understand human behavior more comprehensively and wanted to give anthropological explanations of societal and cultural change. However, their uncritical classification of societies as *primitive* and *wild*, or, in contrast, *developed* and *civilized*, was an illegitimate simplification of the world. Indeed, both anthropologists' attempts are characterized by their ethnocentrism and "racist views of human development and misunderstanding of biological evolution" (Scupin and DeCorse 2016, 296).

Morgan's (1877, 11) materialism and evolutionary framework suggested that technological inventions and the use of technology are the critical factors for societal and cultural developments and were pivotal indicators for his classification of each society in a given stage. In Morgan's view, inventions and technological development are the result of rational thought, which, in turn, is conceived as the driving force of human evolution (Boas 1938, 175). Amongst all inventions, so Morgan, it is the invention of the process of iron smelting and the subsequent use of iron tools, which, in Morgan's view, had the most impact on humanity's progress and which was the motive force for societies to step forward from barbarism to civilization (1877, 11, 48, 190, 549).

Morgan's point of view is a technological determinist conception of human societal development and neglects many other non-technological aspects. As a result, the stage model's unilinearity underpins a uniformity of humankind's progress. It assumes, independently of a society's background (environment, social organization, technological knowledge, available resources, etc.), that people develop "similar inventions . . . customs and beliefs," and underlines "a correlation between industrial and social development, and therefore a definite sequence of inventions as well as of forms of organization and belief" (Boas 1938, 178).

In the trajectory of anthropology, however, many anthropologists were blamed for their technological determinism. They were criticized for being one-sided because they were highlighting technology's notable role in the development of humankind. Anthropologists like Marvin Harris or Leslie White, to name merely two prominent representatives of cultural materialism, therefore attracted criticism on the grounds of their cultural evolutionary models. According to them, "sociological, ideological, or emotional factors" influence technological use and progress but "exert little influence on sociocultural systems compared to technology's dominant role" (Anderson and Sutton 2004, 348). Until recently, anthropologists discussed the cultural materialists' theoretical concept and particularly the question of technology's part—as the critical factor for change or only one amongst others—concerning societal and cultural development (ibid.). Yet contemporary anthropologists reject technology's predominant and salient role in changing and transforming culture and underscore technology's interconnectedness with cultural values, religion, economy, and practices (ibid.). That being the case, change happens on the basis of diverse factors' synergy rather than being reduced to exclusively one factor.

Early anthropologists like Franz Boas rejected the stage model on account of its simplicity and racism. Contrary to the evolutionist model, for Boas, cultural development depends on the historical relations and interactions of the society in question. As a result, he introduced the idea of cultural relativism in his work *The Mind of Primitive Man* (1911), enabling scholars to study each society from within the group. This emic approach considers each group's particular belief system and cultural habits as differing from other social groups. It is the contextual knowledge that allows us to trace back the peculiarity of a social group's cultural habits. In a sense, Boas (1938, 175) proposes to study and analyze culture as a phenomenon rather than based on preconceived theoretical assumptions. In so doing, structural functionalists like Alfred Radcliff-Brown perceived society as a living organism and applied the terms structure and function in their analyses of the principles and reasons of society. Structure, thereby, was "defined as the social relations linking parts of a system" to reproduce and maintain the system, while "function was defined as the contribution of the different parts of the system to the whole" (Munasinghe 2018, 2–3). This model offered the opportunity to study a social group as a self-contained unit, expressed by the one-society/one-culture model of allegedly self-sufficient tribal units.

6.1.2. From Tribe to Ethnicity: Primordialist and Situationalist Models

Since anthropologists were predominantly interested in small-scale societies, the terms *tribes* and *ethnicity,* or *ethnic group,* turned out to be the most-discussed concepts in socio-cultural anthropology. In general, in the course of anthropology's academic history, one-sided perspectives on ethnic groups formulated around the notion of *primitive society*, *race*, and *tribe* were challenged by subsequent anthropologists leading to paradigm shifts from *tribe* to *ethnicity* (Munasingh 2018, 4) and contributed to the reintegration of the notion of ethnicity and culture. Since then, proponents of *primordialist models,* on the one hand, and *situationalist models*, on the other hand, have attempted to give explanations about the cultural traits of social groups. In this view, the term *ethnicity* "is based upon perceived differences in ancestral origins or descent and upon shared historical and cultural heritage," while the term *ethnic group* refers to "a collectivity of people who believe they share a common history, culture, or ancestry (Scupin and DeCorse 2016, 239–240) has received much attention and remains a controversial issue in the literature of socio-cultural anthropology. A debate that was initiated based on two seminal works: Clifford Geertz's *The Integrative Revolution* (1963) and Fredric Barth's *Ethnic Groups and Boundaries* (1969).

Geertz's contributed significantly to the formation of primordial theories of ethnicity, which stressed the continuing importance of premodern cultural traits as the main explanatory factor for a group's connection to their ethnic identity. In contrast, Barth advocated a fundamentally opposite view of ethnicity and highlighted its dynamic, open, and relational character, and laid the foundation for situational theories about ethnicity. The difference between both theories is elaborated by Munasinghe as follows:

> The primordialists point to the explosion of ethnic sentiments and movements in the contemporary world as evidence to support their claim that ethnic identity is derived from affective ties that stem from the facts of birth or the givens of blood, race, language, and custom. The situationalists, on the other hand, point to the emergence of new ethnic groups demanding recognition and the incidence of individuals purposefully changing identities to suit their

> interests as evidence in support of their claim that ethnic identity is based on instrumental manipulation of culture, motivated by collective political and economic interests. There is also disagreement regarding the ontology of ethnicity, with primordialists leaning toward essentialist conceptualizations that naturalize ethnicity while situationalists foreground its provisional and contingent character. (Munasinghe 2018, 1)

In brief, both theories pursue the vexed question of culture's role relating to society and the individual's relation to affiliate cultural change or continuity from different directions. Both theories also have divergent notions of the ontology of ethnicity that culminated in an irresolvable debate between both positions. Primordialists tend to claim that ethnic identity relates to a social group's inherent factors. They highlight the *primordial* (already existing, original) differences and characteristics of social groups and only in a second step pay attention to a group's relation to other ethnic groups and interethnic processes of demarcation. In contrast, situationalists emphasize that ethnic boundaries are changeable, continually redefined by interactions depending on the situation, do not necessarily have to be based on actual differences between the ethnic groups, and emphasize the contingent character of ethnicity. Barth's point is, therefore, that "ethnic distinctions do not depend on an absence of social interaction and acceptance, but are quite to the contrary often the very foundations on which embracing social systems are built" and that the ethnic boundary "defines the group, not the cultural stuff that it encloses" (Barth 1969, 10, 15). Based on their apprehensions of ethnicity, primordialists were later referred to as *essentialists* since they highlighted perennial identities and universal aspects of culture that constitute social life. And situationalists were later referred to as *constructivists* or *instrumentalists* because they paid special attention to individual agency, the significance of self-ascription, and contingency of social life. In my view, instead of drawing distinct boundaries around ethnic groups, one should acknowledge the mutual relationship between ethnic groups and cultural diversity. As Scott stresses in this context, the traits amongst ethnic groups are "lacking sharp, discontinuous changes in ritual, dress, building styles, or even language," and concludes that "any line of demarcation was arbitrary" (Scott 2008, 424).

Following Forsyth and Michaud, I consider that ethnicity refers "to personal and collective decisions, circumstantial strategies, and various other influences that sustain a discrete and negotiable form of collective identity" (2011, 8). In consequence, ethnicity is adaptable and transformable rather than fixed and unalterable. It is continually reproduced and renewed by its members, and it reproduces and renews its members' identity. Concerning a critical use of the term ethnicity, I shall use it to refer to people sharing a common kinship, culture, knowledge, belief system, area of habitation, and language but as a dynamic, changeable concept without strict demarcations. Furthermore, ethnic groups have their own particular perception of themselves, other groups, nature, and their environment.

Despite their versatile use, the terms *ethnicity* or *ethnic minority* have shortcomings since both are emerging as opposing terms and concepts to nationality. Only in relation to something larger, for instance, if there is a dominant (ethnic) majority in a nation-state, is the concept of the term *ethnic minority* meaningful. This is the case, for instance, in Vietnam. Although ethnic groups had constituted the majority in the Highlands of Vietnam for centuries, they became minorities on a national scale after the establishment of the First Republic and the Socialist Republic of Vietnam.[38] Needless to say, ethnicity and nation are modern phenomena, which manifest their meaning in premodern understandings of ancestral origin.

6.1.3. Defining Indigeneity

Alongside the term *ethnicity,* the term *indigeneity* emerged as a core concept of anthropological inquiries in the 1970s to identify particular social groups. Both concepts have similar basic assumptions and describe a social group (based on factors such as history, culture, or social organization). The term *ethnicity* derives from the Greek term *ethnos* meaning *nation* or *people*. It is generally conceived as a kind of collective identity based on shared cultural traits, whereas *indigeneity* is borrowed from the Latin term *indigenus,* meaning *native* or *born in a country*. The term *indigenous* refers to the locality and encompasses inanimate or animate entities that are "produced, growing, living, or occurring naturally in a particular region or environment" (Merriam-Webster OnLine 2018) and can refer to people, animals, plants, and trees. Accordingly, *indigenous* means that something belongs to a place naturally or is part of an environment and is not introduced from outside. Hence, in contrast to ethnicity, indigeneity pays special attention to a social group's homeland or ancestral territory.

Martínez Cobo (1986) made one first definition of the term indigenous people or indigenous population in a United Nation's paper published as *Study of the Problem of Discrimination against Indigenous Populations*, in which he defines the term as follows:

> Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing on those territories, or

[38] The conception of ethnicity and ethnic minority with reference to ethnographies in colonial and postcolonial Vietnam will be discussed in more detail in chapter 7.1.2.

> parts of them. They form at present non-dominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal system. (Martínez Cobo 1986, 379)

Martínez Cobo's *definition* is a very wide explanation in which he emphasizes the importance and link of *continuity* related to *territories* of people *distinct* from others and that this link is based on socio-cultural commonalities within a given indigenous group. Martínez Cobo, then, pays special attention to the importance of a group's self-identification:

> On an individual basis, an indigenous person is one who belongs to these indigenous populations through self-identification as indigenous (group consciousness) and is recognized and accepted by these populations as one of its members (acceptance by the group). This preserves for these communities the sovereign right and power to decide who belongs to them, without external interference. (ibid., 380)

Accordingly, Martínez Cobo's description attributes empowerment to the concept of indigenousness with a positive underlying connotation. For this reason, I shall use his definition, knowing well that any definition of indigenous people remains non-exhaustive and controversial. One lingering problem associated with the term *indigeneity* is the difficulty to define a precise and clear concept of it due to the fact that indigenous communities are spread worldwide and characterized by diversity rather than homogeneity. Each indigenous group is marked by uniqueness though they may share many commonalities with other indigenous groups. In this context, Berger notes that "the notion of belonging to a separate culture with all its various elements—language, religion, social and political systems, moral values, scientific and philosophical knowledge, beliefs, legends, laws, economic systems, technology, art, clothing, music, dance, architecture, and the like—is central to indigenous peoples' own definition" (1987, 12). Thus, any aspect of indigenous people's life is crucial for their *own definition* of themselves and encompasses the socio-cultural realm and the material aspects of life. Therefore, in accordance with ANT's principles, all aspects are relevant since they are all related to each other and contribute to and stabilize indigenous people's socio-cultural and material existence.

6.2. Indigenous Knowledge and Indigenous Technology

As discussed above, the term technology in (post-)industrial societies is indivisibly linked with rationality and industrialization. But what about pre- and nonindustrial (indigenous) people's technology in history and present times? The life and economy of many indigenous people are not yet linked up with industrial and capitalist production. In the case of the Bahnar people studied in this thesis, their economy is subsistence-based, and their manifold work secures their own basic needs. In order to discuss the notion of pre-and nonindustrial people's technology, I shall elaborate on the meaning of indigenous knowledge and indigenous technology.

6.2.1. Indigenous Knowledge

First of all, it is necessary to mention that *indigenous knowledge* is used interchangeably with multiple other terms such as *traditional ecological knowledge*, *traditional knowledge (systems)*, *local knowledge*, or even *indigenous technology.* For linguistic clarity, I will use the term *indigenous knowledge* synonymously with the other terms but *indigenous technology*, as a subset of indigenous knowledge, in the way as described below.

The study of indigenous knowledge must consider the spatial and temporal context of people's life. However, since people have always been migrating, it is highly controversial to define which people are indigenous and not. Moreover, certain techniques, tools, or technologies were possibly introduced to a particular group a long time ago and gradually became part of specific indigenous knowledge. In other cases, certain aspects of indigenous knowledge might have been replaced by industrially designed techniques or industrially fabricated tools (like the fire-lighter that replaced traditional ways of fire making). And in other cases, only some aspects of a tool, such as its design, material composition, or working principle, might have been altered. This is, for instance, illustrated by the bird trap of Bahnar people, which was formerly made from organic materials and now in part with chicken wire but still maintains its original design (for such a birdcage, see right-hand photograph in Figure 65). One has also to consider that every social group was and still is in contact with other groups with which they exchange ideas, techniques, tools, and technologies. As a result, different ethnic groups in a specific area often have a certain degree of common material cultures and technologies.

Indigenous knowledge refers to a social group's life, culture, technology, knowledge, or economy. It implicates a group's material and non-material dimensions of living, such as the knowledge of medicinal plants, animal husbandry, fishing and hunting techniques, warfare, ideas, values, belief system, norms, tools, and devices, and other issues. In many cases, the intangible aspects (value, idea, or norms) are passed orally and symbolically from generation to generation and are associated with experience, know-how, and skill. However, the latter are not so much transplanted from the predecessor's mind to the mind of the successor but rather must regrow in each generation through practical application and learning (Ingold 2000, 5). Grenier provides the following profound definition of indigenous knowledge:

> indigenous knowledge (IK) refers to the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area. . . . The development of IK systems, covering all aspects of life, including management of the natural environment, has been a matter of survival to the peoples who generated these systems. Such knowledge systems are cumulative, representing generations of experiences, careful observations, and trial-and-error experiments. (Grenier 1998, 1)

Thus, indigenous knowledge is associated with a social group's environment and implicates *all aspects of life* (such as social relationships, culture, health, belief system, economy, material culture, or technology). It is often marked by sustainable and reciprocal living with the natural environment. Since many indigenous people's livelihood relies on the conservation of nature, indigenous knowledge also tends to seek a balance between exploiting nature and its recovery. In contrast, industrial societies' profit-motivated economies and technologies tend to dominate nature for its economic value.

6.2.2. Indigenous Technology and Indigenous Bamboo Technology

Indigenous technology (or local technology) is predominantly grounded on local resources and tools at people's disposal. Moreover, indigenous technology is characterized by its environmental-friendliness and its relation to the environment. In the words of Morris, indigenous technology expresses "the ways in which people interact with materials found in their environment, including the tools and material required to perform tasks, make things, or provide goods and services, and the skills and knowledge required for their use" (2012, 250). Similarly, in Gumbo's definition, indigenous technology includes "the know-how and creative process that may use tools, resources, and systems" and serves the "needs and wants by means of investigating, designing, developing, and evaluating products, processes, and systems with the intention of solving the practical problems" (Gumbo 2014, 1). A similar but broader definition with relation to modern anthropology is given by Scupin and DeCorse:

> technology consists of all the human techniques and methods of reaching a specific subsistence goal or of modifying or controlling the natural environment. Technology is cultural in that it includes methods for manipulating the environment. It consists of physical tools and of cultural knowledge that humans can apply in specific ways to help themselves survive and thrive in changing environments in which they live and work. In societies in which people use technologies, such as bows and arrows, canoes, plows, penicillin, or computers, the cultural knowledge needed to construct, design, and use these materials is extremely important. (Scupin and DeCorse 2008, 348)

As Scupin and DeCorse's explanation of technology demonstrates, knowledge is essential for technology—it is culturally shaped and made up of individual manual experience (skill) and know-how taught by older individuals.

Now, while indigenous knowledge encompasses the outcome of the entirety of resources a local group or society has in hand to maintain their livelihood on the grounds of diverse techniques and specific knowledge, indigenous technology, in my perspective, is an applied technology and only a subset of indigenous knowledge. Accordingly, indigenous technology underscores the relevance of technology in context with sensory learning and everyday life (Gumbo 2014, 1–2). According to Gumbo, indigenous technology is marked by its pragmatism and is associated "within a sensory environment that builds on our sense of relationship, meaning, balance, feeling, memory, and place as well as sight, sound, smell, taste, and touch" (ibid.). Among other things, learning is a cornerstone for disseminating technical knowledge and requires its practical experience (or skill) and application. The practical application, in turn, involves creativity. Against this backdrop, pre- or nonindustrial work, just like indigenous technology, is closer to the term *technē* and art than our Western understanding of technology.

Moreover, work, in conjunction with indigenous technology, involves bodily performance and is more similar to an artist's work than to a machine operator's work. This circumstance is precisely elucidated by Ingold (2000, 295), arguing that artisanal work (or the work in the context of indigenous technology) includes the participation and connection of the body in the sequence of production, or to put it another way, the artist makes use of her/his body sense. "The skilled handling of tools," as Ingold argues, has to be regarded "as the embodied qualities of human subjects" and vividly illustrates that "techniques are active ingredients of personal and social identity" (ibid., 318) of many indigenous people.

In line with Gumbo's definition of indigenous technology mentioned above, *bamboo technology* would be an outcome of experience-based practices implicating bamboo as raw and construction material alongside its physical properties. A bamboo technology (of indigenous people) includes all objects and tools made of bamboo. At the same time, skills, or bamboo-working techniques, are maintained as knowledge within a social group and are transmitted from generation to generation orally and through practical application, mimesis, and imitation of the handicraft activities in question. On that account, whenever bamboo comes into play to create something, it implicates traditional working techniques and skills.

Given the bamboo technology of mountain dwellers examined in this work, indigenous bamboo technology signifies the skill and know-how required to build up the entire material surroundings based on bamboo. The construction of such a bambooic material world includes the handling of tools and experience in bambooworking together with the combination with other materials in order to construct houses (including the floor, walls, roof, or doors), water wheels, irrigation systems, or to craft traps, sieves, baskets, bows and arrows, fences, and other bambooic things. In this case, bamboo is indispensable for almost every production activity and makes up virtually the entire material surroundings essential for living. Thus, as described in this work, an indigenous bamboo technology can be seen as highlighting bamboo's influential role in indigenous groups' material culture as integral to their socio-cultural life.

6.2.3. The Multidimensionality of Tools

A one-sided approach to pre- or nonindustrial societies' indigenous technology risks conveying a biased valuation of technology concerning its complexity. In a sense, scholars often attempt to classify a social group's underlying technology as *simple* or *complex* (as vividly shown by Morgan [1877]). This classification, however, is problematic for at least two reasons. First, categorizing a technology as *simple* implies a value attached to technology and unmistakably connotes underdevelopment on the part of certain people. Second, and in many cases, *simple* technologies have different qualities, such as the skillful use of tools or the multiple uses of a single tool in various activity fields. For example, the way many ethnic groups in the Central Highlands of Vietnam work with bamboo might appear simple at first glance, yet several issues contradict this initial opinion. Traditional work employing bamboo relies on many aspects and is characterized by the entirety of individual and collective skill, experience, and know-how. The bamboo technology of the Bahnar people, for instance, requires at least the skillful handling of the machete, the precise differentiation of bamboos, knowledge of the physical properties and characteristics of bamboos, or the ability to combine bamboos with other materials. It is different from industrial technology but, nevertheless, complex and sophisticated in its own way.

Consequently, measuring the technological complexity of tools that people have in hand is problematic and can lead to misunderstandings. A bamboo stick, as simple as it is, can be transferred to countless things and used for multiple purposes: it can be used as a walking stick;

as a long stick to harvest fruits in tall trees; as a weapon for self-defense when attacked by humans and nonhumans; as a fuel, when thrown into the fire; as a stick to make holes in the earth for seedlings; as a handle for the fabrication of countless tools; or as a hunting device such as the blowpipe. It is this multifunctionality that—even though bamboo's usages appear to be simple—enriches people's lives and makes up the basis for a rich material culture alongside other aspects of indigenous knowledge and technology. Consequently, tools do not have to be complex to be valuable for their user, and sophisticated tool use depends, to some extent, on the user's intention.

In a nutshell, even though the required and utilized tools may be simple, in their entirety and in relation to knowledge and skill, they often represent a different kind of complexity and quality that is generally suited to the surrounding environment. This contention is not only valid for tool use but also the use of (raw) materials. One has to understand a material's materiality as it relates to practice as something emerging through work in practice. In the case of bamboo-working, the skillful use of a machete is at least as important as the experience-based know-how of how bamboo (as a raw material) behaves during processing.

6.2.4. Material Culture and Indigenous Knowledge

So far, I have discussed the characteristics of material culture and indigenous knowledge, but what is the difference between them? Are both terms interchangeable? Early attempts of anthropologists that were concerned with material culture, as Lemonnier argues, limited their "study to the 'style' of artefacts, thus reducing the social content of techniques to details of shape or decoration having either no or extremely little physical function" (2002, 2). Lemonnier rightly refutes the notion that the study of art itself only reveals part of the relational nexus of artifacts and human social living. Instead, artifacts and skills represent "the physical rendering of mental schemes learned through tradition and [are] concerned with how things work, are to be made, and to be used" (ibid., 3). Only by a thoughtful observation of a thing's materiality, social embeddedness, symbolic value, and the applied techniques can a thing's relevance be discovered or rediscovered.

As mentioned above, the definition of material culture depends on the epistemological interest of the scholar—its definition may be narrow or broad and may overlap with indigenous knowledge in its most comprehensive definition. What distinguishes material culture and indigenous knowledge the most is their particular focus on their subject matter. The term *material* in material culture signifies its relatedness to physical objects. While the term *indigenous* in indigenous knowledge signifies that it is principally associated with a certain kind of ethnicity, language, locality, ecology (flora and fauna), climate, environment (typography), or tradition. The term *culture* in material culture is associated with the material aspects of culture and may encompass intangible aspects of life. Finally, *knowledge* of indigenous knowledge relates to the specific know-how of a social group.

The term *technology* is also of interest in this discussion. As discussed above, technology is a problematic term when discussing indigenous people's technological capabilities since it is too closely bound up with to industrialization. By contrast, material culture is less tainted with the Western concept of technology and might, in virtue of its openness, be more suitable to describe nonindustrial technologies of pre-industrial societies.

When compared with indigenous knowledge, material culture studies are less restricted in general. They could encompass both the traditional and newly adapted physical objects of a particular social group and examine how these material things are related to cultural aspects. In addition to the meshing of tradition and modern factors, material culture studies are less confined to a particular space. This is the case, for instance, when a social group's daily life is, literally speaking, pervaded by industrial and consumer goods (such as shampoo, watches, toothbrush, cosmetics, or refrigerators) as well as traditional goods (such as baskets, nuts, rice, or carpets). Moreover, material culture studies could principally also explore material cultures of industrial and postindustrial societies or subcultures on a national or transnational scale, whereas indigenous knowledge is restricted to an ethnic group's traditional knowledge and material culture.

Another crucial difference is that material culture studies, as mentioned above, may primarily delve into the entanglement of the tangible products, that is, the *material* aspects of a social group or entire society. In contrast, indigenous knowledge (and to a lesser extent, indigenous technology) includes the physical things and immaterial aspects such as value, belief system, language, knowledge, or skill. However, in its broadest sense, when referring to an ethnic group and its technical know-how, tradition, or skill, material culture may include aspects associated with indigenous knowledge and technology. In this case, the difference between the two terms becomes less clear, and material culture could be used interchangeably with indigenous knowledge and indigenous technology.

In sum, the difference between material culture and indigenous knowledge—and indigenous technology as part of the latter—is not always consistently identifiable, though each one has two areas of interest.

6.3. Postcolonialism's Criticism and Approach to Technology

It becomes clear that technology, as discussed so far, is by no way neutral but inherently part of human sociality and the course of human history. When examining extra-European bamboo cultures in pre-colonial, colonial, and postcolonial countries, one is compelled to scrutinize technology in association with power structures and societal progress. Technology did not only allow the colonization of the extra-European world; it also reinforced the idea of Western supremacy and evolutionary ideologies that underlined the exploitation of colonized people.

Moreover, the Western perception of technology as something opposing nature has also been disseminated in the colonies. For Loomba, colonialism was "the vehicle for the export of Western technologies, . . . [and] the export of these ideas" (2005, 23). Considering the relationship between colonized and colonizers, Arnold sees "technology in the service of imperialism" (2005, 92). That being the case, a critical review of the academic field of the history of technology at this point is essential because the Eurocentric historiography of the history of technology dominated the academic approach for decades and marginalized the extra-European role and contribution to technological progress.

As Arnold notes, the history of technology's view concerning Africa and Asia underwent three main approaches beginning in the mid-1960s: First, technology was defined as Western-based industrial technology and the most advanced and worthwhile technology compared with that of *less developed* societies. Europe alone was conceived as the origin of modern technology. Accordingly, European technology and rationality were exported and, as the *most superior* technology, introduced to the rest of the world based on a diffusionist notion of technological transfer. Second, not before the colonies started to resist Western supremacy, the diffusionist idea gave way to new perspectives that underscored the history of technology in pre-colonial times. Yet, the implementation of Western technology, rather than bringing a promising future, was irreversibly connected to the colonizer's brutality, exploitation, and oppression. It is this circumstance that pushed Western technology's progressive character into the background. The third approach, known as the postcolonial approach, deals with the reverberations of colonization and stands in contrast to the first simplistic, dualistic, and generalized view. Thus, the postcolonial notion accentuates the multiplicity and hybridity of history and calls for critical narratives. And by virtue of a new narrative perspective, it critically contextualizes technology regarding power structures (ibid., 86–87).

Realizing that a more critical and skeptical standpoint is necessary, postcolonial studies have been marked by an intellectual reorientation and reinterpretation on the grounds of the diversity of people's lifestyles. Therefore, postcolonial studies refocused on hybridity and differences in history rather than reproducing monocausal explanations, which were typically determined by static, narrow terms. It is for this reason, as Loomba argues, that "postcolonial studies have been preoccupied with issues of hybridity, creolization, and *mestizaje*—with the in-betweenness, diasporas, mobility and cross-overs of ideas and identities generated by colonialism" (Loomba 2005, 145).

In view of this, the anthropological approach's contribution, as noted by advocates of the post-structuralist practice theorists, is to trace back where things happen. In other words, it calls for getting involved in those sites where technology is applied. Therefore, many contributions to understanding African and Asian technologies came from anthropologists and historians reconsidering technology by recognizing cultural, spatial, and temporal dimensions (Arnold 2005, 86). In a sense, it was particularly anthropology's participant observation that offered a revisit of technology on account of "a less teleological and judgmental approach to technologies that lie outside the norms of Western modernity, a greater concern with technology's local context and signification, and an analytical interest in the interactive (not merely causal) relationship between innovation and practice" (ibid.). As Arnold asserts, this meant "moving technology away from laboratories, foundries and factories into villages, towns and everyday lives" (ibid., 86). Consequently, methodologically open access to technology, as attached to social living and daily practices, rather than a preconceived notion of technology, as attached to industrialization, provided new impulses to study local technologies. Following this view, this thesis attempts to apply the term technology with reference to bamboo in a nonindustrial context as part of social life.

6.4. Sustainable Development and Well-Being

Since this thesis's anthropological part is concerned with the significance of the bamboo culture for Bahnar peoples, it is also concerned with the effects of development and modernization since both profoundly impact the lifestyle and livelihood of the people studied in this work. Thus, in what follows, I shall briefly discuss the problems that arise around the terms *development* and *sustainability* and, following this, the benefits of alternative concepts that are not primarily interested in progress, as understood in the Western manner.

According to the *World Commission on Environment and Development Report* published by the United Nations in 1987, "development involves a progressive transformation of economy and society" (1987, ch.2). This transformation, however, is associated with a plethora of environmental and socio-cultural challenges if associated with one-sided modernization theories and developmental programs. In this light, whenever economic growth was held as the foundation for progress, sustainability often played a secondary role. This is the case, for example, if we regard Vietnam's striving for modernization and industrialization. Based on the socialist notion of progress, the Government of Vietnam undertook ambitious reforestation programs beginning in the 1980s and 1990s but neglected the traditional lifestyle of indigenous people practicing shifting cultivation. As argued by Kelly et al., until the 1990s, "priorities were large-scale reforestation, encouraging farmers to plant tree crops and fruit crops and to develop agroforestry schemes, and popular tree-planting movements," but, on the other hand, "the practice of shifting cultivation [was] strongly discouraged under a sedentarisation program" (2001, 38) and labeled as *backward* and harmful for the environment.

Given the market-driven, developmentalist ideas, Johnston et al. respond with a call "to relegate the dominant economic connotation of development to a less influential and more clearly-defined position in the economic, societal and environmental governance framework" (Johnston et al. 2007, 61). Thus, the term *sustainable development* became a core concept in debates of development and could be categorized in *environmental*, *economic*, and *social sustainability*. According to Basiago (1999, 149–150), environmental sustainability is concerned with the integrity of the ecosystem and environment conservation so that the natural resources can regenerate. And economic sustainability seeks to maintain people's independence and guarantee access to resources to meet their needs and secure their livelihood sources. Thus, based on the idea that all humans have universal human rights and basic necessities, social sustainability aims at ensuring a life in peace and safety.

In relation to the Bahnar people's bamboo culture and livelihood, bamboo relates to all three pillars of sustainability. It is a plant and part of the ecosystem. It is an important raw material and necessary for people's subsistence-oriented economy and the main construction material for the built environment—necessary as the material groundwork for human existence and social living. As will be described in chapters 7.3 (concerning the relation between bamboo plants' growth and shifting cultivation) and 7.6.3.1 (about the connection of bamboo culture and shifting agriculture), since Bahnar people practice shifting cultivation, environmental conservation is integral to their reciprocal relation to nature. Simultaneously, bamboo's multifaceted use is essential for Bahnar peasants to meet their needs and, as the material basis for living, stabilizes people's social structures and social living.

In this context, Giorgia Magni (2016, 3) argues that indigenous people's knowledge of their environment and technological choices have helped them to maintain (in most cases) a responsible use and management of natural resources and likewise strengthened their capacity for resilience and adaptation, mitigation, and to cope with complicated circumstances. "Indigenous groups," as Magni puts it, "have their visions of development, which differ from the idea of development attached to modern societies. Respect of nature and its conservation, as well as community-based management of lands and natural resources, are central to the indigenous idea of well-being" (ibid., 14).

Since the one-sided notions of development (embedded in modern society) are associated with adverse social, economic, and environmental impacts on indigenous people's very way of living, the social ecologist Eduardo Gudynas coined an alternative term and concept to the classical idea of development known as *Buen Vivir*. His concept of Buen Vivir is based on indigenous people's worldview and built upon a specific horizon of meaning: a way of life in harmony with oneself (dimension of identity), with society (justice/equality), and with nature (sustainability) (Cubillo-Guevara et al. 2018, 8). In Gudynas's own words, Buen Vivir "refers to alternatives to development emerging from indigenous traditions . . . beyond the modern Eurocentric tradition" (Gudynas 2011, 441). Furthermore, Buen Vivir is less anthropocentric and seeks a balance with the ecosystem and nature, which is thought to be a crucial pillar for people's very existence (ibid.).

The roots of Buen Vivir, Gudynas argues, are to be found in principles of different cultures native to Latin America, involving ideas such as "unity, equality, dignity, freedom, solidarity, reciprocity, social and gender equity, social justice, responsibility and so on" (ibid., 443).

Accordingly, the concept of Buen Vivir is pluralistic and has to be defined anew by each indigenous people since every group has its own principal ideas about good living, well-being, happiness, and the like. What is more, Buen Vivir also implicates the indigenous population's self-determination and is linked with decolonization, and proposes new paths of "understandings, rationalities, and feelings of the world" (ibid., 445).

According to Gudynas, Buen Vivir reformulates the relation between culture, society, and nature and deontologizes Western dualisms. "The polis," as Gudynas puts it, "is expanded, and the concept of citizenship is widened to include these [nonhuman] other actors within environmental settings" (ibid., 445). Hence, Buen Vivir emphatically "promotes the dissolution of the Society–Nature dualism" and proposes that "nature becomes part of the social world, and [claims that] political communities could extend in some cases to the non-human" (ibid., 445). As discussed in the previous chapters, the proponents of ANT and practice theory, Ingold, Schatzki, and Reckwitz, all advocate a re-evaluation of Western dualistic thinking and vehemently argue for (re-)integrating nonhumans into studies of the social, which is in line with many indigenous populations' worldviews according to which the natural world is not separated from the realm of the social world. In contrast to the anthropocentric Western view, indigenous people, such as the Bahnar, propose a "biocentric environmental perspective, . . . that recognizes that the non-human (either animals, plants, ecosystems, or spirits) have will and feelings" (ibid., 455). By and large, Gudynas's postulations and his Buen Vivir concept are in line with (post-humanist) socio-material theories' demand for reassembling the social, that is, finding an alternative ontological foundation to the classical Western worldview.

To summarize, Buen Vivir does not reject Western technology as such but reinforces indigenous institutions, cultures, and (material and immaterial) traditions alongside Western physics and engineering but promotes development with the people's aspirations and needs (ibid., 446).

Part C: Historical and Contemporary Bamboo Cultures

7. Past and Present Bamboo Cultures of Swiddeners[39]

The central theme running through this dissertation is the relationship between bamboo and humans. In defining this thesis's theoretical scope, I critically reviewed the term technology in contradistinction to *technē*. I also questioned the Western dualistic concepts such as subject vs. object, nature vs. culture, or mind vs. matter. Moreover, I developed the terms *bamboo culture* and *bamboo technology* to describe the conflation of bamboo and humans. This section's concerns are driven by my own experience of the practical and artisanal work with bamboo, my experiences during my fieldwork and participating observations of people in contemporary Vietnam (who still use bamboo in many daily activities), and my study of historical and ethnographic sources. In the historical chapters concerning China and Japan, I mainly examined the bamboo cultures of large-scale societies, while in this part, I look at small groups and their material culture and (intellectual) knowledge about bamboo and (practical) know-how necessary for working on bamboo. As a result, the intellectual and practice-based approach to bamboo reveals much about people's unique indigenous knowledge systems and points out an essential tangible and intangible repertoire indispensable for environmentally friendly and sustainable living.[40]

As explained in chapter 5.4 concerning concepts of material cultures and bamboo culture, my notion of bamboo culture is twofold. On the one hand, bamboo culture is an umbrella term and revolves around different societies' and peoples' use of bamboo in various domains of life. Despite the fact that bamboo might be crucial for the performance of certain activities, bamboo remains only part of a broader material culture. My second definition is somewhat narrower: in contrast to the former, its conceptual scope is locally confined to a small-scale society's use of bamboo; simultaneously, the term is denser: in contrast to the former, the second concept covers bamboo's ubiquitous use in a small-scale society and so emphasizes bamboo's fundamental role in creating a local people's material world needed for people's daily practices. Moreover,

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[39] The term *swiddener* derives from the term *swidden*, meaning "a temporary agricultural plot formed by cutting back and burning off vegetative" (Merriam-Webster OnLine 2019) and is commonly known as shifting cultivation. Hence, the term *swiddener* refers to peasants practicing shifting cultivation.

[40] For my conception and understanding of nature and its relation to society, see my discussion of the topic in chapter 5.2.

whereas the first concept might include bamboo's use in an industrial context, the latter is limited to bamboo's use in pre- and nonindustrial contexts and (but not necessarily) relates to a subsistence-oriented lifestyle. As understood and used here, bamboo culture provides a means to elaborate on the relation of bamboo and shifting cultivation.

Overall, this chapter aims to interrogate and describe the multiple layers of the human-bamboo relationship related to the livelihood of indigenous people practicing shifting cultivation in mountainous areas. In more detail, it mainly questions the embeddedness and connection of bamboo in the life of a small group of Bahnar people in the Central Highlands of Vietnam and opts to present the contemporary bamboo culture of those people. First and foremost, for gaining insights into these issues, I collected first-hand empirical data during two short field studies in 2012 and 2018. However, given the fact that the material culture of Bahnar people has already changed drastically in recent decades, additional ethnographic and historical works that discuss Bahnar people's (im-)material culture were worthwhile to generate a more comprehensive understanding of Bahnar people's usage of bamboo. This part therefore intends to be an anthropological and historical interpretation, description, and representation of the Bahnar people's connection with bamboo.

Since the Bahnar people's life, culture, society, economy, and bamboo culture are intimately connected to the Central Highlands and the natural environment, this link raises questions about the history, politics, and contemporary challenges faced by the Bahnar. Hence, the first part of this chapter is concerned with introducing some issues related to the lives of ethnic groups in pre-colonial, colonial, and postcolonial Vietnam and poses the following questions: How did external actors conceive and regulate highland groups' lives? How did early anthropologists conceive the ethnic groups in Vietnam? And how do contemporary Vietnamese scholars and officials situate ethnicity in terms of the socialist striving for development and modernization? Given that shifting agriculture is key for Bahnar people but disparaged by governmental and non-governmental actors, I address its characteristic features and devote attention to its contribution to environmental conservation and biodiversity. Against this backdrop, I also tackle the question of the bamboo plant's role in farmland management.

Since my underlying research objective in this chapter is to elaborate on the interconnections of the human-bamboo relationship in the everyday lives of swiddeners, I am concerned with the following questions: What characterizes the bamboo culture of the Bahnar? In which domains of life is bamboo to be found? Which tools and objects are made of bamboo? This elaboration is intended to shed light on the extent to which bamboo conditions human life by acknowledging its appearance i) as a plant amongst other plants, ii) as a raw and construction material, iii) all the things made of bamboo (tools, weapons, devices, or mundane objects), and iv) the practices involving bamboo (as indicated in i, ii, and iii). Addressing these questions should give answers on what ways Bahnar people use bamboo to meet their wants and needs and how this satisfaction is related to shifting cultivation. I refer to these key questions in my descriptive chapter (7.4) of the Bahnar bamboo culture and other ethnic groups' bamboo-based material cultures in chapter 7.5.

In the following, I will briefly outline the main subjects of this chapter. The purpose of chapter 7.1 is to determine under which (external) conditions an ethnicity becomes an ethnic *minority,* although living in one's own ancestral homeland. To this end, a brief history concerning the Central Highlands depicts how external powers ruled highlanders both in the remote past and recent history as well as in our present time (7.1.1). Following this, I present the population composition relating to the area which the Bahnar inhabit and its recent development (7.1.2) and a general overview of the language, history, belief system, and territory of Bahnar people (7.1.3).

Chapter 7.2 outlines my research design and research goal. I shall first present how I found access to the field and setting (7.2.1). Then, in chapter 7.2.2, I explain my methodological approach, which is mainly constituted by ethnohistory (as a cross-cultural study involving methods of history and anthropology) and ethnographic work driven by assumptions of socio-material theories (practice theory and ANT). This is followed by a presentation of my fieldwork during 2012 and 2018 and the methods employed to work out various aspects of my research questions in chapter 7.2.3. Chapter 7.2.4 is devoted to previous research about ethnic minorities in Vietnam. It outlines the first ethnographies undertaken in Vietnam, and the challenges ethnographers faced when attempting to conduct field research in Vietnam and why these challenges resulted in only a few written ethnographic records. Since this chapter is partly based on historical sources and ethnographic works, the literature review in chapter 7.2.5 discusses the works I used in addition to my ethnographic data collection. Finally, in chapter 7.2.6, I shall critically discuss the shortcomings and limitations of my relatively short-term fieldwork and highlight the significance of this chapter.

Given that the agricultural method is an integral part of Bahnar people's very existence, I discuss in chapter 7.3 the characteristics of swidden cultivation, how it was wrongly and with serious consequences interpreted as harming the forest and nature, and the bamboo plant's relatedness to shifting cultivation.

Chapter 7.4 is concerned with the bamboo culture of the Bahnar people. It begins with an overview and depiction of the local bamboo species (7.4.1). After that, chapters 7.4.2 to 7.4.7 represent mainly my ethnographic data collection. In these chapters, I illustrate bamboo's implication in various domains, and I compare my data with the findings in other authors' publications. The main goal of these sections is to explore the ways Bahnar people use bamboo, and provides empirical data for a fruitful account of the bamboo culture. This section is therefore mainly descriptive and refrains from drawing premature conclusions and interpretations, which will be the subject of subsequent chapters (7.6 and 7.7).

The purpose of chapter 7.5 is to portray bamboo's use by other indigenous people in the Central Highlands and Papua New Guinea. This part demonstrates the similarity of bamboo's use by other swiddeners than the Bahnar and highlights bamboo's importance for people in different regions. Of course, due to the limited scope of this chapter, it is not possible to guarantee that each group's bamboo culture is treated with the same sensitivity, thoroughness, and sophistication but, despite this shortcoming, chapter 7.5 permits a brief comparative analysis of people's bamboo cultures.

In chapter 7.6, I point out the human-bamboo relationship of the Bahnar people. After addressing how the human body is involved in bambooworking in chapter 7.6.1, I summarize (in chapter 7.6.2) all human-made bambooic things that I discussed in the previous chapters as part of the Bahnar bamboo culture. And by highlighting the material aspects of Bahnar people, I reflect on a Bahnar swiddener's practices concerning bamboo in accordance with a practice theoretical approach. Following ANT's methodological openness, chapter 7.6.3 provides insights about the heterogeneous actors that come into play when analyzing shifting cultivation and the residential house as actor-networks.

The last chapter (7.7) discusses once more bamboo's relevance for Bahnar people and their agricultural system and critically scrutinizes monocausal modernization theories. And by elucidating Bahnar people's perception of themselves and the forest, I refer to alternative concepts (such as Buen Vivir) in contrast to one-sided developmental programs since the former attempt to support indigenous people's ideas of well-being and their concept of nature.

7.1. Being an Ethnic Minority and Swiddener in the Central Highlands in the Past and Present

7.1.1. A Brief Account on the History and Politics of Pre-, Post-, and Colonial Vietnam and Its Impact on the Indigenous People

The first Vietnamese kingdoms appeared in 1000 BCE during the Đông Sơn culture in northern Vietnam. While Vietnam was ruled by the Chinese empires for about 1,000 years, from 111 BCE to 938 CE, it was another 900 years after Vietnam's independence from China before a Vietnamese dynasty (Nguyễn dynasty) expanded further south and annexed the Central Highlands. However, due to the impassability of the terrain, which limited the presence of Vietnamese authorities, the highlanders could not be reigned entirely by the Vietnamese or the former Champa kingdom. Thus, for most of their history, highlanders were "previously confined by regional kingdoms and empires to act as buffer zones between powerful neighbors" (Michaud 2009, 35). However, soon after the French colonial empire took control of Vietnam, "the French enacted policies of dismantling Vietnamese governmental structures in the Highlands and zoned the land to keep populations apart [and] the consequences of such forms of governmentalization and territorialization are still [present]" (Salemink 2008, 64). Hence, as an outcome of the French conquest of the Nguyễn dynasty and the colonization of Vietnam—which started in the middle of the nineteenth century and resulted in French Indochina in 1887 and the division of Vietnam into the protectorates Tonkin, Annam, and Cochin China—"modern borders have turned margins into internal peripheries to be controlled, secured, colonized, and exploited" (Michaud 2009, 35).

Moreover, during colonial Vietnam, the French undertook a series of expeditions to explore and conquer the Central Highlands and subjugate the highlanders: missionaries aimed to convert the local inhabitants, administrative buildings and institutions were set up, schools and roads were built, and indigenous people were trained and schooled—all these efforts, however, were made to exploit the people and the natural resources in the interest of the colonial motherland and allegedly to promote the spread of civilization. This colonial ideology is best expressed by the well-known concept of the *civilizing mission* (*mission civilisatrice*), according to which Westerners attempt to civilize indigenous people. In this context, Salemink critically remarks that "physical and classificatory separations [of ethnicities in Vietnam] were in fact products of the modern colonial and postcolonial states" (Salemink 2008, 64). As a result, French policies created the *otherness* of the highlanders in comparison to the French and the (Kinh) lowlanders.

During French colonization, Vietnamese rebelled against the French invaders, but initially with minimal noticeable success. At that time and on the strength of continuing struggle for independence and persistent resistance to the French colonial regime, in the year 1941, Hồ Chí Minh founded the Việt Minh (in English *League for the Independence of Vietnam*). Subsequently, the Việt Minh opposed the French and later the Japanese, who took over Vietnam from 1940 to 1945 after defeating the French. With the end of World War II, Hồ Chí Minh proclaimed the independence of Việt Nam, but his independence efforts were fought by the French colonial regime, which regained strength and control over Vietnam after 1945. Finally, after years of war, the Việt Minh overcame the French colonial regime that brought an end to the First Indochina War. As a result of the negotiations conducted during the Geneva Conference of 1954, Vietnam was divided into North and South Vietnam. This division was supposed to last two years until elections planned for 1956 were held, aiming to reunify Vietnam. Yet, these elections were undermined by American foreign policy since American authorities were afraid that communism would prevail. Given that anxiety, United States policy supported the southern Republic of Vietnam (1955–1975) and preserved the status quo of a divided Vietnam.

As a result, the ethnic groups of the Central Highlands became part of the Republic of Vietnam (also known as the First Republic) under the regime of Ngô Đình Diệm. Thus, after the French were defeated, the highlanders were governed by a Vietnamese leader, who pursued a policy of assimilation and Vietnamization of the highlanders combined with economic development and a strategy to outnumber the ethnic groups by settling ethnic Kinh from the coastal regions to the mountains (Hickey 1982, xviii, 1, 8). Condominas (1977, xiv) believes that Diệm ordered the ethnic minorities' systematic oppression and aimed to wipe out their culture and customs. From the very beginning, the South Vietnamese government "envisioned a process of modernization for the highlanders, an ideal vision that entailed a neat transition from the primitive to the modern and from the old to the new" (Tan 2006, 210). This transition meant that the highlanders were forced to adapt to the governmental policies and, particularly, to new agricultural methods. As Tan works out, the Republic of Vietnam considered swidden agriculture as being a "very rudimentary form of agriculture" that endangered the forests through "the process of clearance, burning, and cultivation" (ibid., 218). Simultaneously, ethnic groups were forced to resettle at new places closer to the governmental institutions for better administrative control (ibid., 214). The restrictive policies, which viewed ethnic groups as inferior to the modern Vietnamese, intervened in people's very lives and provoked resentment against the authorities by ethnic groups. In the further course of the American War, however, the highlanders' loyalty was of vital strategic interest for the First Republic—most notably to secure the highland areas against the communist influence, and as a result, restrictive policies, such as resettlements, were withdrawn or moderated (ibid., 214).

Summing up, the First Republic intended an agrarian development of the highlanders until 1961 but later changed its policy, supported by the United States. Under the new policy, the hamlets of ethnic minorities were considered strategic elements in combatting the communist insurgency (ibid., 214, 233, 241). Rather than protecting his citizens and country, Diệm willingly supported the American allies' bombing and the destruction of vast areas of South Vietnam. In the aftermath of the American War, hundreds of thousands were killed and displaced, and highlanders' socio-cultural life and material culture have changed drastically since then.

In what follows, I will discuss the impact of socialist evolutionism, *Đổi Mới*, and the New Economic Zones Program on ethnic minorities. During wartime, the Việt Minh needed highland groups' support and promised political autonomy to the ethnic groups if they assisted in defeating the French and the Americans. Despite the strategic importance of the alliance between the highlanders and the Việt Minh, the Việt Minh leaders did not keep their promises. Soon after the takeover of South Vietnam, Saigon's fall, and the reunification of Vietnam in 1975, no more guarantees for self-government were given to ethnic minorities. Instead, Vietnam became a centralized and unified national state whose main objective was to rebuild the country after years of war. Economic and political decisions were dictated by the leaders of the Communist Party of Vietnam, which emphasized national progress according to socialist evolutionist ideas. As Michaud examines, "in the communist rhetoric, highlanders in Vietnam were considered to be at the lowest stage of economic development and in dire need of assistance, while the Kinh enlightened majority was entering socialism, the highest possible point" (Michaud 2009, 31–32). Indeed, on the strength of the socialist rhetoric, the Vietnamese policy aimed to develop the ethnic groups as well as possible. In a similar manner, Vietnamese anthropologists perceived the ethnic groups as underdeveloped. This attitude was marked by the dualistic thinking of the progressed socialist Kinh opposing the backward traditional highlander. Hence, anthropologists, as well as the governmental authorities, felt confident that it was the duty of the socialist woman and man to help the traditional highlander "relinquish his simplicity and reach the superior levels of lowland civilization as quickly as possible" (Viet Chung 1968, 3–23).

As a consequence, such an understanding constituted a primitivizing of the highlanders and intended "to 'handle' highland minorities in the most effective and economical way, . . . , notwithstanding these 'little brothers' [ethnic minorities] and their distinct identities, aspirations and particular needs" (Michaud 2009, 25). Finally, the striving for the progress of the *backward people* ended in programs that forced ethnic minorities into sedentarism and giving up their semi-nomadic life. The demography and agricultural methods in the Democratic Republic of Vietnam had already changed drastically from 1954 to 1976 and equally affected the life of ethnic minorities of Northern Vietnam (Kahin 1972, 583).

In sharp contrast to the Republic of Vietnam, the Communist Party officially has asserted all its citizens' equality and strives to create a peaceful coexistence among all ethnic groups. So, the Vietnamese constitution emphasizes in Article 5 paragraph 2 that "all ethnicities are equal, unified and respect and assist one another for mutual development," and Article 5 paragraph 4 states that "the state implements a policy of comprehensive development, and provides conditions for the ethnic minorities to promote their physical and spiritual abilities and to develop together with the nation" (Vietnamese Constitution 2013). The realization of these paragraphs is, indeed, problematic. Up to the present day, ethnic minorities have not been able to maintain their way of life as promised in the constitution. While ethnic minorities are allowed to continue with such traditions and customs as are considered right by the government policy (e.g., music, folklore, or dancing), other customs (e.g., animal sacrifice, bride price, or swidden agriculture) are prohibited (Michaud 2009, 32).

Another issue is related to the ethnic Kinh's coexistence with the ethnic minorities in the Central Highlands. Condominas (2009, 266) highlights the fact that both groups have different perspectives on land-use systems. Unlike the Kinh people, ethnic minorities have a holistic approach to their surrounding environment. For them, swiddening is the "evidence of the success of man's strength, his awareness and knowledge of the environment" (ibid.). A negation of swidden agriculture and transition from swiddening to permanent agriculture has profound implications concerning swiddeners' very existence and involves the loss of indigenous knowledge and bamboo culture. Currently, swidden agriculture is rarely practiced, not only in Vietnam but throughout Southeast Asia, and "the conditions necessary for swiddening, both the availability of land and the aspirations of people, simply no longer exist" (Fox et al. 2009).

In the past few decades, market liberalization and the belief in economic growth and prosperity have replaced the social evolutionary idea of development. In 1978, China changed its policy from an orthodox Marxist market orientation to a free market economy. In 1986, under the last General Secretary of the Communist Party of the Soviet Union, Michael Gorbachev, the Soviet Union began a process of restructuring and modernization of the social, political, and economic system, known as *Perestroika*. Since Vietnam's economy was, to some extent, dependent on the Soviet Union, the latter's transition did not leave Vietnam's regime unaffected, which was at that period struggling with its economy and was forced to rethink its economic policies, culminating in market-bound economic reforms in Vietnam (Path 2020, 2). These reforms became known as *Đổi Mới* (in English *renovation*), introduced significant changes, and transformed Vietnam's centrally planned economy and collective agriculture into a so-called socialist-oriented market economy that brought the ideas of socialism together with a capitalist marketization and gradually led to an increase of the Vietnamese agricultural production and economy.[41] According to Vương Đình Huệ (the current Deputy Prime Minister of the Socialist Republic of Vietnam), the destruction of rain forests and economic policies pursued after the 6th National Congress of the Communist Party of Vietnam in December 1986 led to a substantial change of the Vietnamese "economic structure and agricultural institution and organization" (ibid. 2013, para.1).[42]

On the other hand, "the development and achievements of agriculture in the past," as Vương puts it, "were at the expense of environmental degradation . . . [with] no ecological and environmental administration in agriculture, which resulted in less sustainability" (ibid., para.6). Therefore, Vương advocates a restructuring of Vietnamese agriculture "to build a modern, effective and environment-friendly agriculture with . . . effective use of resources, . . . high income for farmers and to ensure food security and social stability" (ibid., para.1). Although this is a worthwhile aspiration, its realization is a challenging project. The transition economy necessitates the implementation of economic liberalization but has many adverse social effects. And like other countries with transitional economies, Vietnam also has "purposely established and implemented national laws and policies that recognize and enforce Western-style, state-

[41] Reforms in Vietnamese evoke analogies to the changes brought about by perestroika in the Soviet Union. Yet, according to Path (2020, 2), the origins of *Đổi Mới* are still discussed in the academic world. While some scholars claim that it was an endogenous process and developed in Vietnam, others argue that *Đổi Mới* was profoundly influenced by economic reforms enacted in the Soviet Union.
[42] Vương Đình Huệ was chairman of the Central Economic Commission of Vietnam from 2011 to 2013 and is currently Deputy Prime Minister of Vietnam.

authorized, private property rights at the expense of communal or other traditional systems" (Fox et al. 2009, 319). Despite its economic development, Vietnam is currently concerned with poverty reduction, and although the governmental programs appear to be reasonable and equitable, development and national progress have resulted in many cases of deforestation and the exploitation of new agricultural land. In view of this, the underlying political goal to achieve progress and economic growth was at the expense of those people depending on intact and dense forests and a protected and preserved environment.

As a result of several political and economic decisions and long periods of war, people were forced or persuaded to migrate within Vietnam. Before *Đổi Mới,* under the New Economic Zone program from 1975 to 1980, northern ethnic Kinh migrated (promoted by financial incentives) from the lowlands to the highlands. The political intention was to resettle people from regions with high population density to those with less. For the most part, people living in the Red River delta provinces migrated to the southern provinces, particularly to the Central Highlands. According to Gendreau et al. (2000, 198), this internal migration was conducted for reasons of demographic, economic, and social factors, as well as for reasons of internal and external security and land use planning. Gendreau et al. (ibid.) depict the migration factors, reasons, and goals as follows: 1) Demographic reasons: Resettlement of people of the Red River Delta to decrease the population density. 2) Economic reasons: Development of the remote areas and an increase in agricultural production. 3) Social reasons: Improving life standards by creating jobs in the agricultural sector. 4) Internal security reasons: Migration was an attempt to solve social issues associated with urbanization. 5) External security reasons: The network of hamlets should contribute to national security and defense. 6) Spatial planning reasons: Sedentarization of ethnic minorities and regrouping of their settlements. (ibid.). Finally, in the years from 1976 to 1997, more than five million people were resettled by means of governmental programs, about 70 % of whom migrated intra-regionally and 50 % from northern to southern regions (ibid., 202). This massive in-migration was fostered by governmental programs that tended to develop agricultural production and estimated that about 2.5 million hectares could be of additional use (ibid., 198).

After *Đổi Mới*, governmentally organized migration came to an end. Despite this fact, internal migration in Vietnam is still very high, especially to the Central Highlands. By and large, the economic liberalization led to "a widescale and intense redistribution of the population and labor force throughout the country" (GSO 2010b, 35). Moreover, the Vietnamese population increased from fifty-two million in 1979 to eighty-five million in 2009 (ibid., 34). Subsequently, resettling Vietnamese people in the Central Highlands resulted in an outnumbering of indigenous people and changed both the demography and traditional land ownership. Currently, land scarcity threatens the livelihood of swiddeners the most.

In summary, it can be said that ethnic minorities living in Vietnam had and still have to deal with many issues and questions. While some are about the question of how to maintain indigenous knowledge and cultural identity, other questions are about livelihood and ecological changes. In recent history, the interests of various actors affected the lives of ethnic minorities. In this chapter, I have briefly introduced some of these interests and how they determine ethnic life. On the whole, governmental authorities contributed much to the marginalization of highlanders and interfered with their traditional lifestyle and farming methods through relocation and sedentarization, developmental programs, administrative control, or the introduction of new commodities, plants, tools, and technologies.

Nowadays, however, environmental change is the most critical issue facing ethnic minorities. As Michaud rightly points out, "the politics of environment are of consequence because highland livelihoods are intrinsically linked with nature, and the manner by which the state regulates nature (through environmental policies) has weighty consequences for highland peasants and their livelihoods" (Michaud 2011, 215). Currently, the future of mountain minorities is uncertain. Their traditional nature-based, self-sufficient economy has undergone drastic change and is nowadays dominated by a capital-oriented economy and governmental policies.

7.1.2. Ethnic Groups in Vietnam

One central part of my research about bamboo's use in present-day Vietnam is linked with those whose livelihoods are subsistence-oriented and who share common ground with bamboo as their main essential raw and construction material. A comprehensive embedding of bamboo in everyday life and social practices is encountered in many ethnic groups living in Vietnam's remote regions, such as Gia Rai, Ê Đê, M'Nông, Xơ Đăng, Hrê, Co, or Giẻ Triêng living in the Central Highlands. Writing about Bahnar bamboo culture therefore equally reflects aspects of other ethnic groups' use of bamboo and vice versa.

Before writing about bamboo's use in detail, I will discuss in brief Vietnam's ethnic composition. After that, I will resume my discussion of the problematic concept of the term *ethnicity* and *ethnic minorities* earlier mentioned in chapter 6.1 and explain how ethnicity was and still is defined in ethnographies related to ethnicities in Vietnam. This discussion is not only crucial for linguistic clarity but also to highlight how concepts of ethnicity frame ethnic groups and their lives in Vietnam.

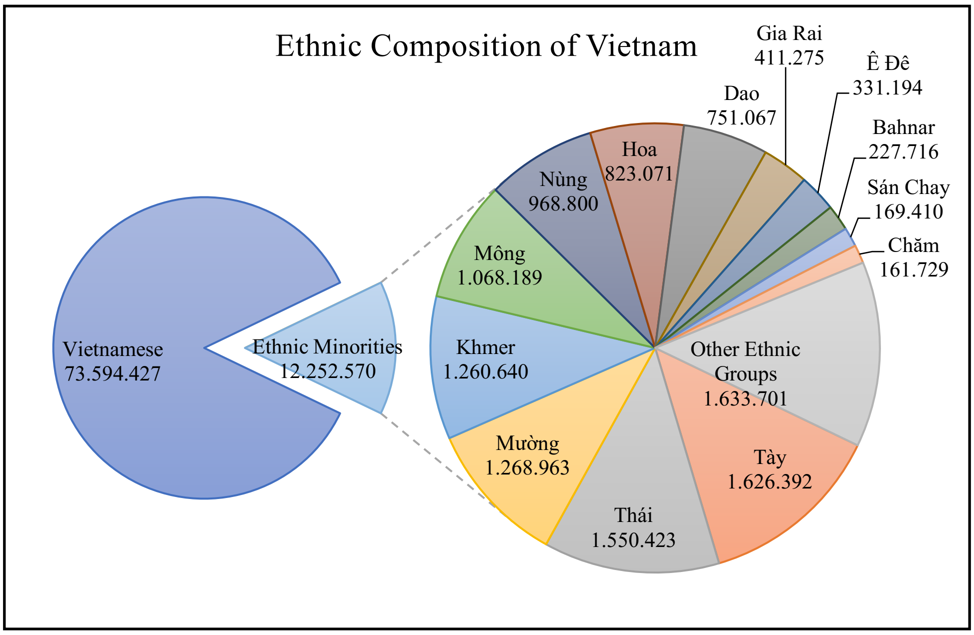

Figure 32 Ethnic groups in Vietnam in 2009. Diagram based on data provided by the GSO (2010a).

Contemporary Vietnam has about eighty-five million inhabitants and is a multi-ethnic state compromising fifty-four ethnic groups. According to the population census of 2009, conducted by the General Statistics Office of Vietnam, the Vietnamese (ethnic Kinh) are the dominant ethnic group in Vietnam, with about eighty-six percent of the total population (around seventy-three million people). By contrast, only five other groups (Tày, Thái, Mường, Khmer Krom, and Hmong) have a population between one and two million; fourteen ethnic groups have a population between one hundred thousand and one million, and eight ethnic groups have less than two hundred thousand. Thirty-four ethnic groups have less than one hundred thousand members, from which ten groups have less than ten thousand members, and six groups have a population of less than one thousand (GSO 2010a, 134–135). Figure 32 illustrates the ethnic groups in Vietnam.

The population census conducted in 2009 numbers 227,716 Bahnar people, of whom about 10 % (23,443) live in cities, while the majority (204,273) live in rural areas. Sixty-six percent (150,416) of the Bahnar live in Gia Lai Province, twenty-three percent (53,997) in Kon Tum Province, and ten percent in other provinces (ibid., 134, 197–198).

In Vietnam, the official expression referring to the ethnic groups is *dân tộc thiểu số*, literally meaning *minority people*. Before that, the term *moi* was applied but is now seen as an inappropriate one since it is a pejorative term that describes the highland groups as *wild* or *savage people* in contrast to the *civilized* ethnic Kinh. According to Vạn (1998, 13), *moi* was originally an alternation of the Sedang people's word *Tmoi*, an endonym used by the Sedang to describe themselves, and meant *nous autres* in French or *we, the mountain people* (*nous, les gens de la montagne*). In contrast, the ethnic groups generally did not use the term *moi* to refer to themselves or others but had their own generic terms for themselves and other ethnic groups and sub-groups (Hickey 1982, xv). Nonetheless, during the French colonial government, French scientists and non-scientists adopted the term *moi.* And only later, due to anthropology's professionalization and the demand for a neutral word to describe highland dwellers, the term *montagnards* replaced the older term *moi.* Later, US anthropologists and militaries employed the term *highlanders* as equivalent to *montagnards*.

In this thesis, I also use the terms *highlanders* or *highland groups* to refer to ethnic groups living in the mountainous regions in Vietnam. By and large, highlanders share common ideas and similar material cultures. One may say that the identity shared by the various minorities living in the mountains evolved over a long time and produced similar world views, material cultures, and lifestyles. In the words of the American anthropologist Gerald C. Hickey, many highlanders' shared identity results from "a process of socio-cultural change attributable to a number of interrelated economic, political, religious, and geographic factors" (ibid., xiv). On the other hand, any subsumption of all ethnic groups under an umbrella term as *highlanders* is unjustifiable because such a catchall term can lead to a misconception and misunderstanding of people from different backgrounds as one (ethnic or cultural) homogenous group—despite the fact that many ethnic groups share cultural attributes, lifestyles, material cultures, and languages—particularly in comparison with ethnic Kinh. Hence, use of the umbrella terms such as *highlanders*, *indigenous people*, or *ethnic groups* should not obscure the differences amongst ethnic people. It is self-evident that each highland group's cultural and material identity evolved under the influence of various interrelated exchanges: within their own ethnic groups, with other ethnic groups in the uplands, and with the encompassing (Champa, Khmer, and Vietnamese) kingdoms, the latter being, in turn, influenced by Chinese or Indian culture (ibid., xv).

7.1.3. A Very Brief Introduction to the Bahnar People

In what follows, I will provide a general overview of the Bahnar people and briefly comment, in the following order, on their history related to the Central Highlands, language, the village's role as the highest institutional entity, social structure, area of habitation, population, belief system, and ceremonial activities involving bamboo. Although it would be important to shed more light on the socio-cultural and economic aspects of Bahnar people's everyday life and their relatedness to their material culture, I have deliberately devoted little attention to this subject for reasons of place and to put more emphasis on the intertwining of bamboo in the material life of people. Despite the fact that the origin of the Bahnar is not completely clear, the Bahnar certainly came to mainland Vietnam by sea before the tenth century CE. According to old Cham inscriptions, scientists assume that the Bahnar lived initially in the coastal areas of present-day Bình Định and Quảng Ngãi Provinces in Central Vietnam until they moved westwards into the mountainous areas (Đặng et al. 2010, 37). Bahnar people's migration to Vietnam and their in-migration from coastal to the Central Highlands exemplifies the challenges related to the definition of *indigenous people* (as discussed in chapters 7.1.1 and 6.1.3). Since humans continuously migrated from one place to another, the term *indigenous* always remains a relative word.

Đao et al. divide the early history of the Bahnar into three periods: An early period of isolation until the tenth century. An intermediate period from 1150 to 1470 under control of the Champa Kingdom. And a third period that was heralded under the sovereignty of Emperor Lê Thái Tông of Đại Việt in the last quarter of the fifteenth century (Đao et al. 2011, 12–13). Gradually, Vietnamese dynasties' influence grew in the Bahnar's areas of habitation, but the French colonial government finally took control in the late nineteenth century. In most of their history, Bahnar people satisfied their wants and needs almost totally by themselves due to their forest-based subsistence economy and barter trade. The latter was functional and purpose-related, and money was unknown until the French arrival (Vạn 1998, 77), which is why barter trade was still common under French colonization (Đặng et al. 2010, 38).

The Bahnar language spoken by the Bahnar in the Central Highlands of Vietnam and the South Central Coast (*Duyên Hải Nam Trung Bộ*) is a Central Bahnaric language—which is part of the Bahnaric language family, which itself is a branch of the Austroasiatic phylum (Sidwell 2002, 1). The term *Austroasiatic* derives from the Latin words for *south* (*Austro*) and *Asia* and means *South Asian*. About 700,000 people speak Bahnaric languages in Vietnam, Cambodia, and Laos. The Bahnaric languages are subdivided into Central Bahnaric, North Bahnaric, East

Bahnaric, South Bahnaric, and West Bahnaric (Lewis et al. 2015), and all subdivisions have their own dialects. Among other ethnic groups that belong to the Austroasiatic language family and who also live in Kon Tum province are the Xơ Đăng, Giẻ Triêng, Brâu, and Khmer.

Many ethnic groups of the Central Highlands have a close relationship with their community, as expressed by their village as "the highest social institution" (Nguyễn Ngọc 2007, 38).[43] The village is where diverse ethnicities' cultures are still alive, and it expresses the people's sense of community. In many languages of the Central Highlands' inhabitants, "there exists no term for any social institution higher than the village" (ibid., 37–38). This institutional hierarchy does not mean that the ethnic affiliation does not go beyond the village but that the continuity of many highland groups' social structure and traditional living depends on the village's continuity. Moreover, in earlier times, "each village was an independent and self-governing unit" (Lưu 2007, 50), and its members had to obey village laws, customs, or prohibitions (Nguyễn and Nguyễn 2011, 374). Therefore, the village is not only a place where people merely live, but where social, religious, and economic life is maintained and in which its members are embedded with their duties, rights, and roles. In the present time, village rules exist side by side with national laws and institutions. Nonetheless, in many respects, it is the village that is seen as the ruling authority and which occasionally limits national law and governmental power.

The Bahnar society was and still is an egalitarian society with only a few differences between its social members. In former times, even if a distinction could be made between poorer and richer Bahnar, "the wealthy also worked like the poor" (Đao et al. 2011, 52). In the present time, however, mutual support has undergone a drastic change. Nevertheless, and despite the effect of the mechanism of the free market, families still remain supportive, but at the same time, solidarity, mutual assistance, and egalitarianism are dwindling (ibid., 163).

People who have a specific duty and responsibility in the self-governing institutional system of Bahnar villages are described by Đao et al. (ibid., 49–51) as follows: at the top of the village is the village head (elected by village members to represent the village in external affairs). The leader and four to five elders form the council of elders. Their function is to protect the village in case of emergency and to act as jurisdiction. Previously, there was also the military commander, functioning as an administrator for military missions; a shaman, functioning as the intermediary between deities and humans; and the village midwife.

[43] Kinship relations, the role of the family, and gender roles also play a decisive part in Bahnar people's lives but are not discussed in detail due to the lack of space. For a more detailed description of these issues and the village's function, social structures, marriage, and customs, see Đao et al. (2011) or Guilleminet (1952).

Important decisions concerning the village were and still are made in the presence of all village residents, who have the same right of co-determination (Nguyễn and Nguyễn 2011, 375). Currently, school education, television programs, Vietnamization, the introduction of cash-crops, changing land tenure, the decline of forests and biodiversity, access to the market economy involving monetary income, and the like have led to a significant change in the social structure of the Bahnar.

The Bahnar ethnic group is composed of several subgroups of which some are Giơ Lâng, Rơ Ngao, Tơ Lộ, Bơ Nâm, Krem, Roh, Krăng, or Bơ Môn (Nguyễn and Lưu 2007, 61). Up until now, the Bahnar have been inhabiting various regions and ecologies with different climatic conditions and have had to adapt to the diverse local ecosystems and environmental circumstances. However, they predominantly inhabit upland areas, which explains why they "call themselves kon kôông (people living in the mountainous region)" (Đạo et al. 2011, 4).

I conducted my research in the North Central Highlands (Bắc Tây Nguyên) in Kon Tum province, which in 2009 had around 430,000 inhabitants, and of which one-third lived in urban and two-thirds in rural areas (GSO 2010a, 5). In Kon Tum province, 43,072 Bahnar lived in rural areas in contrast to 10,925 living in urbanized areas (ibid., 197). In general, the Bahnar population's distribution illustrates that, until now, the countryside is the main area of habitation of Bahnar people: a characteristic Bahnar people share with other ethnic groups living in the uplands.

Although the mass in-migration of Kinh people changed the population structure in many regions, most Kinh moved to urban areas so that the urban-rural divide also became an ethnic divide. In the words of Michaud, "highland zones remain ethnically distinct from lowlands, yielding a cultural mosaic with contrasting colors rather than an integrated picture in harmonized shades" (Michaud 2009, 27).

The Bahnar, like other ethnicities in the Central Highlands, were originally polytheists and animists, believing in deities, ghosts, and spirits that inhabit the environment. According to their belief system, the world is separated into the Sky, the Earth, and the Underworld. The Bahnar not only are connected physically but also spiritually to the Earth level. Various deities inhabit their natural environment, including the rainforest, rivers and streams, hills and mountains, as well as the air; and numerous gods are associated with natural things (e.g., trees, stones, or fire), animals, or with artificial things (e.g., houses, jars, or the village) (Đao et al. 2011, 123; Nguyễn and Nguyễn 2011, 350–352). Under the influence of Western missionaries, however, many Bahnar converted to Christianity.

7.2. Research Design, Methodology, and Methods

Since this thesis is concerned with the human-bamboo relationship, it is in part a study of the material world of things that encompasses everyday goods, tools, infrastructures, the environment, and the human body. Yet rather than understanding the physical things as only representatives or symbols—as conceived and studied by anthropologists before the material turn—I was interested in the multifaceted meaning of bamboo as of the material world and its connection to everyday life, shifting cultivation, Bahnar people's livelihood, material culture, and the like.

I have already put forward some methodological considerations in the introduction to this present work and discussed them in connection with the cross-disciplinary approach of this thesis. I also explained my theoretical assumptions and hypothesis in the theory chapter, which were the entry points for my research design of this chapter. Since my methodological topics are partially integrated into each chapter's introduction and, thus, run through the whole thesis in relation to the various topics, in this chapter I shall focus on the methodology needed to describe the bamboo culture, human-bamboo relationship, and bamboo-nonhuman relationships. By and large, this chapter combines interdisciplinary methods encompassing historical (ethnographic) document research, analysis of contemporary ethnographic texts, and my own ethnographic studies pursued in the light of by socio-material theories.

7.2.1. Field Access and Setting

As mentioned in the preface, my interest in bamboo and its underlying technological and ecological opportunities arose while working on bamboo handicraft projects in my workshop in 2010 and developing bamboo bicycles as part of a student project at the Technical University of Berlin. At the same time, I studied books about bamboo in a wide array of academic fields. As a result of my previous experiences, I decided to do empirical research about traditional uses of bamboo and prepared my first stay in Vietnam, which lasted from March to August 2012. My primary research interest was to take a closer look at bamboo's relevance and function in contemporary material cultures and to gain knowledge through observations in the field. In Hanoi, in April 2020, I met Nicolas Saunié, a French engineer I first encountered during our collaborative work on bamboo bicycles in Berlin, with whom I shared a common interest in bamboo and who joined my exploration of bamboo. In the time that followed, we traveled (with short interruptions until July) together through Vietnam, following the path of bamboo, guided by bamboo's ubiquity in Vietnam's countryside.

By and large, we followed the classical ethnographic chain reaction manner to meet people working with bamboo—one contact led to the next. Since bamboo cultures are sometimes situated in remote areas, we chose to travel with motorbikes and could stop whenever we found something interesting concerning bamboo. As an ethnographer, I attempted to gain more appreciation of and practical experience with bamboo's inherent material qualities and ways of bambooworking to integrate my insights, experiences, and knowledge productively into the present work. Thus, I arranged a possibility for Mr. Saunié and me to work in the bamboo handicraft village in Xuân Lai, Bắc Ninh Province, where we worked for three weeks during May. Here, and at other places, I experienced first-hand knowledge about how to work with bamboo, which was instrumental in understanding not only theoretically but through a haptic approach how bamboo behaves—an experience which helped me rethink the challenges and opportunities of bambooworking and complemented my interpretation of material cultures based on the human-bamboo relationship.

After Xuân Lai, Mr. Saunié and I left northeastern Vietnam and traveled westward and later southward. During that time, we visited bamboo-related development projects in the borderland to Laos, had fruitful conversations with Vietnamese craftspersons, botanists, architects, and politicians, and visited the bamboo arboretum Làng Tre Phú in Bình Dương Province. In June, Mr. Saunié and I split and met again in late July in Hô Chí Minh City because I attempted to find places and people in the Central Highlands of Vietnam and access to the field to realize my anthropological fieldwork for studying people's bamboo cultures.

My decision to study bamboo cultures in the upland regions of the Central Highlands resulted from two aspects. First, traditional bamboo cultures are more preserved in remote areas simply because new technologies and commodities are not yet widely distributed compared to urban areas. Second, before my stay in Vietnam, and based on my preceding background knowledge about the indigenous peoples' material culture, their customs, languages, belief systems, and history I attained through literature review, I expected to find, identify, observe, and analyze indigenous people's traditional ways of using bamboo as described in the ethnographic works.

Permissions to conduct anthropological studies in Vietnam, particularly in the Central Highlands, are hard to get for foreigners because of political reasons. In 2012, therefore, I had little ongoing preparation concerning the question of which ethnic group I would preferably study and expected to find access to the field when being on-site. Fortunately, I contacted and met Mr. Ẩn Nguyễn Ngọc, a resident artist in Kon Tum, who became my informant, translator, and guide and who obtained the local authorities' permission required for my field trip. Mr. Nguyễn Ngọc, although having no anthropological training, has a very comprehensive knowledge of the ethnic minorities and particularly of the Bahnar people's culture, history, and language. It was shortly before our first scheduled meeting that we decided to visit and stay with some Bahnar families. After a little preparation, we went to the Bahnar and lived for seven days in a Bahnar hamlet in July 2012 and stayed most of the time with Mr. Ninh's family (whose house is shown in Figure 33 and in the foreground of Figure 35).[44]

Figure 33 Bahnar houses. On the left part of the photograph is Mr. Ninh's family house and on the right side, the family's granary.

As its name already indicates, the Central *Highlands* is marked by its altitude and comprises numerous high plateaus (like Kon Tum or Pleiku) with an altitude between 500 to 1500 m. It is known as Tây Nguyên in Vietnam and encompasses the provinces of Kon Tum, Gia Lai, Đắk Lắk, Đắk Nông, and Lâm Đồng and is part of the Annamese Mountains (in Vietnamese Dãy Trường Sơn). This mountain range is situated in the eastern part of Mainland Southeast Asia and runs parallel to the Vietnamese coast in a shape of a gentle curve, and divides the basin of the Mekong River from Vietnam's narrow coastal plain along the South China Sea. While the Central Highlands may be perceived as a geographic homogenous and administrative zone, it is equally a cultural zone on the strength of shared cultural and historical commonality by its peoples. Amongst other ethnicities, the Central Highlands are inhabited by ethnic minorities, including Bahnar, Gia Rai, Ê Đê,

[44] The name of Mr. Ninh is a pseudonym to protect his privacy.

M’Nông, Xơ Đăng (Sedang), Hrê, Co, and Giẻ Triêng, and more recently by Kinh (ethnic Vietnamese).

The Bahnar whose material culture I studied live around 40 km to the northeast of the town of Kon Tum; more precisely in hamlets around 6 km to the southeast of the village of Kon B’Rrăp (Tân Lập commune, Kon Rẫy District, in Kon Tum Province; 14°27’55.2”N 108°15’12.5”E) (see Figure 34). Those Bahnar residing in this area call themselves *Jơ Lơng*. According to the village patriarch A Jring Đeng, Kon B’Rrăp has around 186 households with 750 people. In Kon B’Rrăp, I documented mainly the Rông community house and new modes of house construction while the main part of my research was conducted in the hamlets situated further south. The latter are situated on higher mountain slopes and are at a distance of only around 200 m from the forest, which, in turn, borders the Kon Ka Kinh National Park further south.

The difference between the material culture of Bahnar living close to Kon Tum town and those living in Kon B’Rrăp village is evident since the former are more strongly influenced by the effects of urbanization. And there is also a significant difference between Kon B’Rrăp villagers’ material culture and lifestyle compared to those living in the hamlets at the edge of the rainforest (where I carried out my research). While electricity, for instance, is available in Kon B’Rrăp, there is no access to it in the hamlets (except for battery-operated headlamps) and likewise no direct access to paved roads or motorbikes. This observation is in line with Vạn’s (1998, 19) comment that the difference between two villages or hamlets inhabited by the same ethnic group is occasionally more significant than between different ethnicities.

In the past, all Bahnar were engaged in swidden cultivation. The change in their agricultural methods was therefore accompanied by a change in their economy. Recently, most of the villagers switched to permanent agriculture with regular crop rotation. Accordingly, the former subsistence economy of Bahnar people shifted to a subsistence-oriented economy and, lastly, to a more market-driven economy. In the first case, most things were produced on the basis of the local natural resources, while only a few things were bartered. In the second case, in contrast, far more things and products were purchased and less locally self-produced. In the third case, even fewer things were self-produced but purchased for consumption. These transitions have changed not only the way Bahnar people live but also the landscape and the surrounding environment. According to my respondents, dense forests, scrubland, and bamboo groves covered the entire region in the past, and only cleared farmlands and mountain tops had an open view to the horizon. In the present, permanent agriculture is much more common, and increasing farmlands surround the village while the woodland is continuously shrinking.

Some residents in the hamlet have recently and only gradually switched to mixed agricultural methods: While they continue with shifting cultivation as their primary agricultural method and maintain their subsistence-oriented economy, some small cash-crop plantations (coffee and cassava) were added in 2018 for the purpose of monetary income.

Figure 34 Map section of Kon Tum town and the village Kon B'Rrăp. The latter is marked with a red circle.

During that first field trip, I had less theoretical considerations and collected data and observed the local buildings, objects, and tools, and I noticed that bamboo was the most crucial element of Bahnar swiddeners' material culture. Indeed, bamboo (as timber material) was required for almost everything. One is inclined to compare it with the universal applicability and malleability of plastic in industrial societies, but it is environment-friendly without requiring any industrial processing. Being with the Bahnar people and studying their material culture was genuinely useful to analyze bamboo's central role in the lives of swiddeners and to develop my initial hypothesis.

Back in Berlin, in September 2012, I revised my first data collection about bamboo's utilization in contemporary Vietnam and by Bahnar people. Simultaneously, I did essential background research and studied the ethnographic and historical literature about the Bahnar people and the Central Highlands. My second field trip to Kon Tum and the Bahnar people I met in 2012 was in March 2018. I again stayed at Mr. Ninh's house during that field trip, whom I had

Figure 35 The Bahnar hamlet. Different farmlands serve for food production after land preparation. The rainforest in the background stays untouched and provides the Bahnar with useful materials and plants.

already met in 2012. My second field trip was originally planned to have a duration of three weeks, but due to administrative restrictions, it only lasted ten days.

My fieldwork was also initially planned in part with Vietnamese biologists from the bamboo arboretum Làng Tre Phú in Bình, who were to help me identify the various endemic bamboo species. Unfortunately, no cooperation took place as a result of communication difficulties. Accordingly, I could not identify and categorize the bamboos by their botanic names; however, I give their vernacular Bahnaric names. I hope the reader will excuse this shortcoming.

7.2.2. Methodology: Ethnohistory and Practice Theory and ANT Informed Ethnographic Fieldwork

As already explained, this thesis section explores the implication of bamboo in subsistence-orientated farmers' lives in the Central Highlands of Vietnam using the example of Bahnar people. My study seeks to answer the following underlying research questions: How do the multiple applications of bamboo relate to people's everyday life in a nonindustrial context in which life was, and (to some extent) is still related to, a subsistence economy? How is bamboo embedded in a broader socio-material network? What are the characteristics of the human-bamboo relationship of the Bahnar people? And how can socio-material approaches help figure out the relevance and function of assemblages which might include humans but are not necessarily driven by humans as the epicenter of action? First and foremost, and as discussed in the previous chapter (7.1), any discussion of these questions is strongly tied to and entangled in a broader area encompassing politics, governmental authorities, developmental programs, modernization, local history, and the like. Without paying sufficient attention to these fields, it would be hardly possible to answer the research questions mentioned above. Moreover, and in connection with my critical discussion of Western dualism, my ontological approach is, of course, influenced by my personal, academic, and biographic background. Thus, in the words of Costantino and in relation to my methodological approach, I consider reality as “a monistic subjectivist epistemology in which knowledge is constructed between inquirer and participant through the inquiry process itself. Inquiry is carried out through a hermeneutic methodology that is essentially dialectic and iterative and where insights and understanding emerge from the joint construction of inquirer and participant (etic and emic views)” (Costantino 2008, 117). From this viewpoint, I was critically engaged with the interplay between me, as the researcher, and the participants. As a result, my anthropological research findings are both the result of my investigations and, at the same time, the Bahnar people’s views and understanding of themselves, their environment, bamboo, and material culture.

Having said this, I have pursued a methodology that would facilitate a response to my research questions thoroughly by juxtaposing a wide spectrum of data. On the one hand, I have conducted field research by means of an ethnographic approach and studied the multifaceted and multiple ways brought about by humans, bamboo, and other entities. On the other hand, I have analyzed the body of historical and current anthropological literature on the same subject with the aim of comparing and complementing other scholars’ thinking with my own observations and findings.

The combination of historical records, contemporary records, and my ethnographic fieldwork to study the human-bamboo relationship, Bahnar people’s material culture, and bamboo-nonhuman associations provided a more holistic approach to this chapter’s research goal and was essential in furnishing and obtaining more detailed knowledge and information to support this chapter’s working hypotheses. By implication, this endeavor allowed multifaceted interpretations from various perspectives.

Ethnographic works, as Hammersley and Atkinson explain, have some characteristics in common: i) they attempt to describe people’s doings and activities as constituted during everyday life and settings, that is, in the field; ii) they collect various types of data mainly during long-term fieldwork; iii) their data collection is usually unstructured: the research design is constantly adapted to the findings in the field rather than being strict and unmodifiable; iv) ethnographers commonly focus on a small-scale society to obtain a holistic image; and v) document what happens in the field (Hammersley and Atkinson 2008, 3). Yet, despite these commonalities, ethnographic works differ depending on the ethnographer's interest, and it is hardly possible to present a generally accepted definition of what ethnographic work is. Overall, my ethnographic work overlaps with Hammersley and Atkinson's definition, but rather than being a long-term study, my ethnographic work is characterized by two relatively short field trips—which, in my view, could be considered as the weakness of my study since a longer stay would inevitably add a deeper understanding of my research topic.

Nevertheless, doing ethnographic fieldwork enabled me to study the current bamboo culture of Bahnar people, that is, by studying people—if we are to identify and recognize people as the chief anthropological source—and their use of and entanglement with bamboo. Hence, the fieldwork allowed engagement in the everyday life of people at a certain time and place. As such, my study could be viewed as an observation of current history in the making. My fieldwork allowed me to collect first-hand data concerning the use of bamboo and analyze bamboo's current relevance for people's material culture and its part in related practices.

At the same time, and in the sense of ethnohistory, "the use of historical and ethnological methods and materials [allows one] to gain knowledge of the nature and causes of change in a culture defined by ethnological concepts and categories" (Axtell 1979, 2). Accordingly, and as will be described below, the methods employed to identify the meaning of bamboo associated with the Bahnar bamboo culture are achieved through my ethnographic fieldwork and the principles of ethnohistory—both driven by socio-material theories' approach to bamboo.

By and large, ethnohistory synergizes the disciplines and research methods from history and anthropology and combines "the diachronic dimensions of history and the synchronic sensitivity of ethnology" (ibid.). By reconstructing the ethnographic past of Bahnar people's everyday life and lending an eye to the associated tools and mundane objects through historical records, I was able to reconstruct the characteristics of the Bahnar bamboo culture in pre-industrial times and compare it with the current nonindustrial bamboo technology and bamboo culture and, even though following the principle that each culture and society must be understood on its own terms, I compared the Bahnar bamboo culture with other ethnic groups' bamboo cultures. The reconstruction of the past and the study of the present bamboo culture involved both external and internal perspectives, or etic and emic descriptions, which were not mutually exclusive but complementary and, by their synergy, helped to generate a narrative of the material history of bamboo and its engagement with humans.

As expressed by the American historian James Axtell (ibid., 5), ethnohistory means to move forward and backward in time. While the present time is the entry point of anthropologists, historians traditionally begin in the past. And while anthropologists work backward in time from the familiar things of the present to the unknown past, historians go the other way. Accordingly, this chapter's partial focus on history enables a discussion of technological or socio-cultural change concerning the bamboo culture and human-bamboo relationship of Bahnar people. In this light, I shall predominantly use ethnohistorical methods to outline the general characteristics of bamboo cultures and their persistence, and I will note and portray some selective modifications and transformations between the past and present to indicate particular changes over time and the factors determining change. At the same time, the present bamboo culture reveals many aspects of the past bamboo cultures and helps reconstruct bamboo's relevance in a pre-industrial context.

As will be explained below, it is evident that bamboo conditions the material circumstances of the Bahnar people. Bamboo also provides opportunities for the Bahnar people to meet their needs and stabilizes their social world. There is no doubt that if one seeks to bring meaning to the multifaceted social worlds, one should be aware of how they are physically conditioned, determined, and structured. If we were to study a basket maker's work and profession, for instance, it would be odd and counterintuitive to neglect a description of the workshop and the involved material tools, goods, and workpieces. Only by foregrounding the materiality of things and their relatedness to the social sphere does it appear possible to make statements about human-thing relationships. Unsurprisingly, then, the lives of swiddeners described in this chapter consist of a complex amalgam of various entities that go beyond humans and bamboo.

This being so, I opted to find methodological ways for a theoretical depiction of these multiple connections of various entities. Therefore, in chapter 7.6, I question in which manner bamboo is part of people's everyday life and other human-nonhuman arrangements by referring to two social theories and their distinctive approaches to nonhumans, namely, practice theory and ANT. Both provide distinct socio-material approaches to ethnography and are instrumental in analyzing and describing the material aspects of human practices. Yet, compared with practice theories, ANT's post-humanist approach helps figure out the nonhumans' agency—a viewpoint, which is usually under-theorized in history, anthropology, and related disciplines since things and nonhumans were commonly conceived as neutral but not as agentic. By implication, I developed parts of my methodology, and ultimately, methods based on practice theory's and ANT's socio-material approach.

From a praxeological point of view, shifting cultivation can be viewed as a sum of different human-centered practices, while bamboo culture appears as the indispensable material foundation for carrying out such practices. Following the practice theory approach, I consider that many practices necessarily consist of at least two materials: the human body and the (semi-)tangible object (be it a plant, a tool, a house, a fire, or the like). Describing these human-material relations provides many points of connection incorporated in the lives of swiddeners. Accordingly, I pursue the question of how the human body, skill, and knowledge, for one part, and bamboo (as raw material) relate to each other in the way the Bahnar work and use bamboo. Moreover, through the practice theory approach, I discuss how bamboo relates to material arrangements needed to carry out practices connected to shifting agriculture.

Practice theory commonly interprets things and tools and their uses as the backdrop of human practices, but ANT goes a step further and proposes that human and nonhuman entities have the same capacity to influence the social. Agency is spread in a network, and the emergence and development of a given socio-material system (or actor-network) result from enacting relations and enrolling other actors. In ANT's view, agency is detached from intention and subjectivity and allows the description of phenomena, including humans and nonhumans. Thus, a decentralization of the human subject from the epicenter of scientific interest paves the way to analyze entities of various spheres with differing materiality and how they determine human actions and contribute to the network. "Actor-network theory, and other socio-material perspectives," as MacLeod et al. put it, "provide tools to attend to the messiness of the everyday world—and all of its minute negotiations, translations, and processes. In its simplest form, an actor-network theory-informed approach asks us to remain open to the possibility that nonhumans add something worth studying" (MacLeaod 2019, 179). In this light, I employed the ethnographic method geared to practice theory's and ANT's theoretical assumptions to define bamboo's meaning in people's everyday lives and bamboo's relation to broader networks.

7.2.3. Fieldwork and Methods

Due to my first fieldwork in 2012, I had already achieved some insights into the Bahnar people's material culture. Studying the literature about bamboo and Vietnamese ethnic minorities enhanced my knowledge and understanding of bamboo's value for material cultures in the past and present. Both offered insights that helped me formulate questions, conduct interviews, and sharpened my scientific view and empirical approach during my stay in 2018. Moreover, when revisited the Bahnar people in 2018, many recognized me and were open-minded and interested in the progress of my research project.

As claimed by historical ethnography, uniting anthropology and history enlarges both disciplines' scopes due to a greater variety of sources. Alongside the written documents that traditionally represented the main sources of the historian, a combination of ethnohistory with anthropological ethnography provides the examination of "maps, music, paintings, photographs, folklore, oral tradition, ecology, site exploration, archaeological artifacts . . . museum collections, enduring customs, language, and place name" (Axtell 1979, 4). In this light, I studied historical and ethnographic records, became enmeshed in local ways of being and doing, compiled field notes and sketches, took photographs, and made video recordings to obtain significant visual materials to analyze and portray bamboo's part in people's daily life. Thus, my underlying method was participant observation to obtain knowledge of the human-bamboo relationship of Bahnar people based on the things I encountered in my research environment. However, I did not attempt to make a classical and comprehensive ethnographic survey of the Bahnar people that would encompass their material culture, belief system, customs, social structure, or language. Instead, I concentrated on studying bamboo's embeddedness in people's local material culture through socio-material theories informed ethnographic fieldwork.

In order to learn more about my research subject, I was engaged in observation, watched the numerous human and nonhuman agents in action, collected field notes, studied the environment, and asked questions related to bamboo. To better analyze and understand various human-nonhuman encounters, as mentioned above, I took photographs and made video recordings. While the photographs compiled a holistic approach to all the things associated with bamboo, video recordings were helpful in re-analyzing the performance of practices such as tool-creation, bambooworking, or basket weaving with temporal distance. They also enabled me to compare and contextualize my data with the material of various academic fields to achieve a more comprehensive understanding of bamboo in the life of Bahnar swiddeners. Moreover, I believe that photographs convey visual information that goes beyond simply illustrating the text's subject and message but adds further facts and data necessary to portray the underlying research subject. For this reason, photographs are given much space in this chapter, and all photographs presented in this section are selected from my collection taken in the Central Highlands in July 2012 and March 2018.

At the same time, and for a profound analysis of the material world and the relation of Bahnar people's bamboo culture to other fields, I asked the Bahnar people using and creating tools or commodities to describe what they were doing, how they create things, which tools they use and how, what significance they attach to their material surroundings, and the like—whenever possible during the performative act of engaging with bambooic things but, due to the short-term field trip, I also asked about further practices involving bamboo that I could not observe.

Given my research time limitation, I conducted four short semi-structured interviews and several spontaneous conservations—all conducted in English and translated by Mr. An Nguyễn Ngọc into Bahnaric—and recorded them for later transcription. Before interviewing and observing, I informed my participants about my research purpose and assured them that the data obtained would be used only for the present work. The interviews involved questions on a wide array of fields encompassing the agricultural system, nutrition, household labor, agricultural development, botanic aspects related to bamboo, the human-made environment, the material world (including things and tools and their uses), people's perception of their environment, and the like. These interviews, then, allowed hypotheses and questions about bamboo's relevance from the Bahnar peasant's perspective. The spontaneous conservations, in turn, resulted while participating in people's daily routines and shed further light on bamboo's practical use and processing in the course of daily activities.

Overall, due to my socio-material, non-anthropocentric approach, my concept of field differs from its traditional meaning in that it incorporates the tactile and haptic objects, tools, and architecture, the less tangible and nonmaterial entities, the environment, the performative and corporeal activities of people, and interviews. In addition, and as described in detail below, historical ethnographic records, reports about governmental policies and developmental programs affecting the lives of ethnic minorities in the Central Highlands, descriptions of shifting cultivation and bamboo's effects on the farmland, and field data from contemporary ethnographic works provided further important information about my research topic. Only by bringing these different sources together was I able to unveil a concise canvas of the human-bamboo relationship, bamboo culture, human practices, and nonhuman-nonhuman relationships. Against this background, by studying these various sources by various methods, I generated a diagram related to bamboo-based practices as shown in Figure 78, depicted how heterogeneous entities shape and contribute to a network related to traditional bamboo houses in Figure 81, and found ways to illustrate in Figure 79 how various human and nonhuman entities form an actor-network related to shifting cultivation and bamboo culture.

The latter is described at this point and is intended to represent how socio-material scenarios are helpful in gaining insights about the constitution of networks when not limited to the human being: The preparation, cultivation, and protection of agricultural land by Bahnar swiddeners depend on the interplay of human activities, the involvement of tools, and other nonhumans. These nonhumans, understood in their comprehensive variant, can be tangible, semi-tangible, or nonmaterial in their material consistency. For instance, fire is a semi-tangible thing but essential in the transition of forests to agricultural land during the burning process as one step of shifting agriculture. The burning process, in turn, relates to another semi-tangible thing, namely, the wind that affects the direction and strength of fires.

What is more, time can be considered as a nonmaterial factor. Within a short timeframe, for instance, various plants compete with one another and with rice grains for light and nutrition and characterize distinct nonhuman-nonhuman relationships. And within a longer timeframe, weather and climate conditions (such as the rainy and dry season, day-dependent temperatures, and global warming) influence the growth of seedlings and harvest time and could represent nonhumans of different material compositions. Besides that, the rice variety's characteristics are also crucial because they determine a plant's growth habit and resistance to harsh weather conditions and insect or fungal infestation. In conclusion, all entities and effects are intertwined and profoundly impact the success of farmland management.

7.2.4. Previous Research: Ethnographies in the Central Highlands in Past and Present

In general, not much was (scientifically) recorded and known about the people living in the Central Highlands until the twentieth century (Guilleminet 1952, 395; Michaud 2009, 28). Yet, with the French conquest of Vietnam and the establishment of the French colony, the interest in the country's political, historical, and cultural characteristics increased together with the desire to have more information about its resources, climate, fauna, flora, and ethnic minorities. Early explorers or missionaries conducted the very first ethnographies about ethnic groups, and only later did scholars study the ethnohistory of the Central Highlands—less with scientific ambitions than to get information about the *sauvage* (French for wild and uncivilized people) to ensure the colonial interests (Michaud 2009, 28).

The first professional ethnographies in Vietnam were influenced by the *École Sociologique Française*, founded by Émile Durkheim (1858–1917) and Marcel Mauss (1872–1950). At that time, anthropology and sociology were not yet institutionalized widely and offered only a few critical theories and methodologies. However, soon after the foundation of the *École Française de I'Extrême-Orient* (EFEO) in Hanoi—which intended the scientific research of South, Southeast, and East Asian history and culture—an intellectual exchange between Vietnamese and French colonialists evolved. And many ideas were discussed and published in its journal, the *Bulletin de École Française de I'Extrême-Orient* (BEFEO) (Bayly 2000, 583). Accordingly, intellectual exchanges and discussions had an impact on the social and political development of Vietnam. For instance, Marxist and socialist thought created the necessary political basis for the Communist Party of Vietnam (CPV) to oppose France's colonial rule. Bayly (ibid., 584) compares the anthropological debate in colonial Vietnam with that of the British and Indians concerning the definitions of nation, ethnicity, or tribe in colonial India. When the demand for autonomy and self-government continued to develop in Vietnam in the years after World War I, the CPV and neo-Durkheimians started to attack and criticize the colonial regime (ibid., 598).

Realizing profound anthropological research in Vietnam was and sometimes still is complicated for various reasons. During the First Indochina War and the Second Indochina War (called Anti-French Resistance War and the American War respectively in Vietnam), field observations were complicated to conduct, especially for non-Vietnamese scholars. This statement is supported by Lương, who points out that anthropologists faced restrictions "on certain topics and in certain geographical areas of Vietnam," and that long-term fieldwork research for Western scholars "involving extended stay and total immersion in a studied community, has been virtually impossible in the uplands and border regions, and [particularly] on the topics of religion, politics and law, and ethnic minorities" (Lương 2006, 372). Lương (ibid., 397, footnote 1) further notes that from 1950 to 1990, only nine anthropological doctoral theses and from 1990 to 2006, only forty-two theses were conducted at Western universities that had Vietnam as their topic and were grounded in significant fieldwork.

In former times, one main obstacle was the difficulty of access due to dense rainforests and impassable terrain. This was particularly the case if one attempted to study ethnic minorities living in remote mountainous areas of the Central Highlands and the mountainous regions of Northwest Vietnam bordering Yunnan.

In sum, from early French colonization to the end of the American War in 1975, very few anthropological studies were conducted on the indigenous people of Vietnam. As Michaud states, Vietnamese archives contain few publications about the Highlands' indigenous people, and even fewer records have been written in indigenous languages. Therefore, Michaud concludes that "what is left of the early history of the highlanders in Vietnam is scarce" (2009, 28).

After the reunification of Vietnam, Vietnamese researchers continued with studies on ethnic groups in the Central Highlands and, as a result, the early "ethnology in socialist Vietnam has been heavily influenced by the evolutionist paradigm" (Lương 2006, 374), which conceived development as a kind of evolution. In that scheme, ethnic minorities, compared with the lowland ethnic Kinh (or Vietnamese), were regarded as *primitive* or as savage (Bayly 2000, 587), and it was the burden of the Kinh to support and develop their *primitive brothers*. As Viet mentions, "the least 'socialist man' could do for 'traditional man' . . . was to help him relinquish his simplicity and reach the superior levels of lowland civilization as quickly as possible" (Viet Chung, 1968, 3–23). It is evident that socialist evolutionism is based on essentialist assumptions and lacks concern for people's history, historical development, or tradition, which, of course, is problematic for ethnic groups' self-determination and maintaining their cultural heritage (this issue is addressed in chapter 7.1.1). In his book, *The Ethnography of Vietnam's Central Highlanders. A Historical Contextualization, 1850–1900*, Oscar Salemink examines the "multiple relations between the ethnographic representations" of the ethnic minorities in the Central Highlands "and the changing historical context in and for which the ethnographies were produced" (2003, 1). According to Salemink, "economic, political, and military interests within a specific historical context conditioned ethnographic practice" and "the ensuing ethnographic discourses, in turn, influence the historical context by suggesting and facilitating ethnic policies, and by contributing to the formation or change of ethnic identities through processes of classification" (ibid.). It is evident that its author's personal background biases every ethnography (be it a missionary, an administrator, an explorer, or scholar), her/his objectives, and publication time, but can still reveal various insights into ethnic groups and their immaterial and material culture.

The anthropological studies on Vietnam have increased significantly since the late 1980s and have contributed to an enhanced understanding "of the maintenance and transformation of structure, practice, and political economy in the Vietnamese lowlands" (Lương 2006, 393) and upland ethnic minorities. However, as mentioned above, for contemporary anthropologists, and especially for non-Vietnamese scholars, it is difficult to obtain a permit for long-lasting field-work. As a result, international cooperative works are few, and the Vietnamese scientific community is still not fully embedded in the international academic world.

What is more, examining bamboo and its part in daily activities involves a methodological approach that must reveal insights about the material aspects of everyday human life. As done in this book, analyzing human-thing relations requires a methodological openness, an unbiased and flat social ontology, and an understanding of things as co-active members of the social. But as far as my research and literature analysis has revealed, few anthropological works are engaged critically in material cultures or conceive a relational network of human and nonhuman entities' mutual interdependence. Thus, there is virtually no scientific work regarding the Bahnar or other ethnic groups in the Central Highlands in this regard.

7.2.5. Literature Review

After searching the relevant literature, I evaluated and analyzed these sources to arrive at the state of knowledge about bamboo's involvement in indigenous people's lives, or more precisely, in that of the Bahnar. However, I could not study those books published solely in Vietnamese because of my insufficient Vietnamese language skills. The literature I refer to is written in English or French. While some were written by English and French authors, other works were translated from Vietnamese. And only a few works are published by Vietnamese scholars in English or French. Moreover, I have benefited from online databases providing manifold (digitalized) historical and ethnographic texts for my research. Simultaneously, I borrowed books and texts while in the library of the *École Française d'Extrême-Orient* in Hanoi and from the university libraries in Berlin.

In general, the ethnographic literature on ethnic people or Bahnar people is less concerned with peoples' material world and likewise not very comprehensive for several reasons. First, only a few documents describe the highlanders' culture and society before the French establishment in Vietnam, so that the body of literature concerning the ethnic groups remains fragmentary (Guilleminet 1952, 395). Second, since Bahnar people traditionally transmit their own history and customs orally, they have no written documentation concerning their history or (material) culture. There were French and Vietnamese (and to some extent English) missionaries, scholars, and explorers that published the first written records dealing with Bahnar culture. Another, third aspect in this context is that Vietnam is a multi-ethnic country, and according to official data, fifty-four ethnic groups exist in contemporary Vietnam. Thus, research is not confined only to a few ethnic groups but to a plethora of ethnic groups. As a result, and since the Bahnar share common grounds with other ethnic groups inhabiting the same region, literature about ethnic groups other than the Bahnar has been, to some extent, valuable for my research. By and large, the literature's strengths—and particularly that of the historical records—complemented my observations and findings during my fieldwork. Fourth, due to the fact that the focus of the greater part of ethnographic literature was (following the methodology of classical ethnographies in ethnology) on people's belief system, language, customs, rituals, race, social structure, or area of habitation, it was generally less concerned with the material aspects of people. Indeed, there is virtually no literature that deals comprehensively with bamboo, even though bamboo was of outstanding importance for the material culture of many indigenous groups, such as the Bahnar. By implication, bamboo is usually mentioned as a mere by-product of the investigations into ethnic minorities' cultural and social life. In the following, I will enumerate the literature that was relevant to the topic of this chapter.

Oscar Salemink's *The Ethnography of Vietnam's Central Highlanders* (2003) is a fundamental work and deals with the ethnographic representation of ethnic mountain dwellers in the Central Highlands from 1850 to 1900. This book offers an essential overview of what issues motivated scholars and non-scholars of different domains to study ethnic groups in the Central Highlands.

As a result of mass in-migration, war, and political decisions, the Central Highlands' population composition has changed drastically. Its effect on ethnic groups' lives and swidden agriculture is critically reviewed by Forsyth and Michaud eds. (2011), Michaud (2009), and Gendreau et al. (2000). And, in a similar way, Tan (2006) examines how resettlements and sedentarization affected ethnic groups. These books therefore provided valuable information concerning the challenges Bahnar people are faced with.

Since swiddening and bamboo culture are connected, the transition from swiddening to permanent agriculture is accompanied by the transformation of cultural, social, and material aspects. Therefore, I studied the characteristics of swidden agriculture with the aid of Denevan (1992), Lentz (2000), and Mertz et al. (2009) and scrutinized how it is affected by bamboo's growth pattern in swidden farmlands. For the latter topic, I combined my observations and data with that of Sovu et al. (2009) and Kameda and Nawata (2016).

Although not dealing specifically with bamboo, introductory ethnographic works were useful for gaining an overview of ethnic groups residing in the Central Highlands and these peoples' culture, social structure, kinship, language, belief system, customs, rituals, legends, and the like. One early work was written by the French explorer Henri Maître (1912), who undertook explorations in southern Indochina from 1905 to 1911. Based on his explorations in the border triangle of Vietnam, Cambodia, and Laos, Maître published an initial comprehensive book about the mountain dwellers he met. Although not quoted in this section, Maître's book was helpful to gain a first impression of the indigenous people's life in the early twentieth century.

Paul Guilleminet, a French soldier and administrative official in Vietnam's southern mountainous regions, studied the Bahnar people's immaterial culture and language and published his findings in *La Tribu Bahnar du Kontum* (1952), published in the BEFEO. Yet, since Guilleminet's work follows classical ethnographic studies describing Bahnar people's immaterial culture and social structure, it provides only a few references to material culture and the utilization of bamboo by the Bahnar people.

Another influential work, titled *We Have Eaten the Forest* (1952), is by the French cultural anthropologist Georges Condominas and is an exceedingly interesting work that sheds light on the life of the M'Nông Gar people residing in the southwestern part of the Central Highlands before the American War. By analyzing and condemning the South Vietnam regime's policies, Condominas coined and introduced the term *ethnocide* into scientific language. What is more, as a consequence of subsequent years of war, this book became one of the last of its kind until Vietnam's reunification.

The historian Văn Kự Nguyễn and the anthropologist Hùng Lưu (2007) studied the cultural function, design, and construction of Rông community halls, common among the Bahnar and other ethnic groups of the Central Highlands, and published a bilingual book on that subject in French and Vietnamese. This book was helpful for examining the Rông community houses' extra-ordinary role in the traditional lives of Bahnar people.

Literature that was of exceeding value for my analyses of the bamboo culture of the Bahnar were Kinh Chi Nguyễn and Đổng Chi Nguyễn's *Mọi Kontum* (1936) (reprinted in 2011) and Đạo et al.'s recently written book *The Bahnar People in Việt Nam* (2011). In their study of

Bahnar people in Kon Tum, Nguyễn and Nguyễn (2011) describe many essential aspects of Bahnar life during colonial times and before the advent of modernity; the authors recount that life in Kon Tum was already changing in the 1930s. Their book offers remarkable insights into Bahnar culture, which the authors compare with Vietnamese culture and thus, allow greater access to the field than European scholars would have. Đạo et al. (2011) cover similar topics as Nguyễn and Nguyễn (2011), but its proximity to contemporary history also provides insights into the change and adaptation of Bahnar culture.

To outline how swiddeners and mountain dwellers other than the Bahnar use bamboo, I drew on Condominas's (1952) work about M'Nông Gar people and Đặng Nghiêm Vạn's *Les Sedang au Vietnam* (1998) concerning Sedang people. Vạn's book is an outcome of a collaboration with the Ethnological Museum in Hanoi. It has numerous photographs that demonstrate quite impressively the use of bamboo by Sedang people. Many everyday objects, tools, house constructions, baskets, and the like have a remarkable similarity with those of the Bahnar people.

Additionally, and to show that bamboo is widely used in other regions than Vietnam, I refer to Richard Loving's article *Use of Bamboo by the Awa* (1976). In his text, Loving examines the use of bamboo in the pre-industrial life of swiddeners in the Highlands of Papua New Guinea. Although published in 1976, this text is a historical source since modernity's impact has already changed Awa people's lives.

Since the Bahnaric language is spoken with different dialects by the subgroups and because there are different writing systems for Bahnar, dictionaries were useful tools to compare my field notes with two Bahnar-French dictionaries. One was written in 1889 by the missionary Pierre Dourisboure and another, more comprehensive one by Paul Guilleminet (1959).

Overall, other scholars' books were valuable because they mention bamboo's uses that I could not observe on account of my limitations of time and locality. The ongoing introduction of new materials and techniques, for instance, was already changing the material culture of the Bahnar and other ethnic groups from the early twentieth century onward. In this context, historical records and ethnographic descriptions published in the last two decades provided a valuable resource to complement my own observations and findings. And historical records were also particularly informative because they include descriptions of bamboo utilization that no longer exists. The weakness of these works, however, is their lack of interest in the material world.

7.2.6. Limitations and Significance

First of all, my interpretation, findings, and hypothesis based on my applied anthropological methods and fieldwork remain subjective and selective, and likewise, the range of historical, ethnographical records is subjective. Moreover, due to the lack of Bahnar language skills, I could only find access through translation, which reduced the quality of my research.

Writing about some Bahnar people's material culture implies not writing about the material culture of all Bahnar. Like every ethnographic study, my observations and findings are limited to my fieldwork, the people I met, and the things I encountered during my research. And two relatively short field trips are not sufficient to give a representative description of the entire Bahnar bamboo culture. Nevertheless, my epoch- and time-spanning studies of historical and ethnographical records about bamboo as part of material cultures; my observations of bamboo's part in everyday life, agriculture, industry, and manufacturing in Vietnam in 2012 and 2018; and also my own hands-on experience with bamboo in workshops in Berlin and two bamboo-workshops in Vietnam; all of these experiences augmented my understanding of bamboo, and thus, helped me to interpret and analyze bamboo in a broader context.

Therefore, I believe that my following representations about the Bahnar people's use of bamboo are sufficient to show the interdependence between humans and bamboo. Accordingly, my research is complementary to other ethnic people's ethnographies, yet with a distinct focus on human-bamboo relations. Comparing my insights and data collection with other studies was also useful for a comprehensive depiction of bamboo's use by ethnic people in the remote past, recent past, present, and for theory building. Moreover, the juxtaposition of other scholars' works about bamboo's significance for mountain dwellers (in other regions and countries) against my observation provided a material groundwork for discussions of bamboo's supra-regional importance and involvement in humans' material culture and development.

To sum up, studying bamboo in the present-day material culture of Bahnar people reveals not only insights about bamboo's relevance in traditional material cultures but is also a snapshot of the past and present material culture. Moreover, documenting traditional material cultures and technologies as part of people's cultural heritage is becoming increasingly important since traditional material culture is in decline due to modernization, industrialization, or new agricultural methods.

7.3. The Modification of the Environment: Forests, Swidden Agriculture, and Bamboo

In this section, I shall briefly set out various principles concerning the concept of environment and shifting cultivation's main characteristics. In doing so, I continue my earlier discussion about humans' perception of the environment in chapter 5.2. Simultaneously, I attempt to lay down basic knowledge for my description of the Bahnar people's bamboo culture in the next chapter and further reflections about the connection of bamboo culture and shifting culture from theoretical perspectives in chapter 7.6.2.

Every organism, be it animate or inanimate, be it a human or nonhuman animal, be it a tree, plant, or insect, is part of its surrounding environment or, as in the sense of post-humanist theories, part of a network or arrangement. In such concepts, the diverse components are entangled with each other. They do not only influence other components of their network but are equally influenced by others. It is this mutual interrelation, then, which shapes the entire network. From the very beginning, humans have shaped their local environment and modified, to a greater or lesser extent, landscapes, vegetation, and animals. In the present day, however, the global anthropogenic impact on nature has reached unprecedented dimensions.

From a certain point of view, humans can be considered a disturbing factor of nature but also could be depicted as an inherent part of nature—both are correct. In the latter case, humans have a reciprocal relationship with other organisms (animals, insects, trees, and plants) and with nature as a whole. Therefore, it is difficult to say where *wilderness* starts and where it ends, and if there is a wilderness at all. And it is even more challenging to retrace time to a point when the first interactions of people with their environment began. David Lentz (2000, xviii) (an American botanist), who, among other things, has studied the use of bamboo in indigenous people's agricultural systems, argues that people living in a given area certainly will have an impact on the surrounding environment. He further writes that "the most significant type of environmental change brought about by pre-Columbian human activity was the modification of vegetation. Other changes were of soil (erosion, structure, loss of fertility, the creation of fertility), wildlife (genetics, numbers, distribution), microclimate, hydrology, [and] the land surface itself" (ibid., xviii). Even the tropical rainforest of Southeast Asia like other pre-Columbian landscapes, which Europeans perceived for a long time as untouched paradises, was modified by humans. As in the description by the American geographer William Denevan (1992), these forests and landscapes are *humanized forests* and *humanized landscapes*.

Rainforests in Latin America, for instance, have been modified and changed by clearing and burning methods, “in which the kinds, numbers, and distributions of useful species are managed by human populations” (ibid., 374). Although the term *humanized* indicates the influence of humans on nature, it must be applied with caution. Following Lentz’s (2000, xviii) critical argumentation, the *humanized* forest does not implicate humans’ effective modification of forests, which can lead to a mistaken understanding of a forest as a human-made artifact.

The historical demand for agricultural land has mainly driven the modifications of forests, landscapes, and vegetation. Since then, domesticated crops and various farming systems and concepts have evolved throughout the world. One agricultural method, practiced by many indigenous people in Southeast Asia’s mountainous regions, is known as *swidden agriculture*—a farming method inseparably associated with subsistence-based economies (Mertz et al. 2009, 260).

Swidden agriculture (or swidden cultivation and swiddening) is a farming method that implies a clearance of vegetation by cutting and burning the vegetation cover and the temporary management of a plot for agricultural purposes. Furthermore, it is associated with a shift or rather a rotational exploitation of the cultivated land, which explains why it is also referred to as *shifting cultivation*. Another word that is often applied synonymously is *slash-and-burn agriculture*. But this term is regarded as a pejorative term reducing swiddening to the *slashing* and *burning*. And because of this reduction, which overemphasizes the clearance of farmlands by burning them, shifting cultivation had been conceived as a negative form of an agricultural system that is wasteful and harmful.

One main difference between swidden agriculture and permanent agriculture is the factor of time. Permanent agriculture requires continuous use of farming land, whereas swidden agriculture implicates temporary interruptions. In the latter case, after using a plot for agricultural purposes, the farmland is abandoned for many years to guarantee its recovery. According to Fox et al., “swiddening is an agroforestry system; it is neither agriculture nor forestry but a comprehensive landscape management system that operates on a timescale that cannot be captured by a snapshot of a forest or field. Understanding swidden requires a long-term view of the changing agrarian environment” (2009, 308). Indeed, swiddeners exploit the farmland not only for growing field crops. Abandoning the farmland and allowing the forest to recapture the former farmland provides swiddeners with natural resources growing in the primary and secondary forest. Figure 35 is a photograph of a Bahnar hamlet surrounded by farming land and the rain-forest, and it illustrates the different stages of forest use.

There are some characteristic features and steps that people practicing swiddening follow. In the following, I will specify these characteristics as per my observations and my respondents' descriptions. In the first place, an adequate plot is chosen that is neither too steep, too far from one's house, nor too close to the forest. Then, in the second step, the plot is cleared, plants and scrubs are removed, and trees are felled. Ensuring that trees and plants have enough time to dry, a plot's clearance begins before the rainy season. Third, fires are lit to transform the biomass through a controlled burning into nutritious, fine ashes that enrich the soil fertility when washed into the soil. In a fourth step, the planting begins, and seeds are sowed on the fresh farmland. After the first harvest, the same plot is managed to grow fruits and vegetables and then abandoned for many years. As a result, each plot answers a particular purpose like food supply, game hunting, or collecting construction material and medicinal plants. While using the farmland to grow plants is of short-term benefit, its exploitation as scrubland and a young forest has a long-term purpose. For this reason, swiddening is a cyclic agricultural system that may last longer than one decade.

When managed well, shifting cultivation offers a continuous and sustainable supply of food, plants, and bamboo and is an appropriate and multifaceted means of food production. Indeed, it is an outcome of years of experience of preceding generations who found the best way to produce food, drawing on their agricultural know-how. It requires specialized knowledge and practical experience to obtain higher yields and guarantee one's food security. For decades, swiddeners "had been collecting, producing, managing, and selling forest products (e.g., rattan, damar, and bird's nests) and growing pepper, gambir, fruit, coconut and rubber" (ibid., 311). Their livelihood is related and adapted to their environment, and swidden agriculture has become a crucial component of their way of life.

Moreover, shifting cultivation requires annual work that corresponds to the rainy seasons and is considered hard, laborious work that necessitates every family member to participate in agricultural farming. At the same time, shifting cultivation usually generates no monetary income. For this reason, and even though swiddening is a sustainable and eco-friendly farming method that satisfies people's wants and needs, many voices within the Bahnar community and other voices coming from external officials called for a transformation into permanent agriculture—either unaware of or uninterested in permanent agriculture's adverse effects, such as soil exhaustion and market dependence.

In the past, swiddening was often declared a negative, *backward,* and destructive agricultural method due to many prejudices and misunderstandings. The Food and Agriculture Organization of the United Nations (FAO), for instance, reported in the FAO journal *Unasylva* of the year 1957 that swiddening is a severe problem and an obstacle that has to be overcome. The FAO Staff writes that "shifting cultivation, in the humid tropical countries, is the greatest obstacle not only to the immediate increase of agricultural production but also to the conservation of the production potential for the future, in the form of soils and forests" (FAO 1957, 9). Moreover, they argue that swidden agriculture is "a backward stage of culture" and emphasize the need for a "cultural evolution" of the 200 million people practicing swiddening (ibid., 9–11). Although this interpretation was false and not sufficiently scientifically proven, it left its mark on the perception of swidden agriculture by governments, developmental programs, and other actors.

Consequently, although it should be considered an environment-friendly land management method, swidden agriculture is blamed for deforestation, the decrease in biodiversity, or water degradation. Because of false scientific assumptions and political demand for the modernization of agricultural methods, in Southeast Asian countries, swiddening has mainly been replaced by permanent agriculture (Mertz et al. 2009, 259). Needless to say, any transformation of swidden agriculture, understood as an *agroforestry system*, as Fox et al. (2009, 308) explain, has a deep impact on both the landscape and the swiddeners' livelihood. Thus, changing land use is accompanied by transforming the livelihood, economy, culture, or people's knowledge systems.

In the past few decades, many reasons, including "prohibitive legislation, land reform, logging, large-scale land development, exclusionary conservation zoning, and resettlement" (Mertz et al. 2009, 259), have contributed to the decline of swidden agriculture. Today, hybrids of different agricultural land use methods, forestry, and economic income exist at the same time—making it difficult to find one single term to describe the diverse relationships. In some cases, swidden agriculture is combined with permanent agriculture or new agroforestry practices, and many products are sold for cash income due to better access to the market. The transformation from a subsistence-based or subsistence-orientated economy into a market-bound economy shows how mountain people's land management has changed by adopting new land use forms. This development, in turn, has irrecoverable effects on the basic life of people. It is to be expected that this process of transformation will continue in the next decades. New income opportunities may increase the peasants' income and life expectancy, and educational attainment, but farmers are equally at high risk of becoming reliant on the free market.

Another reason why swiddening agriculture is blamed for having adverse effects on the environment is related to the current climate change discourse. It is often said that swiddeners cause lots of carbon dioxide and contribute to global warming because of their burning technique. Unlike natural fires, however, anthropogenic fires occur periodically, are controlled, and are confined to a small area with a relatively weak impact on nature (Lentz 2000, xix). Blaming swiddeners for causing global warming is untenable, especially when compared with the lifestyle in urbanized areas. Fox et al. (2009, 308) highlight that scholars proved that the destruction of the environment is caused much more by industrial forestry than by shifting cultivation—nonetheless, swiddeners have been accused of forest degradation.

Swidden agriculture supplies swiddeners with a plethora of forest products. These products are needed for their livelihood and sustainably meet their needs without dependency on industrial goods. On the other hand, farmers are subjected to an uncontrolled, capricious environment. They have little access to new tools or machines, which would make some work processes more convenient and efficient. Lastly, swiddening can ensure environmental conservation and biodiversity if various plants, trees, and bamboo species are allowed to grow on the fallow plots. However, shifting cultivation is only sustainable if long-term fallows are guaranteed because short fallow periods destabilize the ecosystem and result in degraded lands.

Bamboo is also related to swidden agriculture, and various environmental scientists and anthropologists have studied the relationship between swidden plots, fallowing, recovery of secondary forests, and bamboo's part in this interweaving.[45] First of all, swiddeners must consider bamboo's growth properties and its fire resistance before planting worthwhile plants. Indeed, bamboos can withstand a complete burning even if all the aboveground organic materials die after catching fire. The bamboo plant resists and survives because of its subterranean rhizome system in which valuable nutrition is stored and which is not affected by an aboveground burn. Hence, the rhizomes keep the plant vital and supply it with water and nutrition. Moreover,

[45] This topic is discussed, amongst others, by Kameda and Nawata (2016) in their text *Relationship between Fallow Period, Forest Vegetation and Weeds in Swidden Agriculture in Northern Laos*; Sovu et al. (2009) *Recovery of Secondary Forests on Swidden Cultivation Fallows in Laos*; and by Dove (1985) *Swidden Agriculture in Indonesia: The Subsistence Strategies of the Kalimantan Kant*.

the subterranean rhizomes are woven into the soil like a meshwork, which is problematic for the soil cultivation for plantings.

According to Kameda and Nawata (2016, 7), bamboo resprouts are much more abundant in primary forests than resprouts of trees. And in the case of two fallow fields (one fallowed for twenty years and the other for six years), bamboo was abundant and the primary species in terms of biomass. In contrast, bamboo was rare in fallow fields less than one year old since other herbaceous weeds occupied these fields. Throughout all plots, bamboos and herbaceous weeds recover the swidden plots by virtue of their underground rhizome system much better than other plants and trees. Lastly, the authors state that bamboo stands had no linear growth and that the diameter of bamboo clusters in twenty-year-old fallows was generally smaller than those in six-year-old fallows (ibid.). Michael Dove (1985, 222) observed a similar growth rate for bamboo. He recounts that bamboo stands are much more distributed in younger secondary forests than in older secondary forests and that this is one reason why swiddeners prefer clearance and farming in older forests so as to have fewer bamboo rhizomes as obstacles.

Another aspect concerning swidden agriculture and bamboo is the competition for nutrition, sunlight, and water. Due to the bamboo plant's aggressive growth, bamboos limit the understory light needed by other plants (Judziewicz et al. 1999, 69), and bamboos compete with crops (e.g., rice and maize). Accordingly, it requires effective control of the bamboo plant to limit its growth and obtain a higher crop yield. Such control, in turn, depends on the specific bamboo's growing property—isolated pachymorph clumps are usually easier to manage and require less time and labor than the scattered leptomorph types (Dove 1985, 222).

According to Sovu et al. (2009, 2670, 2673–2674), bamboos have many good and relevant features for the regeneration of forests and eroded lands. However, from a biodiversity conservation position, bamboos may also have adverse effects on vegetation and other plants' distribution. The clumps of the bamboos *Dendrocalamus lonoifimbriatu* and *Cephalostachyum virgatu*, for instance, increase in fallow plots while total species richness decreases. With a focus on the management of tropical secondary forests, Sovu et al. (ibid., 2674) propose two possibilities: either to transform secondary forests into bamboo forests so that local people who use bamboo for rural livelihood benefit from it. Alternatively, controlling the bamboo population allows other plants a greater chance to grow on the same plot of land. Since the shoots of various bamboos are edible and desired as food, Bahnar swiddeners exercise a natural control of the bamboo population by harvesting bamboo shoots, and in doing so, they limit bamboo's growth.

Besides the ability to spread fast through its rhizomes, bamboos have another feature for fast expansion. This is the simultaneous mass flowering and collective dieback that some bamboo species share. The dieback of an entire bamboo plant affects not only the aboveground culms, branches, and leaves but also the rhizomes as the powerful underground energy sources. After a bamboo's death, it takes years for new stands to develop from seeds to new groves and even longer to develop the density and height that the mother plant had before flowering. Hence, massive flowering profoundly impacts the dynamics of forests and ecology and bamboo's own distribution (Daly and Mitchel 2000, 400).

7.4. The Bahnar Bamboo Culture in the Central Highlands in the Past and Present

For a long time, people have developed various material and immaterial cultures and technologies to ensure their livelihoods. For the same reasons, people in the Central Highlands of Vietnam have invented various bamboo tools and objects and techniques involving bamboo. Indeed, the Central Highlands and all the Annamite Range are marked by material cultures resulting from or related to bamboo's application in several domains, including house construction, fence building, basketry, gardening, agriculture, animal husbandry, cooking, and hunting. In the Bahnar hamlets, for instance, bamboo still accompanies Bahnar people from their birth to their death. Shortly after birth, the umbilical cord is cut using a bamboo knife (made from the sharp outer skin of a bamboo culm), which then is buried together with the placenta and the umbilical cord near the family's bamboo house (Guilleminet 1952, 463; Đao et al. 2011, 66) and the newborn child is washed using water stored in a bamboo tube (Nguyễn and Nguyễn 2011, 403). At the end of life, it is again bamboo which accompanies a deceased person. The dead person is laid on a bamboo stretcher to carry the dead body out of

Figure 36 The Kon B'Rrăp village in transition. Motorcycles, electricity, shops, and new types of building are part of village life and are indicators of an adaptation to the market economy as well as socio-cultural change and new hybrid lifestyles.

the house. And shortly after the funeral, when the deceased has been buried in a hollow tree trunk, a bamboo tomb house is built over the tomb (Đao et al. 2011, 72–75).

Since *Đổi Mới*, however, Vietnam is undergoing significant transformation and change with new technologies mainly distributed in industrialized urban areas. Accordingly, the gap between poor and rich people and between rural and urban sites has increased since then. These gaps are evidenced, for instance, by the material conditions of the Bahnar ethnic group, whose access or adaptation to new tools, machines, agricultural methods, or the like has not progressed homogeneously (neither within Vietnam nor within their own ethnic group); rather they have undergone uneven economic and social change (Đặng et al. 2010, 38). Hence, the adaptation or rejection of a new technology varies from case to case, and its sheer presence does not inevitably go along with fundamental changes. The introduction of the bicycle, for instance, changed the mobility of many people in low-lying areas but did not affect the mobility of mountain dwellers. Indeed, bicycles still are non-existent in many mountainous regions since there are hardly drivable roads. On the other hand, motorbikes have proven to be useful machines in both areas. As shown in Figure 36, in Kon B’Rrăp village, even children are accustomed to driving motorbikes.

Figure 37 The upper section of the entrance of the Rông house in Kon B'Rrăp village. Devices such as the television, amplifier, or electric light offer new possibilities for media consumption and cultural practices. A portrayal of Hồ Chí Minh is omnipresent in Vietnam and finds its place in the community house. Behind the television is another painting, which is folkloristic and is supposed to recall old times. It depicts a Rông house in front of which Bahnar in their traditional dress have gathered to perform a ritual.

Then and now, the traditional life of Bahnar people is mainly based on the products that derive from the neighboring environment. The forest provides the needs for their tool kit. In former times, the built environment, diverse baskets, tools, cages, fences, musical instruments, hunting weapons, fish traps, water pipelines, or chicken houses were made from bamboo. Nowadays, the traditional nature-based material culture has changed significantly. In some cases, bamboo and other plant materials (e.g., rattan and timber) have already been replaced by new materials, such as metal nails, corrugated galvanized iron (also called corrugated sheet metal), metal wire, steel wire mesh fences, concrete, or all kind of plastic things. These materials were already available in Kon B’Rrăp village in 2012 and, within six years, have been gradually introduced to the hamlet. One reason for the dissemination of new consumer goods, building materials, and tools is the connectivity of Kon B'Rrăp village to main roads and thus access to the market economy—to connect Kon B'Rrăp village to the main road, governmental authorities have built a suspension bridge to span the river Dak Bla. And what is true for Kon B'Rrăp is true for most Vietnamese villages, which have, so to speak, moved closer to the main roads due to the steady expansion of modern transport infrastructure. While new technologies, tools, and agricultural methods offer some opportunities to increase monetary income and access to information, health care, schools, or other important social institutions, Bahnar people and, particularly, the swiddeners in the hamlets are at the same time faced with major challenges. As Figure 37 shows, new technical devices have been placed inside the Rông house, and their introduction indicates the intertwining of traditional and industrial commodities.

Figure 38 Bamboos native to the Bahnar people's area of habitation near Kon Tum. (*left*) *Sơmluh* bamboo. (*right*) *Poo* bamboo.

In sum, giving up their traditional nature-based economy and collective land tenure while simultaneously adapting to new conditions, sedentarization, or permanent agriculture has profoundly impacted Bahnar people's traditional everyday life and social and cultural traits, but above all, it is the capitalist economy that presents the most serious hindrances and challenges. "The political-economic marginalization of swiddeners," as Fox et al. put it, "has been significantly affected by the extension of capitalist relations and changes in capitalism itself that have driven the privatization of land and increased the amount of commercial agriculture and industrial tree-farming by corporate and government groups, entrepreneurial farmers, and smallholders" (2009, 310). Concerning the relations between the social structure of mountain dwellers and their territory, Michaud identifies two principles. On the one hand are those groups that have "a flexible social structure based primarily on kinship ties . . . and non-territorial social organization," and on the other hand are "territorial groups . . . for whom the land they inhabit is intrinsically part of their core identity" (2011, 216). While the Kinh belong to the first group, the Bahnar belong to the latter group. In the past, territory, forests, rivers, mountains were never private property for the Bahnar but belonged to the collective, that is, that of the village. The landscape and ecosystem represented the home of the Bahnar, who formerly lived in and from nature and had collective rights to use and manage resources.

In the next chapters (7.4.1 to 7.4.7), I will outline the main characteristics of Bahnar people's bamboo culture and, after a short excursion to the bamboo cultures of other swiddeners than the Bahnar (chapter 7.5), I conclude with a theory-based view of the human-bamboo relationship in chapter 7.6.

7.4.1. Bamboo Species

Figure 39 Aboveground appearance of bamboos. (*left*) Branch growing on a *Pơo* bamboo's node (*right*) *Hgơr* bamboo.

The Bahnar in Kon B'Rrăp village and the nearby hamlets differentiate between eight bamboo species growing locally. They select and choose individual bamboo species according to their specific characteristics, including size and shape (length, thickness, straightness), mechanical qualities, processing properties, and a bamboo's resistance against insect attacks.

In general, Bahnar people chose predominantly young bamboos for most of their purposes. Young, green culms are not as dry and hard as old, mature bamboo stems due to their higher water content. For this reason, green bamboos are easier to split, crosscut, and preprocessed into other materials while at the same time requiring less labor and time. By the same token, young bamboo species less than ten months old are selected for basketry and other wattlework.

While some bamboos are directly planted and cultivated close to the village or hamlets, others, such as *kram ơrăk,* as demonstrated by the photograph in Figure 40, grow naturally in the forest. Not all bamboo species are distributed equally in the Bahnar people's area of habitation. Indeed, the Bahnar living in Kon Tum and Gia Lai province share a common culture but not always the same bamboo species.

What is also of interest is that the Bahnar have no generic word that would subsume all bamboo species. My respondents note that they distinguish between eight different bamboo species: *sơmluh*, *pơo*, *hgơr*, *pơle*, *kram*, *lan,* *hơtơp*, and *kram* (*orăk*).[46] Each bamboo species has specific physical characteristics and mechanical properties, but simultaneously, some bamboos are more versatile than others due to superior qualities. Of these bamboos, for instance, *sơmluh*, *pơo*, *hgơr*, and *pơle* are the most used bamboo species, while the other three are rarely used. *Sơmluh* (on the left in Figure 38) is a hollow bamboo with a diameter of about 7 cm. Among other things, it serves for roof construction, deadfall traps, or for the fabrication of strings since it is very strong and flexible. According to my observation, *sơmluh,* originally growing in the mountains, has also been planted in Bahnar villages around Kon Tum town because of its extraordinary value.

Figure 40 *Kram orăk* bamboo. A species that grows wild in the nearby forest and which is known to have solid culms (*orăk* in Bahnaric means *strong*). As its growth habit shows, the *kram orăk* is a pachymorph bamboo that builds a dense stand. In the left-hand picture, Mr. Nguyễn Ngọc and Mr. Ninh inspect the clump in order to decide how to remove parts of it for replanting in Kon Tum. The right-hand picture shows Mr. Ninh removing a part of a rhizome using a shovel. Due to the stiff spikes at its nodes, the *kram orăk* can cause injuries, and it is hard to remove because its rhizomes are firmly anchored in the soil.

Compared with *sơmluh*, *pơo* (pictured left in Figure 39 and right in Figure 38) has a thinner wall but a wider hollow. It is marked by a longitudinal stripe on its wall and is chosen for house construction or basketry. By virtue of its thin wall, it is easy to split and is used, for instance, for floors in bamboo stilt houses. *Hgơr* (right-hand picture in Figure 39) has a thinner wall than *pơo* and finds utilization in house construction. It is turned into strings for basketry and joinings and different wattlework. Given its relatively thin wall, it is considered more appropriate for walls than for floors. On account of its pleasant savor, it also serves as a cooking pot for sticky rice. *Pơle* (see Figure 41) is a species with a large, thick wall but only a small hollow. Therefore, it is needed for house construction (especially for the roof), and its rhizomes serve as a preferred

[46] Although I tried to encompass all used bamboo species and their Bahnaric words, I could not identify them or classify them with their botanical designation. According to Mr. Nguyễn Ngọc, who assisted my transcription of the local species' vernacular names, the Vietnamese have no other terms for these bamboo species but use the local Bahnaric terms.

material to make handles for axes, knives, and machetes. *Kram* is a very thick-walled thorny bamboo species with a large hollow structure. It is required for traps, as a frame for baskets, and when soaked in water and dried in the sun for parts in house construction.

The growth of bamboos depends on weather conditions and soil quality. If a species grows on a spot with appropriate soil conditions, it will develop larger stems and will grow faster than the same species in another place. Besides their value as construction material, some species are also valued for their bamboo shoots. Thus, sometimes people have to decide whether they want to eat the shoots or let them grow. For instance, *sơmluh*'s shoots are edible but are seldom eaten by Bahnar people for two reasons. First, in comparison to other species, *sơmluh* has only small shoots. Second, it is considered one of the most valuable bamboos for construction material because of its extraordinary mechanical properties. Eating them, therefore, would inevitably decrease the supply of bamboo as a building material necessary for many purposes.

Figure 41 *Pơle* bamboo. Characteristic for its thick wall with small hollow.

7.4.2. Bamboo's Part in Ceremonies

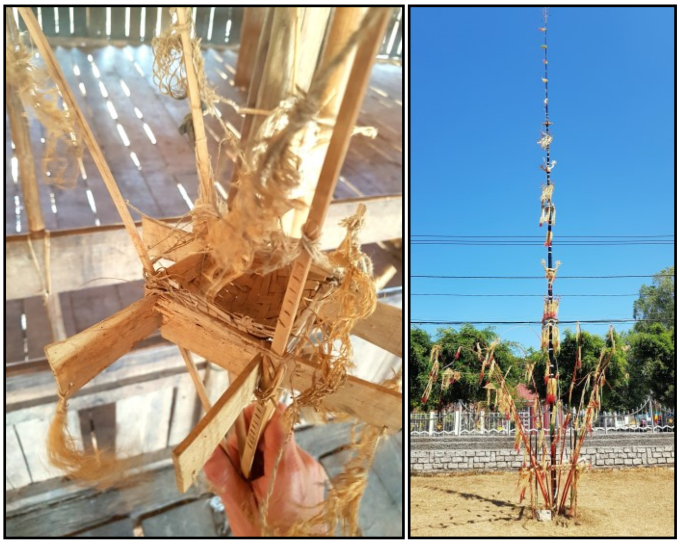

Figure 42 Bamboo in ritual practices. (*left*) The *gònglòng*. (*right*) A *gong* erected in Kon Tum city.

The Bahnar that I describe in the following were barely influenced by the missionaries and maintain their traditional customs and habits. Rituals or ceremonies take place in the houses or the farmland, and those ceremonies that involve the whole village take place at the large community house (Rông house). Many rituals are related to recurring activities throughout the agricultural year, and each family performs its rituals, including the land selection ceremony or clearing ceremony. Other ceremonies are, for instance, the naming ceremony of a newborn, maturity ceremony, marriages, or when a house is constructed. Bamboo is part of Bahnar worship and ceremonies, as exemplified by the use of the *gờnglờng* (seen on the left in Figure 42), which is a kind of altar designed for religious purposes.

Then as now, village feasts start with the erection of a bamboo stake (*gơng*) close to the Rông house. The *gơng* consists of a central bamboo pole surrounded by four smaller bamboos. All are richly decorated and elaborated with ornaments crafted from bamboo fibers (Dourisboure 1889, 310; Nguyễn and Nguyễn 2011, 357). Animal sacrifice is still widespread and is required for many ceremonies, the buffalo (*kapô*) being of particular value. As my respondents said, when preparations are finished, the sacrificial buffalo's forehead and horns are ornamented with bamboo tassels. After that, the buffalo is tied to the stake and later killed by repeatedly stabbing it with a bamboo lance and slaughtered after its death. Amongst all rituals, the buffalo stabbing is one of the most significant rituals and is supposed to bring peace and prosperity to the village. During my research, I could not attend village ceremonies and observe the erection of a *gơng*. The photograph on the right in Figure 42 shows a *gơng* erected in Kon Tum town and is intended to give an impression of its appearance.

The forest is of tremendous importance for the Bahnar. Their material culture could not have come into existence without the gifts of the forest. For centuries, the forest provided the Bahnar swiddeners with plenty of precious resources "such as timber, firewood, materials for weaving, leaves for making liquor, vegetables, bamboo shoots, mushrooms, fruits, bulbs, animals, and insects" (Đạo et al. 2011, 3). In many aspects, the Bahnars' livelihood and material culture are related to the surrounding forest. Except for their area of habitation that encompasses the village and hamlets, it is the forest that covers most of the adjacent land (Đạo et al. 2011, 3).

As mentioned above, swiddening requires a continuous change of the farmland after using it for agricultural purposes. Bahnar people have many definitions of their farmlands related to location and soil quality. The plots are generally called *mir* and distinguished between newly prepared plots for agricultural purposes (*mir rām*), plots when the first yield is reaped (*mir puh klong*), and older plots (*puh rung*). My respondents pointed out that a new plot should preferably be in the lower parts of a mountain slope to guarantee the protection of the rainforest. Protecting the latter from harm caused by fire during the burning process and other interferences is essential, for the forest provides resources necessary for daily life. The process of land possession, known as *plă*, is described by the French missionary Émile Kemlin. According to him, after forest land was transformed into farmland, one's land ownership was marked by bamboo pieces in the shape of a cross inserted into notches made in the trees at every twenty footsteps (Kemlin 1909, 497).

According to Tan, most highlanders of the Central Highlands originally practiced shifting cultivation with "a full cycle ranging between fifteen and twenty-five years" (2006, 235). Đao et al. (2011, 16) write that the Bahnar consider a secondary forest of ten to fifteen years age as ideal for field cultivation, with the farmland preferably in close vicinity to a water source. The diverse stages of the shifting cultivation are closely connected to the tropical climate and the periods of rainfall caused by the two monsoon seasons: the dry season (from November to March) and the rainy season (from April to November).

As mentioned above, Bahnar life is adapted to the requirements of shifting cultivation and follows the cycle of agricultural production. After ten months of agricultural activity, two months (November and December) are dedicated to celebrations and other activities (Đặng et al. 2010, 38). This time (which can also last until February) is called *khey ning nơng,* which roughly means *the months when there is little work in the fields* and a time when swiddeners relax or meet friends (Dourisboure 1889, 221–222) and is also referred to as *leisure months.*[47] During that time, people prepare and attend ceremonies or weddings and other social activities like hunting or weaving (Đao et al. 2011, 27).

7.4.3. Bamboo's Use for Agricultural Activities and Cultivation Tools

Fire-making and fire control are essential for swidden agriculture. Bahnar swiddeners drew on natural resources to make fire before firelighters and matchsticks were introduced. Đao et al. mention one method, whereby Bahnar people "pulled heavy rattan strings around a bamboo trunk, causing friction which ignited bamboo tinder nearby" (2011, 17).

Nowadays, artificially generated electric light enables people to live a more comfortable and safe life even during nighttime and terrestrial darkness. Only a few decades ago, as Mr. Ninh told me, a bundle of cured bamboos still served as a torch. When the torch was lit, one could move around in the darkness to hunt and trap nocturnal animals like frogs. And he also

[47] Nguyễn and Nguyễn translate the Bahnar season *khey ning nơng* as *saison où on s'amuse* which in English means *the season where we have fun*.

mentioned that in the past, people usually used a fresh bamboo stem as a receptacle for transporting for the embers during wanderings in the rainforest. Nowadays, torches are replaced by battery-operated flashlights and headlamps and the ember receptacles by lighters.

Figure 43 Two kind of bamboo fences. A fence protects agricultural land, as pictured left. And, as shown in the right photograph, as protection of seedlings stored in plastic bags held in position with horizontal bamboo poles. Both fences are temporary structures and must be renewed after some time. The greyish color of the fences already indicates their deterioration, but their functionality remains unaffected.

In the history of many Asian cultures, Asian rice (*Oryza sativa*) was and still is a vital food resource and the dominant consumption good. Rice farms, especially irrigated paddy fields, require intensive labor and time. Those Bahnar living in Kon B'Rrăp village's hamlets, besides their vegetable gardening and corn and manioc cultivation, mainly practice dry rice cultivation, also known as upland rice cultivation. They cultivate their rice on mountain slopes without leveling the water or by terrace cultivation. Compared with irrigated fields, the water supply is only determined by the rainy season and the monsoon climate.

According to Barker et al. (1985, 4), as early as the eleventh century, the Chinese introduced a rice species ready for harvest in about a hundred days under the right climate conditions. While the yearly harvest of wet rice in Vietnam has increased in recent decades due to plant selection, fertilizers, or pesticides with multiple plantings per year, dry rice still grows only once a year. In any case, rice farming is hard physical labor, while weeding is conceived as one of the most labor-intensive tasks of all those required for dry rice cultivation (ibid., 28). For this reason, "rice varieties with tough, deep roots are naturally preferred by farmers" (ibid.) for dryland rice systems in order to prevent the rice from being harmed when weeding. Industrially manufactured tools, techniques, and machines were only introduced in Vietnam in the second half of last century. However, no machines are used by the farmers in the hamlets. At the same time, Bahnar swiddeners have no artificial fertilizer, nor do they need it because the fine ashes after the forest's burning are a valuable nutrient sufficient for plantings. Their agricultural food production moreover aims to satisfy people's needs rather than generating a substantial surplus.

In rice cultivation, Bahnar people still follow certain customs driven by their experiences as swiddeners. After the burning of the forest cover and the clearance of the farmland, sowing can begin. According to Đao et al. and corresponding with Mr. Ninh's description, men prepare holes with a dibble stick for the seedling during the sowing work, while women following them fill the holes with seeds that are stored in bamboo tubes (called *đing soi*) into these holes. Besides its function as a seed container, the *đing soi* is also used as a staff to cover the holes with soil after putting the seeds into the holes. The *đing soi* is a multipurpose tool and the one most frequently used by women during sowing (Đao et al. 2011, 18).

During rice harvest, as Đao et al. (ibid. 20–21) further mention, Bahnar swiddeners use specific bamboo sticks. According to them, to separate the rice grains from the plant, Bahnar people use two long bamboo sticks as a clamp (20–25 cm long, 3–2 cm in diameter, and narrowing from the handle towards the end)—a method probably adopted from Lao people.

Figure 44 Wattle door with automatic closing mechanism. The bamboo pole that pulls back and closes the door when under tension is marked with red arrows, and the wire attached to it with yellow arrows.

When sowing is finished, an enclosure of the farmland is essential, for the seedlings would attract domestic animals (mainly pigs and goats) and wild animals that would endanger food production. For this reason, Bahnar people build bamboo fences around their plots. These fences differ in style and shape and are approximately 1.5 m or slightly higher. One typical bamboo fence is illustrated on the left in Figure 43 and on the right in Figure 71.

Bamboo fences generally enclose the entire farmland, necessitating bamboo ladders or other movable bamboo doors to access the farmland. In the latter case, the entrance is occasionally made from a movable bamboo wattle door, equipped with an automatic mechanism, functioning as a kind of upper door closer (see Figure 44). For this purpose, the door is connected by a rope to a thin bamboo rod installed about two meters from the door. When the door is opened, the bamboo rod is put under tension, and if the door is released, the door closes automatically using bamboo's inherent flexibility.

Figure 45 Various tools with bamboo handles. (*left*) A top-curved machete, (*middle*) a short knife with a long handle, (*right*) and an ax (*brai*). For better handling, the machete's handle is additionally wrapped with rubber bands. The ax's slight curved head reflects the natural growth of the bamboo. The blade of the ax is fixed with a wooden slat.

Another way to protect the agricultural fields is through various traps and bamboo spikes installed around the farmland (see chapter 7.4.6 and the descriptions of the design and function of various traps). As illustrated by the right-hand photograph of Figure 43, seedlings are also protected by bamboo fences. Such a protective fence is made of split bamboos of various lengths stuck into the soil and held in line by two horizontal bamboo strips. It is a loose construction but prevents mammals from entering and harming the seedlings. The latter are grown in plastic bags filled with soil and put on the earth, with bamboo culms on the ground to hold them in position and prevent them from tipping over. Before plastic bags were common, plants were usually grown in bamboo sections of similar length and diameter.

Another aspect that comes with swiddening is an elaborate tool kit geared to that agricultural method. Indeed, the tool kit and individual skills are the key elements that make swiddening possible. Prior to the introduction of iron tools, the Bahnar, as other ethnic groups residing in the mountains, used either stone or bone tools to work on bamboo. In comparison to postindustrial societies, Bahnar people, like other indigenous people whose life and material culture is associated with the forest, have a relatively small number of different tools, materials, and techniques.

The limited set of tools and equipment contrasts with the versatile application of tools. First of all, it is the machete (*kơh*) that stands out as a universally usable everyday work tool that is commonly found in many household tasks, for agricultural purposes, or as a weapon. It is a constant companion of Bahnar people and serves to cut paths through rainforest undergrowth, fell small trees and bamboos, or break nuts open. The Bahnar profit from the machete also in numerous bambooworking activities, including (but not limited to) the following: the splitting of bamboo, the cutting of bamboo into strips, the cutting of bamboo branches, or the scraping of bamboo's surface. Due to its triangular cross-section, the machete acts as a wedge to split bamboo lengthwise. The machete and other cultivation tools are, first and foremost, remarkably basic in their construction, but this should not obscure the fact that these tools are essential for carrying out everyday tasks. Besides the machete, other valuable cultivation tools are the ax (*sung*), a top-curved machete (*kăh*) (used particularly for slashing) and other knives, the abovementioned *đing soi* (container for seeds), and a variety of baskets, as well as bamboo containers (Đao et al. 2011, 28–29). As Đao et al. emphasize, despite the simplicity of their tools, the Bahnar people's use of their "cultivation tool kit has proven itself to be very handy and highly efficient" (ibid., 29). Accordingly, new mechanical devices cannot simply replace the traditional equipment of upland rice systems.

Figure 46 Agricultural tools. (*left*) A hoe whose handle and shaft are made from a bamboo rhizome and part of its stem. Most remarkably, the hoe's form and design relate to the bamboo rhizome's natural curved shape. (*right*) A metallic saw blade with fine teeth attached to a bamboo culm and fixed with a bamboo dowel.

Many tools' handles are made using either bamboo stems (see the machete and the knife in Figure 45) or the naturally curved bamboo rhizomes with a remaining part of the culm (see the ax in Figure 45 and the hoe on the left in Figure 46). To protect the machete or the knife and its carrier, split bamboo stems are crafted to fabricate sheaths. For this purpose, a bamboo section is split into two parts, and its edges are smoothened and firmly connected with rattan (sheath making is illustrated in chapter 7.6.1). The right-hand picture in Figure 46 shows a saw blade with fine teeth bought from the shop in Kon B'Rrăp village. As the photograph shows, the blade is attached to a flat bamboo strip and fixed at one end with a bamboo dowel.

7.4.4. The Built Environment

Although I observed many buildings and constructions involving bamboo as a construction material during my field studies, I could not investigate all aspects due to my research limits. While some things have disappeared and are not part of the material culture anymore, some other forms of involvement of bamboo are only observable at a distinct time or another location. Thus, additional descriptions of bamboo by other authors were valuable in this case.

Figure 47 A grass bundle that is collected to renew the thatched roof of the Rông house.

If one walks through a Bahnar village or hamlet, one will inevitably find bamboo as the most significant building material of the human-made architectural environment. Houses, tomb houses, granaries, chicken houses, the community house, and various fences are made using bamboo. In previous times, even "the village was surrounded by a fence made of bamboo spikes and important points were reinforced with spike traps" (ibid., 80) made of bamboo. This comment is in line with the statements of my respondents. For the purpose of control by the authorities, the enclosure of entire villages had already been prohibited by the French authorities in the 1930s (Nguyễn and Nguyễn 2011, 363).

A few decades ago, semi-permanent houses (*hadruơn*) were erected close to the fields, often inhabited by older people to protect the farmland. The *hadruơn* functioned as a kind of watchtower and dwelling, and according to Mr. Ninh, the older people operated them by using bamboo ropes tied to scarecrows, to frighten away birds.

7.4.4.1. Houses: Design, Function, Material Composition, and Construction

Houses are, amongst other things, the most conspicuous part of the built environment. Whereas the houses in Kon B'Rrăp village have already been partly adapted to the Vietnamese house style and erected as ground-floor buildings, some houses—especially those in the hamlet—still are constructed on wooden columns.

Concerning the availability of materials and construction material, my respondents reported that the required materials for house construction were originally taken from the nearby forest. This has also been stated by Đao et al. who write that “the materials for making the house are the available plants around the residential area, including wood for pillars, trusses, staircases, collar beam and sometimes even floor topping; bamboo for purlin, ridge beam, girder, wattle, and floor; reed for the roof; rattan strings and lianas for connecting the beams” (2011, 85). Thus, the surrounding environment provides all materials required for the traditional bamboo stilt house’s construction. But as a consequence of deforestation, the essential trees needed for the production of the wooden columns, staircases, or collar beams have become rare. One can say that the residential house is a forest product and an organic house on account of its vegetal composition. In view of this fact, an abandoned bamboo house, as shown in Figure 49, is recaptured by nature and disappears after a time as a result of natural decomposition.

Figure 48 Two bamboo stilt houses built between Kon B’Rrăp village and the hamlet. Both houses rest on wooden pillars and are erected on flattened ground. The house in the background has an additional small room serving as an entrance.

One common feature that all houses outside the village share is their proximity to a bamboo grove and a stream. While the Bahnar people’s ancestors planted one desired or multiple bamboo species in a place where they wanted to build a residential house, their successors chose the place to build a house according to the proximity to a bamboo grove. This proximity is crucial because the bamboo grove offers a continuous material supply without the necessity to walk long distances to collect bamboo. As a result, people spend less time and labor collecting bamboo. While bamboo is cultivated close to residential houses, rattan cannot be planted or cultivated and is still gathered in the forest.

According to Mr. Ninh, houses are built before the rainy season starts. One very trivial reason is that every activity is more comfortable when it does not rain. Another reason is the supply of materials and their seasonal quality. Grasses are needed for thatching the roof of houses, granaries, tomb houses, or the Rông house. And grasses are considered best before the rainy season begins and harvested around March when the grass is not too old or too dry and does not break easily. Depending on the thickness of the thatched roof, it can last up to eight years. The bundle of grass in Figure 47 is firmly lashed using bamboo strips, and in the same photograph, one can also see the two carrying straps (left and right of the grass bundle), which are made of bamboo and are used as lashes. In both cases, the strips and lashes are made using young bamboos because of their flexibility. Old and mature bamboo would be less flexible, would break, and be less comfortable to carry.

Figure 49 An abandoned stilt house situated close to the hamlet waiting to be reclaimed by nature. The grate is still hanging over the fireplace. The bamboo walls and the thatched roof have been removed and utilized for other purposes.

Stilt houses are typical on the mountain slopes in the Central Highlands but equally in many Asian countries like Thailand, Laos, Cambodia, or Myanmar. The stilt houses of the Bahnar are represented in Figure 33 and Figure 48. In general, vernacular buildings and their design reflect indigenous know-how and dexterity and are well adapted to the environment. The adaptation of stilt houses to the surrounding environment, their architectural utility, and the connections of the architectural design to the way its residents live with and in it are represented by the following interwoven associations (which are again discussed in more detail and from ANT's perspective in chapter 7.6.3.2): First of all, the stilt houses always have a certain distance between the

Figure 50 Wickerwork as part of house construction. (*left*) A typical pattern of bamboo wickerwork which is found in house walls that employ *hgơr* bamboo. (*right*) The open hearth in a Bahnar house symbolizes the continuity of life and gives warmth. Its smoke also protects against mosquitos and serves to preserve food or cure bamboo strips when put on the bamboo grate hanging over the fire.

ground and the house floor so that the rainwater flows underneath the house, and the living space stays dry. Second, the stilt house is well adjusted to the ground's unevenness due to the design of its stilts. Third, dirt and food remains simply fall down through the tiny holes in the bamboo floor. This feature is beneficial from a hygienic point of view, and, in addition, chickens will eat and recycle the leftovers. Fourth, since each Bahnar house has an open hearth and no smoke chamber or chimney, it produces high amounts of smoke that decrease the air's oxygen content. However, the stilt house design allows fresh air to circulate from underneath the floor and provides the room with fresh air while the smoke diffuses outwards through the small vents in the thatch roof or walls. Simultaneously, the smoke functions as a natural defense against insects like mosquitoes. The photograph on the left in Figure 50 shows a residential house's bamboo wall and illustrates the loose design that allows air to pass through. And in the right-hand photograph in the same figure, one can see the open fire in a Bahnar house and how the sunlight indicates the vents in the walls.

The open hearths in Bahnar houses are used to prepare food and provide warmth and have a symbolic meaning besides their practical purpose. The hearth is not only the heart of a house, around which its residents and guests gather, as shown in Figure 50; keeping the fire burning symbolizes, for the Bahnar people, the continuity of life itself. The hearth is generally placed on the floor, enabling people to cook sitting close to it, and its fire is fanned using a bamboo pipe as a blowpipe. A bamboo grate (*claie*) (see Figure 50 or Figure 49) is suspended directly above the fireplace. It is intended to store various things in order to dry, smoke, and preserve them. On this grid stands a bamboo basket with large meshes to allow the smoke from the fire to circulate through it; it is occasionally filled with bamboo shoots, skin, meat, or with strips of *sơmluh* as I observed in the patriarch's house. As a result of the rising smoke, the bamboo shoots and the meat get smoke-dried and preserved, and the *sơmluh* strips get cured to achieve better resistance against insect infestation. This feature is particularly desired when *sơmluh* is woven into valuable baskets, including special baskets carried on the back.

The traditional bamboo stilt houses are generally intended to be built for a specific time only. Formerly, a house was abandoned when the surrounding agricultural areas' capacities were exhausted, and people moved to a new mountain slope and built their houses again. Nowadays, many ground-floor houses in Kon B'Rrăp village, for instance, were built to last for an indefinite period, vividly expressed by the use of long-lasting concrete instead of nondurable bamboo for floor production. As mentioned before, the construction of permanent houses is accompanied by the establishment of permanent agriculture and vice versa. Using non-organic materials and industrially fabricated materials such as bricks and corrugated sheet metal modifies the style and function of houses. Currently, roofs are covered with corrugated sheet metal, which does not require regular repair compared to a thatched roof and serves as a status symbol, demonstrating that one can afford new materials and participate in modern life.

Longhouses were widespread in many regions of the Central Highlands and are still common among the Ê Đê or M'Nông people. In earlier times, as Đao et al. write, Bahnar people lived in long stilt houses with several rooms for family members, separated by bamboo wattles (Đao et al. 2011, 84–85). As a result of social structure changes and cultural habits, the houses became smaller when families became smaller. This point is also confirmed by Nguyễn and Nguyễn (2011, 309) who state, that in comparison to Gia Rai people, the Bahnar already had small houses and families in the 1930s and that each married couple had its own house. The Bahnar houses I was able to inspect only a single room and occasionally a second smaller one as a separate place to store tools and other materials.

Figure 51 Industrially manufactured materials in house construction. (*left*) The patriarch's house with tiled roofs and wooden walls (on the left) and a neighboring house built using concrete, bricks, and a wooden truss (on the right). (*right*) A residential house between Kon B'Rrăp village and the hamlet, whose roof is made with corrugated sheet metal and simultaneously covered with grass. Its wall is made of wood, and plastic pipes are stored under the house. Underneath its floor is an animal enclosure made of bamboo halves.

Unfortunately, I could not witness a Bahnar stilt house construction for lack of time. But I had the opportunity to attend and help with a roof covering of a bamboo house in the north of Vientiane (Laos) and together with local people renewed a bamboo floor in Pù Luông in Thanh Hoá province (Vietnam). I do not intend to suggest that the work sequence, the working method, and the materials employed are identical for all bamboo stilt houses. There are undoubtedly differences, but many aspects in the construction of bamboo houses are similar and follow comparable principles that originate from bamboo usability. In general, the walls of stilt bamboo houses do not bear loads, which affects how houses are constructed. In line with my observation of house construction mentioned above, Đao et al. describe the way the Bahnar build their house: "The roof frame, including truss, sprocket piece or purlin made of bamboo, connected by rattan string, and a reed roof, is assembled on the ground and then raised above the pillar frame. Walls are made of bamboo and fixed with a vertical stile and horizontal bands . . . . The floor is woven from bamboo stems cleaved into halves and battened down" (2011, 86). Interviewing my respondents, they gave the same description of the house construction process. Furthermore, they stated that they used axes and machetes to chop trees and bamboos and to fashion the timber into beams, pillars, or the like. Only recently have tools such as saws, chisels, and planes been introduced (ibid.). Formerly, a group of men carried tree trunks from the forest to the place where the house was to be erected. Currently, motorbikes are deployed to pull tree trunks out of the forest, and the noise of chainsaws constantly reverberates from the forest to the hamlets.

As explained above, there have been further gradual changes in house building. As illustrated by the photograph on the right in Figure 51, the roof cover is made of corrugated metal sheets and additionally covered with grass. The same photograph also shows the use and introduction of plastic pipes, indicated by a green tube (left of the entrance) and a grey tube (underneath the house and next to the motorbike). This aspect is interesting inasmuch as, in the background of the house, there are two huge bamboo clumps that could have served the same purpose. The houses in Kon B'Rrăp village depicted in the photograph on the left in Figure 51 also bear witness to the transition of house building. Neither house is made of bamboo and thatch. The house in the left part of the picture (the patriarch's house) is still a stilt house having an open fire inside and a bamboo floor but with a tiled roof and wooden walls. The house on the right, in contrast, has a concrete foundation and is built of porotherm style clay block bricks and has two floors and a wooden roof truss.

House construction is a matter that involves all family members. Before the actual project begins, materials are selected, gathered, and brought together to the place where the house should be erected. Answering my question of how long the building phase lasts, Mr. Ninh stated that five men build an entire house in around five to six days. But it takes about one to two months to find and collect the appropriate construction materials and prefabricate them before the construction starts.

With respect to labor division, Đao et al. point out that men collect wood and bamboo, whereas women and children collect reeds; and that house construction strengthens the family ties and solidarity among relatives (ibid., 88). The house of Mr. Ninh (see Figure 33 on the right) was built in 2011, and according to Mr. Ninh, a bamboo stilt house's average life span reaches up to ten years. During that time, the floor, walls, roof construction, or the thatched roof can be repaired and rebuilt when necessary, yet the wooden poles cannot be replaced for two reasons. First, they carry the weight of the house and are joined to the cross beams. Second, they are firmly dug into the ground and cannot be removed without causing damage to the entire structure. As Mr. Ninh stated in 2018, one wooden pole of his house has already been damaged by insects, which is why he wanted to build a new house in the next two years. Figure 52 shows four *pơo* culms that were split and flattened and left to dry in the open air. Afterward, when the culms have lost their moisture content, they are crafted into a floor. The same figure also shows industrially produced wooden beams, only recently brought to the hamlet and required for a later house building.

Figure 52 A flattened *pơo* bamboo left drying in the open air. After drying, it will be utilized to repair the floor of the Ninh family's house. The bamboo is flattened while it is young and soft; after drying, it changes color from green to yellow.

Besides the house architecture's external modification, the concept of the household and livelihood has changed remarkably. While only a few decades ago, Bahnar families produced their tools and goods on the basis of a nature-based economy for self-sufficiency, their agricultural production is, nowadays, to some extent, bound to the market economy. While the household was a self-contained unit of production and only a few goods were bartered, today, Bahnar villagers have switched to permanent agriculture and cash-crops. While fewer things are produced by Bahnar villagers themselves and purchased in the market or the village shop, agricultural products are produced for monetary income. Accordingly, households have become part of an interregional capitalist agricultural production.

7.4.4.2. Tomb Houses

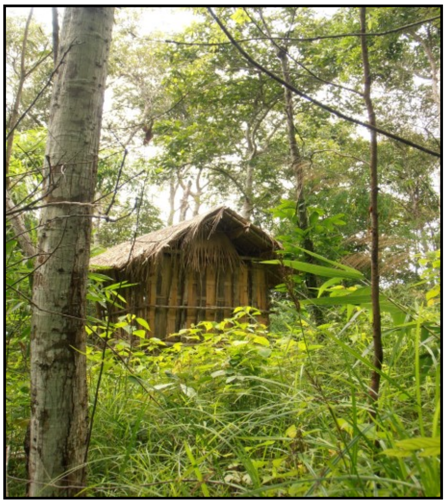

Figure 53 A Bahnar tomb house in the undergrowth of the dense rainforest.

When a Bahnar person dies, her/his body is buried in a hollow tree trunk. The day after the funeral, the relatives build a stilt house of similar structure as ordinary houses and surround the grave with a bamboo fence (ibid., 74). The tomb house's function is to provide the deceased with shelter and protect her/him from rain and sun (Nguyễn and Nguyễn 2011, 346). As illustrated in Figure 53, the tomb house's thatched roof is made of palm leaves and its roof structure with bamboo stems. Out of respect for the dead, I kept a certain distance from the tomb house, yet I could see that the floor rests on four wooden columns. And as seen in the photograph, its walls are made of bamboo wattlework. By and large, the tomb house resembles the granaries (see next subchapter) in its size and physical appearance.

The Bahnar believe that deceased persons still exist and live as ghosts. It is, therefore, the duty of the family to provide food for their loved ones. In order to offer food, a connection is made from above to the subterranean coffin. Nguyễn and Nguyễn (ibid., 424–425) account that at the head of the grave, a bamboo tube is pushed down to the lid of the coffin, and afterward, meals can be put into it so that the ghost of the deceased would find food when it returns to the tomb. Not only food but smoke is also offered in a similar way. Mourners at the grave smoke the deceased's pipe and puff the smoke through the bamboo tube so that the dead can enjoy its smoke too (Lavalée 1901, 307). In this context, the ritual called *mut kiak* is also of interest. As described by Nguyễn and Nguyễn (2011, 424–425), after five to seven months or even years after the funeral, the relatives will honor the deceased for the last time. After performing the ceremony, the tomb house will be abandoned and no more visited. Hence, since the tomb house and the surrounding fence are made of organic materials, its components will decompose, and the tomb house will be reclaimed by nature without leaving any trace—just like the abandoned bamboo stilt house mentioned before.

7.4.4.3. Granaries

Figure 54 The granary of Kon B'Rrăp village's patriarch. This granary is an example of hybridity because non-traditional materials (including sheet metal, concrete, and metal nails) are employed with traditional materials (such as wood, bamboo, or rattan).

Bahnar people keep a continually burning fire in their houses, and one moment of carelessness can easily lead to a house fire. That is why staple foods are not stored in a residential house. For this reason, the Bahnar build granaries (*h'nam ba*) in which the yield is carefully stored after the rice harvest. Each family has an independent granary in order to supply themselves with rice throughout the year. The granaries resemble the tomb house and residential house in their basic construction, only with a small veranda. The rice granary was traditionally constructed on wooden and/or bamboo poles, and its floor, roof construction, walls, and entrance are made of bamboo.

However, new materials are increasingly used, as most vividly expressed by the material components of granaries in Kon B'Rrăp village. As the patriarch's granary design illustrated in Figure 54 indicates, the depicted granaries' wooden poles rest on a concrete foundation and are wrapped by sheet metal. The concrete foundation reduces the decomposition of the wooden pole by reason of lower exposure to rainwater. The sheet metal, in turn, prevents rats and mice from climbing up and infesting the granary. Another little novelty is the integration of a metal nail to fasten the horizontal wooden beams. The use of concrete, sheet metal, and metal nails illustrate to what extent industrially produced building materials are combined with traditional construction methods. Although the traditional rice granary design is still preserved, new materials directly impact the design of granaries. According to the village patriarch, in Kon B'Rrăp village, each granary has to be rebuilt in about five to six years. Subtropical insolation, rainwater, strong monsoon winds, and insect infestation gradually ruin the granary, but once the required materials are collected, a new granary is built in about one or two days.

As my respondents explained, granaries were originally erected some distance from the village and hamlets to prevent them from catching fire if adjacent houses caught fire. In Kon

B’Rrăp village, some granaries are built in the courtyard of houses, and in the hamlets, granaries are also erected at less distance from the houses.

Figure 55 New tools used in the construction of traditional granaries. (*left*) The same granary as the one discussed above in Figure 54. A hammock is attached to its pillars, so one could benefit from the granary’s shade while relaxing. (*right*) A granary close to the hamlet. A wooden fence surrounds it, and its door is padlocked.

7.4.4.4. Rông Community Halls

As already mentioned above, the village plays a crucial role in the life of the Bahnar in terms of social and cultural life. The community spirit and community life are maintained in many villages and expressed by the Rông community house. This point is stated by Hữu Ngọc Nguyễn, amongst others, who writes “that the most characteristic cultural identity of the people of the Central Highlands has taken a very distinctive material form, namely the Rông community hall” (2007, 39). The Rông houses, as shown in Figure 56 and Figure 57, are of impressive size. One can recognize the house already from far distances. Its top is up to twenty meters high, and its length can be up to twenty-five meters. Like the traditional residential stilt houses of the Bahnar people, the Rông hall is built on wooden poles, but with far stronger supports. Depending on the Rông house’s size, it can accommodate between 40 to 150 people. The floor area and style of the halls may be rectangular, quadratic, or semicircular. The Rông community hall of the Bahnar people in Kon B’Rrăp village has a long corridor (see Figure 56).

Figure 56 The Rông community house in Kon B'Rrăp village. The surrounding soil has already been sealed with concrete, and concrete is also used in the construction of the side entrance.

The Rông house is built collectively by the villagers themselves and is considered the *soul* of a village and is the cultural center required for communal life activities (ibid., 40). Nguyễn and Lưu (2007, 78) describe the construction of a Rông community hall with reference to the division of labor. They state that the whole male part of the village is engaged in the phase of design. About fifty men construct the hall, none of them a professional architect or carpenter. Each person carries out a task, and various activities are allocated according to age. While the young men do more laborious tasks, like putting up the roof, older men stay on the ground and are occupied with splitting rattan.

Since the thatched roof is exposed to the subtropical sun and monsoon rain and winds throughout the year, long wooden beams are fixed transversely to reinforce the roof against strong winds that occur especially during the rainy season. The roof has to be renewed partly or totally at regular intervals. In 2012, for instance, the Rông house's roof in Kon B'Rrăp village was in good condition, but six years later, parts of it had to be renewed. For this purpose, women gather the necessary grasses mentioned above, while the male members of the community collect bamboo, timber, rattan and repair the roof.

Bamboo is not only required for the roof, the floor, and the walls; it also is an irreplaceable material as a scaffold during the construction or repair work on the Rông house. Figure 58 (right-hand photograph) displays a bamboo scaffold erected in Kon K'ri village close to Kon Tum. To construct a scaffold, men collect bamboo tubes from wild or cultivated bamboo groves in the surrounding area. Two or three bamboos of about eight to ten meters can be attached vertically to reach from the bottom to the top, and bamboos of lesser length are tied horizontally. The scaffold encompasses the whole hall and covers the tremendous roof. It enables the architects and builders to thatch the roof and the top of the hall. After finishing the hall, the bamboo scaffold is removed and used for other purposes.

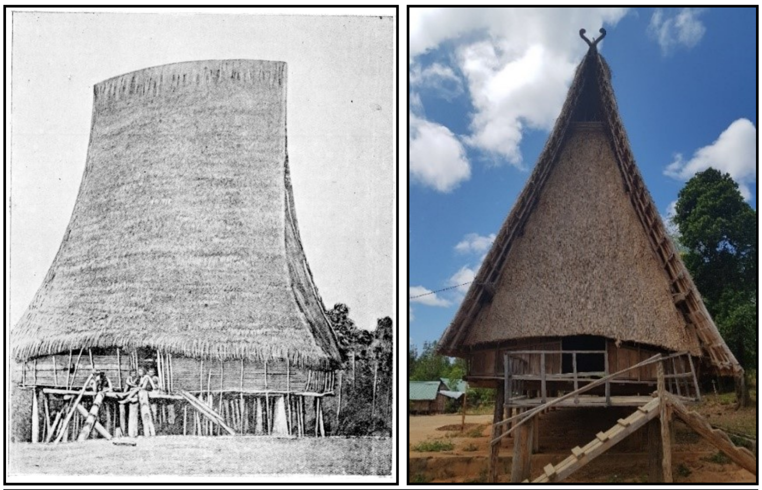

Figure 57 Rông community houses past and present. (*left*) Photograph of a Bahnar Rông house taken during an expedition in the Central Highlands by M. A. Lavallée (1901). (*right*) A contemporary Rông house in Tân Lập commune, Kon Rẫy District.

Today, the Rông community halls remain widespread in the Central Highlands and common "among the Bahnar, Brâu, Cotu, Jarai, Je-Trieng, Romam and Sedang people of the provinces of Gia Lai, Kon Tum, Quảng Nam and Thừa Thiên-Huế" (Nguyễn and Lưu 2007, 34). In many cases, each individual ethnic group has some specific ideas relating to the design of the Rông community hall's top. For that reason, ornamental bamboo wattles are embedded into the upper and lower part of the roof and colored either using natural or industrial colors. However, in the past few decades, many Rông houses have disappeared, and at the same time, their design and cultural function have changed over time. In 2018, for instance, I observed during a visit to Nhà thờ Kon—a village five kilometers from Kon Tum—that the newly built Rông house had, in addition to the typical indigenous patterns, a crucifix on the top of its roof. It was unexpected for me at first, but as there is also a church in the village, it appears less surprising in retrospect.

An unsolved and much-discussed characteristic of the Rông house's roof is the ax-shaped roof design. According to my respondents, the colossal roof should symbolize a ship's sail. A symbol that should remind the Bahnar people that they came by ship to Vietnam and that they originate from overseas.

Regarding the material cultures of ethnic groups in the Central Highlands, the outstanding Rông community hall represents, amongst other constructions, the traditional architecture and handicraft skills of highland groups living in that region. Like the residential houses, the Rông house is a forest product in the sense that the forest provides all the required raw materials to build it. Lưu describes its material composition and the required tools and techniques, as follows:

> The Rông community hall was traditionally built entirely from materials found in the forest (wood, bamboo, forest string, rattan, thatch, palm leaf, etc.). Multi-purpose tools were used (axe, machete, knife). Construction techniques were simple (mostly by joining edges or using prop steps, threading through holes on top of pillars, in combination with tying, creating pulley systems and supporting pillars with cord; more sophisticated joining techniques such as mortise, etc. were unknown). There were no metal materials, and the only machine was the physical strength of the people. (Lưu 2007, 48)

The photographs on the left and in the middle in Figure 58 exemplify the roof structure and wooden supporting system of Rông houses. Around Kon Tum, I observed many new Rông community houses built using concrete for the pillars instead of tree trunks, corrugated sheet metal instead of thatched roofs, or reinforced concrete foundations (as shown in the photograph on the right in Figure 58) instead of natural soil. The involvement of new materials is partly caused due to the extinction of forests and the loss of plant materials and appropriate trees. And it is partly due to the financial support of government projects which encourage the purchase of industrially produced materials. Not to mention, a change in architectural style also affects the lives of those who build and use these buildings. Consequently, "new economic, social, and cultural conditions," as Lưu puts it, "brought many changes in the lifestyles, thinking and consciousness of the people, and in the village" (ibid., 53).

Figure 58 The roof construction of a Rông house and a scaffold needed for Rông house construction. The left and middle pictures are taken from the Rông house shown in the photograph on the right in Figure 57. The left picture shows Nguyễn Ngọc with children playing in the Rông house. It also illustrates the main pillars and the supporting vertical beams of the roof structure. The picture in the middle exemplifies how wooden poles reinforce the roof structure. The picture on the right illustrates a Rông house in Kon K'ri village under construction. Its pillars and vertical beams have already been erected, and the scaffold is attached to it.

7.4.5. Traditional Handicrafts

In the past, the Bahnar people's economy, livelihood, or agricultural methods were almost entirely based on their indigenous knowledge, techniques, skill, and available resources. As described above, their material culture has undergone a considerable transformation. Currently, the traditional Bahnar villagers' and swiddeners' material culture is still changing, and Bahnar people's knowledge, although still preserved in many aspects, is losing its initial status and signification. In the same manner, Bahnar people's traditional handicrafts are changing. In all probability, as a result of access to and purchase of industrially produced consumer goods and tools, the Bahnar will most likely experience a further decline or transformation of much of their material culture over the next few years. Needless to say, since all aspects of life are connected to each other, a minor or major change in one aspect of life entails a change in another. Thus, changes in the material culture accompany changes in people's very lives. In chapter 7.6.3.2, I shall discuss in more detail the interconnection of various entities with the example of how the replacement of the traditional thatched roof with corrugated galvanized steel affects the residents' lives.

The former significance of traditional handicrafts has already been lost, and due to new cheap goods and tools, traditional handicrafts will continue to change drastically. However, some handicrafts are still practiced, and some handmade objects are still essential for a variety of daily activities and agricultural work. A significant part of these objects and tools are made from bamboo.

As the word *hand* in handicrafts implies, the latter is considered as an activity in which objects, things, artifacts, or tools are made mainly by a craftsperson's bodily involvement in the production of things, but most of all, by using one's hands. In turn, the making is related to personal skills (transmitted from generation to generation) and experience. Moreover, the traditional handicrafts of Bahnar are geared to a labor division relating to gender, age, and their underlying economy. Đao et al. mention that "labor division by gender is observed strictly. Women are responsible for housewife work, weaving, educating children, and other tasks such as sowing, weeding, harvesting, gathering, fishing, and occasionally hunting. Men are responsible for hard work such as slashing farmland, building houses, making tools, hunting and weaving" (Đao et al. 2011, 61). According to Guilleminet (1952, 468–469), it is mainly the men who produce tools, traps, wickerwork products, all kinds of containers (to store water, salt, tobacco, or the like), pipes, or bottles made of gourd. He further mentions that everything taken together gives the impression that the house is a workshop. Indeed, the residential house is not only suitable for living in, but a place in which things for daily use are made or repaired.

Although activities are divided between men and women, both partners are equally keen to earn a living. Defining what is hard work may not always be clear. One morning, to give only one illustrative example of the physical requirements needed for daily activities, Mrs. Nhin went to the forest to chop a banana plant. Besides carrying her bamboo pannier full of leaves, she carried a banana trunk on her shoulder all the way from the hills of the forests on narrow paths to the hamlet. After coming home, she cut the trunk into small slices to feed the domesticated pigs (see Figure 59). In this case, the physical requirements needed should not be underestimated, for the banana tree has a heavy weight due to its high water content. Although Guilleminet and Đao's comments on labor division are mostly correct, some women do men's tasks. In particular, older women know how to operate the machete skillfully, split bamboo and rattan, and weave baskets.

Figure 59 Mrs. Ninh is cutting a banana trunk to feed pigs and chicken. The traditional basket carried on the back is presented on the left side, and the neighbor's house is behind the bamboo fence in the background of the picture.

The traditional handicrafts of the Bahnar can be classified by the required materials, which are bamboo and rattan for basketry, cotton for weaving, clay for pottery, and iron for forging. While basketry, weaving, and pottery were part of all households, forging was mastered by only a few people. Since every village had only one blacksmith with unique training and equipment, his tasks included repairing defective agricultural tools, household equipment, or weapons for him and his village (Đao et al. 2011, 36). If no blacksmith lived in one's village, as my respondents explained, Bahnar people tended to barter manufactured metal goods (machetes and other cultivation tools as well as gongs). In the present, on account of monetary income relating to cash-crop and access to markets, the blacksmith's activities are hardly or not at all needed—a fate that cotton weaving and pottery likewise share. As Mrs. Ninh described, the Bahnar tended to plant cotton until the recent past, and women were engaged in weaving clothes. At present, however, both cheap cotton and second-hand clothes are sold and easily purchased in Kon Tum. Nevertheless, during the night, Mrs. Ninh span purchased cotton using a wooden spinning wheel.

Figure 60 Bamboo wickerwork and baskets. (*above*) A typical bamboo mat that serves many purposes. (*below*) Two flat baskets and the traditional backpack in which a tarp has been put.

Amongst the traditional handicrafts, basketry, although it has lost its former popularity, is the most widespread handicraft in current times. Basket weaving takes mainly place in the *leisure months* and again in early summer—a period in which I did no fieldwork. In this context, I refer to the description of other authors and my respondents. Like many other tasks, basketry work is divided according to gender. It is the man who weaves the baskets and whose duty is to improve his skills over years of experience to become a master in basketry (ibid., 33). And to this day, bamboo and rattan are irreplaceable and invaluable raw materials for basketry. While bamboo culms are either obtained from the forest or bamboo groves close to the village or hamlet, rattan can only be collected in the forest. For basket weaving, the Bahnar prefer *sơmluh*, which they collect around nine months after shoots emerge the first time. At that time, the culms are green and young, as when bamboos get old and dry, they lose moisture and become less flexible, and tend to break when weaving. Baskets made of *sơmluh*, especially when their prefabricated bamboo strips were cured over the hearth, are much more resistant to the subtropical weather conditions or insects and considered more valuable than baskets made of other species.

For centuries, bamboo baskets of various kinds were of particular value for daily activities. In recent times, however, the knowledge and production of bamboo basketry have been decreasing for several reasons: deforestation and the diminishing of bamboo groves and rattan (required as the essential weaving materials), the introduction and distribution of inexpensive mass goods and products (ibid., 159) replacing bamboo baskets, as well as the lack of interest by young people.

The replacement of the bamboo pannier with polypropylene bags or bamboo mats with tarpaulin are only two vivid examples of the change of material aspects of Bahnar life. Figure 59 shows Mrs. Ninh sitting on a tarpaulin and cutting a banana trunk. Before the introduction of tarpaulin, as she noted, she chose bamboo mats to cut and dry vegetables on. Such a bamboo mat is illustrated in the above picture in Figure 60. These kinds of mats are made by flattening bamboo sections and removing the nodes using a hoe or adze. After that, the flattened pieces are sorted first lengthwise, and then horizontal pieces are woven in. Later the mat is used in such a way that the smooth outer skin points up while the rougher inner part points down to provide more comfort when sitting on it.

Figure 61 Various bamboo baskets. Baskets are an important part of Bahnar material culture, and various bamboo baskets are required for multiple purposes. The picture on the right shows a knife with a short handle (shown in the middle of Figure 45) whose blade is covered with a bamboo sheath. The knife is used to split thin strips from bamboo laths required for further works (such as the fish trap), and the shavings are kept in the basket lying on the ground and later used for chicken nests.

Panniers are one of the most important basketry products, and there are various panniers for various purposes in different sizes and styles. People generally use them to carry loads on their way from the farmland to their houses. Or else during their excursion through the rainforest. These panniers adapt very well to the body of the person wearing them and are well suited for hiking in the rainforest. Đao et al. enumerate traditional Bahnar panniers and write that there are "big backpack baskets [panniers] for storing rice (*reng p'roong, hgum proong*), small baskets used when doing activities such as plucking rice off ears, sowing or going to the forest (*h'jác*), and big sparsely-woven backpack baskets for carrying water tubes and firewood (*roh*)" (ibid., 34). Nguyễn and Nguyễn (2011, 442) refer to another kind of pannier (*brong*) that has a lid in order to cover and close the pannier so that it can be used to store clothes. On the grounds of their organic composition (both bamboo and rattan), the panniers' quality decreases after a few years, and they are either repaired or replaced. In recent times, a tarpaulin is frequently chosen to cover the pannier and to protect its contents against moisture (see Figure 60). In other cases, woven polypropylene bags (usually needed for packaging agricultural products) replace the traditional pannier. As seen in the lower picture in Figure 60, Mr. Ninh packed and carried one

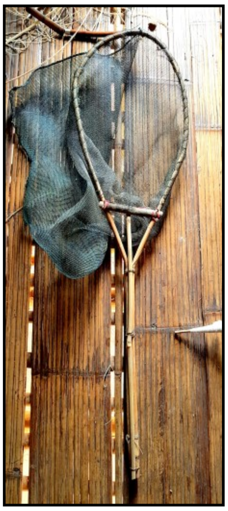

Figure 62 Hand net for fishing. The handle and frame are made from bamboo, the net of a polymer.

polypropylene bag through the forest to the village instead of the traditional pannier to take advantage of its water-resistance.

Bamboo and rattan also play a significant role in the production of other woven objects, as demonstrated by "big and small flat baskets (*k'đong* and *k'đung*), grain sieves (*sêng*), fish traps (*pam lao*), tools for animal husbandry such as the chicken bamboo cages (*đrung*) or bamboo screens (*t'măn*)" (Đao et al. 2011, 34). Figure 61 shows various circular bamboo baskets Mr. Ninh had made. The circular basket on the left in Figure 61 is required for winnowing the rice chaff. The flat, circular basket with a low rim shown in the middle and on the right in Figure 61 is commonly used as a plate on which various dishes are prepared and served for drying grain in the sun.

7.4.6. Food, Hunting and Fishing, and Animal Husbandry

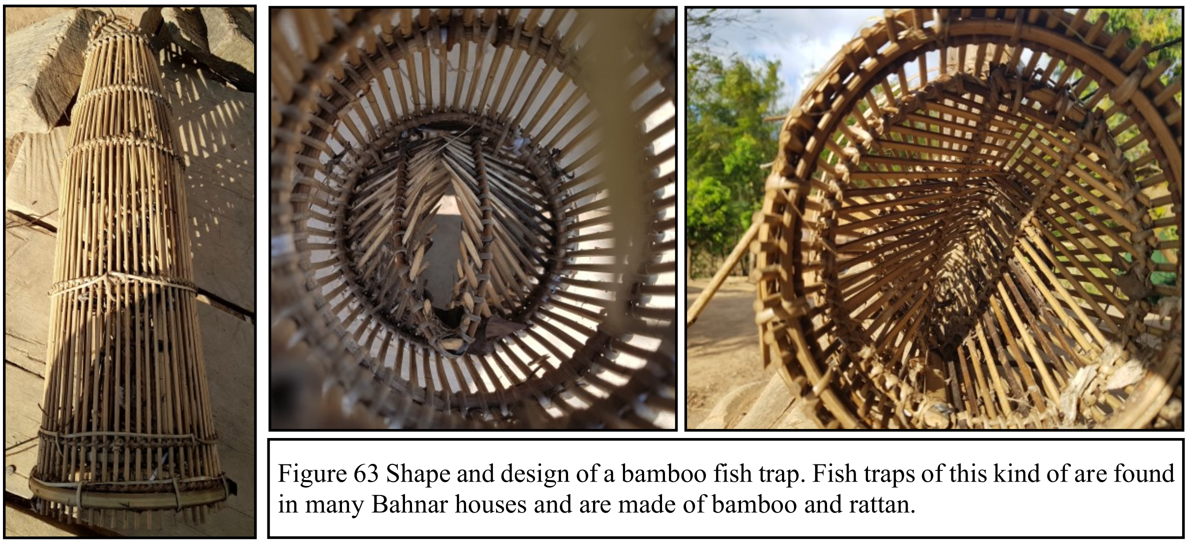

Figure 63 Shape and design of a bamboo fish trap. Fish traps of this kind of are found in many Bahnar houses and are made of bamboo and rattan.

Indigenous people in East and Southeast Asian countries and throughout the Central Highlands have developed numerous hunting and fishing traps and techniques. The general purpose of these tools and techniques is to capture either aquatic animals (e.g., fishes, eagles, or crabs) or terrestrial animals (mammals such as pigs, rats, weasels, and tigers or vertebrates such as birds or frogs). For the Bahnar and other highlanders, hunting and fishing is a vital source of food alongside their agricultural food production. A variety of deadfall traps and fishing traps are likely to be found in each Bahnar household. In the past, tigers were respectfully hunted animals. As a consequence of deforestation and decreasing biodiversity, many wild animals' habitats are severely under threat. However, this is not a development of the last few decades. In the later nineteenth century, the dense forest was home to many wild animals, making hunting convenient, while already in the 1930s, the surrounding environment had changed because of forest destruction (Nguyễn and Nguyễn 2011, 323). Mr. Ninh encountered and chased a tiger without success in the late 1980s, but has since then never sighted a tiger again. One common method to hunt large vertebrates like tigers was to dig a pit of four to five meters square, place sharpened bamboo spikes into it, and cover it with twigs and leaves (ibid., 443). If the prey falls into the trap, it will be severely wounded and unable to escape. A similar pit, but with only one meter of depth, is still found for hunting wild pigs.

There are numerous ways of fishing practiced by Bahnar people. Apart from fishing exclusively with their hands, the Bahnar frequently do this by deploying "baskets, creel, nets with dead snails, termites, worms, or barley grains as lures or blocking a spring and using fishing traps" (Đao et al. 2011, 41). Figure 62 shows a hand net for fishing. It has an elliptical shape and a funnel-shaped net attached to it. While the frame and handle are made of bamboo, the funnel-shaped net is made of nylon. The hand net is commonly chosen for shallow waters or at the margins of streams and is immersed up to a depth of 50 cm.

Figure 63 illustrates a fishing trap made of bamboo splits and rattan strips, which is also used in the shallow water of streams. It has a slightly conical form with a girth maximum at its bottom and tapering at its end. The fish enters at its bottom, passes through a small channel, and gets trapped due to the bamboo spikes (seen in the middle of Figure 63) that hinder the fish from escaping. The trapped fish, then, is removed by untying the lid attached to its end.

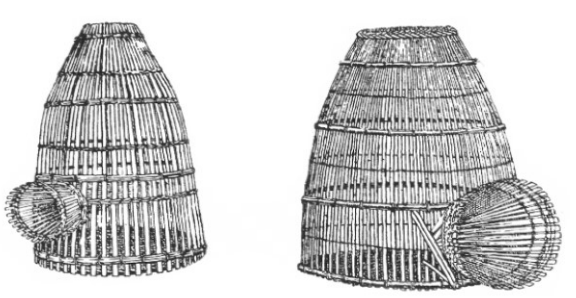

Figure 64 Two fishing traps similar to those of the Bahnar. Both fishing traps, (*left*) found in Sumatra and (*right*) in Binh Dinh province (Vietnam), have many similarities in the way they were designed and used. *Source*: Colani 1936, 233

The fishing traps in Figure 64 illustrate two variants of fish traps. The trap on the left is from the northwest coast of Sumatra and the other one in Bình Định province, Vietnam. Both specimens are in the shape of a basket and have a trapdoor on their sides. Colani (1936, 233) discusses the similarities between these two fish traps and states that they resemble each other in style, size, material composition (bamboo) and function in a similar way, even though belonging to different areas. Concerning their basic structure and material composition, these fish traps also resemble the Bahnar's specimen described above. In my view, this similarity is a further indication of how similar products crafted from bamboo are created in different regions.

Occasionally, during fishing or for other reasons, the Bahnar had to cross large rivers. In former times, Bahnar people living in the mountains had no specific vessels, but, as Guilleminet states (1952, 403), held on to large bamboo culm sections and benefited from bamboo's buoyancy.

Bamboo is also essential for bird trapping and the construction of bird traps. The bird trap shown on the right in Figure 65 is a kind of clap trap. Its frame is made of bamboo stems that are fixed with rattan strips. The clap trap's *cage* was originally made of bamboo but is nowadays replaced with chicken wire. It functions as follows: The clap trap is set on the ground close to places birds frequently visit, such as brooks. The rice grain seeds are distributed around it to lure birds. The moment the prey enters the cage, it triggers a spring mechanism that causes the trap to shut. In this way, the bird is captured but not harmed.

Figure 65 Various traps. (*left*) The deadfall trap is made from *sơm luh* and *pơo* bamboo and wire. It is used to catch weasels and rats. (*middle*) The deadfall trap is made from bamboo and bamboo strips and used to catch mice and rats. (*right*) The bird trap has a bamboo frame and is wrapped with chicken wire.

As explained earlier, Bahnar men surround their farmland with sometimes up to thirty or sixty traps. As shown in Figure 134 (on the left and in the middle), these traps are made of bamboo and rattan. While the deadfall trap (left picture in Figure 65), used to catch rats and weasels, has additional iron wires, the mice trap (in the middle in Figure 65) is made without industrially fabricated materials. Both trap variants are usually set during the daytime and remain in place overnight. The following morning the trapper will go around and check whether he has caught any animals or not. He will reset some or repair the damaged ones. Hence, besides protecting farmland and granaries from harmful animals, trapping animals also provides an additional food source.

Besides the flesh of animals as a food source, Bahnar women collect mushrooms, wild plants, roots, fruits, vegetables, and bamboo shoots. The latter are eaten with great pleasure and are considered beneficial to health. The bamboo shoot is crunchy in texture, has a unique flavor, and is often compared by Westerners to asparagus. The harvest of bamboo shoots depends on the season and growth of a bamboo species; not every bamboo shoot is digestible and tasty.

The Bahnar know exactly which bamboo species to collect at what time. Since freshly harvested bamboo shoots contain toxic hydrocyanic acid, bamboo shoots must be cooked before eating to remove the toxin and bitter flavor. Figure 68 shows a Bahnar family that Mr. Ninh, Mr. Ngọc, and I met by chance during a trip into the forest in July 2012. Using a machete, we dug up the young shoots from the bamboo clump seen in the background. The same picture also shows Mr. Ninh using a rattan strip to skew bamboo shoots which he collected to cook them when home, while the rest was intended to be pickled and stored for months. Đao et al. depict how Bahnar people preserve bamboo shoots: “Old bamboo shoots gathered at the end of harvest are diced, boiled and dried in the sun. Then they are kept with banana leaves in baskets and put on the kitchen trellis for later consumption. When they are ready for consumption, bamboo shoots are steeped in water for two days, then boiled carefully before being cooked with meat, fish and salt” (2011, 104).

Figure 66 Sticky rice cooked in bamboo containers and served in a bamboo basket.

Bamboo enriches Bahnar cuisine and is also crafted into cooking pots to prepare glutinous rice. In this case, a culm piece’s nodes, except for the one at the bottom, are broken through. Then, glutinous rice is stuffed in, water is poured in, and afterward, it is roasted over embers, with a split-off bamboo bark serving as tongs to rotate the cooking pot. Green fresh bamboo culms rather than old and dry bamboo are chosen for this purpose because the higher moisture content of young culms prevents the culm piece from burning without cooking the inserted meal. Once the food is cooked, the bamboo cooking pot is split into two halves, and the rice is eaten either by hand, with a flat bamboo piece by way of a spatula, or, if desired, served on a banana leaf. In

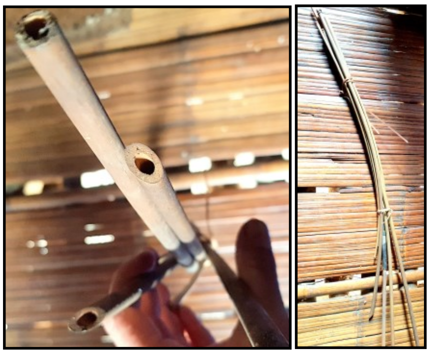

Figure 67 Straws made from pole bamboo. Due to their long internode lengths, these bamboos are typically used to drink wine from jars.

Figure 68 Bamboo shoot harvesting. The picture shows a Bahnar family, Mr. Ninh, and me after harvesting bamboo shoots from the bamboo groves in the background of the picture. For digging out the shoots, we used the machetes, and after pealing off their outer layers, the shoots are skewered by means of a rattan strip.

this way, bamboo shoots and vegetables but also meat are prepared. Figure 136 shows sticky rice prepared in bamboo cooking pots which are served in a bamboo basket.

As my respondents explained, some decades ago, bamboo kitchen tools ranging from scoops, tongs, straws, spatulas, rice paddles to chopsticks were much more common. Today, all these tools have been replaced by industrially produced equivalents. Nevertheless, some bamboo kitchen utensils are still used, as demonstrated by the skimmer in Figure 69, which is required to take out cassava when boiling it in big pots.

Bahnar people make diverse wines using rice, millet, or cassava and drink them from jars through bamboo straws made of *pơle* bamboo (shown in Figure 67). The straws' length depends on the jar's size but is at least 100 to 120 cm and does not require any additional treatment of the bamboo stems. A few decades ago, neither porcelain cups, plastic cups, nor drinking glasses were common, but bamboo cups made of a section of bamboo stems were widespread.

Drinking water often comes from nearby streams. As can be seen on the right in Figure 70, halved bamboo poles are used to adapt the water flow to the human body size. In this way, peasants can wash themselves or fill their bamboo stalks with fresh water. The hamlet inhabitants have placed a stone on the halved cane to ensure that the water flows more evenly.

Figure 69 A bamboo tool that is used as a *skimmer*.

By virtue of its hollow structure, bamboo is a preferred material for creating various containers to store water, oil, food, salt, spices, bamboo shoots, or other things. To this end, a bamboo culm is cut into a section, and all nodes except for its lowest one are removed. The lid is made by the same bamboo-section, or else, the container is covered with banana leaves. In former times, bamboo water containers (*đing nor*) were widespread and chosen to store and transport water but have been replaced by usual plastic bottles (see Figure 70 on the left). As Nguyễn and Nguyễn (2011, 321) report, in the 1930s, bamboo containers were also used by Bahnar people as a non-standardized measure to trade with the Vietnamese. According to them, rice and sorghum were filled into a specific bamboo tube with a diameter of half a palm and the length of a palm.

Figure 70 Bamboo water pipelines. Bamboo is still used to craft water pipelines in the village. (*left*) A plastic water bottle is used instead of a bamboo container. (*right*) A stone is placed upon a halved bamboo to obtain a continuous water flow.

Every household has various domesticated animals, including pigs, goats, and chickens. Livestock is an integral part of swidden agriculture and is an important source of food and essential for ritual animal sacrifices in Bahnar culture. As in other domains, bamboo is also versatile in the built environment related to animal husbandry, used in building the stilt henhouse, animal enclosures, and chicken cages, for instance. Both photographs in Figure 71 show various chicken cages made of bamboo, wood, and rattan. Moreover, fine, thin strips of bamboo, as seen in the upper part of the chicken cage in the left photograph in Figure 71, are frequently used to build a more comfortable nest for the hens.

Figure 71 Chicken cages. (*left*) A *ta drung* (chicken case) made from bamboo strips and wood. (*right*) Chicken searching for food, various chicken cages, and a typical bamboo fence. On the veranda on the left, one can see firewood that is stored. In the background is the granary of the Ninh family, which is surrounded by wire mesh fencing.

7.4.7. Musical Instruments, Game, and Pleasure

The Bahnar culture was, for the most time in history, a non-literal culture. Customs, myths, legends, and Bahnar history were transmitted orally and through music. Still today, a variety of musical instruments enrich the Bahnar culture. Needless to say, just as there is no professional carpenter or architect, there is no professional musician in the sense of modern musicians. Nevertheless, music is an integral part of Bahnar swiddeners' life and accompanies them during everyday practices and ritual ceremonies. When classifying Bahnar musical instruments in terms of material composition, bamboo comes before everything else. In this context, Đao et al. write that "it is clear that most of the Bahnar musical instruments are made of bamboo acquired from nature [while] some also have a combination with a gourd to boost the echo and vibration" (2011, 115). The authors make this statement on the strength of their list and depiction of Bahnar musical instruments, which they divide into four groups: idiophones, aerophones, membranophones, and chordophones (ibid.).[48]

"Bamboo," as Lundström puts it, "is perfectly suited for a variety of musical instruments" (Lundström 2018, 993), and its significance for the construction of musical instruments is evident. Indeed, some musical instruments were originally made of bamboo and can be considered as prototypes in the evolution of some modern musical instruments. Lundström (ibid., 996) states, for instance, that from an evolutionary perspective, brass ensembles evolved from bamboo ensembles. The replacement of bamboo has continued in the present for practical and economic reasons. Theodore C. Grame (1962), who studied ethnic musical instruments, also underlines bamboo's contribution to music in those countries where it grows. He emphasizes that the available material for constructing musical instruments influences and enables the latter's development, and studies them in terms of the technical aspects underlying their creation (Grame 1962, 13). Bamboo's paramount importance as a construction material for a plethora of musical instruments is highlighted by Grame, as follows:

> Of the many materials from which man, in his ingenuity, has fashioned musical instruments, none is more widely used or of greater significance than bamboo; it plays a large role in the cultures of most of the areas where it grows, for it is used as a food as well as a material for all sorts of construction and artisanship. Moreover, it presents unusual possibilities to the investigator because its physical characteristics are so pronounced and so difficult to alter significantly that its influence on the form and shape of man-made objects is easily traced.

[48] Idiophones are instruments, including singing bowls and xylophones, that generate sound by setting the musical instrument's physical body into vibration. Aerophones like brass instruments and flutes generate sound by vibrating air through their bodies. Membranophones, such as drums, produce sound when a stretched membrane is set into vibration. And chordophones, as demonstrated by harps and pianos, generate sound due to the vibration of strings.

> Wood, or metal, or clay are easily shaped; they present but little resistance to the craftsman, but bamboo is very nearly immutable. This very quality—its resistance to change—represents both the strength and the weakness of bamboo, for its physical characteristics allow many instruments to be constructed from it with little effort, while for many others it is almost entirely useless. (ibid., 8)

Figure 72 Ninh family's neighbor playing the *ting ning.*

Grame addresses and illustrates how a musical instrument's production is related to bamboo's physical properties, artisanship, and human ingenuity. It is the interplay of these aspects that relate to the production of bambooic musical instruments. What is also of interest in Grame's description is that bamboo's hollow form prescribes a musical instrument's design. Thus, Grame correctly concludes that bamboo enables certain things and excludes others. Indeed, this is not only true for musical instruments but other tools and devices alike. The sounds made by bamboo relate to bamboo's structure and form as a resonance body. This connection is also elaborated by Lundström, who notes: "Since it is hollow, a simple piece of bamboo emits a sound when bounced on the ground, when struck or when clapping one's hand close to the opening and can be fine-tuned by adjusting in length to the air it contains to get the best resonance" (2018, 992).

The *tơ rưng*, a kind of bamboo xylophone, is an excellent example of the utilization of bamboo's structure to produce sound. It is crafted from bamboo tubes with gradually decreasing lengths tied up with rattan twine. As explained above by Lundström, the pitch level of a bamboo tube is fine-tuned by length adjustment. So, the bamboo xylophone player creates different pitches on the grounds of the different lengths of each resonating body.

Đao et al. enumerate Bahnar musical instruments by classifying them into the four groups mentioned above: To the chordophone group belong the *ting ning* (see Figure 72 and Figure 73), a string instrument with a dried gourd as an additional resonance body attached to the bamboo culm, *goong đe* and *broh* (both similar in design to the *ting ning*). To the aerophone group belong the *lal* (bamboo flute), *avơl* (similar to *lal* but longer), *đinh tút* (panpipe), *klong pút* (an instrument played by clapping at the end of a tube), and *tơ nuôt* (buffalo horn). Membranophones include the small drum *sơ gơr tăng* and the big drum *sơ gơr tih*. The other musical

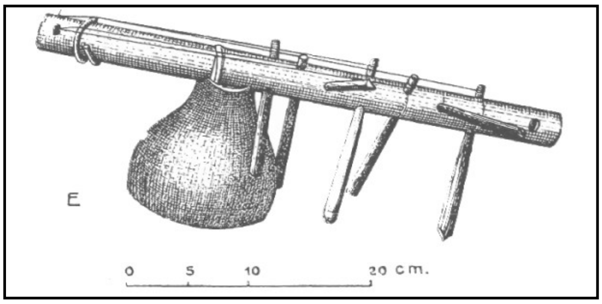

Figure 73 Sketch of a *ting ning*.
Source: Colani 1936, 213

Figure 74 Tobacco pipes.

instruments belong to the idiophone groups such as the *tơ rưng* (known as bamboo xylophone), *chinh chêng* (gong), or *chum chọe* (cymbal). Two other idiophones are operated either by waterpower *khinh khung* (similar to *tơ rưng*) or windpower *chiêng kial* (windchime) (Đao et al. 2011, 110–115; see also Nguyễn and Nguyễn 2011, 449–451).

In sum, the Bahnar use bamboo in the construction of all chordophones, in all aerophones except for the horn (*tơ nuôt*), and all idiophones except for the gong (*chinh chêng*) and the cymbal (*chum chọe*). Moreover, these musical instruments are not only found among the Bahnar; they are crafted and used in a similar way among other ethnic groups in Vietnam and throughout Southeast Asia (Lundström 2018, 993).

As explained above, the specific manner in which musical instruments have evolved and are crafted relates to the physical qualities enrolled in bamboo and are related to human ingenuity, handicraft skills, sense of music, available tools, and materials. In any case, all come together in the very creation of the musical instrument. On the other hand, playing a musical instrument is a practice involving the whole human body and its sensory abilities. It requires the ability to hear, a sense of rhythm, the coordination of hands (e.g., for the bamboo xylophone), or additionally the mouth (for flutes) or even the nose (for nose flutes). Music, if understood as a practice, represents a conflation of humans and materials.

Besides its value for musical instruments, bamboo is also needed to craft stilts for children or design various games. One well-known game is the *dru dra*, which is played by Bahnar people for entertainment and fun and requires four bamboo poles (Guilleminet 1952, 537).[49]

[49] Guilleminet describes two variations of the game, from which I only summarize his first description. *Dru dra* requires eight people divided into two teams and four bamboo poles. Team A positions itself in the form of a rectangle, whereby each member stands in a corner and holds a bamboo cane in each hand. The four players of team B are outside and try to enter the square without being touched by the bamboos maneuvered up and down by the players of team A. If one of the players of team B succeeds in entering, the other three players enter as well and then try to get out. If one of the players of team B is touched by one of the bamboo poles during the escape, one point is lost by team B (Guilleminet 1952, 537).

Moreover, Bahnar men also fabricate tobacco pipes using bamboo’s hollow structure. Figure 74 shows two types of pipes. The one in front is a typical tobacco pipe model, whereas the one in the background was a spontaneous idea of Mr. Ninh.

7.5. Bamboo Culture of Ethnic Mountain Dwellers Other Than the Bahnar

7.5.1. Bamboo’s Use by Sedang and M’Nông Gar in the Central Highlands

Several ethnic groups inhabiting the Central Highlands have many commonalities concerning their material culture, which, in turn, is related to shifting cultivation, the environment, natural resources, climate conditions, as well as to cultural and social aspects, and a shared history. This section will give some very brief examples that describe bamboo’s use by ethnic groups other than the Bahnar, namely the Sedang and M’Nông Gar, by referring to books about these ethnicities.

The Sedang people are one of the numerous neighbors of the Bahnar in Kon Tum province. Just as with the Bahnar, bamboo has been an essential part of traditional Sedang material culture and a significant vegetable source. Vạn (1998), amongst other scholars, illustrates the Sedang people’s material culture in *Les Sedang au Vietnam* (1998).

The M’Nông Gar people, who also live in the Central Highlands but do not live in the same areas the Bahnar, have also developed some similar elements of material culture and bamboo technologies to the Bahnar, as indicated by Condominas’s book *We Have Eaten the Forest* (1977).

Similar to the built environment of the Bahnar, the material basis of the Sedang is structured on the fundamental use of bamboo. Comparing the miscellaneous photographs in Vạn’s book (1998) illustrating everyday objects of Sedang people with my data on the Bahnar people, I found many similarities between these two material cultures and in bamboo use. The Sedang community house resembles that of the Bahnar as, do their tools (machetes, axes, hoes, knives), musical instruments, residential houses, bamboo fences and many other things including traps, bamboo tobacco pipes, bamboo containers, bamboo panniers, or bamboo baskets. Both ethnic groups chose bamboo stems for cooking rice and drink wine using bamboo straws. Moreover, the Sedang also have an open fire in their houses, a similar concept of labor division, animal husbandry, and an egalitarian social structure with the village as its highest institution (see Vạn 1998, 35–75, and his description of the Sedang material culture). Unsurprisingly, Sedang people also exploit bamboo and rattan in the domain of basketry, and almost every everyday object is made from these two materials (ibid., 74).

In contrast to the Bahnar people, however, some Sedang groups have adapted the paddy rice fields from the neighboring Mo Nam and built terraces on the mountain slopes that are connected with pipelines made of bamboo or hollowed-out wood, while in other cases bamboo sections are used for the same purpose, to pour water from a higher to a lower terrace (ibid., 73). But apart from their bamboo culture, so argued by Vạn, the Bahnar and Sedang share a common fate. Just like the Bahnar, the Sedang are also threatened by developmental programs, deforestation, modernization, access to the free market, loss of swidden agriculture, or in-migration, and increasing population density. Their handicrafts, such as pottery, basketry, cotton weaving, or forging, helped them satisfy their wants and needs for ages but nowadays are drastically in decline (ibid., 77).

The well-known French ethnologist George Condominas, who specialized in the ethnic groups of Southeast Asia, studied in 1948 the M'Nông Gar of Lâm Đồng province, which is situated some 40 km north of Da Lat in Lâm Đồng province. Condominas (1977, 13) states that in basketry, the M'Nông Gar "demonstrate their greatest mastery. Using bamboo and rattan, the men make numerous types of baskets and receptacles of many kinds that are widely used". The M'Nông Gar also craft bamboo pipes to smoke tobacco and, in addition, "chew a sort of pipe cleaner—a slender bamboo twig frayed at one end to collect all the tobacco juice when passed through the bowl and the stem of the pipe" (ibid., 15). Like the Sedang and Bahnar, the M'Nông Gar people erect a bamboo pole for the village ceremonies and sacrifice a buffalo (ibid., 19). Rice is also the main staple food for M'Nông Gar people, and bamboo shoots are also harvested and eaten as an important additional food (ibid., 210).

Condominas (ibid., 116) discusses the prohibition of felling trees and bamboo in M'Nông Gar culture when there has been a violent death. According to his account, the ban could only be lifted after animal sacrifices to prevent the anger of the forest spirits. Besides the spirit of the forest, according to Condominas (ibid., 119, 180–181), M'Nông Gar believe in the *giant-bamboo-soul* (*rlaa*-soul), *buffalo-soul*, or *canoe-soul*; and he describes the involvement of bamboo in rituals; for instance, bamboo is chosen to build a ritual hut to honor spirits or in the ritual seeking of a name for a newborn baby (ibid., 227, 220).[50]

7.5.2. Bamboo's Use by Swiddeners in the Highlands of Papua New Guinea

Although living in spatially different regions, people developed similar working techniques and utilizations of bamboo all around the world. So, the traditional bamboo culture of people living in the remote mountainous areas in Oceania had many things in common with Vietnam's highlanders. One work that addresses the Awa people—an ethnic group situated in the eastern part of the Eastern Highland Province in Papua New Guinea, with a linear distance of over 4,500 km to the Central Highlands—and their bamboo culture was written by the Australian linguist Richard Loving. In his article, *Use of Bamboo by the Awa* (1976), Loving summarizes more than fifty different utilizations of bamboo and emphasizes bamboo's vital part in Awa people's lives before the advent of industrialization. His article sheds light on bamboo culture's relatedness to swiddening and a subsistence-based life in Oceania. His observations of the material culture involving bamboo are comparable with those of the ethnic groups in the Central Highlands, as discussed and shown below.

Loving indicates that an Awa group, amongst whom he undertook his field research, differentiates between six cultivated bamboo varieties (*anaura*, *mahrampa*, *pahra*, *antau*, *niya ana*, and *mebe*), which they subsume as *kabahra*. All of these bamboo species, except for *mebe,* are varieties of *Nastus elatus*. Furthermore, as Loving notes, the Awa count one wild bamboo (*kuahraq*) growing in the climax forest, which is selected to produce bowstrings, and another thick-walled bamboo (*kotawe*), which the Awa mainly plant to provide shade (Loving 1976, 522). Among the *kabahra* bamboos, *anaura* has a particular position in the Awa's bamboo culture. According to Loving, *anaura* is the most extensively planted and used bamboo with

[50] A bamboo tube's use during the ritual name seeking for a newborn baby is mentioned by Condominas (1977, 220). According to his description, Baap Can (a M'Nông Gar man) and father of a newborn baby uses a so-called salt tube made of bamboo to ask for the ancestors' consent. Condominas describes the ritual in detail, as follows: "the tube in question is not a receptacle that has actually been used; it is merely a bamboo tube which resembles the ones used for storing salt but which is cut to order for the ceremony. He [Baap Can] fills it to the brim with hulled rice, then transfers the contents to a thicker tube. He cites a name and pours the rice back into the 'salt' tube through a funnel fashioned from the top of a pierced gourd. He taps the bottom of the tube against the ground, which obviously acts to pack down the contents. At the mention of the first name, the tube remains full almost to the top. He repeats the operation several times. When, finally, he pronounces the much desired name 'Kroong,' as if by a miracle the rice no longer fills the tube to the top but comes to within a centimeter of it. The ancestors have given their consent" (ibid.).

countless and manifold applications. It is selected to build fences or woven bamboo walls or floors for house construction. Another crucial bamboo is *mahrampa*. It is a fairly soft bamboo species and serves as a cooking container or to construct gravity-feed water pipes. *Pahra* is required, among other things, to craft tobacco pipes, bowstrings, and knives and is known to be a solid bamboo. *Antau* and *niya ana* are primarily turned into cooking containers, whereas *niya ana* also produces edible shoots. *Mebe* is utilized as a container for valuable things because of its long internodes (ibid., 523).

Altogether, Loving (ibid., 523–542) assigns the numerous uses of bamboo by the Awa to the following categories: *gardening, cooking, building, hunting, containers,* and *other uses*. The enumeration below follows Loving's classifications and expresses the manifold employment of bamboo observed by Loving. *Gardening*: Fence building, water pipe construction, a stake for sugarcane and yam vine (used as climbing support), barricade construction to protect bamboo plots, and bamboo strips as dividing lines for gardens. *Cooking*: Bamboo cooking tubes, bamboo as inner cooking tubes (a bamboo with a smaller diameter is inserted into another bamboo with a larger diameter), drilling rods, old cooking tubes reused as firewood, dry bamboo as fuel, a bamboo-eating implement (serving as a fork, knife, or spatula), water containers, edible bamboo shoots, a bamboo knife, bamboo tongs, bamboo sheaths used as plates, and a bamboo torch. *Building:* Woven bamboo walls, rafters, inside walls, a doorway barricade, village barricade, protecting fences, bridges, and ladders. *Hunting:* Rat traps, a deadfall rat trap, forked bird arrows, a bamboo arrowhead, play arrows, bowstrings, a bamboo pole tied to a tree to reach nests, a bridging bamboo (a pole attached to between the limb and trunk of a smaller tree to reach an adjacent limb, which is not suitable for climbing), and a carrying pole. *Containers:* Various containers (to store seeds, arrows, ornaments, plumes, etc.), drinking water flasks, the tool kit (to store bone needles, flintstone, bone knives, nails, etc.), a lard container, a curer's water container (used for ritual purposes). *Other uses:* Tobacco pipes, a mouth harp, flutes, secret flutes (for cultural rites), dog chains, combs, a leafy bamboo twig as a sun shade (installed at the baby carrier to protect babies from the sun), bamboo clumps as a retreat for sexual relations, bamboos to provide shade (many daily practices are done in the shade of a bamboo grove), walking sticks, and a bier to display a dead person.

To sum up, bamboo is part of Awa people's everyday lives and required for miscellaneous domains of life. What is more, many things Loving lists can be found in the material culture of the Bahnar people studied in this book, and accord with my compilation of the latter's uses of bamboo depicted in Figure 77 and the summarizing overview of Bahnar swiddeners' bamboo culture in chapter 7.6.2

Loving (ibid., 521) goes on to explain that Awa people plant and cultivate bamboos and describes the rules of ownership of a bamboo grove. First of all, a bamboo grove belongs to the person who initially planted the bamboo. Owning a bamboo grove guarantees a continuous supply of material. The closer a bamboo grove is to one's house or garden, the less far one must walk from the grove to the house or the garden, resulting in less work time. Consequently, the Awa take special care that others respect the ownership of a grove. After an owner's death, a bamboo grove is either passed to the immediate family or another relative—any removal of stems without the owner's permission is forbidden and can lead to quarrels.

Loving (ibid., 523) notes that bamboo is employed for many things but that gardening requires most bamboo when measured in weight, the majority of it being used to build fences to protect the garden against wild and domesticated pigs. The relevance of a nearby bamboo grove becomes evident in the following calculation of Loving, who writes that Awa people carry "between one and two tons of bamboo tied in bundles . . . from less than one hundred meters to three kilometers" (ibid.) in order to build fences round the taro garden.

Taro plants require large amounts of water because they tend to lose lots of their moisture due to their big leaves and need a constant water supply, especially in the dry seasons. Thus, like (wet) rice societies, the Awa people need to secure their fields' constant water supply. For that reason, the Awa people make use of gravity-flow bamboo water pipes: a method occasionally applied in contemporary Vietnam for paddy fields. Water pipelines are also necessary to guarantee a continuous supply of water. Loving (ibid., 525) mentions that the *mahrampa* species is primarily crafted into water pipelines since their nodes are soft and easy to take off compared to other bamboos. For this purpose, the nodes must be removed entirely to ensure continuous water flow. Any remaining part of a bamboo node is a hindering barrier for leaves or other organic materials that would otherwise plug the pipeline. The way a water pipeline is constructed is described by Loving as follows:

> The correct procedure is to begin at the stream and to sharpen and wedge sticks into the ground, every three to four meters. Then the first bamboo is tied to the sticks so that the water runs in at the large end and out of the small end. Then the large end of the second bamboo is slid on over the small end of the tied bamboo and the natural curvature of the bamboo is adjusted to best fit the direction the pipe will take. After this, the elevated end of the second bamboo is tied in place to the vertical sticks and then the lower end is adjusted so that the water flows well with no leakage at the joint. Except where the ground is steep, the bamboo pipe is tied at the level, which gives no leakage but the least possible drop in elevation. (ibid., 525)

Bamboo is also involved in other gardening purposes, as in the climbing support that serves as a stake for sugar cane or yam vine. To divide up their gardens into individual plots, the Awa select thin bamboo strips. And they build a bamboo barricade around a bamboo grove to prevent others from cutting one's bamboo culms (ibid., 526–528).

Before the introduction of metal pots and tools, bamboo was widely utilized to prepare food. Loving (ibid., 528–529) notes that Awa people use bamboo containers for cooking and that a constant supply of bundles of green bamboo from a nearby bamboo grove is required due to the daily consumption. While many foods may be cooked in a young bamboo section without adding water, in other cases, as in the preparation of some vegetables like taro, water is also poured into the bamboo container to produce enough steam. The cooking container varies in length, depending on the amount of food. Loving (ibid., 528) writes that a bamboo culm with one node is sufficient for small creatures, such as grubs and fish, peanuts, and mushrooms. Even though bamboo has not the best burning properties compared to tree-firewood, it nevertheless can be used as firewood. While green, young bamboo has a poor burning quality, old, mature bamboo culms or prefabricated bamboos (e.g., fences, floors, or walls) serve as firewood (ibid., 531).

Loving (ibid., 532) remarks that the introduction of metal tools, particularly the machete and other iron knives, profoundly impacted the Awa people's material culture. Before then, bamboo knives were used in several ways, for instance, to peel vegetables or to cut boneless meat. A bamboo knife, as I observed in Vietnam, is very sharp, and "most Awa," as Loving explains, "have scars which testify to the fact that bamboo cuts" (ibid., 532). Bamboo knives are crafted from bamboo culms' outer skin and are remarkably resistant and sharp due to the outer walls' silicified surface. Moreover, the bamboo knives have small serrations by nature, which improves their cutting performance and requires the blade to be pulled forward and back. However, in comparison to iron knives, bamboo knives tend to get dull quickly and require frequent replacement. Cranstone remarks that bamboo knives were also found amongst Tifalmin people living in Papua New Guinea's mountainous regions, and he explains that a pig is butchered efficiently using a bamboo knife, which also "served for skinning and cutting meat and preparing vegetables" (Cranstone 1971, 134). According to his description, "a sliver of bamboo of suitable length is used" for many purposes, and "when it becomes blunt, a strip is peeled back to give a new sharp edge, and after use the knife is discarded" (ibid.). Cranstone also notes the Tifalmin people, who had no iron tools at their disposal, found a distinct way of working on bamboo. He notices that "the serrated lower mandible of a species of lizard provides a miniature saw to make a nick in small-diameter bamboos so that they can be broken cleanly" (ibid.). Accordingly, besides the utilization of stone and iron, the use of a serrated mandible as a saw is a third traditional method bamboo can be worked.

The introduction of new materials correlates with the decline of traditional tools and techniques but enables people to invent and produce new things. Before the machete was introduced, people relied primarily on stones to split and work with bamboo. However, a stone is a less appropriate material to treat bamboo, whereas iron knives, machetes, or axes are superior tools when working with bamboo. It is particularly the work with mature, woody bamboos, which tend to have a hard wood and hard surface that requires sharp and durable materials. Therefore, using iron tools instead of stones changed the working techniques so that the work became faster, easier, more precise and gave rise to new techniques. In this context, Loving (1975, 541) observed that after introducing iron knives in the mid- to the late fifties, young Awa men started to create bamboo combs with the aid of steel knives. He notices further that the traditional ways to build houses changed after the introduction of steel tools. Before, Awa people chose layers of thatch to build house walls, but the shape of houses and their components changed after steel tools were distributed. During the sixties, woven bamboo walls substituted the grass thatch, and the traditional convex construction structure was replaced by flat bamboo walls and overhanging roofs (ibid., 533–534).

Loving's account underlines the influence of introducing steel tools on the (bamboo) material cultures and indigenous knowledge and technology. In his conclusion, Loving (ibid., 542) stresses that until 1976 Awa people were able to maintain their material culture because they inhabited a remote area with few contacts with other ethnic groups. Accordingly, this isolation resulted in an almost unmodified bamboo culture that survived until the late 1970s.

7.6. A Socio-Material Approach to the Human-Bamboo Relationship Based on the Bamboo Culture of Swiddeners

The human-bamboo relationship, to which I return in this chapter, is not only determined by both entities (the Bahnar swiddeners and bamboo) but also by other humans and nonhumans. By emphasizing these various entities' mutual relationships, I transcend the boundaries of classical anthropological, sociological, or technological-historical considerations that traditionally gave less voice to the material counterpart accompanying humans as part of the social. The tangible and semi-tangible, vivid or unvivid, and active or passive nonhumans affect Bahnar people's lifestyle, the way they act, their livelihood, and everyday life. By stressing nonhumans' coactivity, I shall demonstrate how shifting cultivation and bamboo culture are interwoven together. In other words, by describing the Bahnar swiddeners life related to their bamboo culture and shifting culture through practice theory and ANT, I shall indicate the relevance of bamboo for Bahnar people and how bamboo is part of practices and broader networks, and how nonhuman and nonbambooic entities come into play.

By pursuing this goal, I will illustrate how people and their practices are intermingled with bamboo artifacts. And furthermore, how human/human, human/nonhuman, nonhuman/nonhuman interconnections and their analyses provide a conceptual framework and evidence about how agency emerges when not only attached to the human swiddeners alone. In this view, these interconnections exist on different timescales and at different places, and by implication, agency is somewhat existent on different strata.

In what follows, using the practice theory approach and ANT, I examine some aspects of the human-bamboo relationship of Bahnar people. Since both concepts draw our intention to distinctive categories of the social, both provide different analyses to trace humans' relationship with bamboo. In the next chapter, I shall discuss how the human body, skill, and knowledge are connected to materials and tools by the example of Mr. Ninh's bodily involvement in the creation of a bamboo sheath. Thus, how the use of bamboo shapes the human body and skill. In doing so, I conceive bambooworking as a vivid example for human-material conflations and as a practice that equally expresses traits of other practices. At the end of the chapter, I will briefly outline at what points and how humans encounter bamboo.

Following this, in chapter 7.6.2, I shall initially repeat in brief my definition of practices related to practice theory to pinpoint bamboo's relevance for human actions. Then, I will outline the main characteristics of bamboo culture related to shifting cultivation. The main part, however, examines how practices and everyday activities are connected to bamboo. In this, the human subject is at the center of my approach since it is the human being who is the carrier of the practice and all other entities revolve around this human practitioner. On the other hand, the practice theory approach and concept overemphasize the role humans play and hinder a more unbiased analytical approach.

In view of this fact, ANT provides a more symmetric and less human-centralized analysis and reveals how various practices are interlinked. Hence, although practice theory and ANT are flat social ontologies, the latter is flatter than the former and identifies how humans and nonhumans are inextricably linked. As Sayes notes, ANT "attempts to pluralize what it means to speak of agency" (2014, 141). Accordingly, since ANT refutes an empirical analysis with the human subject as its starting point that neglects the nonhumans' part in the social, in chapter 7.6.3, I will apply ANT's analytically unbiased approach examining two distinct networks. One is about the actor-network revolving around shifting cultivation (chapter 7.6.3.1), the other is about the entities revolving around residential houses (chapter 7.6.3.2).

7.6.1. Working with Bamboo: Skill, Knowledge, and Bodily Involvement

Before the advent of iron blades, it is most likely that carved stones with sharp edges were used for bambooworking, as was the serrated lower mandible of animals, as mentioned above (Cranstone 1971, 134). Simultaneously, bamboo was used as a knife itself. So, bamboo knives were used to cut vegetables and meat (Loving 1975, 532) and still are occasionally used in contemporary Vietnam. Since the invention of smelted iron and metal knives, however, metal knives did not only replace bamboo knives but also the manner of bambooworking. Today, bambooworking is strongly connected to the skilled use and handling of machetes or similar knives, which multiplicated and facilitated the ways bamboo could be manipulated—as vividly exemplified by Awa men's creation of bamboo combs or new house designs. I shall pick up the relatedness of the toolkit's change and its effects on the social further below. Here, I focus on bambooworking understood as an activity and practice.

Years of experience in bambooworking and bamboo's daily use by swiddeners, as exemplified by Mr. Ninh, have resulted in the continuous optimization of one's skill and thus in bambooworking performed in a practical and sophisticated manner—whose performance is characterized by the time and effort reduction due to the embodied skill, know-how, and experience.

Like many East and Southeast Asian people, the Bahnar have no workbench or similar things. Moreover, they have no separate workshop where they produce their goods. Their house is their main workshop, and things are usually crafted at the place needed. What is noticeable is that Bahnar (and Vietnamese) do many tasks sitting on the ground or in a squatting position and integrate their whole bodies into the respective work steps. It is not unusual to employ not only one's hands but also one's legs, feet, toes, arms, as well as one's mouth and teeth.

Figure 75 Working with the machete and knife. In the left picture, Mr. Ninh splits a bamboo section. In the right picture, Mr. Ninh splits rattan while clamping the machete between his arm and upper body.

On my last research day, on our way from the hamlet back to Kon B'Rrăp village in 2012, Mr. Ninh, Mr. Nguyễn Ngọc, and I crossed a little stream with a bamboo culm floating on it. Mr. Ninh, knowing that my machete had no protective sheath, decided spontaneously to craft one. After the adjustment of the length of the culm, Mr. Ninh split the bamboo section, modified the edges of the two split sections, sanded and washed it with the mud and water of the stream (Figure 76), split rattan strips (Figure 75) and tied the two bamboo halves together using the rattan strips. On the left in Figure 75, one can see Mr. Ninh splitting the bamboo section after crosscutting the bamboo tube. To split bamboo, Mr. Ninh attaches the machete blade to the one end of the culm. Then, while holding the machete handle in one hand, he presses the other hand on the thick back of the machete. And in the next step, he splits the bamboo by tapping it on a stone.

The photograph on the right in Figure 76 illustrates how Mr. Ninh uses the knife with a small blade to achieve more precise results. For this purpose, he fixes the blade's handle between his arm and his right knee and thigh. This method, then, functions as a press. The same photograph shows how Mr. Ninh works using his feet as well as his hands. One can see him splitting rattan twine by holding it tight between his big toe and the second toe of his right foot. In all figures, Mr. Ninh involves the whole body and works on the ground while squatting on a stone.

Bambooworking, therefore, is more than a *handi*craft. It is a craft involving the whole body and analogous to a handicraft, a *body*craft. Indeed, bambooworking shapes not only the bamboo object but also the human body, human skills, and the entire practice of bambooworking. In terms of ANT, the bambooworker (human subject), bamboo (raw material), machete (tool)

Figure 76 The involvement of the whole body in bambooworking. The picture top left shows Mr. Ninh using the knife for precise work. In the picture bottom left, Mr. Ninh sands and cleans the bamboo halves required to produce the protective sheath. In the right-hand picture, Mr. Ninh uses his hands, arm, upper body, feet, and toes to split rattan.

would form a hybrid entity. It is the human-material conjunction that bestows this hybrid entity with agency and generates objects.

Form-giving, as discussed in contrast to the deficiency of Aristoteles' hylomorphism model, is a process involving the interplay of a human-material-material constellation. In this case, it is a bambooworker-bamboo-machete conjunction. As illustrated by creating a protective bamboo sheath (amongst others), these three entities compose or contribute to a new artifact's shape. First, the bamboo culm's material properties used for the creation of the sheath are unique. The culm has its specific diameter, length, age, material density, and it has already been naturally submerged in stream water, making it more durable and more flexible due to its higher water content. It is not only that bamboo differs from other materials such as wood or rattan; the respective bamboo culm differs from other culms of other species but also the same species. Needless to say, when splitting bamboo with the machete, bamboo's structure plays a significant role. Its longitudinal growth, its long fibers, its elasticity (especially of green bamboo), its knots, and other aspects determine the process of splitting, "the variable undulations and torsions of the fibers guiding the operation of splitting [bamboo] wood" in the words of Deleuze and Guattari (2005, 408). Second, the machete's or knife's shape, sharpness, length, or weight are essential because these tools determine certain working methods. Third, the bambooworker and her/his body (arms, hands, muscles) and physical abilities, skill, and knowledge are equally determinant in the process of creation. Since bamboo is not a stone or a huge tree trunk, it is possible to penetrate its outer part using human muscle power and a machete with ease. From a materialistic point of view, the upshot is that the culm's inherent properties, the tool's design and use, and the bambooworker's body play a decisive role in the very moment of creation. Indeed, all these human and nonhuman entities are prerequisites for such a creation, and it is their mutual teamwork that brings forth new things.

Consequently, besides the nonhumans' objective materiality, it is also the materiality of the human body that is intimately connected to bambooworking. The skilled bambooworker, such as Mr. Ninh, has already embodied bamboo processing techniques and possesses the practical know-how in handling the machete as his primary tool. So, bambooworking is virtually always also an embodied learning marked by intuition. Furthermore, as demonstrated by Mr. Ninh working on bamboo, his entire body functions as a tool and is a source of knowledge, know-how, and skill. Indeed, bambooworking requires various tasks in which the human body epitomizes and functions as a tool. As done by Mr. Ninh, splitting a rattan strip necessitates clenching the rattan twine between his toes while simultaneously clamping the knife between his torso and upper arm. From this perspective, the definition of the term *tool*, as a device set in motion by humans, becomes slippery. Following Leroi-Gourhan's (1993, 242) analyses of human manual activity (discussed in chapter 5.4.3), it becomes evident that it is not only the human hand that is a tool but likewise the human body.

Leroi-Gourhan's analyses of humanity's evolutionary development as a tool-using animal underpins a development from manual work to automatization. But this view begs a further question about Leroi-Gourhan's notion of technological development. Following his perspective, humans gradually liberated their hands from work in the course of their evolution. However, this hand-centered depiction does not take account of the other parts of the human body involved in working. Hence, Leroi-Gourhan's elaboration must be extended considering that not only human's hands but the entire human body (legs, feet, toes, mouth, knee, or thigh) have also been gradually liberated from work and extended in tools. Admittedly, this view implies another problem. It might, so to speak, be the subject of an essentialist perspective portraying human progression in a unilinear way. It implies and suggests a specific value according to which working with one's hands and body is an unevolved, underdeveloped activity in contrast to mechanical or industrial work. Notwithstanding this, the way Mr. Ninh works on bamboo implies a set of activities and practices that unambiguously reject a biased view according to which bambooworking is simple because of being merely manual or, in relation to bodycraft, a *bodily* work—it instead gains its relevance due to its embeddedness in shifting cultivation.

The bambooworking described so far has ignored another aspect crucial for the construction of the bambooic material surroundings. Whenever a Bahnar swiddener starts doing something with bamboo as raw material, the implementation of an idea is linked with preceding and following steps in which the swiddener encounters bamboo as raw material and construction material. As Deleuze and Guattari explained, such a recurring encounter is twofold. For one thing, the bambooworker encounters bamboo's corporeality and material properties in the process of bambooworking. She/he follows its fibers. At the same time, a Bahnar swiddener must start a journey to find suitable bamboos for her/his project. She/he has "to go find the [bamboo] wood where it lies and to find the [bamboo] wood with the right kind of fibers" (Deleuze and Guattari 2005, 409). Localizable points of encounters between humans and bamboo—in its appearance as a plant, raw and construction material, or artifact—mark this journey. By reference to Bahnar bamboo house construction, I shall briefly illustrate both types of encounters.

From the beginning to the end of the house construction, the builder encounters and interacts with bamboo. At the very outset, the builder (due to gender-related labor division, the builder, in this case, is male) starts his journey by searching for the appropriate bamboo species and culms necessary for the house construction. He encounters bamboo (as a plant) for the first time, either in the forests or in the bamboo groves growing near the residential houses. Then, the builder chooses the right bamboos determined for the various house components. When the bamboos are felled, the plant is transformed into raw material. Then, after carrying the culms to the place of construction, the builder once again meets bamboo and transforms the raw material into a construction material. In both kinds of encounters, the builder evaluates and interacts with bamboo's intrinsic materiality. The builder is confronted with bamboo's materiality whenever he uses his machete to chop down the bamboo plant or crosscut or split bamboo.

Summing up, bambooworking implicates various entities of human and nonhuman origin. If we are to understand bambooworking as a practice, it is one decisive part of the human-bamboo relationship of Bahnar swiddeners. Moreover, bamboo and bambooworking play a determining role in the bamboo culture that lays the groundwork for Bahnar swiddeners' social life and practices.

7.6.2. The Characteristics of Bahnar Swiddeners' Bamboo Culture and Its Relatedness to Practices

Since bamboo is part of a wide spectrum of many human activities, I have outlined two different conceptions of bamboo culture and their significant differences in chapter 5.4.2 based on my treatise on material culture. One concept is a catchall term encompassing all practices involving bamboo yet without bamboo being the primary source but one amongst others. In this case, bamboo is *only* part of a broader material culture. The other concept has been discussed in this chapter and is related to shifting cultivation. In the latter case, any bamboo entity (including bamboo as a plant, raw and construction material, tool, artifact, and bambooic infrastructure) epitomizes a single, small unit while referring to the whole bamboo culture. Any bambooic entity potentially represents and epitomizes the bambooworking (thought of as a practice) and the bambooworker (as the carrier and practitioner of the practice). Indeed, it is the alliance of all bambooic things that represent this concept of bamboo culture since bamboo is the dominant material and synthesized in endless artifacts necessary for daily use and social practices. Of course, both concepts of bamboo culture are in no clear and absolute opposition to each other or other material cultures.

In this section, I shall try to combine the various bamboo artifacts and practices involving bamboo in such a way as to depict the characteristics of the bamboo culture of Bahnar people. Following Schatzki's statement that "practices are intrinsically connected to and interwoven with objects" (2002, 106), I am tempted to describe an overall assemblage of human-bamboo relations as part of the Bahnar life based on my descriptions and findings in the previous chapters and based on Figure 78, which demonstrates the versatile implication of bamboo in Bahnar people's practices. Here, the corresponding question is, how is bamboo related to the material arrangements needed to carry out practices necessary for shifting agriculture? By describing the bamboo culture's material constitution, I depict both the manifold artifacts and the heterogeneities of bamboo's practical functions and its multiplicity of uses referring to these artifacts. In this discussion of bamboo-related practices, I follow Reckwitz's definition of practices that I have already mentioned in chapter 5.2.3. To recall its meaning once again, according to Reckwitz, "a 'practice' (Praktik) is a routinized type of behavior which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (2002, 249). In this view, it is the individual who is the connector of an entire assemblage and circuits of material and immaterial things, since she/he is key who reproduces the social through her/his routinized practices.

Having clarified the characteristics of bambooworking as a human-material relationship, where and how humans encounter bamboo, my conception of both concepts of bamboo culture, and my understanding of practice following Reckwitz's definition, I shall now summarize and describe bamboo-based artifacts, tools, and architectural structures I observed during my field stay and secondly in other scholars' accounts discussed in this chapter. I have subsumed the latter into nine categories (see further below) and illustrated in Figure 77, yet this categorization is relative because some bambooic things can be classified in more than one group. For instance, the *đing soi*, although a tool, is classified here in the domain of agriculture and gardening because of its use for sowing. After this review of the bambooic things and human-made bambooic environment, I shall depict practices related to shifting cultivation and to this review of bamboo culture.

On the whole, the following extended definition of Bahnar swiddeners' bamboo culture can be given: Their bamboo culture is an assemblage of i) multiple human practices including the human body, know-how, tool use, and skill; ii) bamboo as a plant, raw material, and construction material; iii) all human-made bambooic tools, objects, and the built environment; iv) and humans' activities oriented on, modified by, adapted to bambooic things.

Altogether, the ways the Bahnar use bamboo are simple and do not require a sophisticated division of labor or special tools. Many things are made for comparatively short-term needs, have a short lifespan, and are produced relatively fast and easily, without the necessity for any advanced and complicated treatment of bamboo stems. Thus, not despite but rather on account of the simplicity of working techniques and especially of green bamboo's easy workability, bamboo contributes much to the Bahnar's material culture. What is remarkable is that the Bahnar exploit only a few bamboo species and primarily the *sơmluh*, *pơo*, and *hgơr* bamboos to create the majority of things they need. Hence, a high diversity of a bamboo culture is not inevitably linked to a high amount and diversity of bamboos. To put it another way, a few favorable bamboo species, bamboo's easy workability, and indigenous skill and knowledge may result in sophisticated bamboo cultures. Of course, other non-bambooic materials provided by the rain forest are equally important, but bamboo's crucial role remains unsurpassed.

It is also self-evident that all the traditionally made bambooic things are organic. Compared to industrially produced goods and commodities, bamboo-based tools and the building environment produce waste only temporarily, if at all. Hence, if thrown away, things will be returned to the natural life cycle or, if needed, are used as firewood. Things and large structures such as a house will gradually perish when reclaimed by nature. Accordingly, the bamboo culture produces no harmful waste that could harm the environment. On the other hand, due to bamboo's short durability, things (such as tools, houses, fences, water pipes) do not last long, particularly if exposed to rain and sun. As a result, Bahnar people must frequently replace their tools and rebuild their built environment, which, of course, takes time and work.

In what follows, I depict bamboo's use in various domains, and in doing so, I attempt to highlight bamboo's role in Bahnar people's everyday life and bamboo as an essential part of carrying out practices.

House construction: Bamboo is frequently used as a building material for houses, granaries, tomb houses, and the Rông community house. If the aim is to build a floor, wall, or door, bundles of green bamboo are collected from the nearby bamboo grove or groves located in the forest. After collecting the required bamboo culms, they are flattened by hammering on the nodes. Then, the remaining node parts are removed, and the culm is flattened. When laid down with their softer skin upright, the flattened bamboo creates a smooth floor. Walls, doors, room dividers are produced similarly and additionally woven together. In contrast, to obtain more stability and a longer lifespan, dried bamboo culms are employed for the house's roof construction. In this case, mature bamboo culms are used for the purlin, as ridge beams, girders, and supporting pillars are tied to other culms through rattan strips. Using green bamboo for these cases would have a negative impact on the structure's stability and stiffness because young, fresh bamboos tend to shrink when their moisture content decreases. Hence, reducing the culm's water content is essential for the robustness of construction, requiring a higher material strength.

Agriculture and gardening: Bamboo is an indispensable material in the domain of agriculture and gardening. By exploiting bamboo's hollow structure, Bahnar people craft water pipelines of different lengths. As my respondents said, water pipelines are occasionally erected to irrigate one's garden. As illustrated in this chapter, the hamlet's residents (who live close to a stream) simply stuck two bamboo culms into each other and controlled the water flow with a small stone at the end of the drain. Based on bamboo's compression strength along its fiber direction, it is used as tree guards, trellis, and pillars. The *đing soi* is an illustrative example of how basic and simple tools fulfill essential agricultural tasks and equally have multiple purposes. It is used to store the rice grains and to create holes for the grains. Bamboos are also vital to build various fences: a farmland fence to protect the crops against animals, a graveyard fence to mark the graveyard and to protect the tomb house, and in the past, a village fence to provide safety against hostile attacks. The swing door stands out from all other artifacts. Based on bamboo's elasticity and the door's design, it has an inscribed ability to close automatically. Another use of bamboo to protect the farmland is to use it as a construction material for watch-towers in which elderly persons stay and pull bamboo ropes attached to scarecrows to chase away birds.

Tools: The Bahnar bamboo culture encompasses many tools made either partly or totally from bamboo stems or rhizomes. Handles for knives and axes are predominantly made of bamboos with thick walls and small holes for reasons of robustness. Moreover, using the natural curve of the culm-rhizome part of bamboo culms, the Bahnar take advantage of this natural bend for agricultural tools. Because of its long natural shape, bamboo culms are often used as an extension of the human hand to reach distant objects like fruits on a tree. Ladders of various lengths are made by attaching two poles through small sections (steps) and have equally manifold purposes. Bamboo ropes and strips, known to have high tensile strength, are used to fix makeshifts, for lashes, to shift loads, or, as mentioned above, to move scarecrows. The pannier is a specially designed woven basket and serves to store and transport things and is suitable for walks in the forest—some older Bahnar use bamboo walking sticks for better equilibrium if the pannier is heavily loaded. For better safety, particularly during walks in the forest, bamboo sheaths protect the machete or knife Bahnar people carry. For better hygiene, traditional bamboo lice combs are still in use and part of each household.

Household and kitchen utensils: Bamboo is found in every house and is an essential part of the household and used to create manifold kitchen utensils. Before the introduction of plastic containers, bamboo containers were the most used objects. They were, and in some cases still are, used to store water, salt, food, and oil or to prepare food. While water and cooking containers are fabricated of green bamboo culms for temporarily limited or single use, food, salt, and oil are stored in dry culm sections. Bambooic drinking cups, (long) chopsticks, and a skimmer are likewise vital kitchen utensils. Bamboo drinking straws are important, especially for rituals in which the Bahnar drink wine from big jars. These straws are kept safe in the corner of the house and taken out when needed. Bamboo fire tongs are an excellent example of bamboo's bending quality. Very young bamboo is naturally flexible, but an almost mature split of bamboo is easily bendable when heated over a fire and allowed to dry for a short moment. In this way, a bamboo split is almost bent to 180 degrees and used as fire tongs to turn the cooking container or grasp coal embers. As explained above, bamboo basketry is still the most crucial traditional handicraft, and manifold baskets are produced for multiple purposes. Moreover, the basic principles of basketry are also applied to create bamboo mats (for working surfaces), grates (hung over the open hearth), panniers, house walls, floors, and the like. One of the least modified tools is probably the bamboo blowpipe used to ignite the fire.

Hunting, fishing, and animal husbandry: Bamboo is an important material to create tools related to hunting, fishing, and animal husbandry. It is needed, for instance, to produce bird traps, deadfall traps for rats and weasels, and deadfall traps for mice. If a mature bamboo culm is tapered, it becomes very sharp and can inflict severe wounds. By using this property, animals are chased into pitfalls containing sharp bamboo spikes. The weaving techniques for basketry are also applied in the making of fish traps, chicken houses, chicken cages, and animal enclosures. Accordingly, bamboo is an indispensable construction material to keep, hunt, and catch animals and by this means to produce meat necessary as an important source of protein. Another basic tool necessary for animal husbandry is the drinking trough produced from a half section of a large diameter bamboo.

Weapons: In the past, more than today, bamboo has been frequently used for crafting weapons. However, since the Bahnar live peaceably with their neighbors and due to the end of the American War and the state ban on the private possession of weapons, traditional weapons have almost disappeared from the traditional toolkit. For instance, the bamboo shield, formerly used for self-defense during armed conflicts, is no longer to be found. Where weapons are still to be found, they are now used for hunting animals such as the (wooden) crossbow (with bamboo arrows), the bamboo lance, bow, and spikes.

Ritual life and aesthetics: Bamboo is part of ritual life, ceremonies, and customs and expresses aesthetic values. Its extraordinary role in this sense is expressed by the *gơng* (*tua brui*) and *gờnglờng*. After erecting the *gơng* (a colorfully decorated bamboo pole with bamboo tassels), the sacrificial buffalo is decorated with bamboo tassels. Then, following specific ritual actions, the buffalo is stabbed with a bamboo lance. The Bahnar people use bamboo in general for practical reasons rather than for its aesthetic values. Hence, bamboo contributes much to functional, structural elements, but occasionally, as in the case of the ornamental bamboo wattles of the Rông house, it can express aesthetic meanings. Another ritual use of bamboo is presented by the bamboo knife used to cut the umbilical cord of a newborn.

Musical instruments: Bamboo's remarkable materiality, traditional joining techniques, and the human-bamboo conflation are probably best illustrated by the creation and use of musical instruments. Moreover, the evolution of metal musical instruments, as discussed in chapter 7.4.7, derives partly from bamboo. This fact underscores how bamboo's natural shape might have inspired people to develop early tools and musical instruments by referring to bamboo's shape and design.

Other uses: There are, of course, other uses that cannot unambiguously be attributed to the abovementioned categories. Like in many other Asian cuisines, bamboo shoots are desired for their texture and taste and prepared fresh or pickled. The bambooic tobacco pipe makes use of bamboo's hollow structure and is a composite tool of two bamboo sections with different lengths and diameters. When walking through villages in the Central Highlands, one will frequently find children walking on long bamboo stilts. And bamboo is part of the well-known game called *dru dra.* In the past, when no firelighters or matches were available, Bahnar people made fires using bamboo. One might say that the first material with which a Bahnar newborn comes in touch is bamboo, presented by the bamboo knife to cut the umbilical cord, while the last thing a Bahnar peasant encounters is the bamboo stretcher used to carry the dead body out of the house.

In sum, my enumeration lists ninety-eight different applications in which bamboo is employed. Of course, this list is not complete but illustrates bamboo's involvement in almost every domain of life and provides a glimpse into the bamboo world of the Bahnar people. It becomes clear that bamboo represents and forms the material bedrock and equally is the most visible part of the material culture of Bahnar people. Almost every bambooic thing implicitly represents and constitutes the material basis to carry out practices. At the same time, these things are mainly mundane objects, yet significant the performance of everyday tasks. Moreover, they indicate practices such as practices of funeral, birth, bambooworking, hunting, fishing, cooking, eating, gardening, land cultivation, music-making, animal husbandry, living, playing, fighting, moving, and the like. Therefore, instead of finding an explanation of social phenomena in the human individual alone, practice theory allows the involvement of more entities besides the human being as participants that engender sociality.

As a matter of fact, the handling, using, and negotiating with the bambooic (everyday) artifacts reveal the entanglement with things and humans in practices. Figure 78 shows various connections of bamboo and Bahnar swiddeners and how both reproduce practices as patterns of the human-and-bamboo-entity in action. These connections show how bamboo plays significant roles in human practices—I already explained the human-bamboo relationship in detail by the abovementioned example of bambooworking. Thus, I shall not go into further analysis and explanation at this point.

In the light of Figure 78, Mr. Ninh is, amongst other things, a basket weaver, farmer, musician, hunter, gatherer, fisher, architect, engineer, technician, artist, and the like. For better understanding, I refer to these practices as *professions* in the meaning of "a type of job [work] that needs special training or skill" (Oxford 2008). All these professions elucidate how bamboo intersects with the practices and activities of Bahnar swiddeners. For instance, Mr. Ninh's daily activities and personal life are interwoven with bamboo in such a way that an individual thread or aspect cannot merely be pulled out without damaging the whole. On my question about bamboo's meaning for him, Mr. Ninh responded first that he simply could not exist without bamboo, and second that using bamboo for him is also connected to his biography and his ancestry. Indeed, Mr. Ninh's personal integrity is manifested in his relation to bamboo. All his professions are related to bamboo. He creates all bambooic things himself, but he also develops a unique relationship with them by creating these things. As becomes clear, Bahnar swiddeners would be unable to exercise all their *professions* without bamboo.

If we consider all practices and bamboo-based professions, they represent the life of swiddeners in the Central Highlands of Vietnam. Accordingly, the professions underline bamboo's importance in meeting one's needs and bamboo's relevance in rituals and customs. Bamboo inhabits almost all practices of Bahnar swiddeners, be they profane or ritual, occasional or recurrent. Following Reckwitz's (2002, 249) concept of practice and his notion of the individual as the carrier of practices, Mr. Ninh is the connector of all practices. Through his bodily and mental activities and his connections and use of bambooic things, he reproduces the various practices needed to maintain a life as a swiddener.

House construction (residential house and Rông house):

- floor, wall, door, purlin, ridge beam, girder, rain gutter, room divider, supporting pillars, scaffold, residential house, tomb house, granary

Agriculture and gardening:

- water pipeline, tree guard, trellis, pillar, *đing soi* (staff), farmland fence, plant cultivation fence, graveyard fence, *village fence, swing door, *bamboo sticks (to rip the rice grain), *watchtower

Tools:

- handle for knives and axes, rake, pole (as an extension of one's arm) ropes and strips, ladder, needle, backpack, bamboo knife, lice comb, sheaths, lashes, *container for measurement, walking stick

Household and kitchen utensils:

- water container, salt container, food container, oil container, cooking container, chopsticks, broom, drinking cup, drinking straw, fire tongs, firewood, grate (*claie*), grain sieve, small flat basket, big basket, bamboo mat, blowpipe, skimmer

Hunting, fishing and animal husbandry:

- bird trap, rat trap, deadfall trap, bamboo spikes, fish trap, handnet
- chicken house, chicken cage, drinking trough, animal enclosure, bamboo shavings (used for nests)

Weapons:

- lance, arrow, bow, *bamboo spikes, shield

Ritual life and aesthetics :

- *gong, gònglòng,* *a bamboo culm that supplies the deceased with food, ornamental bamboo wattles (Rông house), ritual bamboo knife

Musical instruments:

- chordophone group: *ting ning*, *goong đe, broh*;
- aerophones: *lal*, **avơl*, **đinh tút*, *klong pút*;
- idiophones: *Tơ rưng*, *chinh chêng*, *chum chọe*, **khinh khung*, **chiêng kial;*
- membranophone: percussion mallet

Other uses:

- tobacco pipe, sun shade, *bamboo stretcher, *fire making, *a culm as a kind of buoy, bamboo shoots, stilts (for children), **dru dra* (game)

Figure 77 List of bamboo's uses by Bahnar people. This list is based on my and other scholars' observations. Terms marked with an asterisk are utilizations of bamboo that other authors have described.

What is more, speaking of bamboo-based professions or practices reflects two things. On the one hand, all professions shown in Figure 78 are, strictly speaking, activities involving a human-bamboo entity. Each task requires the engagement of the human body and bamboo. Such professions, then, have to be understood as performances, as something that consists of the human-doing-something and by the human involving her/his material counterpart. On the other hand, when conceiving such practices in their relational matrix to the whole bamboo culture and shifting cultivation and underpinning their cumulative use, this subject provides a more remarkable substance, effect, and impression of bamboo. In this light, when understood as a social phenomenon, swiddening is linked to human individuals' intersubjective as well as interobjective interaction. For one thing, these are human-human interactions, and for another thing, human-nonhuman interactions (and may also be called human-object interactivity). In any case, the social is continuously reproduced through humans and nonhumans.

Accordingly, this section has shed light on the bamboo-based material backbone of Bahnar swiddeners' life. In doing so, it has proposed envisioning practices as professions and that these professions depend on certain artifacts. Therefore, this section's underlying goal was to illustrate how practices and everyday activities are connected to bamboo and in which manner the former two are anchored in the lives of Bahnar people. Moreover, its goal was to describe the multiplicity of Bahnar swiddeners' roles in the sense of carriers of practices. Needless to say, these practices are no absolutely self-contained practices but cross over into other practices. Simultaneously, the entire life as a swiddener could be conceived as a practice or social phenomena in a sense that the "constellations of individuals (including actions and mental states) and artifacts" (Schatzki 2002, 68) maintain the social phenomena of swiddening. Such a conception of a social phenomenon, however, would contradict orthodox social ontological concepts according to which intersubjective constellations of humans alone are responsible for the persistence of social phenomena. As a consequence, and since this section's effort was to describe practices as human-material arrangements, it had an *a priori* approach of how to conceptualize the social practices because it implies a focus on the human-centered relation of the human-bamboo relationship of swiddeners.

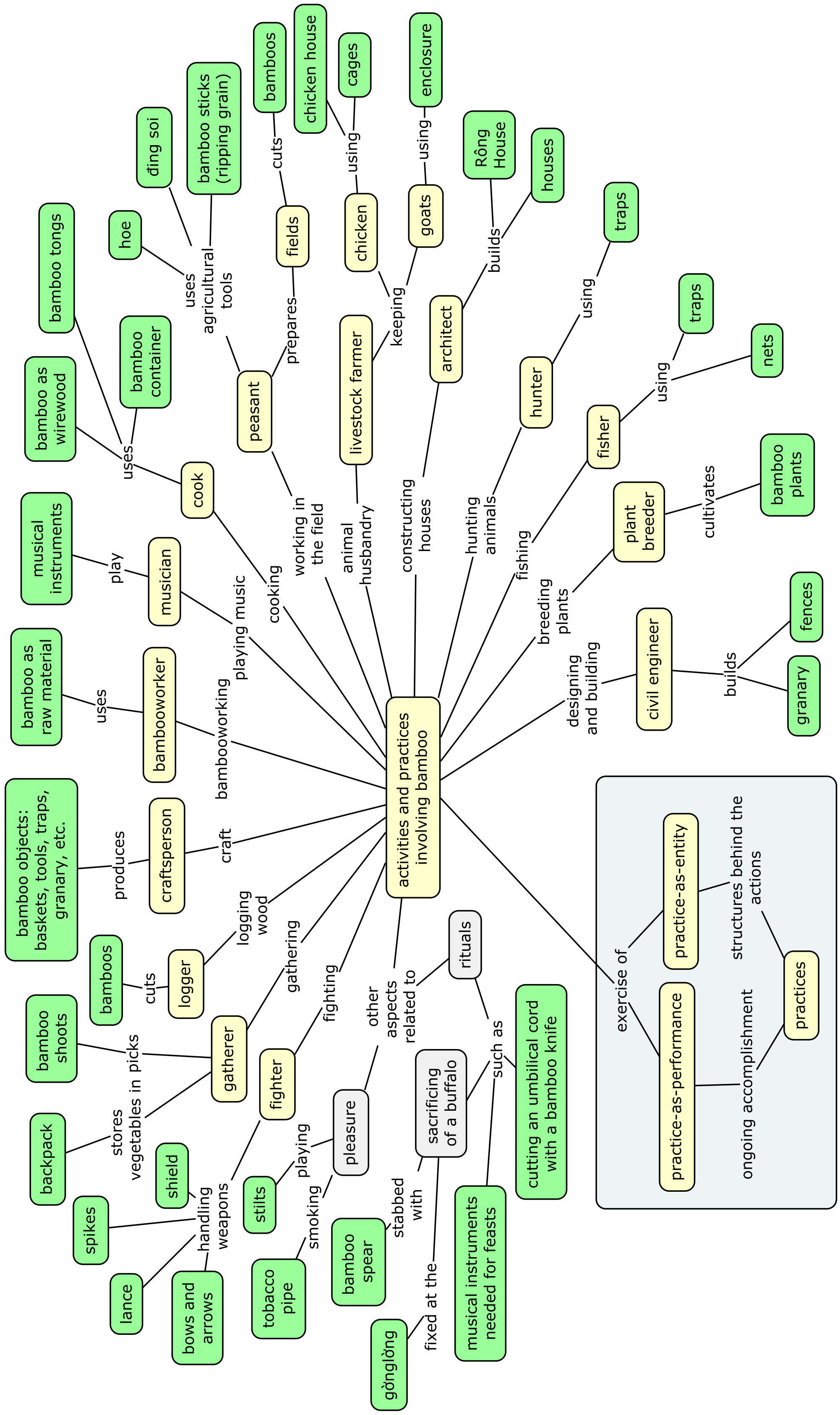

Figure 78 Practices related to shifting cultivation.

Yet, in view of the fact that nonhumans play a decisive role in extended networks—which in some cases are not related at all, or if so only a little, to human activity or practices—it became necessary to represent their effects on and interdependencies within a network by means of ANT. This additional view will be the subject of the following chapter.

7.6.3. Actor-Network Perspectives

Before discussing the connection of bamboo culture and shifting culture and a traditional stilt house as conceived as a network in the next two subchapters, it is necessary to put aside the misleading conception of humans as the only bearers of the social. The previous subchapter has already indicated that practices are limited in their analytical scope when having the human subject as the only bearer of agency. Agency, in practice theory's view, only comes to the fore when humans act. If there is no acting human to be positioned at a place where something happens, ontologically spoken, in practice theory's view, nothing happens. Accordingly, the social is only to be found when humans are active participants in interaction.

On the one hand, it is the human being that forms her/his life in interpersonal interaction with other humans and by means of tools and objects required for practices. This view is wrong in one way and true in another. It is true because, in her/his interaction with other humans and as a norm-following individual, the human being is a *homo sociologicus* and a *homo faber*, a tool-using human (tool-using animal). In both cases, the human is the main actor, the *homo practicus*—that is, the carrier of practices (Nicolini 2013, 4). She/he is the *homo agens*, the acting human, and thus, the core center of the action.

On the other hand, it is wrong because narrowing the focus to the *homo agens* limits agency to humans. In this manner, one is unable to see or sense what is going on all around oneself because one cannot see how nonhumans contribute to the creation and stabilization of the social. A human-centered view betrays the nonhumans and neglects their potential agency that is manifested in their interaction with humans and nonhumans. Latour summarizes these problematic issues as follows:

> Action should remain a surprise, a mediation, an event. It is for this reason that we should begin, here again, not from the 'determination of action by society,' the 'calculative abilities of individuals,' or the 'power of the unconscious' as we would ordinarily do, but rather from the *under-determination of action*, from the uncertainties and controversies about who and what is acting when 'we' act—and there is of course no way to decide whether this source of uncertainty resides in the analyst or in the actor. (Latour 2005, 45)

Once more, Latour urges us to be open to all heterogeneous elements of a network. The human and nonhuman actor should be the narrator and provide information about its participation in the network or its effect and not the biased analyst. In other words, social life cannot be fully understood and explained if nonhumans' full range of agency is excluded from analyses. In the context of agency, Latour once again explains his understanding of the term actor: "An 'actor' in the hyphenated expression actor-network and not the source of action but the moving target of a vast array of entities swarming toward it. To retrieve its multiplicity, the simplest solution is to reactivate the metaphors implied in the word *actor* that I [Latour] have used so far as an unproblematic placeholder" (ibid., 46). Accordingly, an actor is a unit that intervenes in the world in a modifying way. For that reason, ANT's well-known phrase used to express its methodological position is to "follow the actors" (ibid., 29) and how they durably entrench relations.

As discussed in chapters 5.6 and 12.1, in ANT's view, agency is distributed throughout a network. Humans coexist with nonhumans, and both entities' reciprocal relation frequently reproduces agency. Although practice theory and ANT proclaim, or have to be thought of as, flat social ontologies, and even though both emphasize the decisive role that things have by considering their constitutional functioning, both differ in their conception of agency and symmetry. The commonalities and differences of both theories are discussed in chapter 5.6. Here, by following ANT's empirical and analytical approach, I shall trace how nonhumans' agency comes into play in human-nonhuman and nonhuman-nonhuman constellations and how these are essential in maintaining the Bahnar people's everyday life. Accordingly, the post-humanist actor-network approach provides some opportunities to describe the manifold interrelations that come to the fore when elaborating the human-bamboo relationship and, in doing so, to trace the agency of nonhumans. And by ascribing agency to nonhumans, they become part of the social.

As a matter of fact, shifting cultivation, bamboo culture, practices involving things, and nonhuman agency construe the Bahnar swiddeners' lives. They are not the *explanans* but the *explanandum*. They must be discovered as the ingredients of Bahnar peoples' social life. For instance, shifting cultivation results from associations that render stable relations amongst the heterogeneous actors. Using ANT's network concept, I shall try to explain some associations related to shifting agriculture and bamboo culture. I understand the *network* here in Latour's terms, as "a concept, not a thing out there. It is a tool to help describe something, not what is being described" (ibid., 131).

7.6.3.1. About the Connection of Bamboo Culture and Shifting Culture

Through the liberation from the analytical view, the social in ANT's understanding is no more to be found in structure (or classes, institutions, or systems) but instead in the associations of heterogeneous elements. Latour defines "the social not as a special domain, a specific realm, or a particular sort of thing, but only as a very peculiar movement of re-association and reassembling," it is "a type of connection between things that are not themselves social" (ibid., 5, 7).

During my first field trip in 2012, I could only partially recognize the heterogeneous elements involved in shifting agriculture. Only after 2012 and during my second field trip in 2018 did I gradually identify the various actors. On the one hand, it is the human individual acting meaningfully, intentionally, and purposefully when she/he cultivates the fields, creates and uses tools, interacts with other humans and animals, or performs all the practices mentioned above. On the other hand, it dawned on me that some effects came from directions where no human being's actions are directly involved.

Figure 79 is intended to depict how various entities form an actor-network related to shifting cultivation. The figure illustrates how human and nonhuman entities build the network and highlights their mutual determination and dependence. I shall refer to it as the shifting-cultivation network (ShiCu-network) for the sake of linguistic simplicity. For a better representation, I have clustered the various entities into the following categories: *natural phenomena, staple food, natural environment, farmland, time, animals, material surroundings, bamboo culture, nonlocal (human) actors and ideas, the Bahnar swiddener(s),* and *shifting cultivation*.

In view of a symmetric approach to agency and a flat social ontology, one can describe various actors' actions by analyzing their constitutional relationship for a network. The way they modify others construes the network. For analytical access, various entities could be isolated, but if we study them isolated from the network, they tend to lose their capacity to act—they lose their agency and their capacity to be actors. In this way, they would become actors without a platform or stage and other performers. They would even stop acting because their agency only comes to the fore in their incontrovertible and undisputable frequent encounters with others.

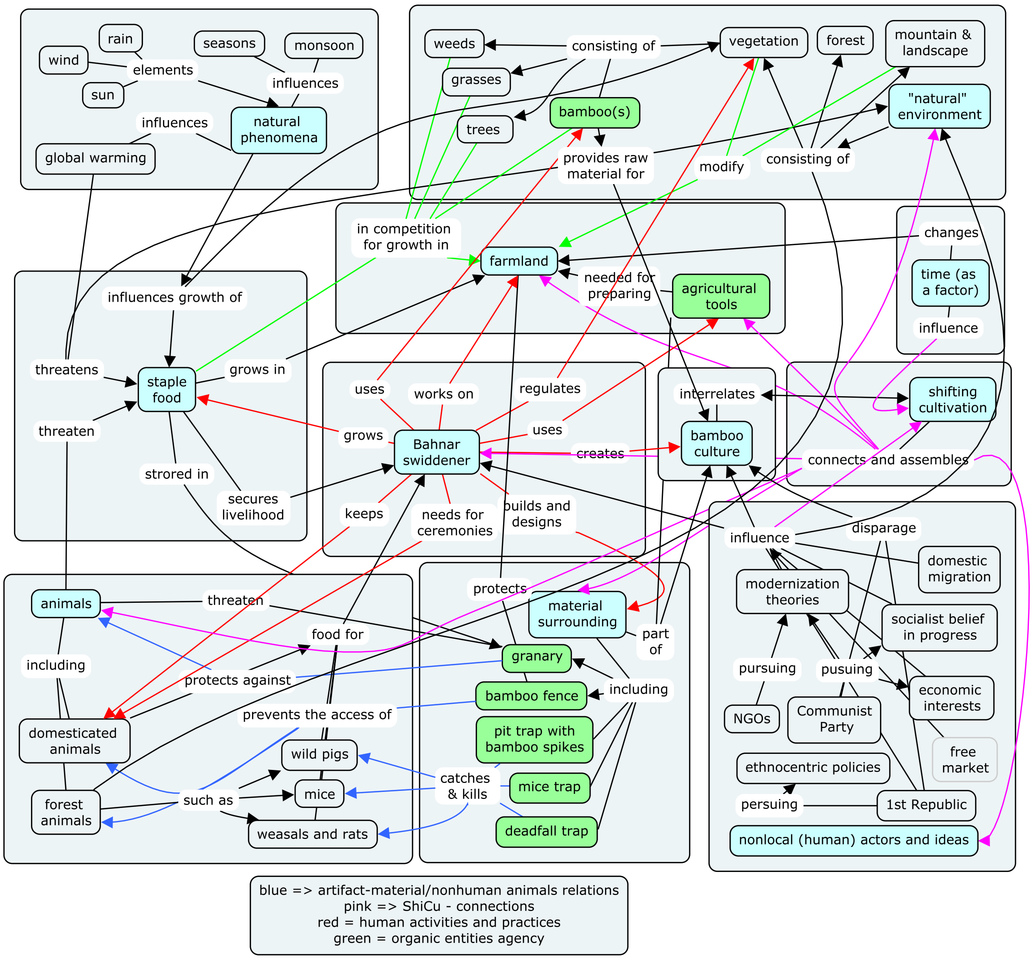

Figure 79 A network consisting of various human and nonhuman entities with a focus on shifting cultivation. For better access to the figure, the various human and nonhuman entities and effects are categorized into clusters in turquoise, and some relations are highlighted with colored arrows. The pink arrows departing from shifting cultivation indicate shifting cultivation's connection to these entities. The other colored arrows indicate a certain degree of agency: Red arrows represent the agency of the Bahnar swiddeners. Blue arrows hint at a bamboo artifact's (enrolled) agency. And green arrows stand for plants' and trees' agency.

Having reiterated ANT's basic vocabulary and methodological approach, I shall now first explain the methods carried out to create the actor-network in Figure 79 and after that describe the actor-network itself.

First of all, I began not with a predefined hypothesis but with theory-driven assumptions concerning the various entities creating actor-networks as proclaimed by ANT. Rather than focusing on the human agent, my entry point was an epistemological symmetric approach involving a complex amalgam of various entities without separating the social from the natural, economic, agricultural system, and political. As a result, this assumption is tailored to my research content according to which nonhuman entities equally shape the socio-material world. In order to find out and document how the nonhuman entities alongside the humans shape the ShiCu-network, I combined the methods mentioned in chapter 7.2.2. Above all, as an ANT informed ethnographer, I followed the actants and observed their translations in the research setting. Having shifting cultivation as my starting point and since the bamboo cultures determine, to some extent, shifting cultivation, I began to compile an initial list of all entities that appeared as significant and which potentially contribute to and stabilize a possible ShiCu-network. This list results from my observations, field notes, artifact analysis, photographs, and video recordings, an ANT-based socio-material analysis of historical and recent texts related to shifting cultivation, politics, and history, and from data obtained from interviews and conversations. Since I was able to take part in the everyday life of Bahnar swiddeners, I could also identify some of their daily activities, activities associated with agricultural work, and *professions* (as described above). Putting these human and nonhuman entities together created messy data. But after generating some coding frameworks and further interpreting, analyzing, and evaluating the various data sources and the entities' activities and connections, I gradually formed a clearer picture of the multilayered ShiCu-network.

This process, however, was marked by its iterative and concurrent character and entailed a constant comparison and interpretation of my data. Accordingly, my first data collection and analysis during and after my first fieldwork in 2012 was followed by a first socio-material analysis of historical and recent texts. Then, my second evaluation of my observations during and after my fieldwork in 2018 entailed a further analysis of historical and ethnographic sources. Finally, the last evaluation of my data collection and theoretical assumptions completed this process.

Now, in what follows, I shall describe the ShiCu-network in Figure 79. First of all, and in contrast to practice theory, the ShiCu-network has no center. It is not the human individual around which everything revolves. It is not the human practitioner who is the only actor. Agency results from the way all entities come together. For better representation and to capture movements, activities, and associations in the network, I highlighted some actors' relations with others. The pink arrows departing from shifting cultivation indicate how shifting cultivation connects various entities. The red arrows represent the practices and activities of the Bahnar swiddeners. The blue arrows hint at how bamboo tools and the built environment interact with other entities. The green arrows stand for plants' and trees' agency related to the farmland. Not all entities' modifying effects are colored but are depicted with black arrows. Moreover, the network illustrated here encompasses only a limited number of entities and some aspects of their agency.

In the following, I shall describe the relations amongst the diverse actors as components of the network through the categories in Figure 79. And how the arrangement and interconnections of people, tools, organisms, animals, natural phenomena, ideas, artifacts, things, and the like construe the ShiCu-network.

Natural environment: As explained in chapter 7.3, the environment's modification encompasses not only the swiddeners' actions to manage the farmland but likewise plants' and trees' influence on the farmland. Here, I shall particularly emphasize how the bamboo plant is related to shifting agriculture. There are two main aspects in this context. First, bamboo's fire resistance plays a decisive role since the plot's burning and clearance are crucial elements of shifting cultivation. Second, the bamboo plant competes with other plants, grasses, trees, and staple food for nutrition, sunlight, and water. In turn, both aspects are based on bamboo's inherent plant architecture and structural composition, such as its rhizome system, its growth habit, aboveground appearance, and reproduction. In chapters 1 and 7.3, I have demonstrated these characteristics. What is of interest here is how these characteristics play their role in the ShiCu-network. Since bamboos tend to have aggressive growth, they modify the growth of other plants, the soil structure, and the topography of the farmland. From an unbiased analytical view, the bamboo plant (as one nonhuman entity) and other grasses, plants, and trees (or other nonhuman entities) develop reciprocal ties in their scramble for growth and contribute to the shape of the farmland. The environment's impact on the farmland, in turn, invokes certain activities of swiddeners, such as effective control of these organic nonhumans' growth patterns. For instance, Mr. Ninh and his neighbors must frequently limit the bamboo groves' growth situated above the hamlet to ensure that bamboos do not harm the farmland and crop yield. On the other hand, the same bamboos provide food due to their edible shoots and are an essential source of bamboo culms as a construction material needed for the bamboo culture. Accordingly, bamboos and their growth habits call for certain human (re)actions. What is more, other plants, grasses, trees, rice or corn plants, and weeds also must react to bamboo's aggressive growth. While the other plants must deal with bamboo's offensive growth in their competition for nutrition and sunlight, humans are forced to manage their farmland by acknowledging bamboo's botanical properties and its effects on other plants, the soil, and biodiversity.

Natural phenomena: The viewpoint of keeping nature, culture, and society in separate frames becomes problematic if we consider global warming and its effects on shifting cultivation. It becomes immediately apparent that global warming drastically affects the intensity of natural phenomena. In ANT's view, things like the ozone layer and global warming crosscut traditional definitions of nature and society (Latour 1993, 108) due to global warming's anthropogenic origins. Of course, natural phenomena such as rain, wind, and sun have immediate effects on the natural environment (including flora, fauna) and humans. They determine the growth of plants and equally of the staple food. If the equilibrium of natural phenomena continues to change significantly, these changes will have major impacts on food security. Heavy rains, especially during the monsoon period, threaten people's livelihood in Coastal but also Central Vietnam, as demonstrated by the disastrous typhoons in summer 2020. All of these effects and entities contribute to circular chains of action: Human-induced global warming affects natural phenomena. Natural phenomena affect plants. Plants' growth and resilience and crop yield affect human food security. And finally, the shift from shifting agriculture to permanent agriculture leads to deforestation and increases global warming.

Another aspect I shall briefly elucidate in this context is the interplay of tangible and semi-tangible material and nonmaterial substances of natural phenomena. Rain and raindrops are tangible; we can touch them. Wind is a semi-tangible entity, we may feel it blowing into our faces, but it is impossible to hold it tight in our hands. Sun or, to be more exact, the sun's rays are nonmaterial entities. We may feel the sun on our skin but are incapable of grasping it. What is obvious and self-evident is that independent of their materiality, these natural phenomena affect equally humans and plants, the plot, and so the success of shifting cultivation. In this light, and as mentioned in the introduction to this chapter, the interplay of fire and wind—thought of as an interplay of two non- or less tangible entities—plays a decisive role in the process of burning and clearance.

Staple food: Bahnar swiddeners mainly grow rice and corn. Their successful growth is critical for the peasants' food security, and it invokes activities needed for their protection because they are a *target* of many other entities. As explained above, natural phenomena and global warming threaten crop yields. Other members of the *Plantae* kingdom compete with rice and maize for nutrition, sunlight, and water. Since domesticated and forest animals constantly threaten the staple food, they compel the Bahnar swiddeners to protect their crops by building traps and fences to prevent animals from invading the plot. Here, too, some reciprocal chains of actions are to be found. Rice and corn plants attract animals. Animals threaten agricultural production. And humans must prevent animals from entering the farmland. Bahnar people's answer to the animals' threat is to set up traps and bamboo fences surrounding their farmland. One can indisputably say that animals' potential action induces humans to re*act*. Enclosing a plot with a bamboo fence, for instance, requires much time, effort, and labor. Loving (1976, 523) has this elaborated for the Awa people who must carry vast amounts of bamboo to their farmland to build fences round their taro gardens. It is not the immediate, but a perceived potential animal threat that forces the human being to perform certain actions—namely, building a fence using bamboo.

Farmland: The farmland is another hybrid thing. Humans and nonhumans shape it. It is the place where rice and corn grow. What is more, the farmland is also symbolically laden. It represents the Bahnar swiddeners' time and effort on account of the transformation of the primary or secondary forests to fertile agricultural farmland. Moreover, throughout the year, its maintenance, alongside the rainy and dry seasons (as part of the natural phenomena), determines agricultural life on a long timescale. This fact is affirmed by Mr. Ninh, who says that his entire life and daily activities follow the cycle of agricultural production. Another aspect related to time and the farmland is the ownership of it. Bahnar families only temporarily own the farmland and abandon it after using it for food production for two to three years. After that short period of agricultural use, the farmland is abandoned in order to recover.

Time: Time is an essential factor for farmers worldwide because seasons regulate agricultural life. Time can be measured by seasons regulating agricultural activities (such as sowing, weeding, or harvesting). Yet, in contrast to permanent agriculture, shifting agriculture correlates with the time factor, which goes beyond one or two years. A full cycle in shifting cultivation ranges from fifteen to twenty years (Tan 2006, 235), a considerable length of time in the human lifespan. Only after this time, when the farmland has grown to secondary farmland, is it worthwhile to re-cultivate the plot.

At a time when there were no calendars or other time-measuring devices, seasons indicated the time for Bahnar people. What is more, people determined important past events like birth, marriage, or death on the basis of their remembering when events correlate with the particular farmed plot.

Animals: Domesticated animals are part of the everyday life of the Bahnar living in the hamlets. These animals (hens, goats, pigs, and dogs) are the daily companions of humans. Both human and nonhuman animals maintain reciprocal dependence. Humans feed and breed animals, and provide them with shelter and safety. Humans build drinking troughs and fill them with water; they build henhouses for their hens and put soft bamboo shavings inside and keep hens in bamboo cages for transport. Animals, in turn, provide food (meat, eggs, grease, or milk) or leather for humans and, as sacrificial animals, are necessary for many ceremonies. As mentioned above, the threats of domesticated and forest animals (wild pigs, mice, weasels, or rats) reach to the core of shifting agriculture and food security. As a reaction to this potential threat to both the crops on the farmland and the staple food stored in the granary, Bahnar people set up material surroundings intended to protect their food in their own place.

Material surroundings: The material surrounding consists, amongst other things, of deadfall traps for weasels and rats, deadfall traps for mice, pit traps for wild pigs, and fences. All these devices are made primarily of bamboo, and they share a status as the representatives of their human creators. These human-made tools and devices are enrolled, inscribed, or endowed with agency—each responds to the respective animals, and each is programmed differently to prevent the respective animals from entering the farmland. On the one hand is the bamboo fence. It is a pacifist entity that hinders pigs through its sheer material steadiness from further progress and forces them to change their path. On the other hand are the unpacified, hostile traps. They are created and designed to catch and kill animals and so also provide an additional food source. Simultaneously, the creation of bamboo fences and traps invokes time and labor. In this view, labor associated with shifting agriculture cannot only be measured by the agricultural work but by all other necessary activities to ensure the successful growth of crops.

The fences, traps, and the granary are mainly made of bamboo, and their design and function are more or less related to animals' threats and behavior. The deadfall traps catching weasels, rats, and mice have a specific design geared to the behavior and size of the animals they are intended to catch. The bamboo fence's shape and design are adjusted to the wild pigs' body size, strength, and behavior. If the bamboo fence meshes were too large, pigs might effortlessly enter the farmland. Conversely, if the meshes are small, this will correspond with more material (bamboo culms) and more working hours (for felling, transporting, splitting, and installing the bamboo fence). A pitfall trap to hunt pigs, for instance, requires a certain depth and volume related to the size of wild pigs and the length of the deadly bamboo spikes.

The granary's shape could also be conceived as a human answer to some animals' cognitive and bodily capacities and their potential disastrous threat. The granary is not only closed by bamboo walls hindering rats, weasels, and mice from entering; it is set up on large diameter bamboo culms that prevent these animals from climbing vertically. The stilt construction, however, is also necessary for rainwater to flow beneath the granary's floor without harming the stored staple food, which indicates, once again, the influence of the natural environment on vernacular construction designs.

Bahnar swiddeners: The Bahnar swiddeners are neither in the center nor on the periphery of the ShiCu-network. Studying their lives entailed following the associations of the network because these are "part and parcel of what makes the group exist, last, decay, or disappear" (Latour 2005, 32). Nonetheless, if we analyze the ShiCu-network, it becomes apparent that humans and nonhumans are equally stitched into the fabric of this network. And that they, independent of their membership of different spheres, add something to the network. However, this should not neglect the critical role humans have in maintaining the network. Without the intentional human transformation of forests into agricultural land, their creation of the bamboo culture, shifting agriculture would simply not exist. The human being has the initial idea and strives to cultivate the land for agricultural production, yet not all agency is centralized in the human subject.

In this sense, humans' actions, activities, and practices, whether intentional and deliberate or unintentional and non-deliberate, are frequently oriented and adapted to the way nonhumans behave, act, or add something to the network. In a way, humans react as an apparatus of resonance to nonhumans' actions, and nonhumans react to humans' actions.

A swiddener's tasks and activities related to shifting cultivation are manifold. The peasant families spend hours of time both on the transformation of farmland into a cultivated plot and further hours of agricultural work on sowing, planting, weeding, and harvesting of the crops. Weeding, for instance, is considered one of the most labor-intensive activities among all the tasks necessary for dry rice cultivation (Barker et al. 1982, 28). From an analytically free view, rice plants and other weeds are entities on their own, having various growth patterns and so varying success in growth. However, humans interfere when weeds emerge and remove them from their farmland to support their rice plants' growth. It becomes evident that weeds infiltrate the peasant's farmland and call for human action. So, these peasant-rice, rice-weed, and human-rice-weed interrelations stand for a human-nonhuman-nonhuman relationship. In the sense of ANT, agency is distributed amongst all these entities simply because the entities alter others' activities. If weeds are allowed to grow, the rice plants must share nutrition, sunlight, and water with them. But at the end of the harvest, rice plants will produce a smaller yield compared to a harvest with previous weeding. However, this human-vegetation relationship is only one amongst others of such kind.

Bamboo culture: One key element of the ShiCu-network is the bamboo culture, which could be conceived as a network itself and is explained in the previous chapter. As mentioned above, bamboo culture is an assemblage of i) multiple human practices including the human body, know-how, tool use, and skill; ii) bamboo as a plant, raw material, and construction material; iii) all human-made bambooic tools, objects, and the built environment; iv) and humans' activities oriented on, modified by, adapted to bambooic things.

In the domain of land cultivation, specific agricultural tools (as part of the bamboo culture) are employed for certain agricultural work tasks. Amongst the tools are the machete (to cut bushes, branches, bamboo, and small trees), long bamboo sticks to separate the rice grains from the plant, bamboo baskets of various designs and shapes for transport or rice and corn storage, a bamboo stick to dig holes for the seeds, or the bambooic *đing soi* (seed containers). Though these tools are simple, they are appropriately adapted to the farmer's needs. What is more, their design and use are not only geared to the human body, skill, or muscle power alone. Bamboo's inherent material properties equally shape and design tools. And other entities and their material interconnections are involved, too: This can be the soil and its penetrability (softness or hardness) related to the digging stick's stiffness. Or it can be the seeds, while their size and growth habit define the planting holes' diameter and depth, or the storage containers' size and capacity. Or again, it can be the branches' and trees' properties (size, age, or hardness) related to the machete's handling for cutting and felling.

The traps mentioned above, the fence, and the granary (as part of the material surroundings) belong likewise to the bamboo culture—just like the traditional bamboo house, the tomb house, and virtually all material counterparts of the human practitioner illustrated in Figure 78 and all things listed in Figure 77. While life as a swiddener calls for certain actions, the bamboo culture provides the material bedrock to carry out most of the practices required for shifting cultivation. Both swidden agriculture and bamboo culture have various entangled lines that constitute each other.

Nonlocal (human) actors and ideas: One principle idea of the Actor-Network position is that agency is distributed amongst its actors. In turn, this distribution is linked to ANT's notion that neither micro- nor macro-level are clearly distinguishable units of an inside and outside.

The network is flat because it follows the associations. In this view, nonlocal (human) actors and ideas are equally associated with the ShiCu-network. On the one hand, there is the Communist Party, NGOs, and the First Republic, all represented by human actors in persona, affecting Bahnar people's lives. On the other hand, there are abstract, intangible ideas, theories, economic interests, constitutions, political decisions, the socialist belief in human cultural and technological progress, modernization theories, and the like—with no lesser influence on the Bahnar and their lifestyle. Though the latter do not exist physically—they exist only in people's minds or texts—they have significant influences on the bamboo culture or shifting cultivation. I already elaborated on the influence of the socialist idea of development and the First Republic's ethnocentric policies and their effects on shifting cultivation in chapters 7.1.1 and 7.3. If people assert that bamboo is an inferior material and attribute poverty and backwardness to it, they modify the perception of bamboo. And if people say that shifting cultivation, which they pejoratively refer to as *slash-and-burn* cultivation, is an underdeveloped form of an agricultural system, they modify the perception, acceptance, and success of it. Even in the bamboo handicraft village in Xuân Lai, most people tend to possess expensive wooden furniture made of tropical wood instead of bamboo due to the latter's bad reputation.

The free market provides industrially fashioned tools and commodities with gradually increasing penetration into the hamlets. Villagers, for instance, already use motorbikes and chainsaws to fell and transport trees from the forest, while those in the hamlets still work with their own physical strength. Needless to say, the acquisition of new commodities will change the bamboo culture and shifting culture drastically. Currently, industrially fabricated clothes, plastic containers, shoes, polypropylene bags, corrugated sheet iron, or tarpaulin have redesigned Bahnar material culture not only in the hamlet or Kon B'Rrăp village but throughout the Central Highlands. Indeed, the decline of the bamboo culture is an ongoing process, and the more new commodities come from outside, the more the material culture changes, the more people's lifestyle changes. If materials, tools, artifacts, the built environment change, practices geared to, depending on, and related to them will change and *vice versa*.

Finally, domestic in-migration (which also can be analyzed as a network itself) profoundly impacts Bahnar people's lives. Chapter 9.2.2 addressed the issues related to the in-migration effect as a major threat to Bahnar people maintaining their lifestyle and ruling over their ancestral land. Though in-migration offers several opportunities, it will most likely significantly modify the Bahnar people's (im-)material culture and society.

7.6.3.2. A House as a Network: Nonhumans at Work

Figure 80 Bamboo stilt houses of Bahnar people in the Central Highlands of Vietnam.

In this subchapter, I will exemplify once more how heterogeneous entities shape and contribute to a network. Here, I shall depict the traditional Bahnar stilt house as my starting point, that is, by conceiving it as a network. In so doing, I intend to elucidate how diverse actors come into play and intervene in the network process. To pursue this goal, I have explored two perspectives. First, I asked how residents and the bamboo house are connected with other nonhuman entities and represented their interconnectedness by Figure 81. Making this connection explicit, I refer to how the nature of a given material entails changes in human action. Hence, I elucidate such shifts through the thatched roof's replacement with a corrugated galvanized sheet and its effect on the living in bamboo houses. Second, I take a closer look at how the open hearth inside a bamboo house is related to residents' activities, the house style (and its relation to bamboo), smoke, and mosquitoes, as represented in Figure 82. Finally, as emphatically highlighted by ANT, I briefly emphasize the ephemerality of networks.

In this context, I attempt to use ANT's symmetric approach of following the associations to explain how these heterogeneous entities are interconnected. Such interrelated mechanisms of action and constitutional relationships are outlined below and will serve as a case study for the constitution of other human-bamboo relations. But I shall first briefly describe methods I deployed to determine the various entities and how they conflate, as depicted in Figure 81. Similar to my approach to the ShiCu-network, my entry points were theoretical considerations and a less human-centered evaluation of all entities mobilized in the network related to the bamboo house. First of all, I noticed many aspects, relations, and entities, as illustrated in Figure 81 alongside the various activities carried out in and around the residential houses during my first fieldwork in 2012 and my participant-observation. As a result, I compiled a first list of the house components, categorized its material components in my field notebook, and took photographs and made video recordings of the house. After my fieldwork, I analyzed my data and re-evaluated them before my second fieldwork started. Then, in 2018, I interviewed the residents concerning the house's construction, durability, style, ownership, function, and the like in order to gain further information; in the process, I took additional photographs and made an initial sketch of the socio-material network built around the residential house and discussed my preliminary findings with Mr. An Nguyễn Ngọc and Mr. Ninh. After my fieldwork, I compared my findings with other ethnographic works and finalized the multilayered network as shown in Figure 81.

In chapter 7.4.4.1 on the residential houses, I have already described the basic architectural principles of a traditional Bahnar bamboo house. As illustrated in the photographs in Figure 80 and the figures in chapter 7.4.4.1, stilt houses are built on wooden poles, while their walls, floor, doors, room dividers, and parts of the roof are made of bamboo. In general, bamboo houses have a common basic design, but each house differs slightly from other neighboring houses. As explained earlier in chapter 5.3 (on the concepts of materiality) and later in chapter 7.6.1 (on bambooworking), manipulating bamboo's materiality is always a *becoming* (or process, creation) related to a material's inherent properties. In this light, a residential house's architectural design results from an interplay of a chosen tree's or bamboo's quality, the topography, environmental condition, and human activities such as skill, bodily involvement, know-how, aesthetic value, tradition, and the transmission of know-how from generation to generation. Likewise, a house's lifespan is determined by factors such as the builder's know-how, the material's qualities in terms of decomposition, a house's siting (mountain slope), and exposition to natural elements (rain, wind, humidity, sun), or insect infestation.

First of all, a house offers shelter for its residents and is also a social place where people meet, gather, cook, live, sleep, rest, and communicate. At the same time, it is also a (bamboo) workshop necessary to fabricate tools or other materials. The traditional bamboo house is plant-based since all its building materials derive from the forest or the bamboo groves. The residents collect the building materials and transport them to the place of construction. The ability to construct a house with the existing, local sources and possibilities endows its builders with self-determination and self-empowerment. They are capable of building their house with materials offered by their natural environment. Which, in Mr. Ninh's words, is a *gift of nature*. And it is again bamboo that serves as one key element for the house's construction.

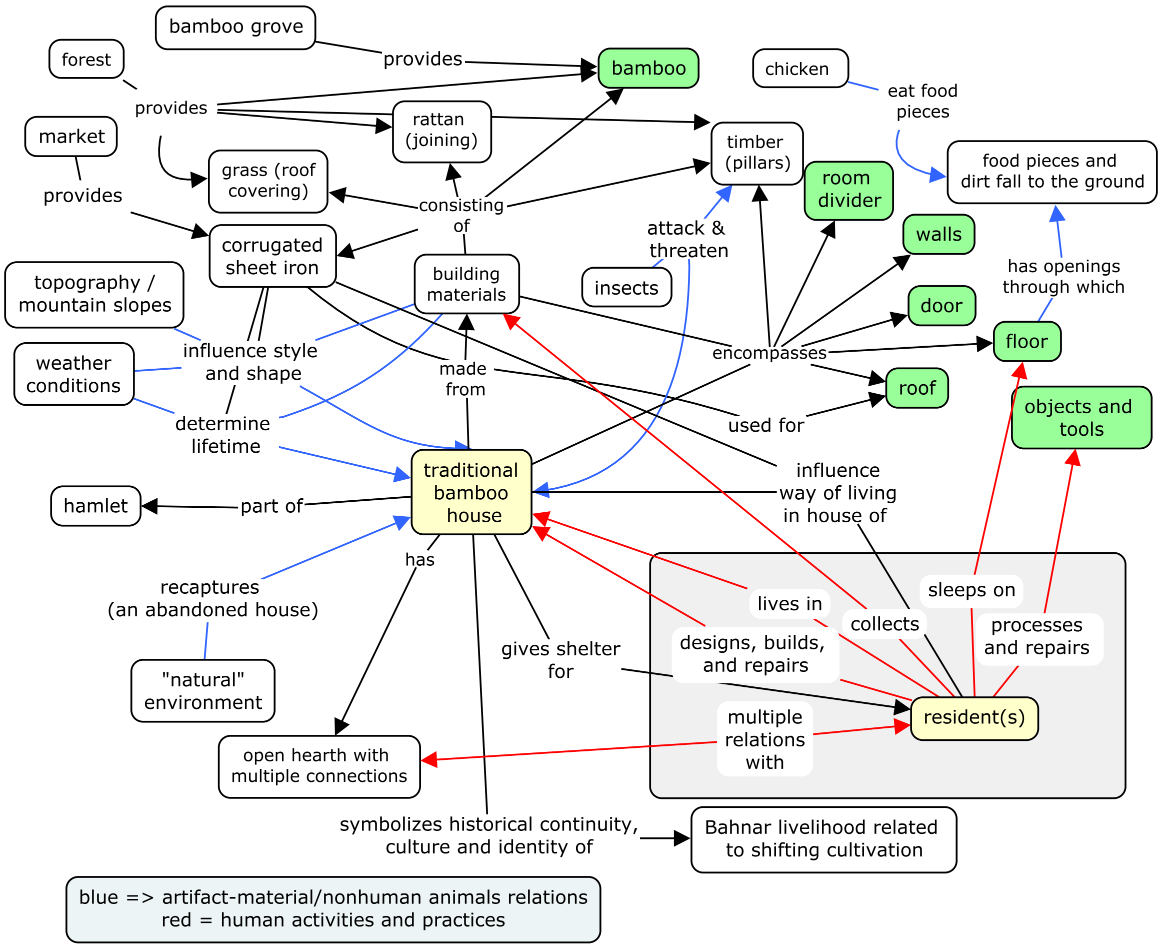

Figure 81 A network of nonhumans with a focus on the bamboo house.

Being an organic building means that the residential house's use and lifespan are limited in time. After about ten to fifteen years, the house's materials start to deteriorate significantly, and new houses must replace them. At the same time, the residents may repair or exchange damaged elements such as the floor or renew the thatched roof if necessary. If a house is abandoned, nature reclaims the house, and after a specific time, no traces of its earlier existence will remain.

When analyzing the principles for the collapse of a house, many entities come into play. The collapse might be human-induced when a house is flimsily built or trace back to nonhuman entities, such as starch-eating insects damaging the pillars or natural phenomena (e.g., lasting harsh weather circumstances). Or a collapse is caused by the ephemerality enrolled in bamboo. Hence, even though being a human-made artifact, the house is governed by nature on the basis of natural laws. The house's organic components (bamboo and other vegetal sources) follow natural laws that determine a house's durability, stability, or appearance. A fact also explained by Schatzki when he states that “the physical properties of its construction materials, according to which it [the house] bears weight, withstand blows, liquefies under certain conditions, and the like, are facts of nature” (2003, 86). Overall, the reason for a breakdown may lie in the interplay of all entities in question. To reconstruct how different entities exert influence on the collapse one must each time examine all possible entities’ contributions. What cannot be denied is that nonhuman entities from different spheres influence the house, its structural integrity and lifespan, and indirect human actions, and the life in and with a house.

The floor is another significant part of that network. In ANT’s view, such an entity, when conceived as an actor, does not have to act like intentional humans for agency to be attributed to it. The question is if the floor has some effects on others. Suppose the answer is yes, then it is worth scrutinizing its role in the network. And indeed, the floor has several roles and implications: The floor’s openings, for instance, guarantee a permanent airflow into the house, which is necessary due to the open-hearth continuous smoke production (see also depiction in the next subchapter). The floor’s openings also allow food pieces and dirt to fall to the ground, which has two beneficial consequences. First, from a hygienic point of view, dirt and food would attract insects. Second, the food pieces falling to the ground serve as additional nutrition for the chickens that pick them up. Another crucial aspect is related to bamboo’s flexibility, which is also incorporated in the floor’s properties, allowing its residents to sit and sleep comfortably. Of course, these facts appear self-evident and plausible, but they gain importance because they impinge on people’s very way of life. A good night’s sleep, for instance, is something fundamental and important for people’s recovery and health. If compared to a wooden floor, sleeping on the soft bamboo floor is comfortable and does not require a slatted frame since the bamboo floor functions as a slatted frame.

Another example of how materials shape human life is elucidated in the following. While Mr. Ninh’s house’s roof was made of grass in 2012, in 2018, he made a roof of corrugated sheet metal. Replacing the one with the other involves several aspects. Not only do new materials give new impulses to the traditional material culture and redesign it, but they also implicitly affect people’s lives. The corrugated sheet metal, for instance, generates, modifies, evokes, and causes certain human activities. Since it is lightweight, it is easily transported by human power along narrow paths to the hamlet. Compared to a thatched roof, the new material diminishes the time required to maintain the roof. Its residents must no longer collect grasses, dethatch the roof, and recover it with new grasses. The corrugated sheet metal simply reduces time and effort. On the other hand, it impacts the way of living in a house. In contrast to an organic roof, the metal is a poor insulator. As Mr. Ninh's indicated, during colder seasons, the metal roof does not keep the warmth inside the house, and during the hot, dry season, it is inadequate protection against the sun's heat. It is self-evident that both aspects modify the way people live in the house. To reduce both effects, some Bahnar tend to cover the metal roof with grasses again, as shown in the right-hand photograph in Figure 51.

Another unintended aspect occurs during heavy rains. While the grass roof consists of several layers and is itself soundproofing, the corrugated galvanized metal functions as an amplifier of raindrops. The volume during heavy rain increases to such an extent that communication in house changes. If one was previously able to speak at room volume, one is forced to adjust one's voice and speak louder as the volume increases. Hence, the metal roof correlates with the noise inside the house. It interferes with the intelligibility of speech and causes new effects on the way people communicate.

Following ANT's view, I describe a house as a network. One association that I have not yet mentioned is the open hearth and its property to be both an actor and network. On the one hand, the open hearth is one of several actors related to the residential house. On the other hand, it is a network itself because of the assembling of various other entities, as illustrated in Figure 82. Overall, the open hearth is a multifaceted entity. It produces warmth and light, necessary for the residents to live comfortably inside the house. It is the place around which people gather, share time, sleep, and communicate. It produces heat for cooking. And, as described earlier in chapter 7.4.4, it produces smoke whose intensity, in turn, relates to the bamboo floors' and walls' small gaps and openings that allow air to circulate. At the same time, the smoke itself has multiple functions. On the one hand, it protects against insect bites in the house and outside the house since its residents carry the scent of fire and smoke and are less attractive to insects. On the other hand, the smoke serves to preserve and cure bamboo shoots, bamboo strips, and other things put in a basket with large meshes situated above the grate hanging over the hearth. The analysis of the traditional bamboo house and the function of the open hearth is once more based on ANT's symmetric, socio-material approach that conceptualizes agency as something brought about in a multilayered field that does not necessarily involve humans in its epistemological approach and, so, allows tangible, less tangible, and nonmaterial things to be described at the same time. The methods applied to describe the network illustrated in Figure 82 and the evaluation of the collected data are the same as described above in relation to Figure 81.

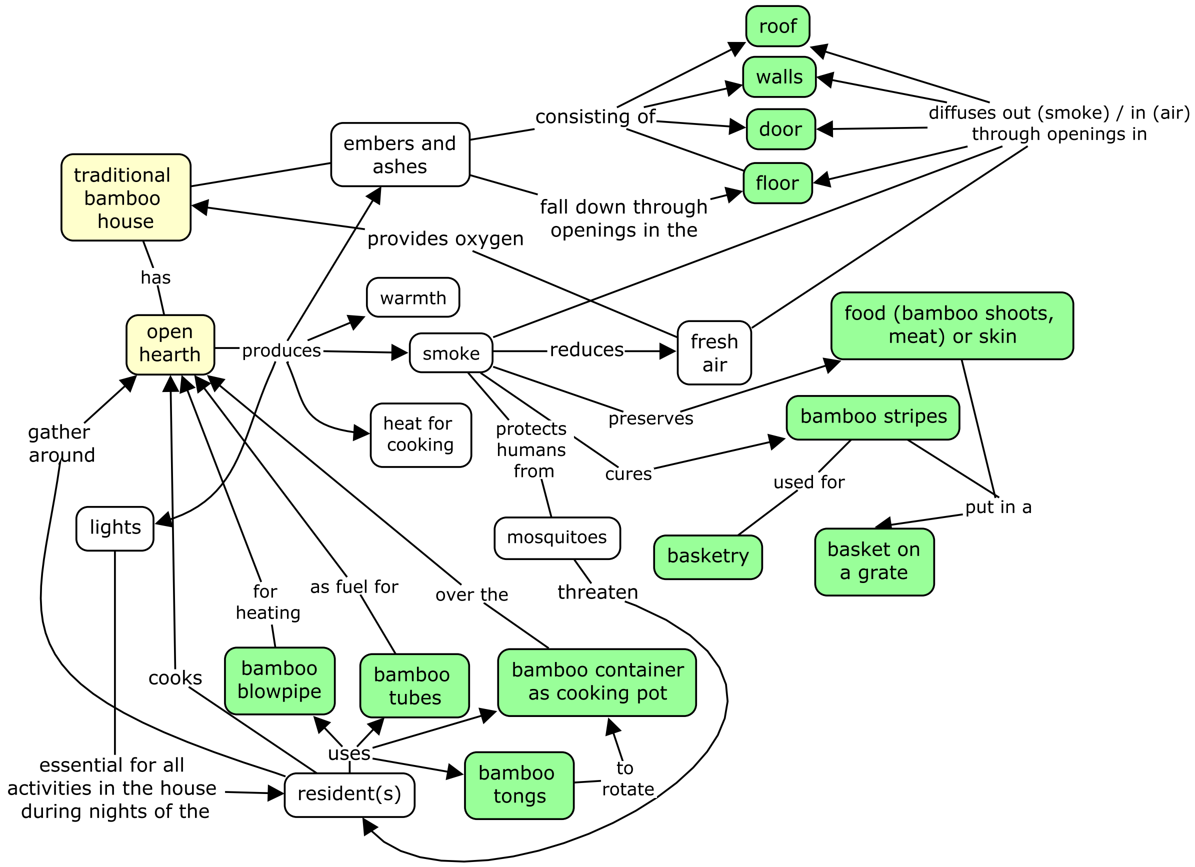

Figure 82 A network of nonhumans with a focus on the bamboo house and open hearth. Interconnection of the bamboo house, the open hearth, smoke, bamboo, residents, and mosquitoes.

To sum up, the two documented networks (the ShiCu-network and residential-house network) represent human-nonhuman relations of different intensity and scope. They also demonstrate how intense such relations are and how materials shape everyday human life. This point became obvious through the above discussion of the corrugated sheet metal's implication on the residents' life. The involvement of new actors, such as the metal roof, brings forth new types of associations and (human) actions. A point I clarified by depicting the ways organic and metal roofs behave and how they contribute to and modify the network. More emphatically formulated, a network is not something fixed, immovable, or static, but "the brief moment when they [entities] are reshuffled together" (Latour 2005, 65). It is a phenomenon of only short duration. A network exists only from one moment to another, depending on how the actors are capable of developing durably entrenched relations. This view stresses ANT's position that the social results from various actors' actions and agency capability. I tried to exemplify this principal position by describing the bamboo house as an actor-network and examining its associations. It also verifies that an actor's replacement implies minor or major changes in how other entities act. Therefore, a change of the material culture by introducing other materials, such as tarpaulin or polypropylene bags, affects how people act and live because new human-material relations arise. What becomes clear is that materials are inevitably linked with the way we live, and that changes in the material composition caused by new entities provoke other entities to react to the new players' actions. Using new materials also underscores material cultures' dynamics, vulnerability, and change. It equally underlines the strength of the network concept that emphasizes following the associations of the network if one's attempt is to find interrelated and less implicit effects on the network.

7.7. The Human-Bamboo Relationship of Bahnar Swiddeners

In this chapter, I discussed the bamboo culture of subsistence-oriented farmers in mountainous regions based on my ethnographic observations and data collection of 2012 and 2018 in combination with other scholars' ethnographic and historical works. In this sense, this chapter ought to be partly anthropological and partly historical in its orientation. While my data collection may be considered an ethnographically designed collection of Bahnar swiddeners' contemporary bamboo culture, the historical references add further information on that subject.

In the following, I will outline my findings of the characteristics of the human-bamboo relationships of Bahnar swiddeners and conclude with a brief reflection about how their future is determined by external factors and what possibilities bamboo offers. For a better understanding, I have structured the individual points and insights into the topics marked by the keywords in italics.

Bamboo Culture, Swidden Agriculture, and Swiddeners' Relation to the Forest

My discussion of bamboo's manifold connections to Bahnar swiddeners' life is predominantly based on my observations at the hamlet and relating to its residents' activities. This discussion proposes to provide the groundwork for a comprehensive examination and understanding of bamboo's implication in people's lives and their bamboo culture. As my findings have shown, shifting cultivation, as described here, is linked to bamboo and bamboo's multifaceted use in Bahnar people's everyday life. By implication, a Bahnar's individual and the swiddeners' collective persistence are located in bamboo's availability, presence, and its versatile uses—though more in the past than in the present, bamboo is still part of almost every material aspect of life: bamboo accompanies Bahnar swiddeners from birth to death and is part of their material culture, rituals, and customs. It has also found its place in language, as demonstrated by the term *akol,* referring to bamboo's nodes and a human hand's knuckles.

In the pre-industrial era, a Bahnar swiddener's daily actions, practices, rituals, or world view was marked by her/his relation to the environment. The surrounding environment was nothing distinct but an integral part of daily activities—as demonstrated for the residents of the hamlets. Their agricultural method is shifting cultivation, which is less the mere cultivation of crops than agroforestry that corresponds to the environment and implies a long period of use.

Ethnic groups residing in the Central Highlands have their own perspectives on the world. In the Bahnar people's spiritual culture, for instance, "the world consists of human beings, supernatural spirits, and souls of the dead and associated with polytheism" (Đao et al. 2011, 119), and rocks and trees are perceived as being alive (Guilleminet 1952, 423). Concerning the Sedang's non-exclusive concept of the pronoun *us*, Vạn notes that it includes the forest, streams, plants, and everything that makes up the infrastructure of the Sedang's social environment, which is intimately related to their lives. Accordingly, the Sedang refer to natural nonhuman entities as if they were their close relatives and protect their forests (Vạn 1998, 166). Vạn's comments about the Sedang's perception of their environment are very similar to that of the Bahnar, who perceive wild animals like themselves as forest dwellers and, so to speak, of the same nature as themselves (Guilleminet 1952, 421). Đao et al. write that Bahnar people's "mindset is that of the forest" because "they live in the forest, mingle themselves within it and find every single demand satisfied by the forest or connected to the forest." (2011, 3). The authors also describe the Bahnar metaphorically as "jungle eaters" because "the forest is . . . the source for most of the everyday life necessitates such as timber, firewood, materials for weaving, leaves for making liquor, vegetables, bamboo shoots, mushrooms, fruits, bulbs, animals, and insects" (ibid.). In sum, the natural environment is, particularly in contrast to Western concepts of nature and society, less marked by a clear differentiation between humans and nonhumans but by common grounds.

Social-Natural History: Bamboo Technology, Swidden Agriculture, and Bamboo Civilization

The Bahnar people's history is, to put it in Schatzki's words, "a social-natural history" (2003, 82). The Bahnar developed their immaterial culture, swidden agriculture, bamboo culture, and bamboo technologies based on their specific relation to their natural environment. In doing so, their primary source of power is the human itself; neither water, wind, nor animals are deployed as extra-human power sources. Simultaneously, the individual Bahnar swiddeners develop themselves and their skills in their physical entanglement with bamboo. In this regard, their bamboo culture and, more specifically, their bamboo technology must be considered as a human-centered practice-based and nature-related appropriate technology that is much closer to *technē* than to any kind of industrially fashioned technology. Moreover, the bamboo culture and bamboo technology are a plant-based culture and technology respectively and thus a forest product. Bahnar people's cultural and technological development can therefore be thought of as an outcome of a certain adaptation to and modification of their ecosystem, in which nature, society, and bamboo technology are interrelated with shifting cultivation and a subsistence-oriented livelihood.

Moreover, as the cases exemplified in this chapter proved, swidden agriculture in the rain forests of the tropics and subtropics developed with and through a sophisticated bamboo culture. In these cases, bamboo culture is of paramount importance for performing swidden agriculture. It is self-evident that the coevolution of shifting cultivation and bamboo culture was only possible because bamboo is endemic in these regions. Hence, Bahnar swidden agriculture is, as proved above, intrinsically linked with bamboo. A fact, however, that is not only true for Bahnar people but other ethnicities such as the Sedang, M'Nông Gar, or Awa. What is more, during my field trips in other mountainous parts of Vietnam, I found comparable uses of bamboo and a similar bamboo culture to those mentioned in this chapter. So, for instance, in the Vietnamese border regions with Laos of Thanh Hoá, Nghệ An, Gia Lai, or Đắk Lắk Province.

Only some decades ago, the Bahnar civilization was one thing in particular: a bamboo civilization—evolved over hundreds of years together and in exchange with other ethnicities' and societies' material or bamboo cultures and nature. It was a plant-based civilization, a commonality shared by other ethnic groups in the Central Highlands of Vietnam. Nonetheless, and despite drastic changes, the bamboo culture maintained by swiddeners that I documented in this chapter still expresses and embodies such a bamboo civilization.

Bodycraft, Form-Giving, and Bamboo's Workability

As discussed in chapter 5.3.3 about the characteristics of manual work, chapter 7.6.1 about the principles of bambooworking and bodycraft, and chapter 4 about the processing of bamboo, working with bamboo is an interrelated human-nonhuman way of giving form to matter. But not by means of the imposition of humans' thought on matter but as an interaction of the craftsperson (and her/his inherent body, mind, and skill), the tools (design, function, or handling), and the material or workpiece (and its physical properties). Any kind of bambooworking reflects the human as a *homo faber* or "organisms-as-a-whole" (Ingold 2000, 9), that is, the full immersion of a human with all the senses in an activity. Thus, bambooworking and bamboocraft reflect what I called bodycraft—an entire bodily involvement during bambooworking, which includes the involvement of bodily senses and the entire body encompassing one's arms, legs, hands, feet, or mouth. Working with and shaping bamboo reflect the material conflation of the human body, the workpiece, and the tools necessary for material manipulation. In ANT's view, such a human-nonhuman-nonhuman constellation is thought to be a hybrid entity, and its agency only comes to the fore in its mutually referential connection. In this light, bamboo's inherent qualities, elasticity, smoothness, strength, as well as its abundance, easy workability, and replicability contribute to bamboo technologies' and bamboo cultures' shape and lay the groundwork for the very material basis of Bahnar people's material relations and lifestyle. Accordingly, the moment humans shape bamboo, bamboo shapes human material culture and, thus, the material foundation of social practices. Simultaneously, bamboo's properties are equally epitomized by the things deriving from it. Bamboo baskets, for instance, represent bamboo's characteristic feature of being split easily in a longitudinal direction and its high flexibility necessary for bending. The benefits from bamboo's natural architectural design and particularly its hollowness are vividly expressed in the creation and playing of musical instruments.

Practice Theory Approach and Bamboo

People's everyday life is accomplished through their intersection with things. This statement is also true for Bahnar people, in whose case the human-thing relation is marked by bamboo's omnipresence in such relations. Conceiving these human-thing relations as practices reveals much about the bodily immersion with the nonhuman referential counterpart or companion of the human and her/his (un-)intentional and/or (non-)purposive activities. All the *professions* of Mr. Ninh that I mentioned above are an expression of these human-thing entanglements. Accordingly, when considering bamboo's role, it becomes evident that bamboo is integral to many practices. Moreover, as expressed by the composite expressions *practice-as-performance* and *practice-as-entity*, bamboo is necessary to carry out performances and is likewise essential for the material assemblage. In this sense, a single practice is equally part and parcel and product of a bigger whole, which is, in this context, a swiddener's life geared to shifting agriculture.

ANT's Approach and Bamboo

According to ANT's position, an actor-network is made up of many entities or actants who form an alliance to achieve their specific goals. Each actant *enrolls* the others because it seeks ways to encourage the other actants to promote and support its own ends and interests. As a general aspect, one can state that the more long-standing such networks are, the more the associations between its heterogeneous entities are renewed, the more powerful and sustainable the actor-network becomes. I tried to draw such a network by describing which actors are assembled by or associated with shifting cultivation. As shown by the ShiCu-network in Figure 79, it becomes immediately clear that entities from different spheres and localities exert influence on other actants and, by implication, on the entire network. The residential house's composition of various human and nonhuman actors is another instructive example of how entities from different spheres build up, generate, and stabilize a network.

Where to Find and Locate the Social?

Finding answers about where to find and locate the social depends on the scholar's theoretical perspective and approach. My theoretical reflections about the human-bamboo relations and where to locate the social had practice theory and ANT as their starting points. While the former maintains an anthropocentric approach, though much less than traditional social ontologies, ANT emphatically claims its symmetric methodology. Practice theory's human-centered approach had positive and negative effects on the study. On the one hand, it offered appropriate positions to describe the human practitioner's role and bodily involvement, as illustrated by Mr. Ninh's various activities. On the other hand, it hindered scrutinizing relations in which the human is not the only actor. This gap, in turn, can be closed by ANT's material-semiotic approach. While practice theory offered methodological opportunities to explore an individual swiddener's life, like that of Mr. Ninh, ANT provided a broader scheme to contextualize nonhumans' contribution to a network. Nonetheless, I do not regard the two approaches as opposing but complementing each other in their shortcomings. Finally, the two together provide a multifaceted analysis of the human-bamboo relationship.

To return to the question mentioned above: where to locate the social? In the view of practice theory, the social must be located in the human-centered practices as the smallest unit of the social since the human is the carrier of practices. Thus, in the practice theory model, materials and nonhumans still play a decisive role, but they are more the necessary material counterpart or equipment of humans' routinized practices than equal participants. In contrast, ANT is a post-humanist theory and refuses to take the human being as the entity around which the social revolves. According to ANT's view, there is no special place for the social. The social emerges due to the reciprocal associations and assemblage of the actors in a network. The social is a fluid thing, an output of the movements of associations of a network. It emerges just like agency due to the associations of its actors. In conclusion, while practice theory makes bamboo's conflation in human practices understandable, ANT offers ways to consider bamboo's versatile roles as parts of a network that goes beyond human actions.

Development, Changes, Modernization, Buen Vivir, and Bamboo

Like any other culture, the Bahnar tangible and intangible culture is dynamic and subject to constant change rather than static and ahistorical. In line with Barth's (constructivist) concept of ethnicity, I consider the ethnicity and cultural traits as provisional, contingent, and characterized by dynamism, openness, and relationality (Barth 1969). In contrast to essentialist explanations (Geertz 1963) that emphasize perennial identities and universal aspects of culture to constitute social life, the constructivist position highlights individual agency, the significance of self-ascription, and the contingency of social life. ANT and practice theory are both likewise anti-essentialist and consider that culture or the social are the results of practice and the movements of associations, respectively. Therefore, writing about bamboo culture means writing about a hybrid culture made up of the past and present and a dynamic culture undergoing a constant transformation process. Indeed, Bahnar immaterial and material culture has been influenced by neighboring ethnic groups, ancient kingdoms and dynasties, French colonial rulers and missionaries, the First Republic's policies, years of war, and contemporary political interests and decisions.

In this chapter, I scrutinized bamboo's relevance and function for a small group of swiddeners. Their material conflation with bamboo reveals much about bamboo's necessity and ubiquity in almost every domain of life. But, although bamboo is of paramount significance for the Bahnar swiddener's material culture, wood and rattan are other essential forest materials.

What is more, not only the swiddeners' lives in the hamlet but also the farmers' lives in Kon B'Rrăp village are linked with bamboo. Today, villagers still use bamboo to create fences, baskets, traps, granaries, pipes, hunting weapons, animal enclosures, chicken cages, toys, and to build house walls, floors, roofs, and the Rông community house's roof structure. What distinguishes the hamlet and village people is not primarily whether they use bamboo or not, but bamboo's omnipresence. Compared to the hamlet people, the villagers' material culture is less defined by bamboo. The industrial age has been knocking at the door of the Bahnar for a long time. While forging, weaving, and pottery were significant handicrafts in the past, they have lost their relevance nowadays. In the present, new materials, techniques, tools, and consumer goods are part of the villagers' material culture and practices. Villagers have access to electricity, the global market, and motorways and possess motorbikes, chain saws, television, or radios. The village dwellers' switch from shifting cultivation to permanent agriculture not only changed their material substructure and surroundings (e.g., new industrially designed agricultural tools and permanent houses), but also cash-crops generated monetary income necessary to acquire new goods. It is understandable from within itself that such transitions in agricultural food production change people's way of life and their attachment to bamboo and their environment, and beget different forms of the human-bamboo relationship. By implication, such a development also means the decline of indigenous skills and knowledge related to bamboo.

In the long run, the Bahnar material culture will experience further change and create more hybrid forms of material culture due to technological change.[51] It is most likely that the Bahnar

[51] As clarified in the theoretical chapter, technological change is a multifaceted process. In this context, the historian Alex Roland assesses that *resources*, *national and regional style*, *ideology and philosophy*, *politics*, *economics*, and *science* interrelate with technology and are useful indicators when explaining technological shift (Roland 1992, 83–87). In the following, I adapt and illustrate these technology-influencing domains through short examples related to the bamboo culture of the Bahnar people. First, *resources* at hand (be it human, material, or energy-based), so argued by Roland, influence technological shape (ibid., 83). The indigenous bamboo culture in the Central Highlands, such as that of the Bahnar, could only evolve because bamboo is an abundant natural resource. Second, the *national and regional style* is related to a host of technological problem resolution processes depending on the location. For instance, the bamboo stilt house's building structure and architectural design answer the local topography, environment, and climatic conditions. Third, *ideology and philosophy* have a major influence on the shape of things and technology. In Bahnar people's traditional belief, the difference between humans, animals, and the forest is less categorical than gradual. Moreover, the Bahnar people's Rông community hall's roof design, to give one example, is ax-shaped and symbolizes a ship's sail. It is supposed to remind the Bahnar people of their remote past because, according to their narrative, they came from overseas. Fourth, *politics* or political decisions shape technology and material culture. As exemplified above, modernization programs intend to develop Bahnar people's agricultural methods and indirectly modify their material culture. Fifth, *economics* are irrevocably bound to technologies. Subsistence-based economies of mountain dwellers, such as that of the Bahnar, require environmentally friendly bamboo technologies that protect the forest, whereas lowland people focused on rice cultivation draw on other technologies. Sixth, *science* provides important impulses for further technological development. Yet science and technology only recently became two distinct fields originally belonging inseparably together. Bahnar swiddeners have no academically institutionalized science, but their agricultural method, architectural design, tool

swiddeners and villagers will adapt to new agricultural methods, agricultural tools, building materials, lifestyle and develop new ways to earn their livelihood. For instance, from 2012 to 2018, I observed some visible changes in the material culture in the hamlets, such as the use of plastic and corrugated sheet metal. Besides that, young people in the hamlets are getting less interested in Bahnar customs, especially in shifting cultivation, which is considered hard work.

As this chapter has shown, the Bahnar do not determine their lives and future entirely alone. Historical reasons, political decisions, years of war, and the effects of modernization have altered their lifestyle and material culture. Through the historical outline of the ethnic groups living in the Central Highlands, I aimed to point out how vulnerable a subsistence-based economy and lifestyle are. In sum, state policy, environmental change, market liberalization, permanent agriculture, in-migration, modernization programs, Vietnamization, and the like (still) profoundly impact the life, culture, social structure, technology, agricultural system, and of course, the bamboo culture of Bahnar villagers and those in the hamlets. By and large, economic development offers new opportunities but also many obstacles and difficulties.

Further changes will probably occur even faster and more dynamically with increasingly negative impacts on nature. Instead of fostering an absorption of new and industrial technologies and materials by the so-called *underdeveloped people*, supporting indigenous people's traditional environmental conservation and management as well as their agricultural methods and nature-based material culture would help to ensure their livelihood and support biological and cultural diversity. Hence, one pressing issue related to indigenous people's lifestyle is how to preserve their (im-)material culture and equally protect their environment. Deforestation, just to name only one critical impact on the environment, is changing Bahnar people's connection to the forest and their perception of it. In this context, Vietnamese authorities should critically discuss the problems ensuing from a socialist evolutionary model and their definition of modernity. They should ask whether the so-called *modern technology* in association with changes in land use and agricultural intensification in the interest of development and economic growth are important goals. And if their achievement justifies ecological deterioration, land scarcity, or the negative impacts on the traditional life and livelihood of ethnic groups such as the Bahnar.

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use, and creation are nevertheless knowledge-based. These examples only give an initial idea of principles for the formation of technology and technological change and are far from comprehensive. Other reasons for technological advancement may lie in an interchange of technologies or techniques between different societies, the change of a social system, time as an influencing factor, war, power structures, and the like.

Unfortunately, until now, the authorities' one-sided conception of modernity, and politically instructed in-migration have caused problems that still require satisfactory answers.

As the global environmental crises dramatically indicate, humanity is in urgent need of finding sustainable ways of living. One way is to improve life in industrialized countries towards sustainability. Another way, and with relation to the people discussed in this chapter, would be to acknowledge shifting cultivation as a sort of sustainable agroforestry that supplies people with a wide range of materials and food to ensure their basic necessities and guarantees social sustainability.

It is not my intention to present perspectives on how people should shape their future, but it is clear that bamboo has contributed much to sustainable and self-determined living on the ground of an appropriate technology based on a subsistence economy. Yet bamboo is one of the most significant and most frequently used ecological forest plants in the Central Highlands of Vietnam. Its abundance is vital for people to keep meeting their needs. Thus, deforestation and the loss of bamboo are linked with the decline of Bahnar people's traditional agricultural methods, lifestyle, knowledge, and environmental conservation methods. Therefore, governmental authorities and modernization theories must consider bamboo's essential role for Bahnar people and its contribution to every domain of life. Instead of introducing new commodities and dependences on an open market, efforts should be made to foster bamboo cultures and inform various institutional actors about bamboo's function and relevance for people and its contribution to biodiversity and environmental conservation. That at least sounds more promising than the environmental conservation policies since the 1980s and 1990s that have favored large-scale projects to the disadvantage of shifting cultivation (Kelly 2001, 38).

As Mr. Ninh explained once, life without bamboo would be impossible since bamboo makes his life possible and easy. It is self-evident that using natural resources strengthens people's autochthonous way of life simply because the forest guarantees a constant supply of raw materials without depending on monetary income. In this light, the human-bamboo relationship, exemplified by the swiddeners, is intrinsically linked to self-determination. Emphatically formulated, Bahnar people have their visions of life and development, community-based land management, and collective as well as sustainable use of natural resources. In contrast to the Western-based linear concepts of continuous economic progress and development, scholars of various fields have proposed alternative concepts of well-being as exemplified by Gudynas's

Buen Vivir concept, which gives more attention to indigenous people's technological solutions and material cultures.

Concerning Buen Vivir, the most striking aspect is Gudynas' emphasis on expanding the actors beyond the human being and bringing nature and nonhuman entities back to the foreground of analysis. According to Gudynas's position quoted in chapter 6.4, Buen Vivir means that "the polis is expanded, and the concept of citizenship is widened to include these [nonhuman] other actors within environmental settings" (2011, 445). Saying that Bahnar people are *jungle eaters* and that their concept of *us* is non-exclusive, including other forest dwellers, underscores this statement and Bahnar people's relatedness to the forest. According to the traditional Bahnar people's perception of nature, the difference between humans, animals, and the forest is less categorical than gradual. As Mr. Ninh once explained during an excursion in the forest, the forest is alive, and everything is connected to everything else. Buen Vivir's demand and Mr. Ninh's notion correspond to ANT's demand for a symmetric approach. Thus, according to Buen Vivir's and ANT's view, only by reintegrating the nonhumans into the scientific focus are scholars able to reassemble the various actors contributing to the social. And only with such an analytically open view are scholars endowed with the capability to find an appropriate description of the social and, thus, people's everyday lives and activities related to bamboo.

8. Bamboo in Chinese History

Bamboo is a unique material, which is and was used equally by small-scale and large-scale societies throughout history. As mentioned in connection with the Bahnar swiddeners' domains of life earlier in chapter 7.6.2, and on account of the various activities performed by Bahnar swiddeners, one is inclined to say that the swiddener is occupied with many professions encompassing that of an architect, builder, farmer, basket weaver, engineer, designer, hunter, fisher, and the like. Indeed, it is the incorporation of bamboo into the material culture of Bahnar people that enables their economic livelihood. In general, it can be said that the Bahnar swiddeners' bamboo culture is relatively homogeneous with equal access to resources, with less diversified labor division, and techniques that, by and large, can be mastered or at least learned by everyone. In contrast, if we investigate bamboo's use in large-scale societies like in pre-industrial China, we obtain a rather different picture with regard to the involvement of bamboo in people's lives.

Concerning my research design, I shall briefly elucidate my methodological approach in the next chapter. At this point, I shall indicate my underlying theoretical groundwork for this chapter. While the previous chapter required a physical moving of my research away from written records into the field and involved an engagement with contemporary bamboo cultures, this chapter goes the other way around. It attempts to find insights into past bamboo cultures through written records. However, in both cases, my theoretical approach draws on theories as mentioned in chapter 5.2 and my definitions of material culture and bamboo culture in chapters 5.4.1 and 5.4.2. Hence, my underlying socio-ontological viewpoint, according to which the distinction between nature and society does not have to be solidified into two different, distinct domains, results from my discussion of socio-material theories (in chapter 5.2)—particularly from practice theory and ANT and their urge to shed light on the nonhuman part of human activities. To say it in the words of Schatzki, "entities can *at once* be social *and* natural beings. Something is social if it helps constitute human coexistence" (2003, 88). In this view, this chapter is partly built upon a practice-centered ontology that encompasses nonhumans' relatedness to human actions and combines this with ANT's symmetric, post-humanist approach and its actor-network concept, according to which agency is spread in a given network and not limited to human actors. Since both have different ontological entry points, the combination of both reveals further insights with the one outweighing the other's shortcomings, which offers multiple perspectives concerning the embeddedness of bamboo in Chinese material culture and technology. Hence, my theory-driven bamboo-centric approach set the framework to take account of bamboo, its physical-mechanical properties, tools deriving from bamboo, and the interaction of humans with bambooic things. At the same time, I do not consider technology as "simply a means by which people pursue their desires and needs" and as being disintegrated from society but as "integrally woven with the nexuses of practice and materiality through which people coexist" (ibid., 90).

Moreover, my discussion of technological change and theories about technological change in chapter 5.6 provided the necessary background to discuss bamboo in connection with technological development in pre-industrial China. In this light, I consider bamboo as part of the social sphere since it preconditioned the very existence of Chinese people's everyday life and was involved in many proto-industrial technologies and local pre-industrial appropriate technologies. Therefore, my epistemological openness was a prerequisite to study bamboo's material history as done in this chapter and in connection with the human-bamboo relationship.

Against this background, this chapter is thematically divided into three main parts. The first part deals with bamboo's versatility and its contribution to Chinese civilization (chapter 8.4). The second part examines bamboo's contribution to papermaking and gunpowder, which are considered two of the so-called *Four Great Inventions* (chapter 8.5). And the third part addresses bamboo's part and use in Chinese peasantry's daily life in early twentieth-century China (chapter 8.6). Yet before I present the structure of this chapter in detail, I would like to comment on the relevance of bamboo in China to contextualize the topic of this chapter in relation to the overall concept of this work.

Since prehistoric times and as proven by all the various uses of bamboo, human skill and dexterity in China have developed in working with bamboo—that is, through a bodily and particularly manual involvement. Thus, if we look at China's material history, it could be said that Chinese people's relationship with bamboo became part of their history. The interaction with and handling of bamboo as a plant-based building material became a core element of the broader Chinese history of the human body, the history of Chinese craftspersonship, material culture, and local technologies encompassing a wide array of activities, practices, skills, techniques, individual and collective knowledge, and specialized expertise—even if the access and use of bamboo are not of the same homogenous character as demonstrated for the Bahnar people.

Nonetheless, bamboo was of inestimable value in many fields such as papermaking, printing, firearms and firecracker production, house and bridge building, shipwrightry, or salt and gas extraction. Simultaneously, bamboo was a useful raw material for a plethora of Chinese pre-industrial manufactures and utilized in specialized handicrafts. On the other hand, while bamboo was essential for a wide range of local technologies, its relationship with rural life carried a unique significance in its ubiquitous utilization as part of the Chinese peasantry's material culture. Consequently, peasants developed an exceptional relationship with bamboo and created various tools, devices, objects, and techniques necessary for agricultural work, cooking, building houses, hunting, fishing, furniture making, water lifting, and the like—in this view, this chapter is partly a practice-centered study since it is interested in bamboo's part in activities carried out in various domains of life. Unsurprisingly, then, many bamboo-made objects surrounded the Chinese peasantry and were prerequisites for carrying out vital everyday activities.

In view of this, this chapter aims to explore three principal questions. First, how is bamboo's inherent structure linked to Chinese material culture? What kind of tools, devices, and techniques developed based on bamboo? How were bamboo's hollowness, springiness, or tensile strength incorporated in bambooic things?

Second, how did bamboo contribute to the technological development of key proto-industries in China? Since the latter question is very broad, I shall take a closer look at bamboo's involvement in papermaking for one thing and its influence on the development of firearms in combination with gunpowder for another.

The third set of questions seeks to clarify what kind of bambooic tools Chinese peasants needed to meet their needs and for agricultural work. What are the characteristics of these tools? How did they contribute as mundane objects to the performance of everyday activities? And how can human-thing entities be analyzed as hybrid entities? In this light, the overall aim of this chapter is to review the evidence of and demonstrate bamboo's part in Chinese history until the early twentieth century.

Therefore, in order to answer these questions, this chapter is structured as follows: After describing my methodological approach and the principal literature used for this chapter (8.1), I shall provide an overview of bamboo's natural distribution in China and put an emphasis on the overlapping between bamboo's distribution and early Chinese civilization's development (chapter 8.2). Then, in chapter 8.3, I will briefly discuss the intra-Chinese and international bamboo trade in the 1920s. In this context, I shall also elaborate on bamboo's natural buoyancy and its implication with transport via waterways.

Following this, the first thematic part (8.4) of this chapter is concerned with the multifaceted nature of bamboo, which I try to elucidate by numerous examples. For this reason, I briefly draw attention to bamboo's part in Chinese writing (8.4.1). Next, with the interest of demonstrating the omnipresence of bamboo and its various usages in Chinese people's life, the subsequent subchapter (8.4.2) first reviews one enumeration of bambooic things as part of Chinese material culture in the 1920s and, second, based on the comprehensive multi-volume book *Science and Civilisation in China* by Joseph Needham (and colleagues), it refers to almost all of bamboo's uses mentioned in this work.

The next chapter (8.4.3) explores the ways bamboo was used in China by taking account of its inherent material properties (*hollowness, tensile strength, flexibility and springiness*), how these characteristic features affected the way people could use bamboo, and how these properties were used to develop and improve certain tools and techniques.

Needham and Wang, who take a closer look at ancient Chinese tools and materials and the Chinese history of technology and material culture, emphasize that alongside wood, iron, copper, various plants, and animal sources, bamboo was "one of the most universally used materials" (1965, IV:2, 61). In this light, chapter 8.4.4 elaborates the difference between iron and bamboo and how the latter stood out in terms of its ubiquitous use compared to iron.

The second part (8.5) of the chapter is concerned with bamboo's contribution to papermaking (8.5.1), and military technology and the use of gunpowder (8.5.2). Here, both fields are understood as representatives of the way in which bamboo contributed to the development of important key inventions in Chinese technological history.

Given that in pre-industrial times, Chinese peasants commonly produced most of their agricultural implements and everyday commodities primarily based on local techniques, knowledge, and available resources, the third part (8.6) of this chapter proposes that most of a peasant's bamboo-related things equally result from a peasant's personal, individual skill, knowledge, and, of course, by acknowledging bamboo's material properties. Accordingly, this part investigates bamboo's role in Chinese rural life in the early twentieth century.

As explained in the previous chapter and the theory section, this thesis takes a less anthropocentric research approach. Therefore, in chapter 8.6.1, using the plow as an example, I will attempt to explain how the human being and her/his handling of the plow amalgamate with the plow and other entities into a hybrid entity by depicting it from the viewpoint of practice theory and ANT.

After that, I shall demonstrate in chapter 8.6.2 bamboo's relevance as a construction material and value in Chinese agriculture by portraying miscellaneous bambooic tools, devices, objects, bamboo's part in the construction of a seed discharging device connected to a plow, various handles, riddles, flails, rakes, and mud tongs used to extract the nutrient-rich soil from rivers. The next chapter (8.6.3) is concerned with irrigation and water lifting tools and aims to contextualize how bamboo was utilized as an essential material component for constructions such as waterwheels and shadoofs. As mentioned earlier, in pre-industrial times, Chinese peasants were occupied with a plethora of tasks and professions. Two of them were hunting and fishing, which will be the subject of the next chapter (8.6.4) that deals with bambooic hunting tools and fishing equipment.

Chapter 8.6.5 analyses bambooic tools needed for cooking and outlines the bamboo steaming tray as a genuine Chinese cuisine utensil alongside the use of bambooic pepper shakers and containers. The next chapter (8.6.6) gives a brief overview of some traits of bamboocraft. It compares similarities and differences between wooden and bambooic chairs and how the construction of the discussed wooden and bambooic specimens must take both materials' characteristics into account. Chapter 8.6.7 briefly introduces bamboo's contribution to clothes and hat making and illustrates how the cotton bow's mechanical composition relies on bamboo's flexibility, and how bamboo sheath leaves were employed to craft large hats protecting against rain and sun.

Since the shoulder pole played a crucial role in transporting things overland, chapter 8.6.8 will provide a brief outline concerning its fabrication and utilization. Then, on account of bamboo's multiple uses, chapter 8.6.9 presents, in brief, some other bambooic tools that could not be classified in the chapters introduced so far. Finally, the last chapter (8.7) includes a discussion of the implication of the findings concerning Chinese bamboo-related material culture, presents the findings concerning my abovementioned research questions with connection to the three thematic parts of this chapter, and refers to the so-called *Needham Question*, which examines the reasons why China and India lagged behind modern Europe in technological development, although both countries had made a great contribution to science and technology.

It should also be mentioned that, due to China's enormous landmass and high population, a full discussion of bamboo's part in China's history of technology and everyday life lies beyond the scope of this chapter. Therefore, this chapter can only address a small fraction of tools and devices involving bamboo rather than being complete and comprehensive. In view of this, and given that there is no genuine, homogenous Chinese material culture or pre-industrial technology, by elaborating on the interweaving of Chinese history with bamboo, this chapter sheds some light on the extent to which bamboo was associated with Chinese inventions and the material aspects of Chinese peasants' everyday life and, thus, how Chinese made a living from bamboo. Moreover, this chapter's issues and findings are linked to the other chapters of this thesis, which explore the multifaceted character of bamboo from different angles. Against this backdrop, some topics and parts addressed in this chapter may appear sketchy but will gain greater profoundness and relevance through contextual and thematic connectivity to the other chapters of this work.

8.1. Literature Review and Methodological Approach

Generally speaking, since wooden and bambooic tools from prehistoric and ancient times are preserved much more seldom than stone and metal objects, the wooden and bambooic basis of human history has long been underestimated. At the same time, and although bamboo has been used in manifold ways throughout Chinese history, only a few primary sources are available that devoted their attention to bamboo (ibid., 61–62). Moreover, as my literature review revealed, to date there is no book that deals sufficiently with the material history of bamboo in China. This may be attributed to the fact that a comprehensive study of bamboo's part in the Chinese history of technology would require a wide-ranging, time-consuming, and profound study of ancient Chinese books, which would be an ambitious endeavor but challenging. Yet, only this effort would offer valuable clues concerning bambooic tools' and objects' socio-cultural, economic, historical, and technical backgrounds. Moreover, such a study would require understanding and reading past and current Chinese characters to gain first-hand information. In this view, and due to my lack of Chinese language skills, I was restricted to literature published in English, German, and French.

Against this background, while the former chapter allowed me to conduct a study related to the practices of Bahnar people in the field and enabled me to gain instructive observations about the human-thing involvement in daily practices, this chapter's interpretation of practices is limited to text-based sources. On the other hand, due to my findings in the previous chapter, alongside my personal experience in bambooworking, I was able to combine these with my evaluation of bamboo-related activities in ancient China.

Overall, this chapter's research principles, methodology, and findings are associated with the socio-material theories (practice theory and ANT) and critical matter-form models as argued by Ingold, which were introduced in chapter 5.2 and which provided the key points for my interpretation, analysis, and epistemological view of bamboo as part of Chinese culture. In consequence, this chapter could be viewed as a result attributed to the field of history and its associated methods since I gained insight into Chinese bamboo culture through the study of primary and secondary sources, which, in turn, were primarily text-based written records. On the other hand, I was able to take advantage of sketches, drawings, and photographic records illustrating various bamboo tools and mundane objects from various periods and sources. In addition, I also draw on four photographs that I took in Vietnam to clarify specific topics and for a comparison of bamboo cultures in the past and present. Overall, these records provided important visual information that allowed me to connect my text-based descriptions related to primary and secondary sources concerning bamboo's part in Chinese culture in order to reconstruct and, simultaneously, get a clearer picture of bamboo as part of Chinese technology, material culture, and the peasantry's everyday life.

Moreover, this chapter, though not explicitly stated in every case, is part of my comparative research of spatially-temporally dispersed bamboo cultures, aiming to evaluate similarities, differences, and (in many cases) associations between them. Therefore, this chapter is in connection with my ethnographic chapter concerning the Bahnar people and the following chapters, which elaborate on bamboo cultures in other regions.

Against this background, Joseph Needham's (and his collaborating colleagues') *Science and Civilisation in China* (1954–present)—encompassing seven volumes with several parts—was the chief literature used for the first two parts of this chapter. Needham's work, or rather encyclopedia, was the first of its kind in terms of completeness and size written in a foreign language (English) that examined the Chinese contribution to humanity's technological development and Chinese technological and scientific history.

In order to achieve their research objectives, the authors studied primarily ancient Chinese books to gain data on Chinese technical know-how, science, or technology by examining their sources' information on Chinese tools, devices, everyday goods, machinery, proto-industries, raw materials, means of production, and many more and their relatedness to Chinese culture and society. Whenever needed, the authors also utilized secondary sources. Overall, the encyclopedia encompasses a time span from the early Chinese records until today, though concentrated on pre-industrial China. Thus, studying Needham's book provided many insights about the intricacies of bamboo and Chinese pre-industrial technological solutions by providing vital background knowledge.

A shorter and more recent book that is also devoted to the various Chinese and pre-industrial inventions is Lu Yongxiang's (editor) three-volume book entitled *A History of Chinese Science and Technology* (2016). I used these volumes in addition to Needham's works since they provided certain other insights and specific details about some subjects. For instance, Shaoyi Zhong's text about ancient Chinese military technology was helpful to examine bamboo's part in this context. Likewise, Fan et al.'s text *The Four Great Inventions* was essential for writing the chapter about Chinese paper making. Moreover, in contrast to Needham's books, these texts represent the current state of knowledge compared to the first volumes of Needham's book published in the 1950s.

One other book, namely, Kuo-Hung Hsiao and Hong-Sen Yan's *Mechanisms in Ancient Chinese Books with Illustrations* (2014), was helpful to acquire knowledge about ancient Chinese mechanisms and machinery, their use and their historical, cultural, and technical background.

Since the first discovered script, dated to around 1200 BCE, Chinese books and records have increased in number and provide a rich body of literature to study various fields—as demonstrated by the comprehensive size of *Science and Civilisation in China*. On the other hand, ancient books had certain shortcomings. Given this, Hsiao and Yan identify three reasons for the lack of information on ancient machines and certain tools. Firstly, craftspeople mostly improved their machines by trial and error rather than making detailed illustrations. Secondly, information about a device was mostly transmitted orally. And thirdly, those who made drawings of machines and tools were not their inventors, so that little information is given about size, shape, and the function of their components (Hsiao and Yan 2014, 3). Unsurprisingly, then, little information is provided about the very first uses of bamboo in general but also in particular. In other words, while some records indicate and illustrate bamboo's use in certain ways, such as its use in combination with gunpowder to produce bombs and rockets, less information is given on initial experiments and the development of tools and machinery involving bamboo. Needless to say, there are almost no sources that elucidate the development of simple tools and objects (such as bamboo rakes, riddles, containers, mats, baskets, and the like) needed for everyday life and work since these were most probably invented by local people to meet their needs and long before the invention of writing.

Moreover, and generally speaking, there is a general lack of data concerning bamboo's contribution to the development of the Chinese civilization. According to Needham and Wang commenting on that problem, "one would have thought that much attention would have been devoted to the manifold methods of putting this wonderful material [bamboo] to use, yet the available literature seems very sparse" (1965, IV:2, 62–63). In light of this, this chapter is intended to provide some findings related to this issue by its compilation of various information given by primary and secondary sources.

Two other valuable sources that were important for this chapter are Willard Merritt Porterfield's book *Bamboo, and Its Uses in China* (1926) and his article *Bamboo. The Universal Provider* (1933). Since European imperial powers gradually forced China's rulers to open up the country and partly ruled over China's territories, China's trade with overseas increased gradually. In this light, Porterfield (1926) offers an overview of China's bamboo trade in the 1920s, examines bamboo's intra-Chinese economic value, and presents his findings based on his study concerning bamboo's part in Chinese society. Thus, on account of his first-hand information, Porterfield's book stands out due to its wealth of information that helped me reconstruct various uses of bamboo in the 1920s, while his article provided additional information on other topics.

As mentioned earlier, the third part of this chapter is concerned with bamboo's part in rural life in the 1920s. In this, my research data and analysis of bamboo's use in Chinese peasants' lives rests predominantly on Rudolf P. Hommel's seminal book *China at Work. An Illustrated Record of the Primitive Industries of China's Masses, whose Life is Toil, and thus an Account of Chinese Civilization* (1937). *China at Work*, first published in 1937, is designed as a study of the tools, handicrafts, proto-industries, and everyday commodities in China and based on the author's fieldwork conducted from 1921 to 1926 and 1928 to 1930 (Shavit 1990, 242)—under the direction of the American archaeologist and artifact collector Henry C. Mercer. Hommel's book is divided into five chapters: *Tools for Making Tools, for Procuring Food, for Making Clothes, for Providing Shelter, and for Enabling Transport*. As one review published in 1937 rightly points out, Hommel provides a comprehensive wealth of information and manifold "insights into Chinese material culture" (Shryock 1938, 691). Overall, *China at Work* comprehensively details the material aspects of Chinese peasants' everyday life by focusing on the peasantry's agricultural implements, everyday commodities, tools, and their use together with some bambooworking techniques and handicrafts. According to Nathan Sivin, an American sinologist and historian, the greatest strength of *China at Work* lies in the collection and illustration of "more than 500 photographs of devices and mechanisms-tools to make tools, and tools which play a part in the traditional provision of food, clothing, shelter, and transportation" (1972, 70). Some of these photographs, then, were useful visual sources to illustrate the richness of bamboo in Chinese material culture and to scrutinize bamboo's relevance in terms of its inherent properties incorporated in tools and devices.

Concerning the weakness of *China at Work,* it must be said that Hommel could neither read nor understand Chinese and only found access to Chinese through an interpreter. In consequence, Sivin finds, "many of his assertions about indigenous knowledge of processes are uninformed" (ibid.). In many cases, therefore, Hommel's approach was that of an interested observer but without delving deep enough into his subject matter. What is more, any portrayal of pre-industrial China's material cultures is a difficult challenge because of China's enormous land size and long history. Thus, one should keep in mind that *China at Work* is a limited representative work confined in space and time. Despite all shortcomings, however, *China at Work* is an insightful and informative snapshot of the past Chinese material culture and, in the words of Hommel, a helpful book to illustrate the "History of Civilization, by means of Tools" (1937, 1).

Since the third part of this chapter is based on *China at Work*, I shall say a few words about the scope of Hommel's research area and relatedness to bamboo's natural distribution at this point. As mentioned above, Hommel conducted his expedition mainly in the 1920s and traveled through Central China, encompassing Hunan, Hubei, and Henan Provinces today, as well as the bordering provinces of the lower Yangtze Valley up to Hankou (a city which merged into modern-day Wuhan). Furthermore, Hommel conducted further studies in two coastal provinces of East China, namely Hebei (former Chili Province) and Shandong (ibid., viii). Due to China's immense territory and on account of the geographic limitations of Hommel's study, his findings are, of course, less representative of other regions and provinces further north (including Inner Mongolia, Heilongjiang, Jilin, or Liaoning), west (including Qinghai, Tibet, or Xinjiang), south (including Yunnan, Guangxi, Guangdong), or east (including Fujian, Zhejiang, or Jiangsu). On the other hand, concerning bamboo's natural distribution—as will be discussed in the next chapter and illustrated by Porterfield's sketch of Chinese bamboo distribution in 1927 in Figure 83—Hommel's research area overlaps with bamboo's distribution. Thus, *China at Work* is a valuable book to study pre-industrial uses of bamboo, even though Hommel's expedition was geographically limited.

8.2. Bamboo's Distribution in China and Its Link to Chinese Material Cultures

Bamboo's distribution on a global scale has already been the subject of chapter 2.5. In what follows, I shall provide a brief overview and additional information concerning bamboo's distribution and the development of bamboo cultures in China, starting with two facts. First, despite the fact that present-day China has the largest bamboo resources worldwide, in terms of quantity, most bamboos belong either to the *Phyllostachys* or *Dendrocalamus* genus. Second, even though bamboos occur in many Chinese regions, bamboo has never been distributed equally in China.

In terms of species abundance, southern China (Guangyi, Guangdong, and Hainan) stands out (Bystriakova et al. 2003, 12), while northern China has fewer or almost no bamboo the further north it goes. According to Yuming et al., "five hundred species in 40 genera are recorded in China, mostly in the monsoon areas of south and southwest China. Of these, 250 species in 29 genera grow naturally in the mountainous province of Yunnan, in the Chinese Himalayan region" (2004, 157). According to Porterfield, in the 1920s, bamboo was abundant "toward the south, and especially on the low-lying plains and valleys near the southeast coast" but did not occur "north of 35° . . . [or in the] east along the Yellow River to Kaifeng" (1926, 17). Currently, *Phyllostachys edulis* (or Moso bamboo) accounts for about seventy percent of China's total bamboo distribution (Lobovikov et al. 2007, 15)—a bamboo species that was introduced to Japan in 1736 and considered the most valuable bamboo in Japan. Concerning bamboos natural distribution in China, Hsiung gives the following description:

> Geographically, bamboos occur throughout China, from the southern tip of Hainan Island to Beijing and from Langxiaan in Tibet to east Taiwan, covering the tropical, subtropical and part of the temperate regions. They are distributed from sea-level up to 3800 m high in the mountains of Tibet and Sichuan. However, most bamboos are thermophilous and are mainly confined to river basins and hilly land with fertile soil and a humid climate in the tropical and subtropical regions. Ecologically, bamboos with leptomorph rhizomes occur mostly in the Huang He (Yellow River) and Chang Jiang (Yangtze River) valleys and those with pachymorph rhizomes in south China. Between them lies a transitional zone of both rhizomal types. (Hsiung 1987, 2)

The map in Figure 83, from Porterfield, shows the distribution of bamboo in China by means of black shading and indicates bamboo's (unequal) distribution in China. Against this background, it becomes clear that bamboo's irregular distribution must have affected local material cultures in China.

Figure 83 Distribution of bamboo in China. The regions in which bamboos grow are shaded. The black circles in the north denote cities where bamboo grows in gardens.
Source: Porterfield 1926, 21

Figure 84 Chinese Provinces.
Source: Wikimedia
https://commons.wikimedia.org/wiki/File:China_political_division.gif
* Photo modified by the author for clearer representation.

According to traditional Chinese historiography, the Xia Dynasty (2205–1766), which is considered the first Chinese dynasty according to Chinese historiography, was located in present-day Henan Province in Central China and succeeded by the Shang Dynasty 1600–1046 BCE that dominated the same region and the middle and lower Yellow River valley. Generally speaking, the later, succeeding dynasties ruled over the territories of the preceding Xia and Shang Dynasty. What is of interest here is the fact that since early Chinese history, ancient and early Chinese people's areas of habitation overlapped with bamboo's natural distribution. This fact indicates that ancient Chinese had bamboo at their disposal, which, in turn, must have influenced their material culture and technological development. On the other hand, due to bamboo's natural occurrence close to rivers, bamboos and bamboo goods were transported from one place to another via waterways, small streams, but also China's large rivers, such as the Yellow and Yangtze Rivers, and traders imported bamboo at places with no or fewer bamboos. Accordingly, though some areas had less access to naturally occurring bamboos, the intra-

Chinese bamboo trade supplied these regions with bamboo. As a consequence, bamboo's part in material cultures and local technologies was influenced by this trade. What is more, species richness is not an exclusion criterion for the development of bamboo technologies. In many cases, local bamboo technologies and cultures developed based on only a few remarkable species, as, for instance, proven for the Bahnar (chapter 7.4.1), pre-industrial Japan (chapter 9.4.1), or North America (chapter 10.2.2). To summarize, bamboo cultures could have been maintained either on the strength of bamboo's natural occurrence or by way of the intra-Chinese bamboo trade.

8.3. Bamboo in Trade and Economics in the 1920s

Figure 86 Bamboo rafts in Quan Hóa District, Thanh Hóa Province, Vietnam.

Figure 85 Bamboo rafts.
Source: Porterfield 1926, 56

As discussed in the previous chapter, given the distribution characteristics of bamboo, it is reasonable to conclude that bamboo was initially used on a local scale and predominantly by farmers, who made up most of China's population until the last decades of last century. On the other hand, bamboo and bambooic goods were transported to areas and urban centers with little or no bamboo occurrences and, at the same time, the Chinese intra-bamboo trade supplied various proto-industrial production sites, including the paper industry, textile industry, mining, salt extraction, and the like. Moreover, bamboo was essential for civil engineering and military technology. By and large, the domestic demand for bamboo fostered the intra-Chinese trade in bamboo and bamboo products, which were essential for the Chinese economy prior to industrialization.

In what follows, I shall outline some aspects of the intra-Chinese bamboo transport and trade (limited in time to the 1920s) based on the information given by Porterfield (1926) and, in doing so, I intend to draw attention to two aspects. First, to the harvest and transportation methods and the characteristics of bamboo in this regard. Second, I shall elucidate the intra-Chinese exchange of bamboo as an important foundation for the Chinese proto-industrial economy on the eve of China's industrial development.

First of all, the harvest of bamboo in pre-industrial China was largely done on the strength of human power because tools and vehicles powered by machines with artificial engines were uncommon until the rise of industrialization. Since well-developed roads and railways were few, most of the transportation of bamboo in the 1920s was by water since bamboos, in comparison to timber logs, did not need complicated machinery to be loaded and transported (Porterfield 1926, 55). "In China," as Porterfield put it, "a simple skidway straight down the hillside to the bank of a stream in the bed of which a stone platform for making rafts has been constructed is all that is needed. No rough bark increases the friction in skidding and no teams of horses are required to pull heavy logs out of the woods to the landing" (ibid., 28). Thus, Chinese natural streams, rivers, and artificial canals provided cheap and safe transport.

Overall, the transport of bamboo by water exploited bamboo's buoyancy which results from bamboo's airtightness and due to the fact that air is enclosed in the cavity between the internodes. Bamboo's natural buoyancy was also used to build bamboo bundles, which were "floated out from very small streams to the canals and thence to the markets" (ibid.). The photograph (taken in the 1920s) in Figure 85 exemplifies such bamboo bundles that were tied up at a landing close to Shanghai. Figure 86 shows a similar picture in contemporary Vietnam (Quan Hóa District in Thanh Hóa Province). In this case, the bamboo poles were harvested in the nearby mountains, tied together, and then transported in the manner described by Porterfield (ibid., 56) and processed in the chopstick factory (on the right in the same photograph). In a similar way, bamboo rafts (around 21 m in length) were also used to carry loads and passengers.

Regarding the trade in bamboo poles and bamboo products, Porterfield (ibid., 55) notes that the latter were transported over long distances on junks and traded within China. For instance, bamboo and bambooware were imported to Tianjin, Yantai (formerly Chefoo), Yichang, Jiujiang, Shanghai, Guangzhou (Canton), Jiaozhou, and to other Chinese cities. Simultaneously, bamboo and bambooware were exported from China to neighboring cities and countries, including Hong Kong, Macao, French Indochina, Thailand, Singapore, Japan, and Korea, but also overseas, to Russia, the United States, and the Philippine Islands (ibid., 64), for example.

The table in Figure 87 summarizes the bamboo trade through Shanghai in 1923.[52] While brooms were the most traded articles, bamboo shoots came first in terms of total monetary value. Moreover, Porterfield's list underscores the international entanglement of the Chinese bamboo trade in the 1920s. In recent decades, the international bamboo trade has increased significantly, as epitomized by bamboo floorings, curtains, toothbrushes, chairs, furniture, cutting boards, plates, countertops, and the like available on the global market.

Table 6. Bamboo Trade Through Shanghai

1923

Articles		Imports from China	Re-exports to China	Re-exports to Abroad	Net total Chinese imports: Quantity	Net total Chinese imports: Val. Hk. Tls.
Bamboo brooms	pieces	2,242,433	1,597,814	—	644,619	14,857
" penholders	piculs	8,884	8,218	—	666	2,407
" poles	Val. Hk. Tls.	17,941	10,416	1,403	—	6,122
" shoots	piculs	60,385	18,952	142	41,291	230,739
" small	Val. Hk. Tls.	1,715	10,229	—	—	8,514
" split, leaf, etc.	piculs	22,365	5,915	4,179	12,271	41,712
Bambooware	"	396	368	–	28	595

Articles		Exports to Foreign countries	Exports to Hongkong	Exports to China	Re-Exports	Total Exports: Quantity	Total Exports: Val. Hk. Tls.
Bamboo brooms	pieces	2,940	—	1,883,107	1,597,814	3,483,861	119,651
" penholders	piculs	—	—	568	8,218	8,786	33,537
" pipe-stems	"	—	—	530	—	530	2,991
" poles	pieces	216,319	9,200	53,991	96,875	376,385	29,809
" shoots	piculs	102	5	1,598	19,094	20,799	243,634
" small	pieces	—	—	1,229,560	310,931	1,540,491	18,436
" split, leaf, etc.	piculs	324	12,616	7,893	10,094	30,927	94,882
Bambooware	piculs	270	58	535	368	1,231	19,910
Bambooware	Val. Hk. Tls.	17,391	136	3,501	—	—	21,028

Figure 87 Bamboo trade through Shanghai.
Source: Porterfield 1926, 72

8.4. The Versatility of Bamboo and Its Contribution to Chinese Civilization

8.4.1. Immaterial Aspects Related to Bamboo

In Chinese culture, bamboo epitomizes gentleness, modesty, and serenity. Bamboo is an important model integral to immaterial Chinese culture and part of the arts, poems, or sayings. Nonetheless, and despite bamboo's symbolic value in Chinese culture, I have deliberately neglected this aspect for practical reasons concerning this chapter's scope, and would like to refer to chapter 9.3 that addresses bamboo's part in Japanese immaterial culture—keeping in mind that various Japanese ideas, worldviews, aesthetic values, and the like originate from China and thus, Chinese and Japanese culture share some commonalities. In what follows, I shall briefly

[52] The word *picul* is "a unit of weight equal to 100 catties, about 133 pounds (60 kilograms), used in various countries of Southeast Asia" (Collins Dictionary, accessed April 26, 2020, https://www.collinsdictionary.com/dictionary/english/picul) and is considered the weight one person can carry with a carrying pole. And the abbreviation *Val. Hk. Tls.* stands for *Value in Haikwan tael*, a former measurement and monetary unit in China.

comment on the Chinese character associated with bamboo due to bamboo's still prominent role in Chinese writing.

The pictograms in Figure 88 symbolize two bamboo culms with twigs hanging down on both sides. The very first bamboo character, sketch (*a*) in Figure 88, derives from the Chinese bronze period (1100–300 BCE). Later variations were made in the subsequent periods and demonstrate the evolution of the Chinese character for bamboo. The Chinese character for bamboo has become an essential character in Chinese writing and is still preserved. According to

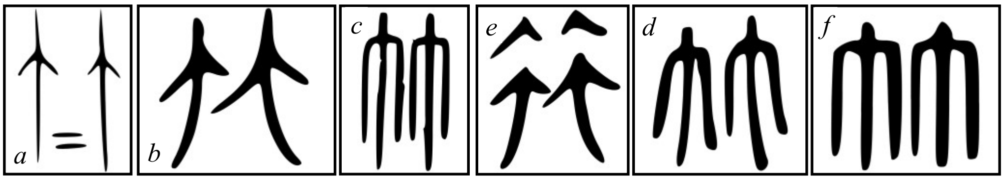

Figure 88 Bamboo in Chinese inscriptions. From the left to the right. (*a*) Bronze inscription and (*b*) Qin slip script (11th–3rd BCE), (*c*) Seal inscriptions (latter half of the 1st millennium BCE), and (*e*–*f*) Liushutong characters during Yuan period (1279–1368).

Bincsik, the bamboo radical 竹子 (*Zhú* in Chinese) is a symbol associated with more than a thousand characters, including "items traditionally made of bamboos, such as the flute (笛), writing brush (筆), box (箱), and basket (籠)—indicating that bamboo has likely played a pivotal role in the daily lives of people in East Asia for thousands of years" (2017, 5).[53] Due to the fact that Chinese writing documents the more than three millennia-old written culture of the Chinese people, and since bamboo is associated with a large number of characters, each time Chinese characters associated with bamboo are written it re-introduces and strengthens bamboo's importance in Chinese history.

8.4.2. Bamboo's Ubiquity in Chinese Material Culture

This chapter is dedicated to bamboo's ubiquity in Chinese material culture and is concerned with a mostly comprehensive enumeration of bamboo's miscellaneous uses. For this reason, I first refer to a list of bamboo articles enumerated by Porterfield that represent bamboo's part in Chinese material culture in the 1920s and, second, to references to bamboo in *Science and Civilisation in China* throughout Chinese history. The aim of this comprehensive depiction is to provide a general understanding of bamboo's role in the material aspects of Chinese people's

[53] Since Japanese writing stems from China, the Japanese symbol for bamboo 竹 (*take* in Japanese) stems equally from the Chinese 竹子 (*Zhú*), and its relation to Japanese language and writing is discussed in chapter 9.3.1.

lives and bamboo-based technological solutions, necessary for the next thematic parts of this chapter.

Overall, Porterfield's list (with English and Chinese names) counts 208 bambooic items, applications, and tools and encompasses the following things:

> Arrows, awnings, baby's pushcart, barrow, baskets (foo, shopping, sewing, poultry, waste, toy), beaters (criminal), beds, blinds (window), bolts, books (covers), bookcases, bottles, boxes (food, cigarette, clothes, incense), brushes, buckets, cable, carriages, cages (birds), castenets, chairs household, chairs (sedan), checks, chopsticks, cigarette holders, clothes rack, combs, cooking vessels, couches, cow-bells, cups (drinking), cups (on water wheels), curtains, dam (fishing), desk (money, paint), bows (military, cotton, for mule litters), bridges, brooms, Li Chu Pa, fifes, fishnet, flails, floats for fishing, flower pots, flooring, flutes, forms for bean meal in oil press, frames (for houses, holding copy books, plants, procession figures, Korean headdress, lantern, silk worm, threshing, umbrella and fan, weaving), fret-work, fruit picker, fuel, garments (summer), gate springs, girdles, grain (seed), god (freak shoot), hair-pins, hamper, handles (implement, hoe, digging fork, polo mallet, spade, umbrella, rake), hats (rain, sun, military), hedges, hinges (thongs), hoops (bucket, tub), houses (shacks, pavilions), divining rod, dredge (fishing), dust pan, fans, fences, Hsi Yen Pa, Lao Hu Pa (playing card, sacrificial, stencil for mimeograph, rouge covered for face), parts (crude machinery), pens, pen-holders, pins, pillows (summer), pipes (drain, gas, opium, organ, stems, tobacco, water), posts (fence), poles (carrying, clothes, boat, fishing, flag, tent, telegraph, vaulting), poison (leaf hairs), probes, props (clothes line, tree limb), pulp, rain coats (leaves), rain spouts (roof drains), rafts, rattle (watchman's), rope (and string), sail stays, sandals, shavings (caulk boats, stuff pillows, stuff mattresses), scaffolding, scoops, screens shield, shoes, shoots for eating, shovels, sieves (homes, exhibition shed), jugs, knives, ladders, ladles, lamps (oil), laths, lattices, lotteries, lumber (raw poles), manikins for the tailor, Mahjongg tiles, manure (dry, liquid), masts, mats, medicine, oarlocks, ornaments, paper (writing, water proof, fire-cracker), tubes (blowing fuel, raising brine), tubs, vases, violin heads, splints, spades, spears, spoons, stools, sticks (joss, walking), tables, tablets (paper holder, records), tags, tallies, tokens, torches, thatch, toys, traps (cricket, crab, fish, shrimp), trays (carrying, drying), teapots, tea caddies, whetstones, wrappers for articles (leaves), wardrobes and cupboards, yokes for cattle. (Porterfield 1926, 52–54)

This enumeration is far from complete, and there were numerous other cases in which bamboo was involved. Nonetheless, Porterfield's list indicates to what extent bamboo was part of Chinese material culture. As epitomized by the tools and objects, bambooic tools were an integral part of Chinese everyday life and practices—even though Porterfield's list does not illustrate to what extent and how these tools and objects were used. What is more, by examining the Chinese vernacular names of Porterfield's list (ibid.), I found that 42 of the 208 things mentioned by Porterfield include the Chinese bamboo radical 竹子 (*Zhú*).

If we check references to bamboo's use in Joseph Needham's (and other collaborators') seminal and comprehensive *Science and Civilisation in China*, we can find numerous instructions, data, and hints in connection with bamboo, which I grouped into the following categories highlighted in italics: Bambooic tools, devices, commodities and bamboo-based techniques and technologies are found in the domain of *physics*: such as bamboo pitch-pipes or musical instruments; *mechanical engineering*: springs, nails, conduits, waterwheels and other devices to lift water, bambooic rings needed to press vegetable oil, chariots, and kite construction; *civil engineering*: road construction, spring locks, reinforcement of roads and dams, roof construction, bridge building, bamboo gabions, bamboo ropes and cables, boat and ship construction, bamboo matting as ship's main sail, pumps, water barrels; *paper and printing*: writing (bamboo tablets), raw material for bamboo paper production, and building materials for various tools necessary for paper production and printing; *chemistry and chemical technology*: distillation with bamboo or as tube to convey liquids and gases; *military technology*: bamboo shields, catapults, bows, throwing sticks, bamboo mines, screens for protection, and scaling ladders; *gunpowder*: as an ingredient in gunpowder, whip arrows, fire-kites, bombs (such as thunderclap bomb or bee-swarm bomb), fire lances, guns (such as winged-tiger gun, bamboo gun, or blowgun), rocket arrows, portable bamboo rocket-arrow thrower, and sky rockets; *textile technology*: looms, spooling reels, quilling, quilling wheels, spindles, bamboo ropes, and silkworm trays; *mining*: bamboo pipes (salt production), waterproof bamboo baskets, aerial tramway hawsers, bamboo flume, or the dragon pump; *agriculture*: seed drill, weeding claw, mats, winnowing fan, storage basket, or granary; *fermentation and food science*: bamboo shoots, catching fish, containers (to store liquids), steamer, chopsticks, fermenting, dining furniture, sieves, raddles, or kitchenware (Needham et al. *Science and Civilisation in China* Volumes 1–7 from 1954 to 2004). To summarize, as demonstrated by the abovementioned two sources, bamboo was the material basis of various Chinese domains of life and proto-industries and contributed much to the development of Chinese science and technology.

8.4.3. Bamboo's Material Properties and Its Mechanical Uses in China

I have elaborated on bamboo's material, mechanical, and physical properties in chapter 3 and discussed its processing methods in chapter 4 and again in relation to processing techniques involving the human body in chapter 7.6.1. In the following, I shall provide further details about bamboo's properties to outline how Chinese people took advantage of bamboo's remarkable qualities.

In a note about bamboo's outstanding material properties, Needham and Wang compare bamboo with a two-phase composite material, such as fiberglass. According to them, bamboo combines "strong high-modulus fibres of cellulose" with "with a low-modulus plastic matrix, lignin," which Needham and Wang take as an explanation for bamboo's multifaceted use in China's material culture (Needham and Wang 1965, IV:2, 61, footnote g). In this light, bamboo shares common ground with composite materials that unite materials with different tensile strengths and elasticity and which "can absorb loading stresses which would rupture the weaker component, and at the same time isolate imperfections in the individual units of the stronger component" (ibid.). Moreover, bamboo's "two-phase structure was dissociated by retting to give the high-tensile-strength fibres alone" (ibid.) and to produce superior materials for various applications. Having these characteristics inherent to bamboo in mind, in what follows, I shall describe further aspects of bamboo, including its *tensile strength*, *hollowness,* and *flexibility and springiness*, and the different applications in connection with these properties as discussed in the following chapters.

Tensile Strength

Figure 89 Bundles of bamboo strips.
Source: Porterfield 1933, 180

As illustrated by the photograph in Figure 90, bamboo bridges and bamboo ropes epitomize how bamboo excels in terms of its tensile strength. Over the centuries, the use of bamboo cables and ropes has been developed and carefully elaborated based on experience and empirical observations and utilized for many purposes (ibid., 64). As Hommel (1937, 87) mentions, Chinese farmers and craftspeople made widespread use of the high tensile strength of bamboo. Twisted bamboo rings, for instance, were needed in the domain of oil making to resist massive pressure without bursting apart (ibid.). Bamboo's tensile strength was also brought into play to reinforce hand mills by bamboo strips, such as the strips shown in Figure 89, which also were wound around wooden grounding discs, aiming to strengthen them and thus prevent cracking (ibid., 92). Twisted bamboo strips (similar to hoops) were also put to use by Chinese peasants to support cracked molds, as well as to reinforce staves of bowls and barrels, washtubs, or chicken feeders (ibid., 139, 151, 193, 156). Similar applications were also used in Japan and discussed in chapter 9.4.5.

Porterfield also investigated bamboo's mechanical properties and referred to physical experiments that had been undertaken to analyze bamboo's properties as a material to reinforce concrete, with tests involving "bending, shearing, elasticity tension, and compression;" as Porterfield concludes, "the ultimate tensile stress of bamboo was found to be 14,000 lbs. per sq. in. [pound-force per square inch]" (1926, 30), which is approximately 96.5 MPa (megapascals). Current studies indicate that bamboo, as a material for reinforcing concrete, has a tensile strength of "295 MPa for a wall thickness of 7–8 mm" (Javadian 2019, 6) and, so, bamboo is comparable to cast iron (200 MPa) and steel (450 MPa).

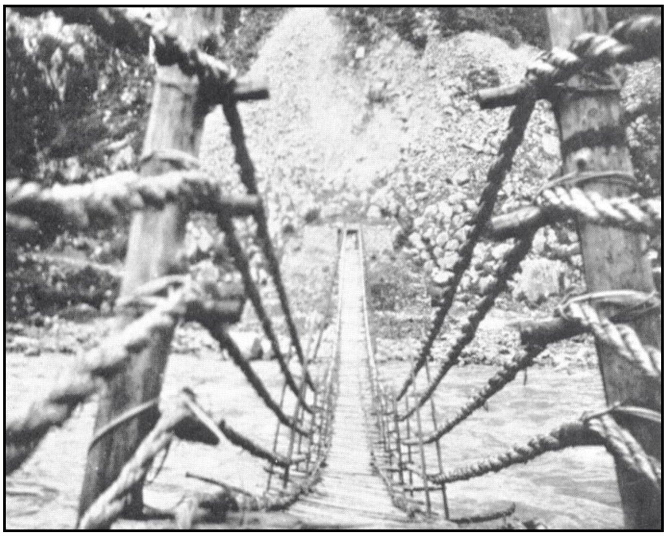

Figure 90 A bamboo cable bridge across the Min River near Wenchuan in northern Sichuan Province.
Source: Porterfield 1933, 182

In general, bamboo withstands high loads and is considered one of the most robust (organic) building materials worldwide. As argued by Porterfield (1926, 30), bamboo's robustness is one reason why bamboo cables were widely produced and used for suspension bridges, to reinforce containers, and also to tow Chinese junks up the waterways. Needham et al. also highlight the tensile strength of bamboo and its wide sphere of application and mention how bamboo ropes were made into anchor cables and towing cables:

> The anchor cable is made of thin strips of the outer parts of the stems of green bamboo, which after being boiled in water are twisted into rope. The tracking (towing) cables (then) are made in the same way. Cables more than 100 ft. long come in sections with loops at both ends to join them together, so that they can be uncoupled immediately if obstacles are encountered. It is in the nature of bamboo to be 'straight' (i.e. to have a high tensile strength), so that one such skin strip can sustain a weight of 1,000 chün [jin, 500kg]. When ships are going up the Yangtze gorges to Szechuan they do not use the twisted cables, but rather bamboo laths cut to the width of about an inch and joined to form a long flexible spar (or chain of rods); this is necessary as twisted cable can easily be cut or broken by the sharp rocks. (Needham et al. 1971, IV:3, 415)

As indicated by Needham et al., bamboo was processed in two different ways: as twisted ropes or thin laths. In both cases, however, the favored materials were young culms since they have the advantage over mature bamboo culms of being more flexible and less brittle. Moreover, keeping the outer skin as part of the ropes and laths enhances their tensile strength since the outer skin is silicified and the densest part of the culm.

Flexibility and Springiness

Bamboo has remarkable flexibility and springiness. This is vividly demonstrated by the various bows and crossbows employed as military weapons or traps utilized by Chinese peasants to hunt animals (or, in connection with the latter, also by Bahnar people as outlined in chapter 8.6.4). Concerning the Chinese bow's origin, Needham et al. assume that it derives from pellet-bows, which, in turn, were some sort of catapults that equally were based on bamboos' springiness (Needham et al. 2002, V:6, 115). Moreover, by taking advantage of bamboo's flexibility and elasticity, Chinese craftspeople constructed various textile mechanisms, such as the cotton bow illustrated in Figure 116, or reels and looms (Hsiao and Yan 2014, 39–40).

Hollowness

There is another characteristic feature common to most bamboo species, namely, bamboo's hollowness. This feature allows bamboo to be transformed into various tools and devices. Thus, after removing its septae, bamboo "forms a natural pipe, and this fact, . . . exerted a cardinal influence on East Asian invention" (Needham and Wang 1965, IV:2, 64), and laid the foundation for the creation of simple but functional and important things for everyday use. On the basis of bamboo's hollowness, people constructed, for instance, water pipelines to conduct water from waterwheels to the farmland or from rivers to households (as described in chapters 8.6.3 for China and 9.4.3 for Japan). As mentioned by Needham and Wang (1965, IV:2, 64), bamboo tubing also found its way into alchemy and early chemical technology since Chinese people exploited bamboo's hollow structure in the form of containers utilized for purposes such as the descensory distillation of mercury or the solubilization of minerals. Bamboo tubes also were of significance for medieval Chinese astronomy because craftspeople could create sighting tubes. And, to give another example mentioned by Needham and Wang, bamboo's cylindrical form had a major influence on the invention of barrel-guns in the early twelfth century (ibid.).

Chinese people utilized bamboo's cylindrical form and hollowness to extract liquids and sediments in many other cases. Hommel gives two examples in this regard. The first one is related to stone blasting in the domain of Chinese mining. In this case, as described by Hommel, miners prepared a hole through wet drilling and charged it with gunpowder. Yet, before charging the hole with gunpowder, they had to withdraw the remaining stone particles and water for optimum blasting. To this end, miners used a bamboo culm with removed internodes and inserted it into the drilling hole, closed its upper end with the thumb, and extracted the remaining water and stone particles. Afterward, if water still remained in the hole, the miner sucked it into the tube and blew it out (Hommel 1937, 10). This example vividly illustrates bamboo's use on the grounds of its hollow structure in combination with simple physical laws of pressure and how such a simple device becomes an effective method to remove liquids from holes. With regard to the described function, the bamboo tube resembles a so-called *thief-tube*, which is a device for withdrawing a sample of liquid from a cask. This particular purpose, in which sediments at the bottom of a rainwater container (*kong*) were removed, is also mentioned by Hommel, writing that a bamboo tube:

> closed at the upper end, but with a small hole . . . on the side near the closed end . . . is pushed into the kong with the forefinger tightly pressed over the little hole until the open end is in contact with the sediment at the bottom. Now the finger is taken off the little hole, the imprisoned air escapes and the slimy sediment is syphoned into the tube. When the tube is filled the little hole on top is closed once more and the tube is withdrawn from the kong. This done, the little hole is opened again, and the contents of the tube are [allowed to] let run out. In this way the sediment cut be completely removed without much trouble, and without disturbing the clear liquid above it. (ibid., 12)

In summary, both examples demonstrate bamboo's utility based on its tubular structure. Even though both tools are simple, in terms of their functional utilization, they helped to accomplish necessary but simple tasks.

8.4.4. Wood, Iron, and Bamboo

In Europe, before the advent of industrial machinery and before industrialization began, wood was the most important building material. Given this, one is inclined to classify the European pre-industrial technology and material cultures as wooden cultures or wooden civilizations—however, not only in Europe but throughout the world, wood was of paramount importance. On account of this, the German historian Joachim Radkau (2012 20) argues that there has always been an interrelationship between humans and wood as an essential building material. Accordingly, in Radkau's (ibid.) view, the hand, musculature, and creativity of humans have been shaped by their interaction with wood, and wooden tools bear the marks of the hand that worked with them. And what is true for wood is true for other materials such as bamboo.

As explained in chapter 5.5.1, for Mumford (1935), tools and machines contributed much to the development of technology and the industrial revolution. If we consider Chinese pre-industrial material culture and technologies—though not distributed equally throughout all Chinese regions in space and time—people's life and material culture were determined by bamboo and wood. Thus, in line with Radkau's statement concerning humans' relation to wood, Chinese local bamboo-based technology and, of course, wood-based technologies resulted from interactions with both materials and their specific properties. And, as also indicated by Radkau (2012, 20), the utilized raw materials determined to some extent the shape and utility of tools and people's material culture, whose design and function were geared to people's necessity to meet their needs.

By addressing humans' exploitation of human and (natural or artificial) nonhuman power sources, Mumford (1935) coined the terms *palaeotechnic*, *eotechnic*, and *neotechnic* to distinguish between the various natural resources and power sources in human history. Needham and Wang comment on Mumford's classification and underscore China's *eotechnic*, which was epitomized by *wood, bamboo, and water*. According to them, "our present 'neotechnic' phase of electricity, nuclear energy, alloys and plastics followed upon a 'palaeotechnic' one in which coal and iron were the keynotes but before that there had been an enormously longer period, the 'eotechnic' phase," and the latter phase in its Chinese materialization "was the age of wood, bamboo, and water, and it lasted until the spread of Renaissance technology over the Asian continent" (1965, IV:2, 1). In view of this, bamboo (alongside wood and water) made a great contribution to Chinese civilization, eotechnic, and proto-industrial technologies. It is not that the other two important materials, namely, wood and iron, were not used widely in pre-industrial China. Instead, it is the case that along with wood and iron, bamboo was another key material at people's disposal and enabled them to create various other tools, everyday artifacts, and constructions due to its unique material structure and composition.

James Dyer Ball, a nineteenth-century Hong Kong scholar, also highlights bamboo's importance in pre-industrial China by comparing iron with bamboo. With reference to his time, he notes that "what iron is to the English, such is the useful bamboo to the Chinese" (Ball 1903, 72–73). According to Zhong, iron-smelting products in China dated back to the mid eighth century BCE and emerged first in Central China. While iron was primarily used for weapon production since it was very valuable and rare, during the fourth century BCE and until the first decades of the third century BCE, iron-smelting technologies were increasingly improved. Later, due to groundbreaking innovations in the field of pig iron smelting technologies, agricultural implements were produced and equipped with iron (Zhong 2016, 518). "Not by any means that the use of iron is unknown in China," Ball points out, "far from it; it is largely used for many purposes; but bamboo is even more extensively employed, not only for the purposes that iron is ill-fitted for, but also for many for which that metal is well adapted" (1903, 73). And in the further course of his text Ball interjects that "the question is not what it [bamboo] is used for, but what it is not used for" and concludes that "the answer, with but little reservation, would appear to be that it is used for nearly everything" (ibid.).

On the one hand, Ball's comparison of iron with bamboo exemplifies the importance of both as crucial raw materials, and on the other hand, it defines the difference between East and Southeast Asia in contrast to Europe concerning the consumption and use of iron. As a third point, Ball states that bamboo can substitute iron, and bamboo has many more applications than iron. Therefore, on account of his observation and bamboo's ubiquity in many domains of life and fields, Ball declares that "the bamboo age . . . reigns in China" (ibid.). And indeed, as this and the following chapter will prove, in whichever way a *bamboo age* may be defined, bamboo alongside wood was the material backbone of ancient China. And after the invention of the iron, bamboo, alongside wood and iron, characterized pre-industrial Chinese material cultures.

8.5. Bamboo's Contribution to Papermaking and Gunpowder as Two of 'The Four Great Inventions'

As discussed in this thesis, different kinds of bamboo cultures and bamboo technologies flourished throughout the world and provided the material groundwork for many people. If we are to discuss bamboo's part in China's history, bamboo was equally a versatile material in the daily life of Chinese people. But, as the following discussion will demonstrate, bamboo also contributed significantly to China's pre-industrial technological development.

By and large, until the European Enlightenment and Industrialization, China was among the most advanced countries in terms of science and technology. Many significant inventions and pre-industrial technologies derive from China and gradually arrived in Europe via the Silk Road and, in turn, provided fresh impulses for the development of science and technology in Europe. Amongst all the inventions, however, *The Four Great Inventions*—the compass, gunpowder, papermaking, and printing—symbolize the advanced level of science and technology in ancient China since they stand out due to their significance. And if we take into account bamboo's role in relation to these inventions, it is striking that bamboo was essential for two of the four inventions, namely, the utilization of gunpowder and paper production. As mentioned earlier, bamboo had already been used in the form of containers in Chinese alchemy and early chemical technology (such as distillation or solubilization of minerals). Later, its natural, cylindrical design offered an ideal container that profoundly impacted the invention of barrel-guns, which are seen as the prototype for all succeeding models of canons and guns (Needham and Wang 1965, IV:2, 64). Similarly, bamboo had considerable significance for papermaking. It became an indispensable raw material for pulp production, and many bambooic tools were employed in the process of papermaking. In this respect, the following two chapters deal with both inventions.

8.5.1. Bamboo Tablets and Bamboo as Raw Material for Papermaking

Writing media greatly benefited China's socio-cultural, economic, and technological development and offered much to maintain cultural heritages and communication in space and time. Against this backdrop, this chapter is devoted to bamboo's involvement in making early Chinese writing media (bamboo tablets) and bamboo's use as raw material for papermaking. However, this chapter cannot fully depict the socio-cultural impact of writing and papermaking, nor does it shed light on the reasons that caused the development of bamboo tablets and papermaking in China due to its limited scope.[54]

"The direct ancestry of the Chinese book," as Needham and Tsuen-Hsuin put it, "is in the tablets of bamboo or wood" (1985, V:1, 29). Accordingly, before the advent of paper (around 300 CE), bamboo and wooden tablets were widespread in China and the principal media for writing and had already "a most significant and far-reaching effect on the tradition of the Chinese book and culture" (ibid.). According to Fan et al., "the earliest bamboo tablets that were discovered in Hubei Province date back to the early States Period (443 BCE), with a slip-length of about 75 cm and a width of 1 cm, and written on both sides" (2016, 167).[55] The bamboo tablet's design and shape, composed of long and narrow strips, was primarily determined by bamboo's splitting property along its fibers in the longitudinal direction. These strips and their

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[54] The interested reader will find further information on this subject in Needham and Tsuen-Hsuin *Paper and Printing* (1985, Volume I Part 1 pp.1–131); or Fan et al. (2016, 161–191) in their chapter entitled *Invention, Development, and Influences of Papermaking Technology*.

[55] For a more detailed depiction of bamboo and wooden tablets, vernacular names, fabrication, or size, see Needham and Tsuen-Hsuin (1985, V:1, 32) and their comments on this subject.

long and narrow shape, in turn, determined the direction of ancient Chinese writing, that is, from top to bottom and the design of later books. Accordingly, the bamboo tablet is a good example of how a raw material's physiochemical composition influences the design and becoming of human-made things and, so, how matter actively guides the creation of things.

Concerning the tablet's material composition, Fan et al. (ibid., 167) find out that wherever bamboo was available and abundant, people used it, but in regions with fewer bamboos, such as in the remote regions in China's northwest, people alternatively used wood.

After the invention of paper, however, bamboo and wooden tablets were substituted by paper, which was thinner and lighter compared to the former and easier to handle and transport. Yet this replacement happened gradually, and the use of bamboo and wooden strips alongside silk and paper overlapped temporarily. In this context, Needham and Tsuen-Hsuin divide the spread of the chief Chinese writing material into three main eras. While bamboo and wooden tablets were common from the earliest time until the third and fourth century CE, silk writing materials emerged around the seventh century BCE and lasted until around the sixth century CE. Paper was not invented until the first century CE but soon superseded the old-fashioned materials and gradually crossed Chinese borders, reaching Europe only in the modern era (Needham and Tsuen-Hsuin 1985, V:1, 1, 29). Later, in the late Eastern Han Dynasty, due to the huge demand for superior quality paper (by the state, merchants, or craftspeople), paper production and paper technology underwent continuous improvement (Fan et al. 2016, 173).

Concerning the raw materials most suitable for papermaking, it could be said that ancient Chinese paper makers utilized a plethora of plant fibers with high amounts of cellulose to create good quality paper in the best economical way possible, which included "bast plants, such as hemp, jute, flax, ramie, and rattan; tree bark of mulberry and paper mulberry; grasses, such as bamboo, reeds, and stalks of rice and wheat; and such fibres as cotton" (Needham and Tsuen-Hsuin 1985, V:1, 52). In terms of their chronological use, hemp was the very first material used in the domain of papermaking "from the Former Han (-206–+8), followed by paper mulberry from the Later Han (+25–220), rattan from the Chin (+265–420), bamboo from the middle of the Thang (+618–906), and straw probably from before the Sung dynasty (+960–1280)" (ibid.). Needless to say, the choice of raw fibers needed for paper production has varied considerably in relation to the available, local raw materials, with each having certain advantages and disadvantages that needed to be weighed against each other. With regard to bamboo, papermakers took advantage of bamboo's long fibers, its rapid growth compared to trees, its relatively low cost, and its abundance close to rivers, facilitating transport on waterways to the paper production centers—which, in turn, were close to rivers due to their great demand for water.

So far, I have examined the use of writing media, the various raw materials needed for paper production, and the development of paper production. In what follows, I shall elucidate in more detail the working steps in bamboo paper production by the example given by the Chinese scientist and encyclopedist Song Yingxing (1587–1666) in his comprehensive encyclopedia, *Tiangong Kaiwu* (*The Exploitation of the Works of Nature*):

> The making of bamboo paper is a craft of the south, especially popular in Fukien province. After the bamboo shoots have started to grow, the topography of the mountain area should be surveyed. The best material for papermaking is the shoots that are about to put forth branches and leaves. During the season of *mang-chung*, the bamboos on the mountains are cut into pieces from five to seven feet long. A pool is dug right there in the mountain and filled with water in which the bamboo stems are soaked. Water is constantly led into it by means of bamboo pipes to prevent the drying up of the pool.
>
> After soaking for more than one hundred days, the bamboos are carefully pounded and washed to remove the coarse husk and green bark. The inner fibres of the bamboo, with a hemp-like appearance, are mixed with high-grade lime in a thick fluid and put into a pot to be boiled over a fire for eight days and nights. The pot for boiling bamboo, four feet in diameter, is enclosed in a wooden cask, measuring fifteen feet in circumference and more than four feet in diameter. The pot is attached to the cask with the aid of mud and lime and has a capacity of some ten catties of water. The cask is covered for boiling for eight days.
>
> After the fire has been put out for one day, the bamboo fibres are taken from the cask and thoroughly washed in a pool with clean water. The bottom and four sides of the pool are lined securely with wooden boards to keep out dirt. When the fibres have been washed clean, they are soaked in a solution of wood ashes and put again into a pot, pressed to flatten the top, and covered with about an inch of rice straw ashes. When the water in the pot is heated to boiling, it is poured into another cask and strained with the solution of wood ash. If the water cools off, it is boiled again to repeat the straining. After some ten days of such treatment, the bamboo pulp naturally becomes odorous and decayed. It is then taken out to be pounded in a mortar until it has the appearance of clay or dough, and the pulp is then poured into a vat for use. (Yingxing 1637 *In* Needham and Tsuen-Hsuin 1985, V:1, 69, tr. Sun and Sun 1966, 224–7)

Yingxing's description of papermaking is illustrated in the sketches *a–e* in Figure 91, which demonstrate the five major steps in manual bamboo papermaking: (*a*) the preparation of the fibers by removing bamboo's silicified outer wall, (*b*) boiling the fibers, (*c*) dipping paper sheets, (*d*) extracting the water, and (*e*) drying. These sketches also reveal other insights about bamboo. As can be seen in sketches (*a*) and (*b*), bamboo was used to build the fences surrounding the paper production site. Bamboo was also used as firewood to boil the pulp and heat the drying wall, as demonstrated by the worker sitting behind the oven in sketch (*c*) and the other worker heating the wall required for drying the paper sheets in sketch (*e*). As depicted in the bottom right in sketch (*c*), papermakers exploited bamboo's tubular structure to conduct water

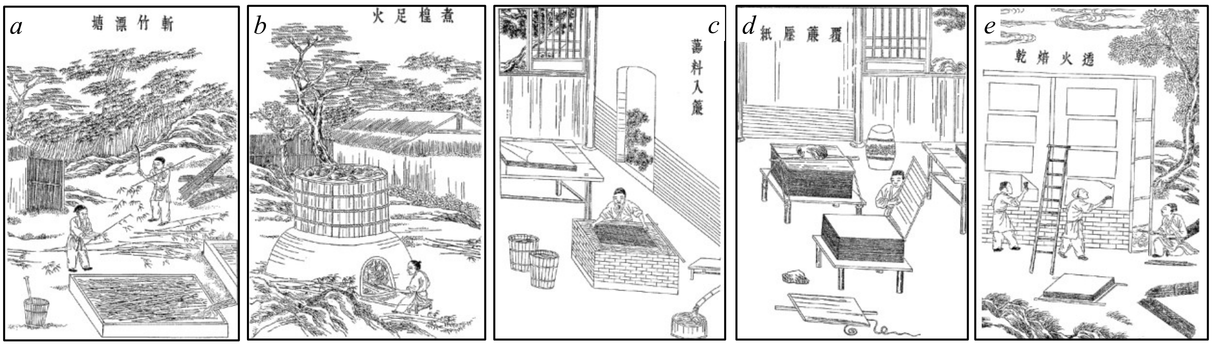

Figure 91 The five major steps in ancient Chinese papermaking as outlined by Yingxing. From the *left* to *right*: (*a*) Cutting and soaking of bamboo culms and twigs. (*b*) Boiling the inner parts of the bamboo culm after removing its silicified outer wall. (*c*) Dipping the bamboo mold to lift the bamboo pulp. (*d*) Layers of paper sheets are stacked and pressed to release the remaining water. (*e*) Drying of the paper sheets on a heated wall to remove the remaining moisture.
Source: Yingxing, *Tiangong Kaiwu* 1637 From: Wikimedia.org

and used bamboo-made screen-molds for dipping, as demonstrated by the worker in sketch (*c*). Concerning the development of screen-molds, Needham and Tsuen-Hsuin (1985, V:1, 43, 66) note that bamboo was utilized to craft well-sized, fine screen-molds—using square bamboo slats for the frame and slender bamboo strings to stitch the woven screen around the frame bars—and treated them with an insecticidal dye for longer durability.

During the Ming Dynasty, so argued by Needham and Tsuen-Hsuin (ibid., 49), bamboo became the predominant material for papermaking due to the natural abundance of bamboo in its southern regions. As a result, bamboo production sites were founded in what are now the provinces Jiangxi, Zhejiang, and Fujian due to the numerous bamboo groves growing on the mountain slopes and alongside rivers and streams.

Overall, paper had become indispensable in China, especially for the production of documents, contracts, banknotes, edicts, certificates, and books, which were of paramount importance for trade, the economy, and bureaucracy. Moreover, in the context of Chinese culture, literature was held in the highest esteem, and its development, spread, and support were only possible due to the invention of paper. Similarly, books were valuable sources to describe technological findings and the working principles of machines and deeply impacted their spread and improvements. To sum up, even though various raw materials were essential for ancient Chinese paper production, bamboo played a decisive role since it helped increase paper production and, consequently, facilitated the access to and use of paper essential for various domains.

8.5.2. Military Technology

Chinese military history begins in ancient China's Xia dynasty and is marked by pioneering inventions such as the crossbow, the utilization of metals to equip armed forces, military tactics and strategies, or firearms. According to Zhong (2016, 515), the main principles and characteristics of Chinese military technology were developed in the sixth century and endured until the early twentieth century and expressed the conflation of humans, technologies, and organizations in relation to warfare and military affairs. As briefly summarized by Zhong, "human beings are the subject of wars, . . . technologies are the means of wars, finding expression in various weapons, military supplies, and a variety of engineering approaches," and the combinations of humans and military technologies are represented by "structured organizations, strategies, and tactics" (ibid.). Following Zhong's classification, this chapter is devoted to the Chinese means of war and, above all, to bamboo's part in Chinese military technology.

Since gunpowder had a profound impact on warfare, Zhong (ibid., 516) distinguishes between the *Cold Weapon Era* (early ancient times until the tenth century) and, after the invention of gunpowder and the associated firearms, the subsequent period described as the *Firearm Era* (late tenth century until the twentieth century). Due to the fact that bamboo was utilized in both eras, this chapter portrays the material history of bamboo as it relates to the history of Chinese military technology and addresses the manifold uses of bamboo as a raw material to produce military weaponry.

First of all, Zhong arranges the various weapons into three categories: "fighting weapons (dagger-axes, spears, knives, swords, etc.), projectile weapons (javelins, crossbows, stone-throwing machines, etc.), and protective equipment (armor, helmets, shields, etc.); other important military supplies included chariots, warships, and cavalry and harnesses" (ibid.). While the first types of weapons were made mainly using naturally occurring raw materials such as stone, horns, animal skin, or bamboo, the search for harder materials, from bronze through iron to steel, caused the decreasing significance of natural raw materials and their subsequent replacement by metals. However, as I attempt to show below, Chinese weapon builders have taken advantage of bamboo's material properties and used bamboo in a variety of ways to make weapons and defensive implements, even though metal weapons played increasingly important roles.

During the *Cold Weapon Era*, the use of bamboo for every kind of stabbing weapon may be the most natural use since bamboo combines several significant attributes that are vital for this purpose. The bamboo spear is probably one of the first deadly bamboo stabbing weapons that humans made. Concerning the bamboo spear's handling, use, and efficacy, three factors come into play. First, the elongated structure and the ability to grasp bamboo with one hand's circumference, which made it easy to handle. Secondly, due to its sharp tip, the pointed bamboo spear was a dangerous weapon and could inflict severe injury on unarmored opponents. Third, unlike wooden spears, bamboo spears are much lighter, making them more convenient to carry. Accordingly, the bamboo spear is a tool that is attached to the human hand, sensuous perception, and bodily power, which together determine the use of it. Moreover, the spear's handling and function are, in the words of Ingold, "performed by the links and joints of the human skeleton" and "empowered by the muscles" (2000, 303).

When bamboo is split, it can also be fashioned into sharp knives. As described in the chapters about Native Americans (10.2.2.3), the Awa people (7.5.2), and in the context of the *Bamboo Line Hypothesis* (5.4.3), various people worldwide have used bamboo knives to cut meat or even to commit suicide. Accordingly, the use of bamboo knives as a military weapon in Chinese history must have its beginning in ancient times.

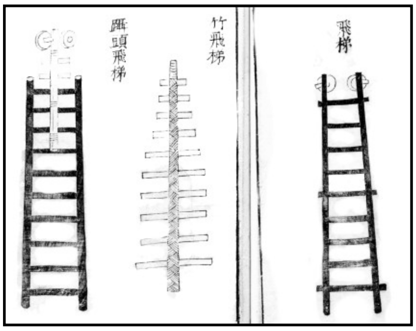

Figure 92 Bamboo scaling ladders. *Source*: Wujing Zongyao (1044, 232)

There were also other tools, weapons, and implements of war based on bamboo's length, such as flagpoles, spikes, hand ladders, as well as scaling and flying ladders necessary for sieges. The latter are illustrated in Figure 92 as depicted in the *Wujing Zongyao* (1044). The flying ladder's use and material composition is summarized by Needham et al. with reference to the *Wujing Zongyao* as follows: "the 'flying bamboo ladder' . . . , consisted of a single pole made out of a large bamboo with rungs fitted through the shaft. The second was the 'flying ladder for climbing to the top' . . . [and] was made of two sections connected by a pivot . . . , the upper section being constructed out of a single bamboo pole as in the 'flying bamboo ladder'" (2002, V:6, 454). Concerning the use and characteristics of bamboo ladders, I elaborate on this topic in relation to their use by firefighters in Tokyo in the later nineteenth century in chapter 9.4.2.

Associated with the increasing improvements regarding gunpowder's qualities, the Chinese improved their weaponry or invented new weapons and firearms to strengthen their military power. In this light, I shall place particular emphasis on bamboo's contribution to the development of firearms, which had various advantages compared to the *Cold Weapon Era*. As argued by Zhong, "success of creating fire lances freed primary firearms from dependence on bows, crossbows, and stone-throwing machines and made them to be directly operated by soldiers for firing at enemies" (2016, 547). Thus, soldiers used bamboo lances as a kind of fire lance to burn down their enemies by spreading rain fire on them, followed by a stabbing of their enemies (ibid., 548). Later, bamboo contributed to the development of tube-shaped firearms equipped with gunpowder and bullets after bamboo's first use as a bamboo-tube proto-gun in the thirteenth century (ibid., 548–549). Needham et al. have a similar view, saying that "the hollow bamboo stem was the invitation of Nature which led to all cylinder-barrels" (2002, V:6, 3).

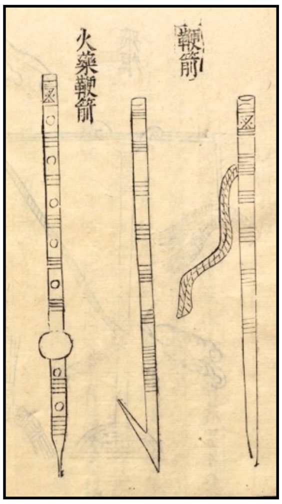

Figure 93 Gunpowder whip arrows.
Source: Wujing Zongyao (1044, 327)

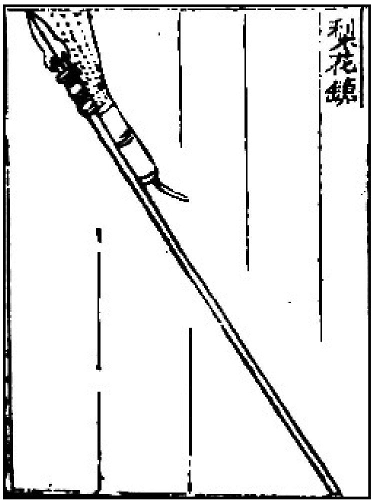

Figure 94 The pear-flower gun (fire lance).
Source: Huolongjing 1644, 24

Generally speaking, all firearms were spherical, but their shape and use changed when people used bamboo on the grounds of its natural cylindrical form in the middle of the tenth century. According to Needham et al. (ibid., 8), this transition, from spherical to cylindrical firearms, can be attributed to the ubiquitous occurrence and naturally determined structure of bamboo. Hence, concerning the employment of bamboo's cylindrical form, Needham et al. state that "biological analogies must always have been in men's minds (at least subconsciously)," and as a result, bamboo provided "the cylindrical tubes through which excretion and emission occur" (ibid. 8). In another passage, Needham et al. (ibid., 9) outline the development of fire lances deriving from the petrol flame-thrower pump and argue that this transition resulted in a portable hand weapon and later, due to the use of gunpowder, to new inventions based on bamboo's cylindrical form.

One other aspect comes into play if we regard the development of bamboo firearms, namely, a bamboo culm's natural explosion when heated over a fire. This point is also emphasized and described by Needham et al., who explain the following:

> Air is contained between the septa of the stalk, and if it is thrown upon a fire, the segment will explode with a loud report. Even if longitudinal slices are put in a fire they will emit

> noisy cracks, but the explosion of the heated air between the nodes is what really makes a fire-cracker. The packing of gunpowder into small containers, when it came in, was simply a way of imitating the scaring sounds originally emitted by burning bamboos. It must be remembered that in Chou and Warring States times, before the invention of paper, writing was done either on silk or on slips of bamboo. The characters were first written on green bamboo, for easy erasure, and then the bamboo was dried over a fire; this was the origin of the phrase sha chhing, 'killing the green,' applied to the making of documents! The phenomenon of the cracking of bamboo must therefore have been very familiar in ancient China. (ibid., 128)

As mentioned earlier in chapter 3.1, the term *bam-boo* stems from the Malay language and refers to the sound impact that bamboo causes when exploding. Namely, an initial bang *bam* and the subsequent reverberation *boo*. Against this background, it can be assumed that the phenomenon that bamboo explodes when heated must have led to the assumption that high pressure inside a closed cylinder is related to powerful explosive force.

Another explosive weapon was the use of long green bamboos by crafting whip arrows (or javelins) on the basis of bamboo's springiness. Its construction and operation are described in the *Wujing Zongyao* in the following words: "Take a length of newly (-cut) green bamboo 10 ft. long, with a diameter of 1.5 in. (as the pole). The lower end is shod with iron (and fixed to the ground). A silk cord 6 ft. long is attached to the top end of it. Take also another piece of strong bamboo 6 ft. long to make the *pien chien* [whip arrow] itself, and give it a pointed head. Check the junction of the two poles, and fix there a bamboo guide-hook" (Wujing Zongyao 1044, chapter 12, 60; transl. Needham et al. 1986, V:7, 9). In this regard, using the flexibility of bamboo is, in principle, somewhat evident if we consider that people have been taking advantage of this characteristic feature since ancient times. Therefore, the use of bamboo's springiness and resilience when bent certainly led to the idea to exploit this property for catapulting things over fairly long distances. Later, using projectiles such as bamboo gunpowder arrows, as illustrated in Figure 93, increased these projectiles' explosive and destructive power, aiming to inflict maximum damage on the enemy.

Amongst other firearms and weapons exploiting bamboo's and gunpowder's explosive interaction are, as mentioned by Needham et al. (ibid), for instance, the *bamboo fire kite* (157); *wind-and-thunder fire-rollers*, which were cylindrical rollers made of bamboo and filled with various ingredients such as gunpowder, iron fragments, and projectiles and rolled down a hillside into the enemy camp (218); the *poison-dragon magically efficient fire-spurting tube,* made from a piece of bamboo that released poisonous fumes and used to defend city walls (234); the *empyrean-soaring sand-tube* that emitted flames and sand out of a bamboo tube intending to inflict blindness when it gets into the eyes of the enemy (234); the *bamboo rocket-*

arrow carrier (as illustrated in the sketch in Figure 94) that carried multiple arrows attached with bamboo containers filled with gunpowder to reach relatively far (493). Furthermore, bamboo, in combination with gunpowder, was also used to produce civilian fireworks (473).

To sum up, bamboo was instrumental in Chinese military technology before and after the invention of gunpowder and enhanced existing weapons' efficacy (as demonstrated by the gunpowder whip arrow). The versatile use of bamboo in pre-industrial weapons technology impressively illustrates how various types of weapons have been developed with bamboo's help and by taking into account its inherent characteristics. Early weapon engineers made use of bamboo's length to create flying ladders, spears, javelins; bamboo's hardness to produced sharp spikes, traps, and knives; bamboo's hollowness by charging it with gunpowder for various explosions and weapons; or bamboo's strong material density to create powerful armors and shields for protection. However, hardly any other invention has changed warfare more than the invention of gunpowder. The transition from the *Cold Weapon Era* to the *Firearm Era* involved the inventions and developments of numerous types of weapons and gradually led to a professionalization of the military strategies and technologies in China but later also in Europe and throughout the world. Flying fire arrows, for instance, were miniature missiles penetrating the enemy ranks, causing fear and severe injury to both humans and horses. Hence, as the foregoing has shown, the invention of gunpowder led to the invention of firearms and involved the conversion of the explosive power of gunpowder into penetrative force. On the other hand, the development of early effective gunpowder explosions in China must, to some extent, be ascribed to bamboo's inherent cylindrical shape and abundance in China. In other words, bamboo's hollowness and tubular structure provided an excellent groundwork to charge it with gunpowder and other ingredients for effective explosives.

8.6. Bamboo's Part in the Daily Life of Peasants in Early Twentieth-Century China

For the longest time in its history, China was an agrarian country. It is estimated that by 1952, still around eighty-three percent of the Chinese working-age population was primarily engaged in agriculture, and even in 1977, around seventy percent worked in farming, whereas for 2012 it is estimated that thirty-three percent were employed in agribusiness (Cheremukhin et al. 2015, 12). Thus, only in recent decades has urbanization increased in intensity, and China has only gradually changed from an agricultural country to an industrial country. The Chinese population, estimated to be under 150 million until the late sixteenth century, increased to between 370 and 470 million from the mid-1700s to 1900 during the Qing dynasty (Deng 2015, 2). The remarkable growth of China's population during the Qing dynasty, so argued by Deng, was achieved through "a synergy of (1) farming technology (rice yield and maize adoption), (2) farmland, and (3) disaster relief" (ibid., 47). Hence, appropriate agricultural implements and methods (or *farming technology*) have been, amongst other factors, crucial for food security on a national scale.

On the other hand, and although agricultural technology had developed further, Chinese agriculture remained a labor-intensive activity for most of history. Moreover, compared to industrialized countries' farming technologies, including machines driven by fuel or electric motors, Chinese agriculture was less productive due to the lack of modern machines. In contrast, early pre-industrial Chinese agricultural tools allowed an early stage of agricultural efficacy. These agricultural tools, in turn, frequently involved bamboo in the creation of "irrigation wheels, water-pipes, hoe-handles, hand-rakes, aeration mats, sieves, screens, windows, fans, thrashing sticks, carrying rods, grain containers, granaries and supports for vines, beans, gourds, bananas and aquatic crops" (Hsiung 1987, 3).

In his investigations throughout Central China, Hommel also observed countless bambooic things and discussed them along with their economic value. Like many other Westerners, Hommel was fascinated by bamboo's versatility and its benefit for everyday life and summarized bamboo's applications as follows:

> I give at random a few of the thousand and one applications which confronted us at every turn in going through the country. The whole unsplit stems, or parts of them, are used for ships' masts, for scaffolds in building construction, for fences, water pipes, walking sticks, carrying poles, furniture, fishing rods, well sweeps, tool handles, containers. The wood of the stems split up is utilized for mats, baskets, hats, musical instruments, bows and arrows, chairs and stools, tables and shelves, screens, staves, tallies and token money, chopsticks, fans, combs, umbrella frames, torches, candle wicks, ropes and many other things. (Hommel 1937, 222)

The description of these and other tools' use, construction, and handling will be the subject of the following chapters. This chapter critically reproduces Hommel's depictions, explanations, and interpretations of these and other tools. However, it should be mentioned that by pursuing this aim, the following pages run the risk of being rather fragmentary and incomplete for two reasons: Firstly, because Hommel's descriptions deal with very diverse domains in which humans encounter and use bamboo. Secondly, my interpretation and analyses remain brief and are more explorative and descriptive than qualitatively exhaustive but, nonetheless, seek to represent versatile bambooic tools and, thus, to meet the criterion of providing a complementary picture of bamboo's utility in the pre-industrial Chinese peasantry's toolkit.

For better clarity, I have grouped the various usage contexts under different headings, in which I tried to summarize and integrate thematically overlapping contents, and highlighted the individual objects in italics.

8.6.1. Human-Thing Conflations as Described by the Plow and Seed Discharging Device

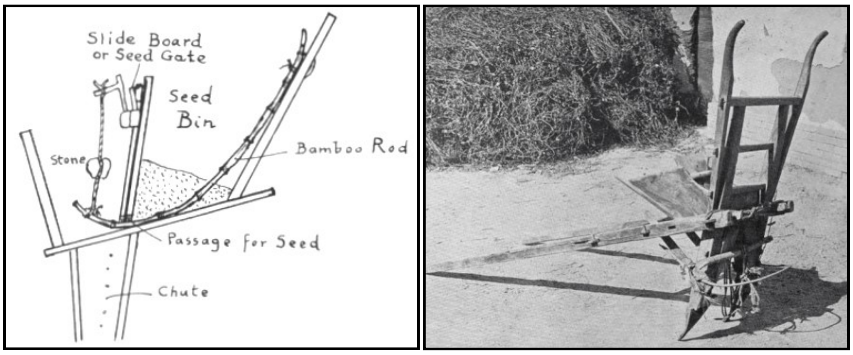

Figure 95 Seed discharging device (*left*) of the grain sowing plow (*right*). *Source*: Hommel 1969, 46

The most visible characteristic of a farming system, except for the crops, is the type of tillage used to cultivate the agricultural farmland. Accordingly, the various agricultural farming methods are often characterized on the grounds of the primary tillage implement used to cultivate the soil, such as the digging stick (used by the Bahnar peasants to create holes for the seeds) or the hoe (a versatile agricultural tool used to move small amounts of soil). With regard to extensive soil cultivation, however, the invention of plows was groundbreaking and one of the most significant pieces of farming equipment needed for plant cultivation, making it easier for farmers to sow seeds in the furrows created by the plow. As elsewhere, Chinese plows were constantly improved in terms of their design, material composition, efficiency, or handling, but, above all, it was the cast-iron plows that brought much relief to the Chinese peasantry (Bray 1986, VI:2, 138–195). Regarding the plow's working principle, it can be said that the plow is generally used for loosening and turning the arable soil by means of its curved blades in order to bring the nutrients in the lower layers to the surface and, before the machine age, the plow was mainly pulled by draft animals while its moldboard was commonly controlled by a farmer following the animals at close distance. In order to save time and labor, Chinese farmers developed a simple but effective mechanism to plow and seed the grains at the same time; namely, a seed discharging device that was attached to the plow and allowed seeds to be sown automatically while turning over the soil. This device is presented in Figure 95 and depicted by Hommel as follows:

> The seed bin has a passageway which communicates with the ante-chamber where a stone dangles. The stone is fastened to a flexible bamboo rod, and when the peasant serving the sowing plow swings the plow by means of its handles gently from side to side, the suspended stone swings and imparts a back and forth motion to the bamboo rod which half-blocks the passage for seed from the seed-bin into the side by side chute holes. The function of the rod is to retard the flow of the seed, and at the same time throw alternately a few seeds towards the left into the left chute, and then again a few to the right into the right chute, according to the rhythm of the dangling stone. (Hommel 1937, 46)

According to Hommel's explanation, the seed discharger's basic operation principle is based on bamboo's natural flexibility and its interplay with the stone's oscillation. As can be seen in Hommel's sketch in Figure 7, the seeds' passageway correlates with the bamboo culm's diameter, which could be adjusted relating to the seeds' size and shape to achieve an even distribution of seeds. In contrast to rice planting, where seedlings are first raised in seedbeds before being planted in the field, the sowing plow was available for a variety of crops, including "wheat, barley, millet, and white sorghum" (ibid., 47).

What is more, the use of a plow in general, and particularly when drawn by draft animals, is a composite entity representing the dynamic interaction and relatedness of i) human body and mind, ii) human's skill and knowledge, regarding the operation of the plow, ii) the plow's materiality and working principle, iii) the draft animal's body and behavior, and iv) the soil's qualities. All of these human and nonhuman entities converge in a single moment, namely, during plowing. If one of its composite elements were extracted, the plowing would be disrupted and interrupted.

In line with the practice theory approach, the act of plowing can be conceived as a practice carried out by the farmer and only viable through the conflation of its (human and nonhuman) components. Following ANT's vocabulary and methodological approach, the plowing could also be regarded as a hybrid entity (in the sense of an actor) consisting of humans and nonhuman entities whose main purpose is tilling. In both cases, the plow is only meaningful and fulfills its intended purpose when it is in action and only when its components work together. What we have is a specific *human-animal-tool-soil-relation* in action. Or, in more detail concerning each entities' specific characteristics, a *human(body-skill-knowledge)-animal(body-behavior)-tool(bamboo-stone-oscillation)-soil(condition)-relation* in action. This specific relation, as Callon and Latour would argue, ties together "scattered elements into a chain in which they are all indissociably linked" (1981, 289) and is characterized by its hybridity: it is in part a cultural and technological thing since plowing and the plow are human inventions; it is in part a cultural and natural thing since it requires domesticated animals—who are partly natural and partly cultural due to human selection and breeding; or it might also be interpreted in connection with the economy and human societal relations. In any case, this human-nonhuman entity stands out due to its heterodoxy.

Moreover, using the grain sowing plow, as described by Hommel, underlines once more how the farmer's body is attached to the seed discharger's operation and how the farmer's movement correspond to a tool, namely, how the operator's swinging correlates with the oscillating stone and the passageway closed by the bamboo rod. In this view, agency results from a causal entanglement of human and nonhuman entities. If we focus on the farmer, her/his conflation with the plow demonstrates what Malafouris defined as a space in which "*brain, body and culture conflate*" (2008, 22, 24). Or, in Schatzki's words, this human-animal-thing conflation, when conceived as an arrangement, becomes an agent of the social, since "bodies, organisms, artifacts, and things of nature" (2015, 32) are intertwined in time and space and demonstrate how human existence evolves and is continuously rearranged through things and organized activities (ibid., 2002, xi).

For the sake of analytical completeness, it should be mentioned that the human-animal-tool-soil entity could also be conceived, in ANT's view, as a network, insofar as it encompasses and affects more actors than those which have been mentioned so far. Amongst these are, for instance, microbes, ants, or earthworms (which are reduced by plowing); slugs and harmful insects attracted by the leftover residues turned over by plowing; pathogens contained in surface remains; or weather conditions (frost and rain) that affect the quality of the soil that is tilled.

In sum, on the one hand, the plow and the plowing method demonstrate a small-operating unit or an actor that comes to life in a specific practice or action. In other words, it is a composed entity in movement wherein the human body is only one part of this entity. On the other hand, it is a network and demonstrates the relatedness of tiny organisms, humans, the environment (soil, insects), the climate, and the like.

What is more, other tools and devices that will be discussed below are similar placeholders for all kinds of human-thing conflations involved in the practices and activities of Chinese peasantry. Similarly, these heterodox entities could also be expressed as networks. In what follows, I shall describe the material composition and handling of various tools and devices. In doing so, I shall not emphasize these tools' and devices' hybrid character and depict each tool's or object's interconnectedness with humans, as done at this point with respect to the grain sowing plow. Nonetheless, one should bear in mind the human-thing conflation in the following descriptions, even though it is not explicitly mentioned each time.

8.6.2. Agricultural Tools

Rakes and Flails

Figure 96 *Title*: Japanese rice flail made of wood and bamboo.
Artist: unknown
Date: unknown, acquisition date 1960
Source: British Museum
Accession No.: As1960,10.435

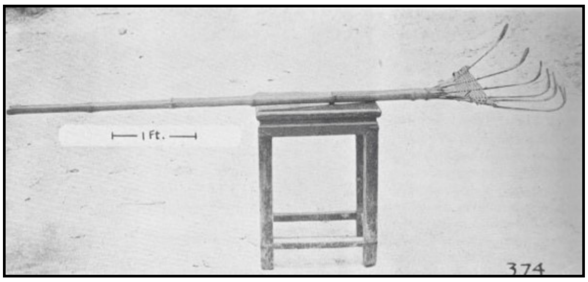

Figure 97 Bamboo rake.
Source: Hommel 1937, 68

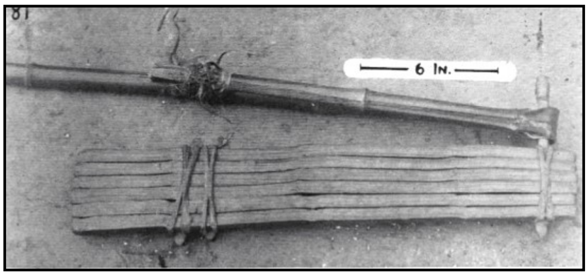

Figure 98 Bamboo Flail.
Source: Hommel 1937, 74

While wood was the primary material for building agricultural tools in regions without bamboo, in regions where bamboo occurred, many tools were made partly or totally of bamboos, such as scythes, rakes (see Figure 97), flails (see Figure 98 and Figure 96), or shovels (Hommel 1937 60–81).

Amongst other tools, the bamboo rake in Figure 97 demonstrates bamboo's versatile applicability if we analyze its construction, since "the whole tool handle and prongs," as Hommel puts it, "is made of one piece of bamboo, except for a few strips of wickerwork likewise of bamboo, which hold the prongs in their proper relative position" (ibid., 66). As Figure 97 shows, the bamboo rake has sixth teeth fixed with bamboo strips to prevent splitting and achieve more strength. For the prongs' curved shape, necessary to rake leaves and straw, the rake's teeth were bent over a fire (ibid.).

Flails designed for threshing rice were also often crafted from bamboo. The bamboo flail in Figure 98 has three cross braces and consists of a bamboo handle and six bamboo strips (53 cm long and 1.6 cm square) and is fastened by strips of pigskin (ibid., 72). The specimen in Figure

96 is of Japanese origin, and it resembles the Chinese version, except for its wooden part to which the bamboo components are attached to. The threshing flail, a very simple tool, was still effective and used to strike the grain to loosen its husks.

Riddles and Sieves

After threshing the grain using a flail, the chaff needed to be separated from the grain. Wind threshing is probably the most ancient method and widespread in many regions of the world. The grains are thrown into the air so that the wind carries away the lighter chaff, while at the same time, the heavier grains fall down. The bamboo riddle with large meshes illustrated in Figure 99 was used for winnowing threshed rice grains, while the specimen in Figure 100 has small meshes needed to clean grains from other substances. The riddles' basic function was to divide and separate materials according to their granularity through circular motion and riddling—and represents once again a human-thing conflation, insofar as the human's hand induces the riddles movement and thus causes the matter (grains, stones, and other remains) to fall to the ground or not. In the riddling process, light substances descend through the meshes to the ground, while heavy and larger matter would remain together with seeds, grains, or beans and separated by hand. Besides their use as an agricultural tool, riddles, or better sieves with fine meshes, were also used in the kitchen, for instance, to separate and break up clumps in dry ingredients like flour.

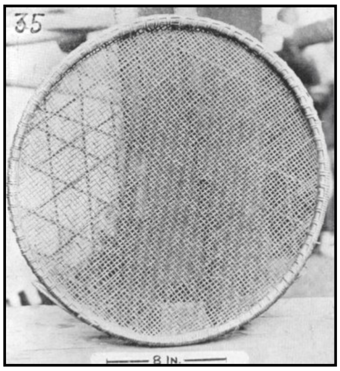

Figure 100 Riddle.
Source: Hommel 1937, 77

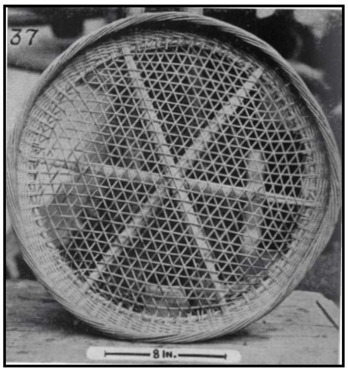

Figure 99 Riddle for winnowing threshed rice.
Source: Hommel 1937, 78

Concerning the material composition of the specimens illustrated in Figure 100 and Figure 99, it can be said that both are made of bamboo. Moreover, their meshwork design and mesh sizes testify to these tools' fitness for the intended purpose and, thus, to the size of the vegetable or other substances, such as beans, grains, seeds, or flour. Hence, peasants adjusted the riddles and the riddles' mesh sizes depending on their purpose. In consequence, the riddle makers utilized bamboos and took advantage of bamboo's transformability into thin or gradually thicker strips. A peasant using a riddle represents a certain kind of hybrid entity.

By the entanglement of the human body (including the human's muscles, skeleton, hand and arms) and skill in association with the tools' characteristic shape, the size and shape of beans (or grains, seeds, and flour) alongside gravity, this entity comes into play and presents a particular human-thing entity.

Therefore, using bamboo for riddle and sieve construction demonstrates bamboo's material property and suitability in the domain of weaving and basketry—particularly its excellent splitting properties (due to bamboo's long fibers) and young bamboo's high flexibility (due to its large water content). Unsurprisingly, then, Chinese peasants crafted and utilized various riddles and sieves differing in form, diameter, mesh size, or purpose using bamboo (ibid., 76–77).

Mud Tongs

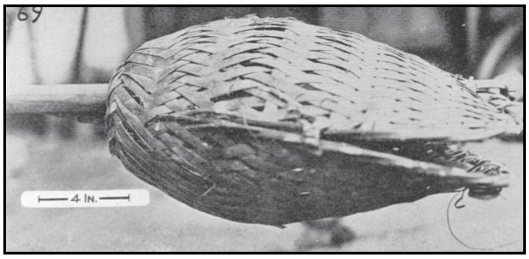

Figure 101 Mud tongs.
Source: Hommel 1937, 59

One necessary organic fertilizer that significantly improved the crops' growth and productiveness was gained by extracting the beneficial mud or silt from rivers. One specific device needed to extract the sediments was, as described by Hommel (ibid., 55), the so-called *mud tongs,* as illustrated in Figure 101.

This tool consisted of two woven bamboo baskets in the form of two half-shells attached at the end of two bamboo stems. Its working principle and handling resemble a giant pair of tongs. By pulling the bamboo stems apart, the tongs are opened and closed by pushing the culms. For extracting the sediments, the woven half-shells are submerged into the water to scoop the nutrient-rich soil; then, when filled with mud, its mouth is fastened to enclose the mud, and then the mud is emptied into buckets or distributed directly on the field (ibid., 54–55). If we consider the material composition of the mud tongs' half-shells, it is noticeable that they are bamboo weaving products and are, once more, representatives of the wide array and plasticity of woven bamboo objects.

8.6.3. Irrigation and Water Lifting Tools

Water irrigation is intrinsically embedded in Chinese agriculture—particularly in regions with unregular rainfall—and has been of paramount importance for China's food security. Regarding wet rice cultivation in the lower Yangtse valley, King reports on account of his observations that “besides fertilizing, transplanting and weeding the rice crop there is the enormous task of irrigation to be maintained until the rice is nearly matured. Much of the water used is lifted by animal power, and a large share of this is human” (1911, 297). As a result, Chinese peasants required a fine regulation of their irrigation systems for supplying their paddy fields continuously with water to ensure a good yield. In view of this, and depending on the environmental conditions, landscapes, or climate, Chinese peasants built complex irrigation systems and utilized a wide array of tools such as waterwheels, bucket chains, square-pallet chain-pumps, well-sweeps, or swinging buckets. And, in doing so, constructed various waterwheels and similar types of machinery geared to human power, draft animals, water, and wind (Hommel 1937, 49–54).

Against this background, in what follows, I shall refer to waterwheels and well-sweeps as examples of the Chinese methods of water lifting and irrigation. In this context, King (1911, 301) mentions that waterwheels were common in the lower areas where the rivers have a sufficient gradient. Hommel (1937, 49–54), describing various irrigation wheels, also reports that waterwheels were used to convey water to the agricultural farmland and mentions that they differed in size, material composition, and function.

In Jiangxi Province, Hommel observed and describes a bamboo-made undershot waterwheel that was used to lift water from the river captured by carrying bamboo buckets (or

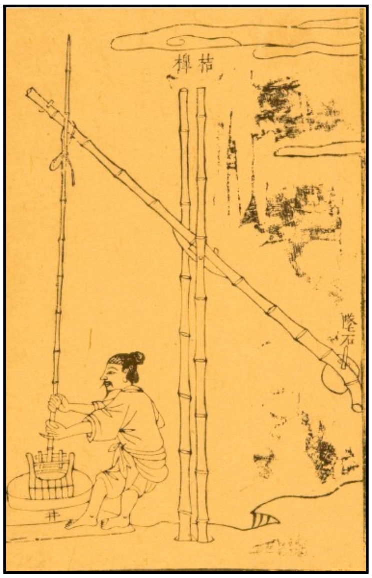

Figure 102 A bamboo shadoof.
Source: Yingxing 1637, 36

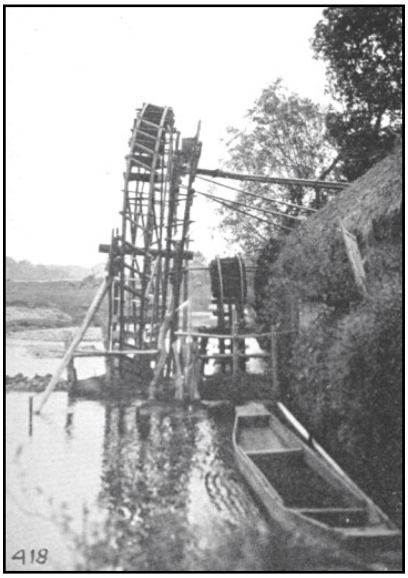

Figure 103 Undershot waterwheel.
Source: Hommel 1937, 120

Figure 104 A wood-bamboo shadoof.
Source: Hommel 1969, 57

containers)— when passing slightly below the water surface—and, after arriving at the upper end, poured into long bamboo water pipelines that transported the water to the farmland. This waterwheel and its functioning and construction are documented and explained by Hommel: “A series of bamboo tubes closed at one end are fastened obliquely to the framework with bamboo withes. The tubes are submerged and filled with water and by the turning of the wheel are placed in such a position when on top that the water pours out from them into a wooden trough, whence the water is conducted through bamboo tubes into nearby fields for irrigation” (ibid., 120). Regarding bamboo’s relevance for the waterwheel construction, it can be said that people predominantly exploited bamboo’s hollowness, epitomized by the small bamboo containers and piped water installations. On account of his observations of waterwheels, King states the following: “As with native machinery everywhere in China, these wheels were reduced to the lowest terms and the principle put to work almost unclothed” and exemplify “a masterful grasp of principle . . . [using] the unused energy of the stream and succeeded thus in turning it to account” (1911, 363, 364).

Hence, compared to waterwheels of industrial design, the Chinese pre-industrial waterwheels appear primitive but, with regard to their intended purpose, contributed much to the development of farmland irrigation in Chinese history. Even though bamboo waterwheels had a shorter life span than iron-made waterwheels and, simultaneously, were more time-consuming and labor-intensive to maintain than modern machines with electric or fuel pumps, they stood out due to bamboo’s easy availability as a cheap, regrowing plant source and their efficacy. On account of these aspects, bamboo waterwheels are still utilized in some remote areas of contemporary Vietnam. One specimen is exemplified in photograph *e* in Figure 25, taken at Mường Lát District in Thanh Hoá Province, and illustrates the material composition of bamboo waterwheels, as described above. What is more, besides bamboo’s use as a container to catch the water and for water pipelines, the same photograph depicts how the waterwheel’s various elements are connected, namely, by using bamboo strips.

Another device for water supply related to bamboo is the shadoof, or well-sweep (or swape). According to Needham and Wang, it is “the oldest and simplest mechanism which lightened the human labour of dipping, carrying and emptying buckets” (1965, IV:2, 331). According to Hsiao and Yan, levers were known already in ancient China around 1700 BCE, and shadoofs were common during the Shang Dynasty (1766–1122 BCE) and used for irrigation and drawing water (Hsiao and Yan 2014, 63). This view is contradicted by Needham and Wang

(1965, IV:2, 333), who believe that the shadoof was known in China only in the fifth century BCE and that Arabic travelers introduced it to China.

Be this as it may, the shadoof was a vital irrigation tool that was operated manually to lift water from streams to irrigate fields and gardens. The principle of its operation is equivalent to that of a seesaw. The shadoof consists of a frame, a long pole, a bucket, and a counterweight. When the bucket is submerged into the water, the counterweight facilitates better handling, which is why the shadoof is conceived as a less exhausting method of lifting water. Hommel (1937, 54) also discusses a shadoof (see Figure 104) that was made of a short wooden post (fixed in the ground), a long wooden pole (attached to the short wooden post), and a long bamboo culm (attached at the end of the long wooden pole). On the other hand, and as illustrated in Figure 102, the shadoof could also be made entirely of bamboo culms. The interchangeability of the shadoof's material composition underlines, therefore, how wood and bamboo could substitute the other.

8.6.4. Hunting and Fishing

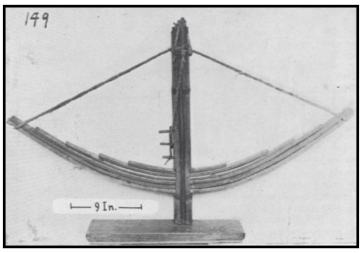

Figure 106 Crossbow trap with spring leaf mechanism. *Source*: Hommel 1937, 127

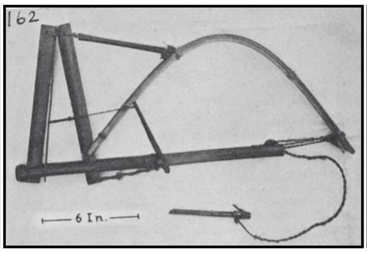

Figure 105 Chinese bow trap. *Source*: Hommel 1937, 127

Figure 107 Bow trap used by Bahnar people in the Central Highlands of Vietnam.

Throughout history, many different devices have been invented to capture prey. For Chinese farmers, animals were essential as an additional source of food (meat), to gain useful materials (leather, fad), for trade (e.g., fur or feathers), and the like, while particularly wild animals had to be controlled to prevent damage to crops. Against this backdrop, Hommel describes various tools used for trapping animals, such as the crossbow trap (in Figure 106) or the bow trap (in Figure 105), which will be outlined in the next paragraphs.

The crossbow trap was fabricated of bamboo and hemp. According to Hommel, the crossbow trap is a simple but effective hunting device consisting of a "six-leaved spring, made of bamboo pieces, inserted into a slot in the bamboo stock" (1937, 126). Concerning its operation principle, Hommel notes the following:

> A little forked prop of wood, shaped like the letter Y, serves to hold the bow string when in tension. It is tied to the butt end of the crossbow with a cord attached to the two forks of the wooden prop, leaving however the extreme fore-ends free. After the bowstring has been stretched, the prop is set vertically against the bow-stock so that its two forks straddle the channeled stock just under the bowstring and hold the latter taut. Another rope attached to the single shaft of the prop (the bottom end of the letter Y) runs to three pegs on the side stock of the bow . . . and is held there with a toggle. As soon this toggle is pulled off the pegs, the fork is loosened and releases its hold on the bowstring. . . . The bow is placed in such a position that it points at right angles to the path which is known to be frequented by game or wild animals. (ibid., 125–126)

What is most striking, as Hommel rightly comments, is that the Chinese crossbow trap epitomizes "a fully developed spring suitable for wagons and carts" (ibid., 126). Indeed, the crossbow trap's leaved spring mechanism resembles those leaf springs constructed for the suspension of wagons and automobiles and demonstrates the best bamboo's elasticity and springiness. Overall, as Hommel further notes, "Chinese springs are mostly wooden, and of bamboo because its elasticity is most suitable" (ibid., 128).

In Jiangxi Province, Hommel observed another type of trap involving the spring mechanism and bamboo's springiness, namely, a bow trap (see photograph in Figure 105), installed alongside the places frequented by small animals such as rats and weasels. About its installation, Hommel explains the following:

> One end of the bamboo bow or spring is inserted in a notch on the lower right side of this jaw and presses against it. The jaw is held open by a short cord attached to the jaw bottom kept taut by the leverage of a stick set against a peg in the main shaft of the trap. At its upper end this stick has a string attached to it which is fastened to a small pin 1.4 inches long set between the open jaws. The right end of this pin, or release, rests against the narrow edge and is just barely pushed under the narrow bamboo strip running up the side of the stationary jaw. (ibid.)

Thus, the prey, lured by rice grains, releases the trap's working mechanism when it "touches the narrow bamboo strip between the jaws" that triggers the pin "and the trap springs upon the legs or body of the animal" (ibid.). What is worth mentioning in this context is that I was able to observe Bahnar people in the Central Highlands of Vietnam using and crafting a very similar trap (which is illustrated in Figure 107) to catch rats and weasels. As the specimens in Figure 105 and Figure 107 show, both traps share striking similarities in how they were fashioned and intended to be used. Unfortunately, my research into the origin of this trap did not provide any further insight that could have shed light on whether the bow trap was invented simultaneously in different places or spread from one place to another.

Besides trapping animals, fishing added to the food supply for peasants. While many fishing methods involved iron hooks, Hommel describes one distinct fishing method that is based on the springiness of bamboo and which he observed at Poyang Lake in the north of Jiangxi Province:

> It is a sliver of bamboo, about an inch long, very elastic, the ends bent together to hold between them a grain of rice, and a circular section of a reed pushed over the bent-together ends to hold them in that position. A string is tied to the middle of the bamboo sliver which in its bent position assumes an oval shape. . . . The bent-over bamboo sliver with the rice as bait dangles in the water, a greedy fish snaps for it. The slender reed ring is severed and the bamboo sliver straightens out in the fish's mouth, lodges in it or in the throat and the fish is caught. Usually quite a number of such fishhooks . . . are attached to a line, which is stretched out horizontally under the water. (ibid., 128–129)

As becomes clear, this bamboo fishhook's operating principle relates to bamboo's inherent elasticity and springiness, which, when bent, tends to spring back into its original position due to its internal stresses. Before the advent of iron hooks, it is most likely that fishing methods often included bamboo fishhooks since their production was easy and cheap.

Besides streams, rivers, lakes, or the ocean, the paddy rice fields provided a suitable living environment for fish and eels. As Hommel points out, these aquatic animals were occasionally trapped using bamboo baskets of various kinds and fishing methods. One fishing method in the rice-fields is described by Hommel (ibid., 131), who says that a peasant, holding a long bamboo stick in one hand and a bamboo basket in another hand, stood in the rice field observing the fish. Then, using the bamboo culm, the peasant disturbed the water to force the fish to move and swim around. If the peasant spotted a fish, she/he immediately drops a bamboo basket over the fish. Afterward, the trapped fish were extracted through an opening in the basket's top. Certainly, this fishing method does not require an elaborate tool kit but patience and experience. What is more, and as already exemplified in chapter 7.4.6, Bahnar people equally use similar bamboo baskets of various forms and designs to catch and transport fishes and other aquatic animals.

Figure 108 Fishnet tools. Bamboo net needle (*above*) and mesh stick (*below*). Photographed in Vientiane, Laos.

Bamboo, to give a final example regarding fishing, was also used to create tools for net making. In this case, people used a bamboo net needle and a bamboo mesh stick to produce the meshes of the fishnet. On the whole, the mesh stick resembles a knife with one edge thick and rounded and the other thin, yet it is not sharp but smooth and employed to form the meshes' desired length (ibid., 133). In 2012, in Vientiane (Laos), I observed a Laotian fisher using these tools to produce fishing nets using a synthetic thread, as illustrated in Figure 108.

8.6.5. Cooking and Kitchen Utensils

Figure 109 Steaming trays.
Source: Hommel 1937, 155

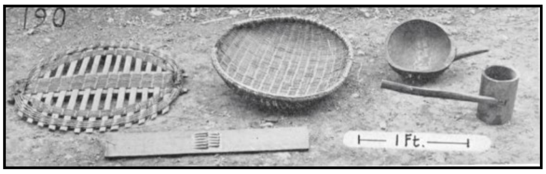

Figure 110 Various kitchen utensils. A bamboo steaming screen (*left*), basket for rice washing (*top*), wooden dipper (*top right*) bamboo dipper (*right*), and brass nails (*below*)
Source: Hommel 1937, 157

The characteristics of traditional Chinese cuisine depended, as elsewhere, on the available foods and were based on the local preparing methods. However, rather than speaking of a uniform Chinese cuisine on a national scale, one should consider the historical background of how the different cuisines developed. Therefore, people's diets have differed depending on many factors, such as ideas of diets, locally available ingredients, or geographic and climate factors. So, for instance, many ethnic groups still have their own diets and styles of preparing food, and, on account of this, one should conceive Chinese cuisine in terms of different regional cuisines as illustrated by Cantonese, Sichuan, or Yunnan cuisine. Bamboo shoots, for instance, were part of the diet of many Chinese, except for northern subarctic parts of China or western high altitudes or desert areas, where bamboo does not grow.

What is of interest here are the bambooic kitchen utensils as part of a broader Chinese kitchen tool kit. In this view, Hommel (ibid., 150–159) underscores bamboo's value and notes that various kitchen sieves, steaming trays, dippers, baskets for washing rice, screens for steaming, chopsticks, or pepper shakers were made of bamboo. In what follows, I shall depict some of these tools.

One genuine Chinese cooking technique involves the *wok* (an iron cooking pan) and various stream trays and steaming screen. The combination of the wok and a bamboo steaming screen, for instance, made it possible to cook two ingredients simultaneously. The bamboo screen, as shown on the left in Figure 110, was placed on the wok's edge, yet without touching the food underneath. While the food in the wok boiled, the rising steam heated the food lying

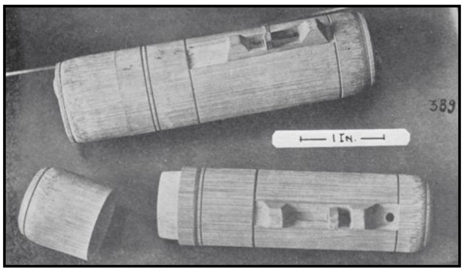

Figure 111 Pepper shakers.
Source: Hommel 1937, 153

on the screen (ibid., 151). A similar method is achieved by bamboo steam trays illustrated in Figure 111. These interlocking trays have perforated bottoms, allowing one layer to be stacked on top of the other and several ingredients to be cooked simultaneously.

Overall, this cooking method has several advantages. Firstly, in comparison to boiling, steaming is a healthy way of cooking since it has fewer adverse effects on the nutrients of vegetables during cooking. Secondly, the steam trays reduce food preparation time since several foods are prepared simultaneously, which, thirdly, reduces the amount of firewood or coal required. And fourthly, food stored in the trays can be kept warm and transported easily.

In order to season food, black and white pepper were common ingredients in Chinese kitchens. However, since the pepper plant is endemic in tropical South and Southeast Asia, its seed must be imported to the northern Chinese regions. After its harvest, the peppercorn is dried and hardened so that it is commonly ground before being consumed. In some cases, the peppercorn is ground using pepper (hand) mills, and in others, when the peppercorns have been already ground, the ground pepper is filled into shakers. In Nanchang, today the capital of Nanchang Province, Hommel photographed a bamboo pepper shaker (see Figure 111) and described it as: "a round bamboo box with a lid turned on a reciprocating … lathe. Lid and box are topped and bottomed by the natural joint of the bamboo. The ground pepper is introduced into the box and is shaken out through a small hole (at the side of its lower end), which can be closed with a slide" (ibid., 152). The bamboo shaker resembles a common bamboo container, yet with a small hole and a device to keep the hole closed when needed.

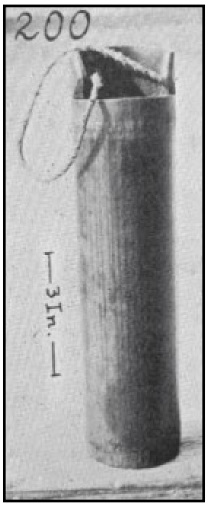

Figure 112 Oil container.
Source: Hommel 1937, 153

One last kitchen tool I shall depict at this point is the bamboo container. Due to bamboo's cylindrical form, these are exceedingly convenient devices for the storage and transport of foods and liquids. The bamboo container illustrated in the photograph in Figure 112 was used as an oil container and created out of a section of bamboo with both diaphragms left unfractured. Then, as Hommel reports, "the upper one is pierced, and a rim above it left extending. Part of this rim is sawed off to form a gutter for pouring. No stopper is used, as there is little danger of spilling when the container is hung up to the wall or ceiling" (ibid., 349. Before the widespread use of glass bottles, bamboo containers were found in many households and are still utilized, for instance, by the Bahnar people (see chapter 7.4.6).

8.6.6. Furniture Making and Bamboocraft

Figure 113 Wooden chair. *Source*: Hommel 1937, 304

Figure 114 Bamboo chair. *Source*: Hommel 1937, 303

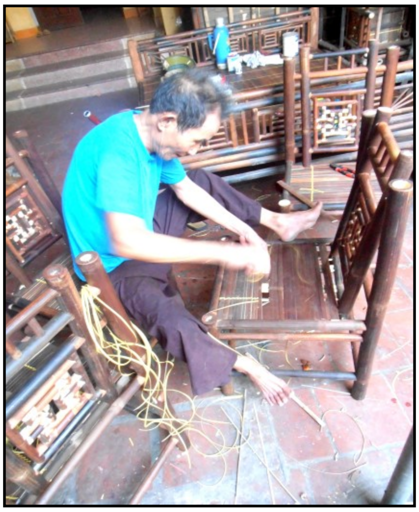

Figure 115 Working on the ground in the bamboo workshop in Xuân Lai.

While bamboo is chosen to make countless things, the list of tools needed to process it is relatively short. I have already mentioned the principles of bambooworking in chapter 4 and will provide further information concerning the bambooworker's toolkit in pre-industrial Japan in chapter 9.4.2. Accordingly, I shall not deal with these tools and their uses in this section but, except for a short sidenote on the importance of iron knives, discuss the similarities and differences of wood and bambooworking exemplified in the domain of furniture making.

Today, the tool most frequently used to work on bamboo and probably the simplest bambooworking tool is the knife (similar to machetes). These knives have different forms, sizes, and qualities and are still widely used in East and Southeast Asian countries to cut down bamboos or process them. All these knives share common grounds, such as their blade's triangular profile, serving as a wedge and enabling the bambooworker to split a bamboo culm lengthwise with ease. Moreover, these knives are relatively heavy and have a thick blade spine, enabling them to split the hardwood of mature bamboos and even bamboos with large and thick walls. Simultaneously, the thick spine allows the bambooworker's palm to be laid on it to put extra pressure on the machete to split with less effort and provide better handling. The knives' handling is illustrated in the photographs in Figure 23, showing how a large bamboo section is split using a long knife, and by the photographs in Figure 75 accompanying the discussion of Mr. Ninh's handling of knives and machetes in chapter 7.6.1.

Before the advent of chairs, people in China usually sat on the bare ground or makeshifts. According to Fu (2016, 155), during the Qin (221–207 BCE) and Han Dynasties (202 BCE–220 CE), Chinese peasants mainly sat on a mat or some low couches. Later, Chinese people increasingly invented new furniture for greater comfort when sitting or lying down. Against this backdrop, it should be mentioned that chairs and stools were and still are not widespread equally throughout all East and Southeast Asian societies. While Bahnar swiddeners and many Vietnamese and Japanese peasants and craftspeople perform(ed) much of their work in a *squatting position* or sitting on the ground, Chinese peasants and craftspeople adapted to the use of chairs and stools over time. The photograph in Figure 115 shows the father of the bamboo workshop owner in Xuân Lai village, producing a bamboo chair. The most striking thing about this photograph is that although he produces bamboo chairs, he remains sitting on the ground rather than sitting on a chair and working on his workpiece. A similar motif in relation to the Bahnar is illustrated in Figure 59, showing Mrs. Ninh sitting on the ground and cutting banana leaves, and in the photograph in Figure 75 that shows Mr. Ninh during bamboo sheath production.

Concerning the development of chairs in China, Fu notes that "in the 200 years between the late Tang Dynasty [923–937 CE] and the Northern Song Dynasty [960–1127 CE], indoor furniture . . . underwent the transformation from low couches and beds for people to sit on their knees to chairs and tall tables for people to sit with their feet hanging in relaxation" (2016, 20). Hanns Spörry, a Swiss entrepreneur and collector of Japanese bamboo objects, traveled through China in the last decade of the nineteenth century and also noted that Chinese people usually worked sitting on chairs that typically consisted of a base, a simple or upholstered seat, and a backrest (Spörry 1903, 197). In another passage, he remarks further that besides chairs and tables, benches with back and side rests, benches with only one adjustable side rest, armchairs, carrying chairs, taborets, and stools were common in China and frequently made of bamboo (ibid.).

Hommel (1937, 307–309) mentions two different kinds of chairs he observed in Zhejiang Province and differentiates them according to their construction material, namely, wood and bamboo, and infers that bamboo chairs (see the specimen in Figure 114) were the most common in Zhejiang Province and described the employed processing techniques as follows:

> Two bamboo tubes . . . are bent twice at right angles into the form of the letter *U*. Each *U* forms thus one pair of legs for the chair. In order to make this bend, part of the wood has been cut away leaving only a small strip of the wall of the bamboo tube. This strip is bent to a right angle over a fire, otherwise, it would break. Two shorter bamboo tubes of somewhat smaller diameter are then fitted at their respective ends horizontally into the bends mentioned and secured there with bamboo nails. Enough wood has been cut off under the bent strip to permit the insertion of these shorter tube ends which thus serve as front and back seat rail of the chair. The stability of the four upright legs is further increased by rungs. . . . The seat is formed of slats of bamboo each end of which is inserted between two transverse cross bars of bamboo mortised . . . The bow of the backrest on the chair . . . consists of one piece of bamboo bent to form a curve. The bending is accomplished by cutting triangular sections from the bamboo tube, leaving a connecting strip, which bends until the surfaces of the incisions meet. This is a simple way of bending bamboo and can be done without heating the wood over a fire. The ends of this now are pointed by making a diagonal cut through the tube extending [*sic!*]. (ibid.)

In his detailed delineation of the mentioned bamboo chair, Hommel enumerates crucial aspects of chair production considering bamboo's materiality and processing techniques. In doing so, he elucidates two fundamental ways of bending bamboo. One method is applied in the making of the legs of the chair. In this case, after removing sufficient material, the bamboo culm is bent over a fire until a right angle is reached and afterward allowed to cool down. In contrast, the second method does not require any bending over a fire and is applied to make the backrest. In this case, triangular sections are cut off from a bamboo tube, which then is bent by human physical force. Afterward, the backrest is fixed through bamboo dowels to the rungs. In both cases, the removal of material is a prerequisite for bending because the bamboo wall does not resist the high compression strength caused by bending. This bending method is discussed in chapter 3.2 and demonstrates how by taking into account bamboo's bending principles, bending in combination with fire makes it possible to shape and redesign bamboos.

As mentioned in chapter 8.4.4, wood and bamboo played decisive roles in Chinese technological history and stood out in view of their malleability and daily use in practically all domains of life. Unsurprisingly, then, wood and bamboo could be used interchangeably or replaced by each other in some instances.[56] In this connection, concerning the replacement of bamboo with wood, Hommel made an interesting observation in rural Jiangxi Province, where he found a chair made of softwood (see the one shown in Figure 113), which in style and construction was a copy of a bamboo chair. In his description of the bamboo chair's wooden replica,

[56] For more information concerning the similarities and differences between bamboos and trees and their woods see my discussion in chapter 4.5.

Hommel states that “each pair of legs, is formed of one piece of wood. In order to bend it at the intended angles, the wood has been notched away so as to leave only a narrow strip, flexible enough to be bent at a right angle” (ibid., 309). When comparing the bamboo chair’s manufacturing as described above with its wooden replica, the most striking peculiarity is the removal of materials required for the bending of the pair of wooden legs. While this is a typical method to bend bamboo, it is less frequently applied to tree wood. Nonetheless, it indicates how a bambooworking method could be utilized in woodworking and vice versa.

In conclusion, though woodworking and bambooworking relate to two different materials, Chinese peasants equally mastered the ability of both woodworking and bambooworking. Therefore, instead of separating both materials into two distinct spheres due to their materiality, it is most likely that peasants used both on account of personal skills, material availability, the intended purpose, the requisite worktime, or the amount of effort. This, in turn, led to a Chinese peasantry material culture that was predominantly based on both materials.

Bamboo Pegs

In the woodworking, building, and furniture-making domains, the nails, dowels, and pegs were made of iron, wood, or bamboo and were indispensable for fixing materials and reinforcing joints. Many house types in pre-industrial East and Southeast Asia were initially built from bamboo and wood before the spread of modern materials.

Overall, bamboo nails and dowels could be easily crafted using a knife or machete, and due to bamboo’s abundance, it was readily available in many regions. Hommel (ibid., 23), illustrating a collection of Chinese nails, writes that bamboo pegs were hand-cut and produced by peasants. As a consequence, bamboo nail or dowel production did not depend on the blacksmith and the technology of metallurgy. In this light, Hommel (ibid., 255) notes that Chinese carpenters worked sparingly with iron nails even though wood or bamboo dowel production and the preparation of drilling holes entailed extra work. Needham and Wang present a similar argument, writing that “wrought-iron nails were probably always used sparingly by Chinese woodworkers, who achieved the same end by making wood or bamboo pins or dowels” (1965, IV:2, 60). On the other hand, one disadvantage of bamboo nails may lie in their plant-based material origin since they deteriorate faster than metal nails. On account of this fact, wrought-iron dowels and nails were regarded as indispensable in the Chinese shipbuilding industry (ibid.).

8.6.7. Cotton Bow and Hats Making

Cotton Bow

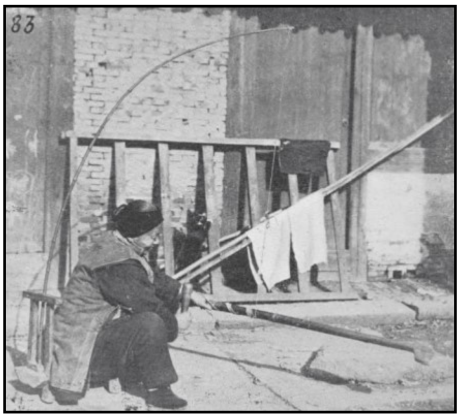

Figure 116 Women using a cotton bow. *Source*: Hommel 1937, 164

Different tools and devices were developed in China for the production of clothing. Among them were numerous kinds of spinning wheels, spindles, spooling threads, and looms. These implements involved a specific purpose and technique for converting (cotton or hemp) fibers into yarn. While some of these tools were entirely built from bamboo, others were partly made of bamboo. Describing all of these devices in their entirety is far beyond the scope of this chapter. Therefore, the chapter is limited to the cotton bow in order to illustrate once again the springiness of bamboo.

The cotton bow, illustrated in Figure 116, is a tool used to obtain a fluffy cotton mass required for the further processing of the cotton. As shown in the same photograph, the cotton bow is fixed to the bower's chair and handled in the way that one hand holds the cotton bow while the other hand holds the striking bin. In addition, a bamboo rod is fixed in the bower's chair and connected to the cotton bow by the fibers. When tapping the bow, the bamboo culm is under tension and causes a swinging, transmitted back to the bow. Through the cotton bow's vibration, caused by bamboo's inherent springiness, the cotton fibers are disentangled and forced to arrange themselves (Hommel 1937, 163).

Hats

Farmers exposed to all weather conditions require adequate protection against the hot sun and heavy rain. In this context, Hommel (ibid., 206) displays large round hats made of bamboo strips and dried bamboo sheath leaves and mentions that Chinese peasants wore them for agricultural work in the paddy fields. Since sheath leaves' botanical purpose is to protect the young bamboo stems from harm, they are rigid and watertight by nature, and due to the fact that they surround the young culms, they are relatively large. Noticing these properties, Chinese peasants took advantage of the leaves to create large yet light and practical hats.

8.6.8. Shoulder Pole

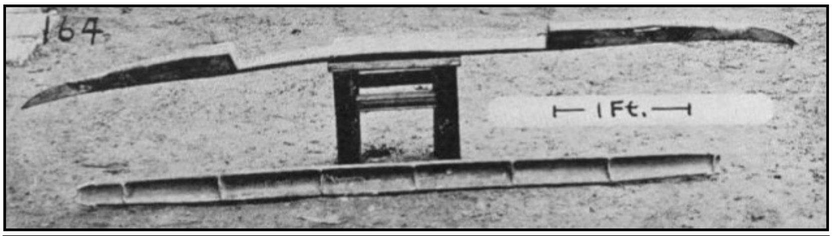

Figure 117 Two kinds of carrying poles.
Source: Hommel 1937, 336

The transportation of various goods from one place to another is of paramount importance, as in the case of house construction, road building, coal mining, or agriculture, and has been essential for the development of human civilization. To this end, roads and canals were built, and loads were transported using various land and water vehicles. One notable way to transport loads relying on human power is to use a carrying pole, which for many non-Asiatic people is a symbol for China or Vietnam. According to Hommel, it was "by far the most important implement used in Chinese transport" (ibid., 344).

The bamboo shoulder pole has remarkable strength. It is cut from tubular bamboo with an appropriate diameter, flattened to a kind of slat, tapered at its ends, and the smooth part resting on the carrier's shoulder. The load is either directly attached to the carrier pole or a rope is employed. In the latter case, "the ends are notched to prevent the rope to which the load is tied, from slipping off" (ibid., 345). Figure 117 depicts two kinds of carrying poles. While the one lying on the chair is used only to carry bundles of brush-wood (ibid.), the other one lying on the ground represents the most typical form of carrying poles. As illustrated in the same photograph, parts of the nodes remain and are not removed and provide an additional buckling resistance. The notched ends of the shoulder pole in Figure 117 are hardly visible, yet the shoulder pole in Figure 118 indicates how the rope is fixed to it and exemplifies the carrying pole's operating principle. Besides its value as a carrying pole for transportation loads, bamboo was also needed to produce chair carriers, whose whole framework and shafts were often made of bamboo (Ball 1903, 73).

In any case, the carrier must ensure that the weight on both sides is balanced for better handling and movement. The shoulder pole is generally carried on one shoulder and allows the carrier to navigate better through crowded places and to have a free hand when needed—using bamboo in this manner exploits the resilience of the bamboo. When moving, the carrier pole swings due to the loads' weight and the carrier's movement, the carrier benefiting from the recoil of the shoulder pole when moving. Street sellers in Hanoi, for instance, still use such

Figure 118 A carrier with baskets for transporting manure.
Source: Hommel 1937, 303

shoulder poles. Studying their movements shows that the initial step is the hardest (especially when carrying heavy loads) because, at that moment, the carrier stands with both feet on the ground and must first lift the load to take the first step. When set in motion, carrying loads become much easier due to the movement of the loads. This method of transportation is again illustrative of a human-thing conflation. Accordingly, it is a hybrid human-thing composition, consisting of at least the human body, the carrying pole, the loads, and the ropes attached to the carrying pole and loads. Moreover, this transportation method is most suitable for level areas but less for narrow footpaths in mountainous regions with altering altitudes. On this account, mountain dwellers in Vietnam—as far as I could observe—do not use the shoulder pole but bamboo panniers for transportation.

Another interesting aspect revealed by Porterfield's summary table concerning the bamboo trade through Shanghai in 1923 in Figure 87 is the unit of weight called *picul*, which was used in East and Southeast Asian countries and represents the maximum loading capacity a single person is thought able to carry by a shoulder pole. The picul, therefore, underlines how popular and widespread the shoulder pole was in many East and Southeast Asian countries and how important it was as an essential means of transportation and weight measurement.

8.6.9. Other Uses: Ladders, Screens, Mats, Roofing Tiles, and Lighting Splints

So far, I have introduced many applications in which bamboo is involved, but others have not yet been considered. In the following, I shall briefly portray and enumerate other uses mentioned by Hommel for the sake of completeness. But in doing so, I shall just indicate their context of use and purpose instead of portraying them in their full range.

Because of their long natural shape, bamboo poles are frequently employed to extend human limbs to reach distant objects. In this manner, Chinese people utilized long bamboo culms crafted into poles to pick tree fruits or push poles for rafting, to make dugout ladders, or ladders with two poles linked by rungs (Hommel 1936, 262, 284).[57]

Screens and woven mats made from bamboo were essential in many domains. A semicircular screen of woven bamboo strips, for example, was attached to the frame of a roller or harrow to protect the farmer against splashing mud when it was dragged over fields (ibid., 58). When the harvest was brought in, vegetables, corn, wheat, or rice were poured upon woven bamboo mats to dry in the sun, and wooden threshing boxes were enclosed by bamboo screens (ibid., 78, 69–71).

Bamboo was also used as a construction element for many tools, for instance, to craft the handles for scythes, Chinese log hooks, or heating stools (ibid., 67, 220, 309). In Hommel's book, several photographs indicate that some wood- and bambooworking tools such as saws (e.g., bow saw, bamboo worker's saw, crosscut saw), line markers (a piece of bamboo with a frayed end), or bow drills were partly or entirely made from bamboo (ibid., 230–252).

Bamboos may also be formed to roofing tiles when split into two semicircular halves. Hommel, mentioning bamboo roofing tiles, argues that the "semicircular form of the Chinese [earthenware] roofing tiles may have been derived from . . . bamboo tiles" (ibid., 258).

Lastly, bamboo was also useful in producing lighting splints that were put in a recess in the wall of a room. These lighting splints only emitted a dim light, but it was sufficient to see one's surroundings until they burnt down overnight (ibid., 258).

8.7. Findings and Discussion

As this chapter has made clear, bamboo is a multipurpose plant with exceptional mechanical properties (such as its tensile strength and springiness) and an outstanding natural structure (i.e. its hollowness and length). This being so, bamboo has been used in the most diverse ways throughout Chinese history and involved in many domains of life, agriculture, and proto-industries. Bamboo is, technically speaking, a *non-timber forest product*, but due to mature culms' woodenness, bamboos were able to substitute wood and timber products and provided great potential in many ways—as testified by Porterfield's (1933) compilation of bamboo tools and Needham's (1954–until present) references to bamboo. Whenever bamboo proved

[57] For further discussion of the impact of bamboo's material property in the production of ladders, see chapter 9.4.2.

advantageous compared to wood, it was quite natural to choose bamboo, as in the construction of ladders (due to bamboo's length), its use for water transport (due to bamboo's hollowness), its use for basketry (due to bamboo's flexibility and splitting capability), or all tools and devices relying on bamboo's flexibility and springiness.

In contrast, wood has a solid material density compared to bamboo and provided other advantages. In this context, Hommel's *China at Work* refers to a plethora of tools and devices that were made of wood, such as wooden hand-driven machines, wooden water irrigation wheels, spool reels, presses, buckets, plows, harrows, winnowing machines, wheelbarrows, ships, and the like (1936). "Wood and bamboo," write Needham and Wang, "appear in greatest prominence as the materials of construction of the machines of ancient and medieval China, only certain essential parts being made of bronze or iron" (1965, IV:2, 65). As such, Chinese bamboo culture is only one subset of the broader Chinese material culture.

Nonetheless, Porterfield states that "there is no doubt that bamboo is the great provider of China," and claims that "no other plant has ever been put to such general use, or has been so closely associated with a people in so many of the intimate details of their daily life" (1926, 36). Bamboo's part in Chinese material culture and pre-industrial technology in the early twentieth century is also attested by an anonymous observer, who writes the following:

> The greatest blessing in the matter of natural productions that exists in China is the bamboo. It is thought that over sixty varieties of bamboo exist, and it can properly be termed the national plant. It is applied to domestic, commercial, and industrial uses. Its shoots are a great delicacy, and are among the dainty and expensive dishes that usually grace the tables of the Chinese mandarins. Its roots are turned into canes, while the tapering spire is used in making masts, poles, tables, stools, chairs, chopsticks, pipes, umbrellas, fans, musical instruments, &c. (Anonymous 1909, 915)

Referring to bamboo as a *national plant* with which China has been *blessed* stresses the part bamboo played in China. Indeed, though wood and iron were equally essential materials, bamboo had a distinct role and contributed much to the development of certain tools and technologies, as exemplified by the papermaking and military technology in particular and by all other tools and devices in general. The fact is that China, if compared to Europe, had an additional naturally occurring material at hand, namely, bamboo, which was of great benefit to China's technological development by allowing human creativity to take advantage of bamboo's inherent properties.

Although not explicitly discussed in this chapter due to the limited scope of this thesis, if we consider that China, until the European Enlightenment and Industrialization, had much more advanced knowledge in the fields of science and technologies than the Western world, one must acknowledge bamboo's part in this context. As evidenced by bamboo's contribution to papermaking and the inventions of firearms, as two of *The Four Great Inventions*, it becomes clear that Chinese technological development would have taken a different course if bamboo had not been available as a renewable natural resource.

In this context, I shall briefly refer to the underlying leading question that Needham was concerned with throughout his academic life, the so-called *Needham Question*, which examined why China and India, though both were ahead in terms of science and technologies compared to the Western world, were later surpassed by the latter, notwithstanding their earlier successes. Historians have devoted much attention to answer this question and present socio-economic arguments; highlight the influence of different worldviews, ideologies, and concepts of nature; emphasize the development of Western science and its impetus for technological development; and the like. In my view, though not explicitly elaborated in this chapter, bamboo might have a profound impact on Chinese (and Indian) technological progress.

On the one hand, bamboo provided many technological solutions, as demonstrated by the simple machinery and tools built on the basis of bamboo. At the same time, bamboo was an abundant and, above all, a resilient, renewable natural resource. While tree forests declined in Chinese history due to the clearance of wilderness without attempts at afforestation, bamboos had a higher resilience and could regrow due to their strong rhizome systems and, therefore, provided a continuous supply of essential raw materials. Accordingly, these factors might have consolidated Chinese material culture related to bamboo.

On the other hand, bamboo has been used in many ways as a simple makeshift that stood out in terms of effectiveness, but at the same time made long-term constructions impossible due to bamboo's rapid decomposition. Thus, the short life of things made of bamboo is already inscribed in their very creation. As a result, the ready availability of bamboo might have offered certain opportunities in the development of Chinese technology, but in the long-term might have hindered further developments due to the shortcomings of bamboo and the makeshift character of tools and devices made from bamboo.

Furthermore, some pre-industrial machines like the waterwheel worked *autonomously* once set in motion. Most tools and devices, in contrast, needed to be operated by humans. The human-centered working principle, in turn, underlines Chinese proto-industrial and pre-industrial technology and machinery. Even though China contributed much to humankind's technological development, their machinery and technology remained less technologically advanced compared to industrialized countries in the 1920s and 1930s. On the other hand, as King concludes based on his investigations of Chinese agriculture and the machinery employed, Chinese agricultural implements and machinery stood out in terms of convenience, functionality, and efficacy, as proven by his following statement:

> Crude as it appears there is nothing in western manufacture that can compete with it [Chinese pre-industrial machinery] in first cost, maintenance or efficiency for Chinese conditions and nothing is more characteristic of all these people than their efficient, simple appliances of all kinds, which they have reduced to the lowest terms in every feature of construction and cost. The greatest results are accomplished by the simplest means. (King 1911, 299)

Overall, if we compare the state of Chinese technology in the late eighteenth and early twentieth century with industrialized countries and, in doing so, consider technology as a one-way route, developing from the primitive to the complex, then Chinese machinery and technology may appear antiquated and archaic.

Yet, if we consider their efficacy and functionality, and their relevance and convenience for peasants, then these tools and machines can be esteemed from a non-judgmental point of view to interpret their place in the daily lives of Chinese people. Moreover, Chinese tools and machines have a long history and contributed much to the development of Chinese society, culture, and technology. In view of this, rather than being confined to a limited time, one should keep in mind that many of the bamboo-related things discussed in this chapter were invented and improved centuries ago and long before the European Enlightenment and technological achievements induced by industrialization. In other words, bamboo accompanied Chinese peasants and rural dwellers long before the first Chinese dynasty was established. Accordingly, as proven for Ecuador (in chapter 10.2.3.1) and Japan (chapter 9), it is most likely that the early Chinese—long before the advent of iron tools—processed bamboo and produced various tools and everyday commodities to meet their needs.

The main theme and goal of the third part of this chapter was to determine bamboo's part in Chinese rural dwellers' life in the early twentieth century prior to industrialization. In doing so, I predominantly referred to Hommel's *China at Work* and his observation of everyday commodities and tools needed for carrying out agricultural work, everyday activities, and other domains of life. The most obvious finding to emerge from this part is that bamboo was used by Chinese peasants in many ways and was one fundamental and essential raw material for local material cultures.

Overall Chinese peasants took advantage of bamboo's material properties in many ways, which are illustrated and epitomized by human-made things, tools, commodities, or the built environment. By exploiting bamboo's natural springiness, for instance, it was possible to build the crossbow trap (a mechanism also used for carriages), the bow trap, the cotton bow, or the bamboo fishhook as mentioned by Hommel. By profiting from bamboo's hollowness, people were able to construct irrigation systems encompassing the bamboo waterwheel—made of long bamboo poles and its carrier buckets benefiting from bamboo's hollowness and from these sections' natural closure on one side when one node is left unbroken—and bamboo water pipelines plugged into each other as a conduit for water over long distances. The superior splitting property along bamboo's fiber direction endowed people with a universally applicable material to produce splits of all kinds and laid the material groundwork for basketry and weavings. For instance, people created various riddles for agricultural work and could easily adjust the bamboo meshwork by splitting thin bamboo strips and designing fine meshwork to produce sieves needed in Chinese kitchens. Steams, steaming trays, bamboo mats, and all kinds of bamboo baskets demonstrate how Chinese peasants exploited bamboo as a weaving material.

This chapter's main weakness was the paucity of literature I have referred to and studied. On the one hand, studying other works focusing on Chinese agriculture and peasants' everyday life would reveal further insights about bamboo, but on the other hand, such an undertaking would go beyond the scope of this chapter. Therefore, this chapter's intention can only be to provide a first glimpse into the human-bamboo relationship of Chinese peasants expressed by their material culture. This confinement becomes even more apparent when considering that there has never been a uniform and homogenous Chinese agriculture but many forms and methods involving various types of agricultural implements and activities. Hence, writing about a *genuine Chinese bamboo culture* is less fruitful if we reflect on China's enormous size.

On the other hand, inventions like writing, paper, and printing favored an exchange of people from different regions and, thus, also enabled a technological exchange. Simultaneously, the spread of bamboo-related tools and devices from one place to another could have spread gradually in space and time. As a result, a certain use of bamboo, as in the case of the bamboo bow trap, most likely disseminated over long periods and distances since the same trap is used in the Central Highlands of Vietnam and Central China. By implication, the bow trap's spread may imply that people were in contact over long distances and everywhere where bamboo was available; in principle, people could reconstruct exchanged or introduced tools or rebuild them on the basis of orally transmitted descriptions.

To sum up, despite all its shortcomings, this chapter's third part presents analyses of bamboo in the peasantry's everyday life that contribute in several ways to our understanding of human-thing relations and provide a basis for further analysis. In this light, my discussion of the plow and plowing and the relatedness to the human body and other entities aimed at enhancing our understanding of tools and nonhuman entities. Given that tilling is a prerequisite for human agriculture, scholars have explored its inventions, designs, spread, improvements, material composition, and handling. In contrast, less attention is paid to how humans and things conflate in certain hybrid entities and how these heterodox entities found their place in a multifaceted network or arrangement or, more broadly understood, if one regards these things to constitute a network themselves. Nonetheless, practice theory's and ANT's epistemological viewpoints guided my approach to reveal insights into human-thing relations, as most vividly demonstrated by the use of the plow. Overall, although a detailed illustration of every human-thing, human-tool, or human-bamboo(-thing and -tool) relation is not provided, it becomes clear that bamboo has a deep impact on human life itself.

9. Bamboo in Meiji Japan's Material and Immaterial Culture

The use of bamboo in Japan evolved and flourished long before the last two millennia. As Brauen (2003, 34) notes, the earliest Japanese bamboo artifact found by archaeologists is a weaving of thin bamboo strips that date back to the Jōmon period (traditionally dated between 14000 BCE until 300 BCE)—a time in which iron was not yet known. Since a young, fresh bamboo is relatively soft in comparison to mature bamboo, it is most likely that early hunting, fishing, and gathering peoples of the Jōmon period found techniques to work on (particularly young) bamboos using stone and bone tools in order to create wickerwork, tools, baskets, and the like.

One might say that bamboo accompanied the historical trajectory of the Japanese people since their very arrival in the Japanese islands from the Korean peninsula around the fourth century BCE. At the same time, many bamboo tools and objects like combs, baskets, sieves, or fishing equipment were developed in the Yayoi period (300 BCE until 300 CE) (ibid.). Moreover, during the Yayoi period, ideas and technologies spread from continental Asia to the Japanese islands, as well as various objects and iron tools, which laid the foundation for the subsequent development of Japanese material culture and bamboo culture. The vast amount of bamboo artifacts and wickerwork objects, typical in the Nara (710–794 CE) and Heian (794–1185 CE) periods, for instance, were kept in the imperial treasure house Shōsō-in in Nara and prove the sophisticated development of bamboo objects and related techniques from the eighth to the thirteenth century.[58] While bamboo was part of the aristocratic lifestyle at that time, bamboo's main uses must be practically embedded in the context of village life since urbanization in Japan did not significantly begin until the seventeenth century.

Thus, for centuries, bamboo has inspired entire generations of Japanese craftspeople and peasants, who used bamboo to create a distinct Japanese bamboo culture. Today, bamboocraft and the related skills of crafting items from bamboo are considered among Japan's earliest crafts and technical skills (Boudine 2018, 3). Indeed, in pre-industrial times, bamboo permeated every part of daily life and was found in art, crafts, design, literature, food, festivities, language, ancient tales, flower arrangement, and music. Bamboo's versatile uses in pre-industrial Japan range from simple, inconspicuous, practical utilization to elegant, fine, and sophisticated

[58] Since 1887 the treasury has been managed by governmental institutions. The Shōsō-in preserves more than 9,000 items, amongst which are valuable bamboo objects related to musical instruments, ritual implements, tableware, basketwork, containers, arrows, writing tools, and the like. In 1984, the Shōsō-in published a journal devoted to bamboo in its Bulletin of Office of the Shosoin Treasure House (No. 4) (in Japanese).

designed tools and objects. Moreover, bamboo forests are intertwined with the Japanese landscape, and bamboos fascinated people due to their beauty. Though other materials such as tree wood, rice straw, ceramics, or iron were equally important, bamboo contributed much to the distinct Japanese material culture prior to the spread of modern technologies. As a consequence, one can say that bamboo was a daily companion in Japan and shaped the Japanese lifestyle both in urban and rural settings.

In this chapter, my underlying research question is to investigate bamboo's entanglement in Japanese immaterial and material culture. Concerning bamboo's value for Japanese culture, I address the issue of bamboo's part in art, language, ceremonies, gardening, aesthetics and interpret its symbolic meaning. On the other hand, I ask to what extent bamboo was necessary as a raw material for pre-industrial Japan and how bamboo contributed to the establishment of Japan's material culture. In doing so, my questions revolve around bamboo's part in the material aspects of people's everyday life before industrialization. In line with my definitions of the term and topic of material culture set out in chapter 5.4, material culture in this chapter encompasses the tangible things people produce, use, and consume in their everyday lives. Following this definition, I ask which (movable and immovable) bambooic things surrounded peoples in pre-industrial Japan. Since bamboo has specific material qualities, I question how people took advantage of bamboo's intrinsic physical properties in their creation of tools and objects. Conversely, I question how the physical-mechanical characteristics of tools depend on bamboo's very materiality. These questions are based on my view that everyday objects, tools, and artifacts reveal much about how people lived, met their daily needs, which technological solution they found for everyday problems, how people ate and cooked, how they lived in their houses, and how people's health and wealth were affected by the materiality of things.

A pervasive reflection on Japanese bamboo culture from the early beginnings until the commencement of industrialization would inevitably go beyond this work's scope. Given my work's limitations, I do not attempt to give a wide-ranging account of bamboo's part in all aspects of Japanese history or life and treat all subjects at equal length. Nor do I attempt to represent the full repertoire of a comprehensive Japanese bamboo culture, but to discuss aspects of Japanese bamboo culture in a specific period. To be more precise, my underlying interest and research revolve primarily around the time from the onset of Japanese modernization in the 1870s until the outbreak of the First World War. My approach and research goal here is twofold. On the one hand, I address bamboo's immaterial value and significance in Japanese society and culture. On the other hand, I shall discuss crucial aspects of bamboo's conflation in parts of Japanese everyday life—thus, my focus is much more related to mundane objects and tools and how people chose bamboo to cope with everyday necessities in a pre-industrial context. As will become clear, this chapter can only outline some traits of bamboo in Japan. Nonetheless, I hope this chapter will provide useful and significant clues for discovering Japanese bamboo culture and questions raised in this chapter.

This chapter's structure is as follows: I will first outline my underlying methodological approach based on my literature review in chapter 9.1 and address the primary historical sources I utilized to analyze both bamboo's function as a mundane object in everyday activities and its immaterial role in Japanese society and culture. Then, I mention valuable secondary sources and non-textual sources needed for this chapter and conclude by outlining the scope and limitations of my research.

Since my narrative is to elucidate bamboo's ubiquity in the context of nonindustrial settings, my inquiry starts in the late 1870s and ends in the first decades of the twentieth century, when Japan had successfully undergone major transitions. Japan's striving for modernization and industrialization coincides with the regency of Emperor Tennōs Mutsuhito (or Emperor Meiji) that lasted from 1868 until 1912 and is known as the Meiji Restoration. Chapter 9.2 will provide a brief overview of the Meiji era since the main part of the literature I used for this chapter was published during that period. What is more, during this period, Japan changed from a feudal, isolated, and agricultural country to a nation-state due to significant economic, political, technological, and social change. This brief account is necessary to interrelate bamboo's integration in traditional Japanese material culture and depict its gradual disappearance due to the introduction of new mass goods. Following this, in chapter 9.2.2, I will outline the social status of bambooworkers and bamboo craftspersons and question the historical background that led to their social discrimination as *polluted* and *defiled* persons in feudal Edo Japan (1603–1868) under the military administration of the Tokugawa Shogunate (Tokugawa Bakufu) and its four-class system.

After briefly indicating bamboo's significance for Japanese tales in chapter 9.3, in the chapter that follows (9.3.1), I shall outline bamboo's part in the Japanese language, highlight its role in the context of art and culture, its significance for Japanese feasts and ceremonies, and indicate its ornamental value for bonsai gardening, ikebana, and gardens. In the next subchapter (9.3.2), I address Daoism's contribution to the development of the traditional tea ceremony, and in this light, bamboo's relevance as essential utensils for the tea ceremony. In doing so, I also indicate how the tea ceremony could be analyzed from the viewpoint of practice theory and ANT and why the tea gathering is a placeholder for other human-material arrangements. Although these chapters are kept very brief, their underlying aim is to portray bamboo's versatile cultural values alongside its practical use in everyday activities.

Chapter 9.4 will sketch bamboo's involvement in Japanese society on the basis of an enumeration of things fabricated from bamboo. Although Japan has a rich diversity of bamboo species, three bamboo species were most frequently selected by virtue of their outstanding properties. I will briefly depict these bamboos and their basic characteristics in chapter 9.4.1 and also outline the increase of wood demand in the seventeenth century. This is followed by an ensuing discussion of bamboo's basic principles together with related working techniques and required tools (9.4.2). In this context, there are two domains I tended to focus on more: a) the use of water pipelines and other uses based on its tubular structure (chapter 9.4.3), and b) bamboo in house, roof, and fence construction (chapter 9.4.4). The reason for emphasizing these topics is their importance. First, water was an essential part of every person's daily routines and required technical solutions to transport or store it, and water was likewise essential for hygiene and healthy living. At the same time, its tubular structure facilitated the creation of many other tools needed to convey water, smoke, or steam. Second, houses and the built environment were crucial for living, everyday activities and always surrounded the people living in and with them.

To indicate the uniqueness and ubiquity of bamboo in Japan, I will enumerate in chapter 9.4.5 further bamboo objects and provide a brief introduction to their functionality and utility to demonstrate the richness of bamboo objects in Japanese society. Therefore, I will provide a glimpse into Japanese households, body hygiene, kitchen utensils, and goods for everyday uses—both by means of photographs taken between the 1870s and the 1890s and by historical reports. I conclude this subchapter with an outline of bamboo as an integral element of agriculture and fishing.

With a brief discussion of bamboo as an essential cornerstone of Meiji Japan's everyday culture, I conclude the chapter (9.5).

9.1. Methodology and Literature Review

By analyzing the aspects of Japanese bamboo culture in Meiji Japan and inquiring into bamboo's utilization and enrollment at that period, this dissertation conducts a textual analysis of primary sources to gather first-hand information. Secondary sources were required for background knowledge and positioning and portraying the subject in connection with Japanese history, culture, and socio-economics. Besides written records, I utilized photographic images, sketches, drawings, and paintings of bamboo objects from various periods and sources. These non-textual materials impressively express bamboo's ubiquity and allow a glimpse of pre-industrial Japanese bamboo culture. On the one hand, this is meant to provide a better illustration of the objects, and on the other hand, the relevance of bamboo and its use context is to be presented in more detail with the aid of the illustrations. Thereby, texts and illustrations are connected to the principal chapters and subchapters and complement each other.

By utilizing these sources, this chapter is intended to complement the other chapters of this book in that it sheds light on topics not covered in the other chapters. It portrays, for instance, bamboo in the domain of art (paintings or design) and ceremonies (tea ceremony or festivities), bamboo as a material subset of an urban lifestyle, and bamboo's role in the water irrigation system. And by addressing these topics, this chapter contributes both to a comprehensive material history of bamboo and a reassessment of how bamboo was integral to Japanese life during the time when Japan was undergoing a crucial transition from a feudal, agrarian to a modern, industrial country.

In my efforts to answer my research questions mentioned above, I shall limit my investigation primarily to the late nineteenth and the first quarter of the twentieth century for three reasons. First, although numerous Japanese publications about the material aspects of the Tokugawa and Meiji periods exist and might offer valuable information related to this chapter's subject, I could not use them due to language obstacles. I consider this shortcoming as problematic since many Japanese sources would have provided valuable information about bamboo's part in daily life. Simultaneously, as Souyri (2017, 264) clarifies, most of Japan's historiography was dominated by a Confucian interpretation of history that overemphasized powerful authorities and consequently seldom provided data about the peasantry, their daily routines, and material life—a perspective on history that changed only gradually in the early twentieth century.[59] Accordingly, since historians rarely delved into the everyday lives of the peasantry, little is known about the multiple layers of villagers' and ordinary people's use of bamboo prior to the pre-Meiji era. This is particularly relevant because bamboo is commonly considered and perceived as the material of ordinary people whose daily routines and labor are related to it. Hence, research on that topic is problematic due to the lack of first-hand information and would require the study of old Japanese records for further data.

Second, as a result of my limited linguistic access to written records and owing to the lack of an English (or German) translation of many Japanese works that were published before and during the Meiji era, I concentrate mainly on English and German primary sources, produced predominantly by non-Japanese authors who visited Japan during the Meiji period—my use of Shigami (1889), Soetsu (1933), and Okakura (1919) are exceptions to this.

Third, my primary sources cover only some aspects of bamboo, and I can only partially reconstruct bamboo's use during the Meiji era. This is partly due to the fact that some Western authors had little or no ongoing knowledge of Japanese history, material and immaterial culture, and bamboo. Thus, some of their descriptions and explanations remain inaccurate and imprecise. On the other hand, foreign authors were interested witnesses investigating the material world of the Japanese people. While Japanese scholars' interest in ordinary (bamboo) objects has only gradually arisen since the 1920s (see my explanation on Japanese folk craft below), foreigners were often enthusiastic and open to common everyday things—as proved, for instance, by Spörry's collection mania of bambooic things. Hence, even though Westernized and with little knowledge of Japan, the Westerners' curiosity paved the way towards an interest in material things and their implication in daily life. As Dresser, a British designer and design theorist who visited Japan in the 1880s, says, "it would be almost impossible to describe the impression of novelty left on our [the Westerners'] minds" (1882, 4). While the non-Japanese authors' cultural background might have been a hindering factor when approaching an understanding of the Japanese lifestyle and material culture; at the same time, their distinctiveness and curiosity opened a window onto a new world. As a result, even if things were small, inconspicuous, and incidental, they often appeared exciting and curious in the eyes of foreigners so that, in their view, they needed to be elucidated.

[59] As Souyri (2017, 265) points out, only in the late 1920s did Japanese scholars (such as Yanagita Kunio) criticize the then dominating positivist history which devoted attention to administrative and governmental archives and neglected the daily life of peasants.

One seminal publication that explicitly refers to bamboo is Hans Spörry's *Die Verwendung des Bambus in Japan* (1903) (*The Use of Bamboo in Japan*). Spörry, a Swiss entrepreneur without any previous knowledge of Japanese language and culture at the time he arrived in Japan, was asked by Carl Joseph Schröter (a well-known Swiss botanist) to collect bamboo objects during his stay while working for a Swiss silk trading company in Japan. Soon after his arrival, Spörry was overwhelmed by the beauty and ubiquity of bamboo. Within six years (from 1890 until 1896), he collected almost 2,000 bamboo objects, contrivances, and other movable things that, in one way or another, were related to bamboo. His collection has remained unique and became known as *Spörry's Bamboo Collection*, housed in the Ethnographic Museum of the University of Zürich in Switzerland.[60] This collection, and its related catalog, illuminate the material aspects related to bamboo in late-twentieth-century Japan. Spörry's bamboo collection can be subdivided into three sections: i) objects made of bamboo, ii) objects that imitate bamboo, and iii) objects that display bamboo (Brauen 2003, 26). Though Spörry's bamboo collection represents an incredibly rich assortment of everyday objects, tools and artwork, and though he gained a deep insight into bamboo's ubiquity at his time, his book only partially reveals information about the embeddedness of bamboo in the daily life of the Japanese for two reasons. First, Spörry mainly collected bamboo objects. He visited Japanese traders and purchased bamboo artifacts and, therefore, provides very little first-hand information about bamboo's practical embeddedness and use by craftspeople. Second, Spörry spent most of his time in Yokohama and traveled only occasionally through the countryside. His observations are confined to Japanese townspeople, whose lives underwent a significant change due to the impact of industrialization, new technologies, and (non-indigenous) mass products while Spörry was visiting Japan. In contrast, an investigation of the Japanese countryside would have provided a comprehensive and dense illustration of bamboo in a peasant's life.

Another significant aspect of Spörry's collection is related to the collected objects' origins. According to Spörry (1903, ix), all collected artifacts were autochthonous objects that the Japanese had been using long before the Europeans arrived and introduced new materials and objects to the Japanese. Indeed, Spörry arrived in Japan two decades after the end of the Tokugawa era (1600–1868), at a time when social and political reforms were changing the socio-economic

[60] Although Spörry's bamboo collection at the Ethnographic Museum of the University of Zürich would provide additional first-hand information on bambooic artifacts' materiality and their design and complement Spörry's written records, studying it would have gone beyond the temporal framework of this work. Interested readers will find a comprehensive visual presentation in the museum's newly published book edited by Brauen 2003.

situation in Japan and urbanization had started and progressed even more dynamically afterward and changed the material culture of townspeople. Hence, Spörry's collection was already a collection from the past, even at his time. In other words, although the objects he collected had been in use only some decades before his arrival, the objects were in part witnesses of an older, past Japan.

In 2003, Martin Brauen edited and republished parts of Spörry's book and supplemented it with 460 color illustrations that primarily are based on Spörry's bamboo collection and provides additional information about Spörry's biography and his collection. Thus, this book extended Spörry's own description related to bamboo and meant a crucial secondary source for this chapter.

Edward Sylvester Morse wrote two other books that vividly capture Japanese daily life at the end of the nineteenth century. One is titled *Japanese Homes and Their Surroundings* (1886), and the other one *Japan—Day by Day, 1877, 1878–79, 1882–83* (1917). Morse, an American zoologist and orientalist, lived in Tokyo in the late 1870s and early 1880s and was the namegiver of the Jōmon period. His first book, published in 1886, contains detailed information about the design of pre-industrial Japanese residential houses and how the houses were constructed. Moreover, Morse describes Japanese houses' surroundings (garden, water irrigation system, fences, etc.) and house amenities (kitchen, bathroom, roof, etc.) in towns and villages. He was also interested in Japanese customs and traditions such as *Ikebana* (the Japanese way of flower arrangement), the tea ceremony, or the realm of art and provides some insights on these topics. Morse's first book features over 300 sketches drawn by himself, which provide additional and unique information about a variety of different aspects. His second, two-volume book (1917)—equally enriched with countless sketches—is, to some extent, a diary that is filled with all the things that were new and curious for Morse. As a result, this book affords an insight into the tangible and intangible culture of early Meiji Japan through an interested observer's eyes.

On the other hand, his books have some shortcomings. For instance, his first book lacks a description of poor and rich people's houses because of being limited to "a description of the homes of the middle classes, with occasional reference to those of the higher and lower types" (Morse 1886, xxxi). Morse was convinced that this approach would "give a fairer picture of the character and structure of Japanese homes and houses" (Morse 1886, xxxi). When Morse visited Japan, the country was still markedly rural. At this time, bamboo was less affected by industrialization and part of a traditional peasant's life. Simultaneously, it was a cheap, renewable resource commonly exploited and used more often by lower-income households than wealthier people's households. Despite their shortcomings and lack of information, Morse's books nonetheless provide plenty of worthwhile descriptions and illustrations that portray the material aspects of everyday life related to bamboo.

Another useful primary source comes from Johannes Justus Rein, a German geographer sent to Japan by the Prussian Ministry of Commerce to study traditional Japanese industry. Based on his stay and research in Japan between 1874 and 1875, he then published *Japan. Nach Reisen und Studien im Auftrage der Königlichen Preussischen Regierung* (1881) and *The Industries of Japan* (1889). Although entrusted with the task of studying Japanese industry, and though his books are very comprehensive and encompass many aspects of Japan at his time, his information about bamboo remains scarce. However, some of Rein's descriptions were useful in characterizing certain aspects of bamboo's uses and provided valuable information.

Other vital sources published during the Meiji era were Christopher Dresser's *Japan. Its Architecture, Art, and Art Manufactures* (1882), Shigemi, Shiukichi's *A Japanese Boy* (1889), Yanagi, Soetsu's *The Beauty of Everyday Things* (1933), and Kakuzo Okakura's *The Book of Tea* (1919). Dresser (1882) draws our attention to aspects related to the traditional Japanese built environment, pre-industrial processing technologies, and arts. In this context, he provides worthwhile insights about bamboo in these domains. Though not extensively quoted in this work, Shigemi's autobiography (1889), concerning his childhood and youth, offered a range of aspects related to the material aspects of daily life. Soetsu's work (1933) stands out in many respects. It is the first of its kind that urges the study of traditional Japanese objects and techniques applied by craftspeople and acknowledgement of their contribution to *folk art*. It discusses the cultural importance of handicrafts and laid the cornerstone for the institutionalized research into Japanese craftwork. Moreover, Soetsu (1933) was helpful with information about the bamboo plant as a frequently used motif of art and for his reflections about the role of everyday things in Japanese society. Finally, Okakura's book (1919) revolving around the history, performance, and embeddedness of the tea ceremony in Japanese culture that reveals much about Japan's history, philosophy, religion, aesthetics, and people's worldview(s) was helpful to investigate Japanese history and society at his time.

While some Westerners were interested in everyday life and bamboo objects, others developed an interest in the cultivation of bamboos. David Fairchild, an American botanist and author of *Japanese Bamboo and Their Introduction into America* (1903)—one of the first comprehensive works about Japanese bamboos published in English—exemplifies how foreigners appropriated the endemic bamboos of Japan. Moreover, Fairchild played a key role in introducing Japanese bamboos as a garden plant to the United States and Europe. As a result of his enthusiasm and interest in bamboo, he initiated the import and cultivation of bamboos throughout the world, which until the late 1860s was thought not to be possible due to climate conditions (Satow 1889, 1). The first Japanese botanical treatise on bamboos based on Western science was Katayama Nawohito's *Nihon Chiku-fu* (1899). His book was translated by the British scholar and Japanologist Ernest Mason Satow soon after its publication and entitled *The Cultivation of Bamboos in Japan* (1900). Fairchild's and Nawohito's books were important sources for my topic as regards botanical aspects and reflect the history of early scientific classifications of bamboos but were less instructive concerning bamboo's uses as a raw and construction material.

There are plenty of (English) books revolving around Japan's history published in the past few decades. For this chapter, I used *The Routledge Handbook of Premodern Japanese History*, edited by Karl F. Friday (2017), and William E Deal's *Handbook to Life In Medieval And Early Modern Japan* (2006). Both books were worthwhile for gaining thematic orientation on the fundamentals of Japanese society and history before the end of the Meiji era. Another valuable source was Susan B. Hanley's *Everyday Things in Premodern Japan: The Hidden Legacy of Material Culture* (2005). Hanley examines the role of everyday things in relation to people's everyday lives and raises a meaningful set of questions concerning Japanese society's physical well-being. In doing so, she draws on a wide variety of sources to make her case. Concerning this thesis, her findings clarify and provide crucial information about various domains of everyday life, such as body hygiene, water systems, or house styles.

As mentioned above, texts and illustrations are connected to the main subject of each chapter. My underlying goal was to provide a vivid illustration of bamboo's relevance and function in Japanese society and culture. Hence, I referred to miscellaneous visual sources such as paintings, sketches, historic photographs, and photographs of museum objects—yet not every use of bamboo and every bamboo object I mention in this chapter is illustrated.

Another crucial aspect that needed to be mentioned is the ubiquity of bamboo in Japanese society. It is self-evident that my descriptions of bamboo are limited and confined to my sources and research questions. Though I attempt to display a Japanese bamboo culture, and even though I discuss many aspects of bamboo and its relatedness to pre-industrial Japan's material aspects, this attempt offers only a partial glimpse into this subject. In the words of Dresser, "to enumerate the various uses to which the bamboo is put would be to furnish a list altogether unreadable, for they [the Japanese] seem to make everything of bamboo, and to treat it in every imaginable manner" (1882, 458). Consequently, bamboo's part in Japanese shipwrightry, paper-production, warfare, bridge-building, mining, its use in kite-making, and other uses as in embankments, dikes, or waterways, for instance, found no place in this chapter and bamboo utilization in agriculture or fishing is mentioned only briefly. On the whole, my investigation tells only part of the material history of bamboo. This shortcoming does not, I hope, eclipse bamboo's relevance in Meiji Japan and is, to some extent, compensated by the other chapters of this book.

What is more, given this chapter's scope, in chapter 9.4.5, I mention and summarize miscellaneous uses of bamboo. This chapter enumerates bamboo objects to provide a clearer picture of bamboo's use in addition to the previous chapters, but on account of its summarizing character results in a less dense description of the particular bamboo object's connection to its socio-cultural embeddedness in Japanese society. I frankly admit to this lack of information because mentioning these bamboo objects, despite their shortcomings, still adds further data about Japanese bamboo culture and is essential to grasping bamboo's relevance and function in Meiji Japan.

9.2. A Brief Outline of Japan's History

When writing about Japan prior to industrialization, one must consider that Japanese cultural and material history and its history of science and technology were very strongly connected with China's history and, to some extent, also Korea. Not only is the Japanese writing system of Chinese origin, but many other cultural, technical, social, philosophical, and religious aspects, views, and assumptions also derive from China. I shall not attempt to identify and describe China's and Japan's intricacies, though their long-lasting exchange and relationship would reveal much about the origins and traits of both countries' material cultures and their pre-industrial use of bamboo. Nevertheless, here and there, I will briefly outline some aspects of both regions' interconnections and exchange but mainly Chinese effects on Japan. To give some examples at this point, Confucianism, Buddhism, and Daoism, along with new tools, goods, and technologies, came from China to the Japanese islands and influenced Japanese (im-)material culture. And even the three most exploited bamboo species in late Edo Japan were introduced to Japan from China.

The following subchapters trace in brief the development of Japanese history from the seventeenth to the first decades of last century and attempt to evaluate the impact of modernization and industrialization on Japanese society, culture, material culture, bamboo, and the social status of bambooworkers and bamboo craftspeople.

9.2.1. From Tokugawa to Meiji Japan: Social, Cultural, and Technological Transformation

One of the most striking characteristics of Japan's landscape is the abundance of mountains that cover approximately two-thirds of the country. Conversely, only fifteen percent are available as farmland. While mountains provide crucial raw materials such as wood and bamboo— still almost two-thirds of Japan is wooded—they also were obstacles for trade, communication, warfare, or a centralized and uniform administration (Deal 2006, 57–58).

In contrast to the Meiji era, Edo Japan was a feudal country. Farmers made up the great majority of the Japanese population. It is estimated that around 80 to 85 percent were peasants in Edo Japan, living in some 63,000 villages distributed throughout the Japanese islands (ibid., 113). Hence, even though urbanization progressed further during the nineteenth century, the Japanese population was mainly made up of self-sufficient farmers. Consequently, they made most agricultural tools and material necessities by themselves. At the same time, merchants traveled through villages to offer their goods, and local markets were gradually established during the medieval period, selling nonagricultural products, pottery, or household items (ibid., 120). A peddler pulling a cart loaded with miscellaneous household goods is shown in the photograph in Figure 171 and demonstrates how peddlers traveled and traded their everyday goods. At the end of the Tokugawa period, however, Japanese material culture increasingly developed, daily goods were frequently traded, and people "were able to buy books, furniture, sweets, fresh fish, hair ornaments, and all sorts of small luxuries even in remote villages" (Hanley 1997, 2).

Though most visibly induced by industrialization, changes and transitions had been part of Japanese history before the Meiji Restoration. Though little information about the population earlier than 1600 is available, the majority of Japanese lived in rural areas and within a village context—whereby the majority were farm villages on the plain areas and, to a lesser extent, inhabitants of fishing villages and mountain villages (Deal 2006, 62). In contrast, however, in 1700, around five to seven percent of the total Japanese population were townspeople, “making Japan one of the most urbanized countries in the world in this time period” (ibid., 63). On the whole, it was particularly the time from 1615 until the Meiji era began in 1868, which laid the groundwork for the emergence of industry, a time span described by Japanese scholars as the *early modern* or *recent period* (ibid., 2). This period was marked by significant socio-economic improvements, peace, and continuous urbanization, the rise of merchant classes, and an elaborated urban popular culture (Deal 2006, 12; Perez 2009, 60). During Edo Japan, and under the strict control of the Tokugawa military government, Japan adopted self-isolation lasting almost 250 years, prohibiting and preventing foreigners from entering Japan—the only non-Asiatic trade allowed was with the Dutch, the trade locally confined to an island close to Nagasaki; and likewise, contacts with China and Korea continued (Deal 2006, 13, 127). In the early eighteenth century, Tokyo had around one million inhabitants and was a fruitful ground to improve local industries. Thus, technological choices were marked much more by local traditional craftspersonship, pre-industrial agricultural methods and industries, and a distinct Japanese socio-cultural understanding and way of producing and creating things using Japanese-style tools. Accordingly, during the Edo period, only a few foreign products reached Japan and people relied on resources in their islands and what nature provided them.

At the late end of the eighteenth century, China and Japan were, like other Asian countries, either threatened or ruled by European or US imperial policy. The non-Asiatic countries’ presence and the establishment of European colonies in India and other Southeast Asian countries nourished Japan’s fear of being defeated and subjugated. Not surprisingly, many Japanese felt that an adequate counterweight to the political and imperial dominance and the threat had to be found. Shortly after the military menace of large American warships that had arrived in Tokyo in 1853, Japan was forced to open its markets and end its seclusion (ibid., 14). Though many supporters of the Tokugawa shogunate were against Japan’s opening and formed an antiforeign movement, its opponents urged rapid modernization of the country. Soon after defeating and abolishing the shogunate, Emperor Mutsuhito was inaugurated in 1868, and Japan’s transition from a feudal state to a modern nation began (ibid., 14–15).

Under Emperor Mutsuhito’s rule, political, socio-cultural, technological, and agricultural improvements were implemented, and new ideas and technologies were introduced. The underlying goal was to achieve quick industrialization and modernization in conjunction with national wealth and military strength. As mentioned before, this period became known as the Meiji period (明治時代) or Meiji Restoration (明治維新) and covered the time span from 1868 until 1912. Japanese authorities reopened the country for foreign ideas, and despite initial reservations and difficulties, the Japanese "digested foreign cultures well and used them as a source of nourishment for their own culture and built up the national strength" (Fujii 1969, 2), unified and ruled by a centralized administration and national legislation. And indeed, this period brought about tremendous changes in Japanese society, culture, technology, industry, military, and the like. However, Japan only gradually developed from an agricultural, feudal country to a pre- and later industrialized country (Hanley 1997, 4). In Fujii's view, this transformation was "too mild to be called a revolution and too drastic to be labeled a reformation" (1969 [1958], 1). Moreover, the creation of Japanese nationhood was marked by aspects that strived to create a universal concept of Japan as a nation-state with one national identity and a collectively shared national narrative of the Japanese people's history. Accordingly, in the creation of the Japanese nation-state, a plethora of traditional bodies of thought were "constantly reinterpreted, reworked, and interwoven" (Morris-Suzuki 2015, 6).

Concerning the tangible aspects of everyday life, the Meiji Restoration was definitively a turning point because new technologies (such as trains, telegraph, electricity, or artificial power), commodities, industrial means of production, alongside Western fashion, food, and thought, were introduced together with Western scientific approaches, philosophical ideas, rationalization, and democracy. Therefore, on account of severe changes in the material aspects of life, ordinary people were feeling the influence of the West the most. In the words of Fujii, "the adoption of foreign culture was extended to every possible field, and as this expansion covered a very wide field, all aspects of Meiji felt its impact" (1969, 12). At last, Japanese society, and its underlying material culture, underwent radical changes with the advent of non-Asian countries. Nevertheless, the Europeanization of Japan's industries and the adoption of new mechanical technologies was by no means merely the "transplanting of novel things on an utterly empty soil" (ibid., 63), yet related to present (pre-)industrial but sophisticated means of production, in which bamboo, alongside other materials, played a decisive role.[61] In a nutshell,

[61] Japan went through four periods of economic and industrial development during the Meiji era and a fifth until the end of World War I, as Fujii's description proves:

> "The first period from 1868 to 1879 involved change of the feudal economy and the beginnings of the modern industrial economy. The second period from 1880 to 1893 was one of

industrialization, mechanization, and the introduction and application of new technologies contributed to a radical transformation of Japanese customs and beliefs and simultaneously caused the decline of the traditional arts and crafts, manual industries, and agricultural methods (Soetsu 1933, 43). Needless to say, all this contributed to the irreversible decline of the entanglement of bamboo in the everyday life of Japanese society. One can say, while new commodities, tools, and technologies increased, bambooic ordinary everyday objects and tools, handicrafts, and traditional techniques declined.

With the proliferation of European ideas about economic progress, "Japan sought to emulate Western civilization by studying and appropriating the idea of the Enlightenment, which was regarded as its starting point" (Lee 2018, 2). Thus, in the early Meiji period, Japanese intellectuals created new notions of development, civilization, and nature and "made every effort to import the concept [of enlightenment] into Japan" (ibid.). In this attempt, they substituted the former Chinese concept of *ka*, which until then had served to distinguish *civilized people* from *barbarians* in favor of the new term "*bunmei-kaika* (文明開化, civilization, and development)" (ibid.). Unlike the former concept, *bunmei-keika* was influenced by the European Enlightenment, the concept of economic growth, the modern individual subject as a citizen, rationality, and democracy. As a result, the meaning of *bunmei* "was not harmony and hierarchy," as in *ka*, "but production: the ability to create material wealth which would release the human spirit from the bonds imposed on it by nature" (Morris-Suzuki 2015, 24). Unsurprisingly, the economic progress led to policies that fostered a massive, nationwide industrialization of Japan at the expense of nature.[62] As a consequence, modern concepts changed the human-nature

> conversion of industrial policy and readjustment of banking and finance. The third period from 1894 to 1903 showed the first remarkable advance of modern industrial economy. The fourth period from 1904 to 1913 covered the second remarkable advance of the modern industrial economy. The fifth period from 1914 to 1919 represented the third remarkable advance of the modern industrial economy. (Fujii 1969, 63)

In each period, political decisions in the domains of economy, modern industry, and the finance sector were inevitably linked with each other, having the improvement of Japanese society, economy, and industry as their primary goal. The principles for this development were laid in the first two periods. In the subsequent three periods, modern industry became established, and initial successes along with further achievements were accomplished. Given the fact that Japan's industrial revolution and modernization were initiated and determined by governmental authorities, contemporary Japan is the outcome of a revolution from above, to which the ordinary people had to adapt themselves.

[62] It would be worthwhile to discuss the Japanese understanding and notion of nature and how Confucianist or Taoist concepts were related to the Western dualistic concept (such as nature vs. humans or object vs. subject). However, I shall not discuss this challenging question here due to a lack of space. Nevertheless, Japanese scholars' discourse about the notion of nature have never been marked by a homogenous or static view but by diversity and change. For more information about that topic, see Morris-Suzuki (2015, 35–59) and her discussion about the development of Japanese concepts of nature in the Tokugawa and Meiji period and how and where scholars of

relation. They contradicted the earlier, basic principles of Buddhism and Shintoism's nature-centered perception that aimed for an individual and collective ecological striving to live in harmony with nature.

9.2.2. Japanese Fixed Social Hierarchy and the Bambooworker's Social Exclusion

Another crucial change related to the concept of *bunmei-keika* was the dissolving of the Japanese feudal structure. Until the Meiji Restoration, Japanese society was divided into a hierarchical order consisting of four classes: warriors (samurai), farmers, artisans (craftspeople), and merchants. This class or classification system had been adopted from China and helped to allocate and supervise "skilled labor in the service of the state" (Moll-Murata 2018, 293). The fixed social hierarchy, established by Emperor Toyotomi Hideyoshi (1536–1598) and formalized in the following Edo period, entailed behavioral and material effects (Deal 2006, 12, 108). Socially separated from each other, these classes, named as the *four occupational groups* (士農工商) or *four categories of the people* (四民), developed distinct cultural and social aspects (Fujii 1969, 6). There was no racial segregation in feudal Japan but a sharp social distinction and disparagement. Or, as Morris-Suzuki has expressed it, one should envisage Edo Japan as "an inherently unequal social order where everyone theoretically occupied a place in an intricate galaxy of statuses spiraling outward from a center represented by the imperial court and the Shogunal administration" (2015, 83). Behind this concept of class-categories was the intention to settle and monitor people and their activities and economic function, with samurai and farmers conceived as necessary and fundamental, merchants and artisans as a secondary and subordinate group (Moll-Murata 2018, 293). At the same time, it was this social classification—integral to the feudal Edo era—in which capitalistic elements were already developed and on which the Meiji Restoration was founded (Fujii 1969, 64).

What is more, in Edo Japan, there was a social class inferior to peasants. These were the outcasts, referred to as *eta* (representing hereditary outcasts) or *hinin*, which literally meant *nonhuman* and which was associated with *unclean* professions (Deal 2006, 111). This exclusion and classification originate in a Neo-Confucian notion of family, social harmony, and spiritual value (ibid., 112), according to which activities involving blood were despised and considered

different domains located the human being and nature along with her depiction of the Japanese spectrum of environmental views.

bad and impurity as contagious. So, gravediggers, butchers, and leather workers but also beggars, actors, or entertainers had been classified as *polluted* and *defiled* persons; and by reason of their social background, they were later socially segregated in different quarters, from which the definition *burakumin* (people of the village) derives (Deal 2006, 114). Hence, the distinction and discrimination were not based on ethnic or racial differences but came down to the question of people's family background and profession. Only after the formal abolition of the class system, with the promulgation of the *Five Charter Oath* in 1868, were all citizens unified under the umbrella of a Japanese nation-state. At that time, 90.5 percent belonged to the three classes below the samurai (who made up about 6.5 percent of the total population), while the outcasts with 1.75 percent (380,000 people) were below all classes; and above them all was the aristocratic and royal family with about 1.25 percent of the Japanese population (Deal 2006, 112). Since belonging to a social class was determinant to Japanese social organization, this affiliation was indicative of social relations in Japanese society. Moreover, despite its official abolition, the consequences of Japanese class division are still present, and discrimination against the *burakumin*'s successors still poses an ethical and social problem in contemporary Japan.

"The official view of artisans," as Deal clarifies, "was positive: They contributed to society because they built the infrastructure and produced the goods and products required for society to function" (ibid., 114). In contrast to artisans' work and labor, however, Japanese society did not recognize the outcasts' work as worthwhile and desirable, although the work carried out by outcasts was essential and indispensable for society's functioning (Goodwin 2017, 299). Bamboo craftspeople, although also artisans, and despite their contribution to society, were equally considered as belonging to the *unclean* people. However, why bamboo craftspersons and bambooworkers were considered as *burakumin*, although their activities did not involve blood, and although bamboo was an adored plant and motif for artists and a symbol for the right way of living, remains unsolved.

Brauen gives two possible explanations to this question: One reason relates to "the fact that poor bamboo workers, for economic reasons, tended to settle along river banks . . . and thereby came into contact with unclean occupations like the leather processors" (2003, 41). The second explanation relates to the origin of bamboo workers. According to Brauen, bambooworking "in earlier times was reserved for day labourers and (mountain) farmers, who became impoverished and so moved to the cities and as landless folk became outcasts and 'nonhumans'" (ibid., 41). Another reason may lie in the wealth, status, and patronage of the craftspersons' clients on which the craftspeople's economic livelihood often depended and likewise affected the craftspeople's social status. In some cases, craftspersons produced their objects and goods patronized by a wealthy and powerful client (Deal 2006, 112; Goodwin 2017, 303). In other cases, the craftspersons remain "poor, making a living by producing simple goods such as baskets or bamboo utensils" (Deal 2006, 112). Although some bambooic objects were finely crafted and desired by aristocrats, wealthy samurai, or merchants, the majority of bambooic things were made and used by villagers and marked by everydayness. Therefore, these things had to be cheap, practical, and functional rather than standing out as an elaborated and much-desired product. On the whole, while fine arts were fostered and acknowledged, bamboo craftspeople and their products were attributed to the realm of everydayness. On account of these facts, in my view, the ordinariness of bambooic things prevents the social recognition of bambooworkers and affected their livelihood and material circumstances. Spörry (1903, 36), who visited a bamboo workshop in a poor suburban district of Shizuoka, reports, for instance, that he was surprised to see a bamboo artisan living in miserable conditions.

In contemporary Japan, however, artisans working with bamboo have become respected and honored for their contribution to traditional Japanese folk art, especially those making valuable bamboo baskets.

9.3. Bamboo's Cultural Value in Japan

In the next two subchapters, I shall highlight bamboo's immaterial value. In chapter 9.3.1, I shall outline bamboo's role in the Japanese language. Following this, I address the acknowledgment of bamboo plants' beauty and why and how it was admired as a frequent motif in Japanese paintings and artwork through my interpretation of two paintings of the sixteenth and seventeenth centuries. Moreover, I depict, in the following order, bamboo's part in festivities, bonsai gardening, *ikebana*, gardening, and two articles related to bamboo in the Japanese Civil Code. The next subchapter (9.3.2), then, addresses bamboo's part in the tea ceremony and emphasizes bamboo's relevance as a material basis to carry out practices.

Although bamboo is a recurrent feature of Japanese tales, poems, sayings, and idioms, and its discussion in this context would reveal much about its immaterial value in Japanese culture and society, this aspect is not dealt with due to lack of space. Nonetheless, I shall briefly mention its part in tales, exemplified by *The Tale of the Bamboo Cutter* (*Taketori Monogatari*), a tale originating from the Heian period and considered the earliest surviving Japanese work of fiction (Keene 1956, 229). It opens with a description of how the bamboo cutter encountered a newborn baby in the bamboo groves:

> Once upon a time there lived an old bamboo cutter. Every day he would make his way into the fields and mountains to gather bamboo, which he fashioned into all manner of things. This old man was called Sanuki no Miyakko. One day the noticed a light at the root of the bamboo stalk and, thinking that this was very strange, went over to examine it. He saw that the light stone inside the hollow bamboo, where a most fetching little girl about three inches tall was sitting. The old man said, 'I have found you because you are here, in this bamboo which I look at every morning and evening. It must be that you are meant to be my child.' He took her in his hands and brought her back to his house, where he entrusted the child to his old wife. She was an enchanting creature, and still so young that they kept her in a little cradle, the better to care for her.
>
> From that time on it often happened that when the old man went out to cut bamboo he would find a stalk filled with gold, and in this way he gradually became very rich.
>
> The child grew rapidly in their care. In just three months she was already as tall as a grown woman, and they decided that she should be suitably costumed. (ibid., 2)

Notwithstanding the diverse interpretation of this story, its initial part epitomizes, in my view, many aspects related to bamboo. First, it reveals the close relationship of villagers' lives to the bamboo plant that served as an essential raw material for many purposes and, as the story tells, *fashioned into all manner of things*. Second, since bamboo is commonly known as a symbol for family and family ties in Japan, its old, mature culms represent family elders. Their duty is to protect and supply the young culms and emerging shoots with nutrients. This relation, in turn, represents family ties according to which parents must protect and foster their children, as done by the bamboo cutter and his wife, who protect and take care of the baby. Third, the child's rapid growth within three months alludes to bamboo's fast longitudinal growth within this time. Fourth, and in line with my notes below, the emphasis of the child's enchanting character is also attributed to bamboo. Overall, *The Tale of the Bamboo Cutter* reveals much about bamboo's significance in Japanese (im-)material culture.

9.3.1. Bamboo in Language, Customs, Aesthetics, and Art

Bamboo in Writing and Language

The Japanese character for bamboo, which is 竹 (*chiku*), developed from the Chinese character 竹 (*Zhú*), indicating two bamboo leaves hanging down, as illustrated in the pictograms in Figure

119.[63] While *chiku* always indicates a material composition involving bamboo, the Japanese character 竹 (*take*), deriving from *takaki,* which means *tall*, refers to the plant bamboo (Spörry 1903, 184; Nawohito 1889, 12).

Figure 119 Chinese and Japanese characters for bamboo. (*left*) Chinese *zhú* and (*right*) Japanese *chiku*.
Source: Spörry 1903, 184

As Spörry (1903, 185–186) points out, in the prehistory of Japan, provinces, mountains, islands, and places were named after bamboos, as in the case of *Take-san* (bamboo mountain), *Take-shima* (bamboo island), *Take-saki* (bamboo cape), *Take-ya* (bamboo house), or *Take-ga-wo* (bamboo hill). Bamboo was also taken for the first and last name of persons, such as *O-o-take* (great bamboo), *Waka-a-take* (young bamboo), *Bi-chiku* (beautiful bamboo), or *Take-kichi* (happy bamboo); all of these names only refer to male Japanese. Having bamboo as part of a given name indicates its positive qualities and its cultural significance.

Bamboo's Symbolic Meaning in Japanese Culture and Art

Figure 120 Template for teaching how to draw bamboo.
Source: Dresser 1882, 284.

Impressed by Spörry's collection, Schröter (1903, 7) points out that it is bamboo which in its inexhaustible supply has become the most loyal friend of the Japanese. Yet, besides its significance for the material culture, bamboo was of cultural and spiritual value in Japan. For ages, bamboo has been "the natural symbol of the plenitude of nothingness. It grows around empty space (its core is hollow), a void that is central to the spiritual development of the Zen masters" (Boudine 2018, 3). Therefore, bamboo was often planted close to temples and was a familiar object in the Japanese landscape. What is more, bamboo was not merely adored for its symbolic value related to spirituality and religion but was also a recurrent icon in literature and art, representing ideas of ecological immortality, purity, auspiciousness, or uprightness. In its long history, bamboo has inspired many East and Southeast Asian artists and ordinary people. The bamboo plant's frequent use in Japanese art and paintings and why and how people perceive its beauty is discussed, amongst others, by the Japanese philosopher and aesthete Yanagi Soetsu (1889–1961):

[63] The Chinese character's origin and development are discussed in more detail in chapter 8 concerning bamboo in China.

> What qualities set off real bamboo grass from bamboo patterns? Real bamboo is a product of the natural world; bamboo patterns incorporate the human perspective. Real bamboo is alive, an organic substance. The human eye endows it with meaning. Without this human input the bamboo remains physically the same, regardless of whether it is seen or not. Anyone can visually apprehend bamboo grass, but the way it is viewed depends on the person. Not everyone perceives the beauty of bamboo in the same way. There are some people who remain unmoved by its beauty, and even if they are moved, it is in a very shallow way. Bamboo becomes beautiful only when it is seen as beautiful. A bamboo pattern is an arrangement made by the human mind. All patterns are the product of human perspective. A pattern is not a realistic depiction of nature but a new creation. Bamboo is a part of nature, but bamboo patterns belong to the human world. (Soetsu 1933, 53)

Soetsu's discussion about the function of patterns reveals much about the culturally acquired perception of bamboo in the domain of Japanese art. Though any bamboo painting remains a schematic approximation of the bamboo plant, the paintings sought to convey bamboo's characteristics attached to the plant. For Soetsu, therefore, the patterns of bamboo indicate the liveliness of bamboo, and the bamboo patterns' "symbolism is not a figment or a fantasy. It might be argued that true symbolism is true realism. A bamboo pattern is a vibrant form of living bamboo. It is worth repeating again: patterns capture bamboo's essential nature, its bamboo-ness" (ibid., 54).

Figure 121 *Title*: Bamboo in the Four Seasons.
Date: late 15th–early 16th century
Artist: Attributed to Tosa Mitsunobu
Source: The Metropolitan Museum of Art, New York
Accession No.: 1975.268.44, and 1975.268.45

Attempts to *capture bamboo's patterns* are evidenced, for instance, by the copy of a sketch used for teaching bamboo drawing in Meiji Japan and illustrated in Figure 120. As suggested by the sketch and in line with Dresser's (1882, 284) comments, students had to learn the various shapes, patterns, and designs associated with bamboo to develop and master bamboo drawing. Using bamboo as a motif in arts underlines its role parts in culture.

Of course, bamboo was integral to art before the Edo period—as demonstrated, for instance, by the painting entitled *Bamboo in the Four Seasons* shown in Figure 121. This painting, created in the Muromachi period (1392–1573) and attributed to Tosa Mitsunobu, presents bamboo as a subject of the four seasons: spring, summer, autumn, and winter. During spring, the

Figure 122 *Title*: Bamboo in Wind and Rain.
Date: ca. 1694
Artist: Shitao (Zhu Ruoji)
Source: The Metropolitan Museum of Art, New York
Accession No.: 1984.475.2

young bamboo shoots appear aboveground and grow up rapidly and become mature bamboos. In winter, the bamboos resist harsh weather conditions and bear the weight of snow but maintain their fresh, green color and leaves. In particular, it is the latter aspect in Mitsunobu's composition that stands for the vitality of bamboo, and that symbolizes a long and healthy life.

Since many aesthetics and painting techniques came from China to Japan, it is also worth mentioning a famous Chinese painting of bamboo made by Shitao, a famous Chinese landscape painter of the early Qing Dynasty (1636–1912). In his painting (see Figure 122), Shitao placed a quotation by Su Che—a Chinese mandarin who lived in the eleventh century—related to another bamboo portrait painted by Wen Tong. Su Che's interpretation is quoted by Shitao, as follows:

> Walking among bamboo in the morning, being a companion to bamboo in the evening; drinking and eating amid bamboo, relaxing in the shade of bamboo. Only after much observation of the transformations of bamboo can one completely understand it. If this is not done, then whether horizontal or slanting, crooked or straight, its character will be obscured. If that guest had not been startled, my heart would not be on the right path, and I would always have been an outsider in bamboo painting. (Su Che *In:* Shitao, ca. 1694, *Bamboo in Wind and Rain*) [64]

Hence, as Su Che indicates, the bamboo plant is a faithful companion of people. And an understanding of its nature and characteristics requires a precise observation of its different forms of appearance. Only then will the true character of bamboo reveal itself to the patient observer.

Bamboo in Feasts and Ceremonies

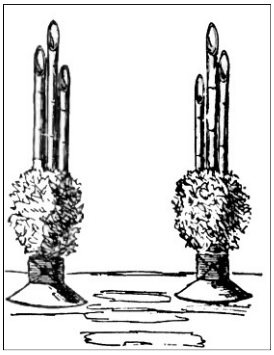

Figure 123 Kadomatsu.
Source: Morse 1917, 92

Festivities demonstrate the rich cultural heritage of people. They are intended for the sharing of special memories and moments of emotion amongst people and have a vital role in structuring people's social lives and connecting them with their families and societal history. In general, festivities require objects designed for ceremonial activities. In Japan, bamboo is still relevant in many feasts, rituals, and ceremonies. For

[64] Translation by Maxwell K. Hearn of The Metropolitan Museum of Art.

instance, incense sticks are part of many Shinto rituals and have a long history, and various other bamboo objects are specially created for ceremonies, either for ornamental or practical purposes. Two festivities using bamboo are outlined in the following to underline bamboo's symbolic meaning.

Already during the Muromachi period (1338–1573), pine, bamboo, and prunus blossoms became known as the *Three Friends* resisting the cold winter (Brauen 2003, 40). In a nutshell, pine signifies everlasting youth, and bamboo, which is considered an auspicious symbol, stands for "steadfastness, constancy, flexibility, strength, hardness" (ibid.) and "uprightness and usefulness (Dresser 1882, 277). For this reason, bamboo was widely chosen for decorations for feasts, including (but not limited to) New Year's Day celebration, Boy's Day (today Children's Day), or the Tanabata festival.

During the New Year's Day celebration, the traditional *kadomatsu* (gate pine), a spiritual contrivance that commonly consisted of bamboo, pine, and occasionally of Japanese plum tree, was erected in pairs in front of houses and was supposed to welcome ancestral spirits. These three plants are still present in Japan and embody longevity, prosperity, and stability. Figure 123 is a sketch from Morse that illustrates a *kadomatsu*. In this case, the bamboo tubes were of shiny green color and about 3.5 meters in length and encompassed by pine twigs at their lower end (Morse 1917b, 91).

Tanabata, literally meaning *Evening of the Seventh* and also known as Star Festival, is another important Japanese festival that is celebrated on July 7 of the lunar calendar. On this day, the two stars Vega and Altair (in Japanese *Orihime* and *Hikoboshi*) meet in the sky. According to ancient Chinese tradition, these two stars represent a pair of lover, separated by the Milky Way for the rest of the year.

A Tanabata festival held in Edo (formerly Tokyo) in the second half of the nineteenth century was portrayed by Utagawa Hiroshige. His painting, reproduced in Figure 124, shows countless bamboos arching over houses. As displayed in the same painting and following Rein's account, bamboo stems, including their twigs and green leaves,

Figure 124 *Title*: The City Flourishing. Tanabata Festival (Shichu han'ei Tanabata Matsuri), from the series *One Hundred Famous Views of Edo (Meisho Edo hyakkei)*.
Artist: Utagawa Hiroshige
Date: 1857
Source: Brooklyn Museum
Accession No.: 30.1478.73

were set up in the courtyard of houses. The bamboo culms' crowns were then decorated with various ornaments composed of paper. These paper strips (called *tanzaku*) were of five different colors and inscribed with various verses, poems, and sayings (Rein 1884, 440). These bamboos were also used to create temporary altars at their base with offerings to the star-deities (Hearn 1905, 21). Shigemi describes his childhood memory of a Tanabata festival as follows:

> At Tanabata we march through the streets with green bamboo trees, reading the air with certain shouts and beating the instruments, and upon meeting the boys of other streets have a scuffle. The scene is a confusion of bamboos and bits of rainbow-colored papers which are tied plentifully to the branches. . . . The day after the festival we take our bamboos to the see and cast them off to be drifted away by the waves and finally up to the Heavenly Stream or the Milky Way, where the gods may read our wishes written on the rainbow-colored papers (Shigemi 1889, 107).

In accordance with Shigemi, Hearn (1905, 21, 4) also states that at the end of the Tanabata festival, the abovementioned bamboos were taken down and thrown into the nearest stream together with the paper strips carrying the sayings and poems.

Bamboo in the Domain of Bonsai, Ikebana, and Gardening

Bonsai gardening is a Japanese variant of gardening, in which shrubs and trees are grown in small containers to limit their growth and shape them aesthetically, and bamboos were likewise cultivated in small containers for ornamental reasons. Spörry (1903, 18) reports that a ten to fifteen-year-old bamboo only developed stems of the length and diameter of an ordinary pencil. What is most striking is how the bamboo bonsai's small culm size contrasts with their natural size to which they can develop.[65]

Bamboo was also visual in the field of *ikebana*, the Japanese art of flower arranging, which dates back to the seventh century and which is associated with the arrival of Buddhism in Japan and the Buddhist custom of offering flowers to Buddha. Yet, detached from Buddhism, *ikebana* became a characteristic art form in the fifteenth century (Moriyama and Moriyama 2001, 274) and is one of the three classical Japanese arts of refinement together with the tea ceremony (see next chapter) and incense appreciation (*kōdō*). The primary purpose of *ikebana* is to bring nature into the daily life of people. At the same time, it represents a cosmic order that is linked with Shintoism. The flower arrangement, particularly its structural composition (numbers of

[65] My own bonsai gardening of *Dendrocalamus giganteus*, which is commonly known as giant bamboo since it reaches a height of thirty meters, demonstrates the possibility of cultivating bamboos of minimal growth. Though my *Dendrocalamus giganteus* is nine years old, its stems are less than 1 cm in diameter and less than 50 cm long.

twigs or flowers), is influenced by Shinto mythology and determines the design and shape of *ikebana* (ibid., 275). In a word, the specific flower arrangement always had a symbolic meaning and expressed Japanese worldviews and philosophies, as pointed out by Okakura:

> laws of composition and detail formulated by the various flower-masters of this period, showing, as they would, the fundamental theories which governed Tokugawa decoration. We find them referring to the Leading Principle (Heaven), the Subordinate Principle (Earth), the Reconciling Principle (Man), and any flower arrangement which did not embody these principles was considered barren and dead. (Okakura 1919, 114)

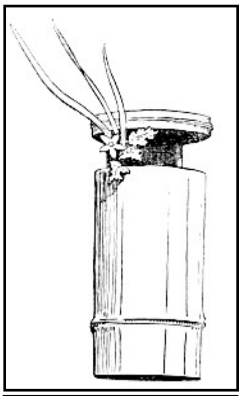

Figure 125 Bamboo Flower Holder. *Source*: Morse 1886, 305

As a consequence, the tea master displayed flower arrangements during tea ceremonies and tended to express certain philosophical intentions and views. In these ceremonies, bamboo was frequently used to create bamboo vases and flower holders of different designs, shapes, and functions. Although vases and flower holders were made of different materials, such as ceramics, "bamboo, in its simplicity of line and neutral color," was of remarkable significance for *ikebana* due to its availability and because it made "a vase always charming" (Averill 1922, 204). What distinguishes *ikebana* from Western flower arrangements is that the former is characterized by its display of only a few flowers and leaves in contrast to the Western flower bouquets that are typically composed of a large number of colorful flowers.

Bamboo's significance for *ikebana* is commented on by Morse (1886), among others. According to him, flowers were found in all households, and many flower-vases were composed of a section of bamboo, as illustrated by the specimens in Figure 127, Figure 125, and Figure 126. Furthermore, Morse (ibid., 303–307) writes that the bamboo-vase was a ubiquitous model of a flower holder and mentions that another type of bamboo flower holder was obtained by splitting a bamboo stem into two halves and hanging one of the semi-cylindrical parts horizontally.

In the domain of gardening, bamboo was admired as a decorative plant with exceptional properties and cultivated for its ornamental value. According to Spörry (1903, 15), such bamboos with long internodes, unusual growth habits, shapes, or unique colors were desired by the Japanese. One bamboo that matches Spörry's specifications and which has a striking appearance is *Phyllostachys pubescens var. heterocicla* (formerly known as *Phyllostachys heterocycle*), shown in Figure 129. It is rounded on one side, roughly asymmetrical in its lower parts, and cultivated due to its unique shape.

Figure 126 *Title*: Vase.
Artist: unknown
Date: 17th century
Source: The Metropolitan Museum of Art, New York
Accession No.: 91.1.1061

Figure 127 *Title*: Double-Cut (Nijū-giri) Flower Container. Named “Cool Summer Morning” (Shinryō), accompanied by calligraphy.
Artist: Kōgetsu Sōgan
Date: early 17th century
Source: The Metropolitan Museum of Art, New York
Accession No.: 2019.571a, b

David Fairchild, who was touched by the bamboo plant’s beauty and the Japanese perception of bamboo, comments that bamboos “are among the most graceful forms of vegetable life that exist, and add an indescribable charm to any landscape . . . . They are waving plumes of delicate green foliage, which, whether seen against the skyline or backed by a darker mass of forest, always give a peculiar softness to the scene” (1903, 12–13). Given their beauty, bamboos were to be found alongside houses, in gardens, close to temples, and were part of Japanese landscapes.

Johannes Rein, for instance, mentions that Sasa species were planted in Japan for their aesthetic value and cultivated as hedges (Rein 1884, 166). Figure 128 illustrates bamboo as part of the Fukiage Garden of the Edo Castle in Tokyo (known since 1888 as New Imperial Palace Garden). The photograph, attributed to Kusakabe Kimbei (1841–1934), a well-known Japanese photographer of the Meiji era, gives an impression of bamboo’s possible length and size. Compared with the visitors, it becomes clear why bamboo is called *giant grass*. The same picture also reveals bamboo’s significance for fence making. In the interest of protecting the bamboo groves, the giant grasses were surrounded by a bamboo fence hindering the visitors from stepping into the groves.

Figure 128 *Title*: Mikado’s Garden Fukiage Tokyo.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: National Gallery of Victoria, Melbourne
Accession No.: 2003.12

The fence, however, did not only protect the bamboo groves; bamboo fences were admired for their beauty and simplicity and likewise represented the decay of life (see my explanations

Figure 129 *Phyllostachys pubescens var. Heterocicla.*
Artist: Alfred Parsons
Source: Freeman-Mitford 1896, 161

related to bamboo fences in chapter 9.4.4). What is more, the same photograph indicates the interplay of bamboos with other plants and trees. In the foreground of the picture, one can see deciduous trees and in the background conifers. Since the Fukiage Garden was part of the Royal Garden, the botanists were interested in impressing the garden visitors by the fresh, green color of evergreen bamboos and conifers that stand for vitality throughout the year in contrast to the deciduous trees.

In sum, bamboo was planted for centuries in Japan, and not only early Japanese botanists' but also peasants' knowledge of bamboos' botanical aspects such as their growth habit, florescence, shoot regeneration, or propagation resulted from years of study. However, it was only in the year 1885 that Katayama Nawohito published the first vernacular book that applied Western-scientific-based categorization of bamboos and so presented the first comprehensive data concerning the botanic aspects of bamboos in the Japanese islands.

Bamboo in the Japanese Civil Code

While bamboos were admired plants, their aggressive growth was likewise troublesome. Since the Japanese cultivated bamboos in their gardens, bamboo rhizomes often threatened neighboring property due to their rapid underground growth and aboveground culms. As a result, and to stop quarrels between neighbors, legal regulation was introduced on the matter to nip disputes in the bud. In the Japanese Civil Code from 1896, the cutting of branches and roots of trees and bamboo is regulated in Article 233. It says that "if a tree or bamboo branch from neighboring land crosses a boundary line, the landowner may have the owner of that tree or bamboo sever that branch" (Civil Code of Japan, 1896, § 233, 1 and 2). The cutting of branches and roots is also reported by Spörry (1903, 15), who points out that the fast-growing habit and rhizome structure of bamboos occasionally caused damage in productive lands. And, to control the growth of a bamboo grove, the Japanese buried old roof tiles in the soil, which served as a kind of barrier forcing the underground rhizomes to appear aboveground. Bamboo is also mentioned in Article 225 (2) *Installation of Fences* in connection with the construction of bamboo fences between two pieces of land (Civil Code of Japan, 1896, § 255, 2). This article indicates two aspects. First, it implicates access to bamboo as a raw material for fences, and second, based on bamboo's ubiquity and easy workability, the article presupposes the widespread knowledge of bamboo fence building. Indeed, whether they are simple or elaborately made, bamboo fences were the most perfect embodiment of the built environment in pre-industrial Japan.

9.3.2. Bamboo's Part in Tea Ceremony

If we regard bamboo in Japanese customs, it becomes clear that bamboo forms the material basis for many things, as exemplified by its use in the abovementioned feasts and ceremonies. In a similar way, bamboo fulfills an extraordinary role in the Japanese tea ceremony, which deserves a brief mention at this point.

Studying the tea ceremony from the perspectives of practice theory or ANT would reveal much about humans' and nonhumans' intricacies. However, I will not elaborate on these theories' perspectives on the tea ceremony's human-material conflation due to place and time restrictions. Hence, after discussing the tea ceremony's development and main characteristics, I will only outline some perspectives related to the tea ceremony as practice or network and refer, for a comprehensive discussion of human-material constellations, to chapter 7.6, where I discussed various aspects of the human-bamboo relation.

First of all, and although very briefly discussed below, the tea ceremony's material aspects demonstrate bamboo's essential role in the tea ceremony. At the same time, bamboo's role in this context is equally representative for other aspects of the material basis of people's lives that are, in one or another way, related to bamboo—as, for instance, bamboo's use as kitchen utensils, for body hygiene, as agricultural tools, or as bambooic musical instruments, and the like.

In the following, I intend to briefly outline Daoism's determining role in the tea ceremony's development. Discussing the latter is important to understand the aesthetics attached to the tea ceremony because alongside Buddhism and Confucianism it shaped the Japanese worldview and society. Deal identifies some common ground of Confucianism and Daoism, which is expressed by the similar idea "that everything in the universe functions in accordance with the 'way' (Chinese: *dao*), or in more Confucian terms, heaven (Chinese: *tian*)" (2006, 222). Therefore, it is the duty of humans to find the right *way,* and exactly on this point, the two worldviews differ. In the words of Deal:

> Daoism favored contemplation of the true nature of the *dao* as a way to understand how to live a harmonious life in accord with the natural rhythms of the universe. Confucianism, on the other hand, emphasized the 'way' of social and political action with a great deal of importance placed on social hierarchy and the cultivation of personal values and virtues. (ibid.)

While Confucianism had major impacts on the Japanese social structure, by determining individuals' roles and duties in society, Daoism paved the way for individual enlightenment through meditation and self-awareness. One can say that Confucianism emphasized the social role of people, and Daoism facilitated the individual experience of one's own personality, character, and individuality. In accordance with Daoist philosophy and perception, the famous Chinese poet Lu Yu (733–804) discovered in the ceremony of drinking tea the same harmony and order that prevails in all things of nature. In his much-praised work, the *Chajing* (*The Holy Scripture of Tea* or *The Classic of Tea*), he formulated the *Law of Tea* during the Tang dynasty (618–907) and established the groundwork for the development of the tea ceremony (Okukara 1919, 36)

The first tea seeds and tea plantation occurred in Japan in the early eighth century, and its introduction is credited to the Japanese monk Saichō (ibid., 43). Subsequently, monks established Japanese tea gathering (known as *sadō* in Japanese) as a cultural activity. However, its further development was influenced by Zen Buddhism, which was significantly inspired by Daoism and first arrived in Japan from China in the last decades of the twelfth century and attracted samurai due to its emphasis on self-discipline (Deal 2006, 285).

Okakura, who attempts to introduce Westerners to the values and ideals of East Asia through his seminal book about tea, underlines the tea ceremony's aesthetic value and writes that "the fifteenth century saw Japan ennoble it [tea] into a religion of aestheticism—Teaism," and simultaneously "inculcates purity and harmony, the mystery of mutual charity, [and] the romanticism of the social order" (1919, 17). Indeed, the *sadō* represents the Japanese sense of aesthetics, as demonstrated by Roloff and Roloff (2003). According to them, the tea ceremony is a Japanese synthesis of the arts. Thought from the outside towards the inside, the ceremony encompasses the arts of garden design, architecture, calligraphy and ink painting, flower arrangement, metal casting, lacquer work and lacquer painting, bamboo carving, and ceramics. Finally, it is a synthesis of the arts, realized by the host and guests together, each as a unique, unrepeatable event (Roloff and Roloff 2003, 11). In Okakura's (1919, 64) view, the ideal of *teaism* originates in the Zen notion of greatness, even in the smallest things of life. To sum up, while Daoism provided the ground for aesthetic ideals, Zen ideals and thoughts put them into practice. This greatness of the smallest things, for instance, is highlighted by the tea master when she/he passes the unique tea utensils, among them many bambooic utensils, to her/his guests for them to study and appreciate (Deal 2006, 303).

Today, there are various tea schools, each having its own particular prescribed performances that govern how to offer tea and perform the tea ceremony. In brief, the host of the *sadō* strives to give her/his guests a moment of contemplation. For this reason, special tea-rooms were designed to support harmony and contemplation during the tea ceremony. Then as now, specific tools were designed and selected for this purpose, many objects made from bamboo. Morse, who attended a Japanese tea gathering, provides the following account of the part bambooic things play in the gathering:

> A bamboo dipper of the most delicate construction, to dip out the water; a wide-mouthed jar, from which to replenish the water in the kettle; a bowl, in which the tea is made; a bamboo spoon, to dip out the powdered tea; a bamboo stirrer, not unlike certain forms of eggbeaters, by which the tea is briskly stirred after the hot water has been added; a square silk cloth, with which to wipe the jar and spoon properly; a little rest for the teakettle cover, made of pottery or bronze or a section of bamboo. (Morse 1886, 150)

Spörry (1903, 75–78) enumerates twenty-seven tools involved in the tea ceremony and indicates that (depending on the preparation method) half of the tools and three-quarters of the tea tool kit consisted partly or entirely of bamboos, such as the bamboo whisk, dippers, spoons, fire fans, wader ladles, coal baskets, sink-coverings, lid rests, kettle mats, or tea scoops. Amongst all these tools, the skillfully handmade bamboo stirrer (or whisk) was an extraordinary tool for the *sadō*. It was carved from a single piece of bamboo and used to whip the tea and hot water into a delicious brew. There were several types of tea whisks with different forms, designs, and purposes, and their production required the knowledge and skills of a master craftsperson. One specimen is shown in Figure 131. Figure 130 also shows some of the tools needed for the tea ceremony, like the bamboo whisk and small spatula in the middle of the photograph and a red-colored bamboo container at the front.

Figure 131 *Title*: Tea whisk made of bamboo.
Artist: unkown
Date: unkown, acquisition date 1930
Source: British Museum
Accession No.: As1930,0411.2

Figure 130 *Title*: Tea bowl and accessories.
Artist: Attributed to Kusakabe Kimbei
Date: 18th century
Source: The Metropolitan Museum of Art, New York
Accession No.: 36.120.496a–h

On the whole, the ceremonial tea gathering and its performance allow multiple interpretations. Thus, one can inquire into the tea ceremony's aesthetic values and ideas, its medicinal aspect, study it as a spiritual practice, or in respect of architectural issues. Examining aesthetic issues, for instance, will turn the attention to the architectural interior, the shape and design of tea utensils, and the aesthetic and symbolic aspects of *ikebana*, which has been an integral part of tea gatherings.

From the perspective of practice theory or ANT, one issue would be to inquire how bamboo was embedded in the practice of the tea ceremony and analyze to what extent bamboo (as a tool, equipment, architectural interior, or building material) contributes to or stabilizes an assemblage or practice. As already indicated above, the Japanese tea ceremony requires its performance as a (ritual) practice and implicates human and nonhuman entities of diverse fields. It consists of at least of the following aspects: i) people participating in the tea gathering (while requiring special ritual performances both from the host and the guest)—"guests needed specialized knowledge of myriad art forms including ceramics, bamboo carving, lacquer, metalwork, calligraphy, painting, flower arranging, architecture, poetry, and garden design" (Deal 2006, 302); ii) the physical equipment required for the tea ritual (e.g., tea bowl, tea caddy, bambooic tea scoop, bambooic tea whisk); iii) water and tea as materials of organic sources (tea is preprocessed by drying and fermentation); iv) the ritual clothing (wearing the kimono); v) sculptures and paintings in combination with flower arrangements; vi) and the built environment, that is, the tea room or the garden.

In conclusion, the tea ceremony without the tactile things and the built environment is unimaginable and impossible. It is precisely this sort of material arrangement that represents the reciprocal birth of practices, be they profane or ritual, a singular occasion, or ritualistic. This short digression illustrates how things and humans may be involved in a network, having multiple functions, meanings, purposes, or importance. In a sense, each (human and nonhuman) entity depends on other agents "in interaction and in particular on the functions they fulfill (the roles they play) in the network. Each significance comes with its own markers, its own characteristics and its own place in the human actors' worldview" (van der Leeuw 2008, 221). Therefore, without specialized knowledge, the tea ceremony would reveal only parts of its meaning, and the cultural significance of bamboo and other tea utensils would remain undiscovered.

9.4. The Use of Bamboo in Everyday Life

Although I shall not substantiate and elaborate the practices (in the sense of practice theory) or actor-network association (in the sense of ANT) concerning bamboo, the following chapter aims to investigate the multiple layers of the human-bamboo relation in pre-industrial Japan by drawing our attention to the utilization of bamboo and bambooic things in an everyday life context. In doing so, this chapter attempts to demonstrate how deeply bamboo was anchored and embedded in Japanese society before industrialization.

In the process, I follow Soetsu's view of traditional handicraft's purpose and function. According to him, "the aim of handicraft is the creation of everyday objects for use by the masses. [And] only exceptionally does it mean the making of luxurious objects for use by the very few" (1933, 59). Bamboo's use represents its practical purpose and function as symbolized by everyday tools and objects derived from it and constitutes a material ground for people's lives. Or, as Hanley puts it, "the physical aspects of life form the background for everything we do. Our environment, both natural and artificial, is so much part of everyday life that few people think about it in terms of how it molds our lifestyles, affects our social relations, determines how we allocate our time, forms our view of the world, and influences our behavior" (1998, 23). By emphasizing bamboo's part in pre-industrial Japan, I hope to define its relevance and function in this period.

9.4.1. Economically Important Bamboos and Wood Production

Bamboos are endemic throughout the Japanese peninsula; however, a general aspect that has to be considered when cultivating bamboo in temperate zones is their cold tolerance. While some bamboos, including *Fargesia* or some *Phyllostachys* species, can withstand temperatures between -10 and -15, and occasionally temperatures down to -20 degrees Celsius, colder temperatures and long-lasting cold may partially or even totally destroy the plant.

Since bamboo species are well adapted to (cold) temperate and warm subtropical and tropical climate conditions, they are endemic in the Asian monsoon countries. They are part of many countries' landscapes, and it is their ubiquity that stands out. As Rein (1886, 272) pointed out for Japan, no other plant than bamboo was as crucial as rice, and no other woody plant was as versatile in its use, nor did any other plant decorate the landscape with the same grace. Rein (ibid., 272–273) further remarks that nature has given bamboos several valuable qualities that no other wooden species possess to the same extent, and that no other tree or timber combines so much strength, elasticity, and resilience with ease. Indeed, it is bamboo's elasticity in combination with its tensile strength that makes it a superior material in many ways.

While some bamboos were planted for their aesthetic value close to temples or gardens, other bamboos were cultivated for economic reasons. The urban demand for bamboo was satisfied by the bamboos growing in the mountains and bamboo groves close to urban areas. In this context, Rein states that bamboo groves "serve the most manifold purposes, making an agreeable diversion in the landscape, and are especially frequent on the boundaries of the larger cities, where great use is made of the cane" (ibid, 216–217). A similar report comes from Hearn, who says that peasants brought bamboo stems into Tokyo by countless wagonloads (Hearn 1905, 21, 4), most probably from the surrounding bamboo groves mentioned by Rein. Needless to say, the harvest of naturally growing bamboos and the cultivation of bamboo as a crop plant provided worthwhile bamboo timber. In contrast, and as explained below, the three most valuable bamboo species in the Meiji era are still considered essential for bamboo handicrafts and industries. Moreover, their pre-industrial use underlines that craftspeople had already recognized the economic value of these bamboos.

According to Spörry (1903, 18), the three most significant bamboos in the Meiji era were *Mōsō-chiku*, *Madake*, and *Hachiku*. Other species were of little or almost no economic interest. Small and grass-like bamboo species belonging to the genus *Sasa*—commonly known as dwarf-bamboo, though some species have culm heights over two meters—growing in the undergrowth in the forests, for instance, were mainly planted for their aesthetic value (Rein 1884, 166), and it was only at the end of last century that scientific interest in Sasa bamboo arose (Takamatsu et al. 1997). According to research conducted in the 1980s, the Sasa species covered almost ninety percent of Hokkaido's forest land (Ujiie 1985, 1043). However, its industrial exploitation and use had hardly begun except for the manufacture of hardboard and particleboard for a short phase in the 1950s and again in the 1980s (ibid., 1044).

Mōsō-chiku or Mōsō-dake (commonly known as Moso bamboo or by its Latin name *Phyllostachys edulis*) originates from China and was introduced to Japan in 1736 and spread only gradually throughout Japan. Currently, Moso is still valued for its edible shoots, as a building material for house construction, as well as in the production of parquets and floors (Ohrnberger 1999, 207). *Phyllostachys edulis* has leptomorph growth and is the largest bamboo growing in temperate climates.[66] It may reach 25 m with a culm diameter of around 8 to 18 cm and is the largest bamboo growing in Japan. By the end of the nineteenth century, Moso was found in almost every province of the Japanese islands—except for the far north of the main island and Hokkaido due to their cold climatic conditions (Nawohito 1889, 36). The Fukiage Garden, detailed in Figure 128, demonstrates how large the bamboos can grow and why dense bamboo groves were conceived as impenetrable thickets.

Madake (*Phyllostachys bambusoides*) is also of Chinese origin and known as *Giant Timber Bamboo* or by its vernacular name *Gangzhu,* meaning firm bamboo (Ohrnberger 1999, 200). According to Ohrnberger (ibid., 200), *Phyllostachys bambusoides* is nowadays the principal economically valued woody bamboo in China and Japan, having a high wood quality, which makes it suitable for splitting, and it is furthermore frequently employed for reforestation.

Hachiku (*Phyllostachys nigra f. henonis*) was the third most frequently used bamboo in Japan and also comes from China; its introduction to Japan is undated. Ohrnberger (ibd., 227, 200) says that it is nowadays a crucial material to make handles for various farm implements or to produce sunning poles and punt poles. *Hachiku* was also a useful building material and utilized to construct scaffoldings. Moreover, its splits are pliable and tough and frequently employed in handicrafts.

Spörry (1903, 19) notes that, although *Madake* was thought to come close to Moso's extraordinary material qualities, and *Hachiku* was valued for having a very durable, strong, compact, and at the same time, elastic wood, Moso bamboo was considered superior to all other bamboo species. Concerning the use of Moso bamboo, Spörry identifies that Moso was mainly manufactured into vases, cake basins, sake bottles, all kinds of containers, as well as boxes and tea boards. On the other hand, it was of minor use for wickerwork because its wood was considered to be too brittle for that purpose. Spörry further argues that the finest Japanese wickerwork was created from *Madake* and *Hachiku* and that all other bamboo species were second or third in line (ibid.). Rein (1886, 270–271) also reports that *Madake* was one of the most valuable and most cultivated bamboo species and that Moso was valued for its edible shoots.

[66] Ohrnberger provides further data about Moso bamboo's distribution in China. He writes that Moso "is distributed in the warm-temperate parts, mainly from the Hanshui River and Qinling Mountains in Shanxi to the South of Yangtze River, between 100 and 700 m altitude, occasionally up to 1,000 m altitude, generally in acid soil; perhaps originated in Henan. Naturalised or cultivated in all provinces south of Yangtze River; 80 % of occurrence is concentrated in Zhejiang, Hunan, Jiangxi, and the West of Fujian. Occurrence is also recorded from: Shanxi, Henan, Shandong, Jiangsu" (1999, 207).

Estimations about Japanese bamboo diversity suggest that around 84 to 139 different bamboos grow naturally in the Japanese islands (INBAR 2006, 29). However, as mentioned above, despite numerous bamboos' availability only a few bamboos were of crucial economic interest and used because they stood out in terms of economic value and material properties. This fact shows that it is not the number of available bamboos that is decisive for developing a sophisticated bamboo culture. Three bamboo species with extraordinary material qualities are sufficient to design and create innumerable objects and constructions. This statement is in line with my observation concerning bamboo's use by Bahnar people in chapter 7.4.1. From all bamboo species growing naturally, the *səmluh* bamboo stands out due to its superior material qualities and is the most often used bamboo species by the Bahnar. And as Loving reported for the Awa people in Papua New Guinea, the latter's bamboo culture was equally based on only a few bamboos (see chapter 7.5.2).

What is also noteworthy is that all three economically significant bamboos were imported from China to Japan. Therefore, Japan's early bamboo culture was established on endemic bamboo species, and only later were Chinese bamboos added. What is more, rather than growing wild, introduced bamboos must have been propagated with the aid of rhizomes. Propagation by seed was indeed hardly possible due to the infrequent flowering and sexual reproduction of many bamboos. It is said, for instance, that Moso bamboo flowers once every 65 to 125 years. Thus, Moso bamboo's dispersal in Japan was human-mediated. As Rein (1889, 229) claims, bamboos were planted on the edges of forests, temples, and close to towns, whereas the natural habitats of bamboo species in Japan are mostly grasslands, the understory of forests, alluvial forests, as well as mountain ridges, and ravines (Kobayashi et al. 2015, 42).

One other aspect that should be mentioned at this point is the manifold use of tree wood alongside bamboo. As I explain below, Japanese craftsperson predominantly used wood to construct houses and other buildings, and bamboo was secondary for this purpose, though still important. Mountains, which cover some eighty percent of Japan's landscape, impeded agricultural work but were richly wooded and so, a crucial source for wood and bamboo. While wood was used in Japan for ages, its economic role increased from the late sixteenth century. According to Totman, Japanese lumber consumption increased significantly in two phases during the Tokugawa period. The first "boom" was between 1580 and 1660 and involved a nationwide increase in buildings and monuments and gradual urbanization. The second rise in lumber demand, which Totman describes as the "maintenance phase", followed the first phase and lasted until the Meiji Restoration (1987, 56). While an increase in buildings and constructions marked the first phase, the second was characterized by a "ceaseless repair and replacement to maintain the urban structures produced earlier" (ibid.). Nonetheless, as Totman (ibid.) points out, during the Tokugawa period, the main demand for lumber came from villagers who produced, processed, and consumed lumber themselves—most likely a large part of it was used as fuel. Hence, most of the lumber was needed for villagers' self-subsistence, who made up nearly 80 percent of the Japanese population in the Edo period.

Figure 132 *Title*: Honjō Tatekawa. Carpenters in a lumberyard. From the series Thirty-six Views of Mount Fuji (*Fugaku sanjūrokkei*).
Artist: Katsushika Hokusai
Date: ca. 1830–32
Source: The Metropolitan Museum of Art, New York
Accession No.: JP2982

Whenever needed for urban use or the construction of monuments and non-village buildings, lumber was produced and rafted on rivers and loaded on ships transporting them to the place needed, and its production and organization gave rise to merchant families trading in lumber (ibid., 58–63). Figure 132 reproduces a painting by Edo artist Katsushika Hokusai (1760–1849) that shows stocks of lumber and bamboo in the Honjo District of Edo city around 1830. On the left side of the painting, two workmen stack shingling, and in the middle of the painting, one workman splits timber. What is more, the bamboos to the right of the man splitting timber are set up vertically and have a yellowish color, whereas the bamboo right of the workman is green. The different color indicates the bamboo culm's age. It is most likely that green bamboos were harvested and rafted to the lumberyard needed for basketry or makeshifts, whereas mature, woody bamboos were required for long-duration objects and constructions. The stocks of lumber and bamboo also indicate the availability of these essential sources not only for the recurrent demands of townspeople but also for the fast reconstruction after disastrous fires or natural calamities that urban areas were exposed to (see my discussion related to that subject in chapter 9.4.4).

9.4.2. Bamboo Objects as Part of Folk Craft, Bambooworking, and Mechanical

Applications

The effects of modernization, Westernization, industrialization, and the gradual establishment of a Japanese consumer society caused a decline in traditional products. As a reaction to this loss, Japanese philosophers, craftspeople, and scholars attempted to highlight and foster traditional crafts in the second half of the Meiji era. As a result, "the folks craft movement (*mingei*) and the peasant art movement (*nomin bijutsu*), . . . aimed to raise the manifestations of everyday, rural and simple life to the level of art" (Morais 2019, 141). This striving was mainly influenced by Yanagi Soetsu and the potters Shoji Hamada and Kanjiro Kawai. They created the Japanese word *mingei* for *folk craft* or folk art (Soetsu 1933, 21). A neologism composed of the terms *min,* meaning *masses* or *the people,* and *gei,* meaning *craft* (ibid.). By coining the term *mingei*, Soetsu, Hamada, and Kawai attempted to establish an alternative concept to the aristocratic fine arts and highlighted the beauty and sophisticated techniques of objects made and used by ordinary people in their everyday lives (ibid.). In Soetsu's view, "folk craft objects . . . have two principal features. One is that they are things made for daily use. The second is that they are common, ordinary things. Conversely, they are neither expensive nor produced in small numbers. Their creators are not famous artists, but anonymous artisans" (ibid.). In another passage, Soetsu formulates very emphatically the availability of everyday tools and goods when he says that "everyone comes regularly into contact with [the ordinary objects] in their daily lives. They cost very little and can be procured almost anywhere and at any time" (ibid., 35). Following Soetsu's view and as the following chapters demonstrate, one can say that the ordinary bambooic things were intrinsically interwoven with the material conditions of people's lives due to their availability, while their practical usage was of extraordinary interest.

In his emphasis on fostering traditional craftwork, Soetsu, who was also a philosopher, addresses the agency of nonhuman things and explores the way materials behave or interact with the craftsperson. He then highlights the contribution of materials in the creation of things and attributes a degree of agency to the things when he says that tools and objects "work thoughtlessly and unselfishly, carrying out effortlessly and inconspicuously whatever duty comes their way" (ibid., 37). Soetsu's comment on how the workpiece's materiality contributes to the design of objects is in line with my discussion of materiality in chapter 5.3. For Soetsu, the becoming and creation of objects are determined by nature and expressed by inherent properties of a raw material that leads the craftspersons' techniques and activities:

> It [the material] extends its influence to all shapes and all patterns, between which there is an inseparable bond. A good cosmetic finish is not simply applied to an object, but submits to its natural needs. Raw materials must not be thought of as merely physical matter, containing as they do the will of nature. Nature tells us the shape and pattern a material should assume, and nothing good can be achieved by ignoring its dictates. A good artisan seeks nothing that nature does not seek. (ibid., 39)

For this reason, form-giving results from the craftsperson's activities and skills, the utilized tools and techniques, and the materiality of the workpiece. Thus, the craftsperson must follow "the flow of nature" (ibid., 42) intrinsic to the raw material. Because the handmade objects created by craftspersons contrast with the uniform, machine-based production of goods, they are characterized mainly by simplicity and traditional techniques and material knowledge.

In what follows, I mainly discuss the ordinary everyday objects made of bamboo, their part in Japanese material culture, the techniques to create these things, and the most characteristic mechanical applications and methods using bamboo. In my view, most things derived from bamboo are in line with the definition of *mingei.* They were cheap, available for almost all parts of Japanese society; their intrinsic functionality and simplicity characterized them; not much was known about their creators; they were handmade, and their creation was marked by Japanese craft techniques prior to industrialization; and finally, they were commonly used for daily activities.

Needless to say, before the import of industrially manufactured goods and tools and the subsequent industrialization of Japan, Japan's tangible culture was defined by the local environment's natural sources. Accordingly, the most utilized materials in Japan before industrialization were organic materials such as clay, wood, bamboo, and, to a lesser extent, inorganic materials (such as minerals and iron). Since this dissertation's subject is bamboo, I shall neglect the other materials' contribution to Japanese material culture and highlight bamboo's part in people's daily lives.

Spörry's collection, consisting of almost 2,000 bamboo artifacts, illustrates the multifaceted history of bamboo's use before and during the Meiji era. Schröter, who was overwhelmed by Spörry's collecting mania, depicts and enumerates the way bamboo was put to practical ends in Japan by referring to the objects Spörry had sent to Switzerland:

> The nodes strengthen and decorate the culm. The slender (whole) culm is a flexible part for coarser wickerwork in rustic style . . . , already useful as a handle and shaft, a stick, a fishing rod, etc. Bamboo's hollowness makes it possible to use it skillfully in many ways: A section or internode closed at its top and bottom due to its diaphragms is a barrel, to which one only needs to attach a bunghole and a tap . . . . A culm section being open on its top and a diaphragm at its base may be used as a water pot, mug, brush stand, flower vase, tobacco pot, tea caddy, brush holder and or other containers. If one cuts both diaphragms away or breaks

> through them and obtains a long culm, one may use it as a tube suitable for water pipes etc. The insulated node wall provides plates for vase tables or spoons, whose stem consists of the branch that springs from the node. If one halves the culm lengthwise, one gets slits, from which the Japanese make teaspoons, letterboxes, sandals, chopsticks, etc. And finally, if one flattens the curved half-wall, one gets boards which are used as soles for sandals, cake basins, sacrificial rice offering plates, etc.
>
> Bamboo may be easily split; from rough slats the bamboo baskets are woven, frames are nailed together, blinds are made, veneers are assembled, umbrella frames are made, fan rails are made. From the fine strips, baskets of all kinds are woven with an endless variety of techniques and patterns. A tube split at one end into many strips becomes a fan, and if the strips are laid out flat and covered with paper, it becomes a tea whisk when the strips are bent into circles . . . . The finest bamboo threads are used for the well-known woven cladding of small porcelain cups and bottles. (Schröter 1903, 7–8)

This list is far from complete, but it provides an account of how deeply bamboo was interwoven into the physical surroundings in Japan. One can say that bamboo was probably amongst the most iridescent materials in Japanese everyday material life. In the words of Rein, "the tree-like bamboo finds a use in every size, at all ages, in great quantities and for manifold purposes" (1889, 230). Fascinated by the versatile applications of bamboo, Rein concludes that "every attempt to number the manifold uses . . . seems vain, for . . . in every form of activity and at every age, man is surrounded by its forms and accustomed to its uses wherever the bamboo grows in Southern and Eastern Asia" (ibid.).

Hence, due to bamboo's ubiquitous use, it is impossible to name all of its innumerable uses. However, many things that Schröter lists can be found in the photographs displayed in Figure 170 and Figure 171, which illustrate bamboo basket street sellers offering household goods needed for daily activities (such as cooking, food storing, cleaning, or body hygiene) and in the image in Figure 134, showing how bamboo objects were sold in coarse wares shops in Tokyo's streets.

Since bamboo was an inseparable component of daily routines and one of the most frequently used materials rather than being confined to a niche existence, the bamboo plant was essential for the formation of Japanese material culture. One can say that because of bamboo's ubiquity, it was a connecting link between humans and nature and between humans and the built environment. In reality, Japanese material culture would have been entirely different in design and shape without bamboo. Morse, impressed by bamboo's unlimited uses, is of the opinion that the Japanese might more "easily surrender the many devices and appliances adopted from European nations than to abandon the ubiquitous bamboo" (1886, 84).

Figure 133 *Title*: Vegetable Peddler.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.700.4.66

Figure 134 *Title*: Coarse Wares Shop.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.875.3.6

The Creation Principles of Bamboo Objects Based on Bamboo's Materiality

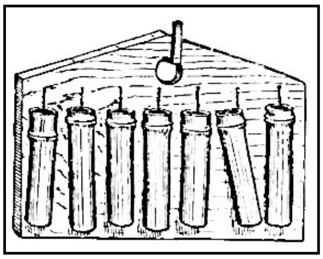

Figure 135 Gate Rattle.
Source: Morse 1886, 259

Schröter's summing up of bamboo's multiple uses, as quoted above, is instructive about the way bamboo is used. First, as a stem maintaining its natural hollow structure, its diaphragms either removed or kept—in this case, bamboo's tubular structure serves particularly to create a variety of containers of simple or elaborated design. One finely crafted specimen, a *sachi* [beer] bottle, is shown in Figure 140. This vessel is formed from part of a bamboo stem, with two horizontal nodes that form the lid and the container. One of the least modified ways of taking advantage of bamboo's structure was to remove its nodes and use it as a cylindrical tube. Used in this way, one could use it as a blowpipe and tool for making bubbles. The latter is illustrated in Figure 136, which shows a man using a long bamboo tube to make bubbles (Morse 1917a, 207).

Figure 136 A man making bubbles with a bamboo tube.
Source: Morse 1917a, 207

Besides that, one can transform bamboo into a musical instrument (flute and xylophone) or a gate rattle, as depicted in Figure 135. The gate rattle is a musical instrument that was suspended from a swinging door or hung on a gate. Once set in motion, the adjacent bamboo-sections strike each other or the wooden plate. The gate rattle generated noise, which signaled to a house occupant whenever a visitor entered her/his property or the courtyard (ibid. 1886, 245). Beggars also used rattling bamboo sections to attract attention before residential houses (Shigemi 1889, 95). Second, bamboo is split into two semi-circular halves and turned into goods such as teaspoons, flower holders, or sandals (for the latter, see Figure 163). Third, after further splitting, bamboo strips could be used for wickerwork and weaving (such as baskets or mats) or the creation of other objects (such as fans or chopsticks). The whisk in Figure 131 and the saucepan brush made of bamboo sections in Figure 138 exemplify the extent to which bamboo can be split. Similar brushes are still common in Vietnam and used to clean dishes or else as a whisk for cooking.

Bambooworking: Tools and Techniques

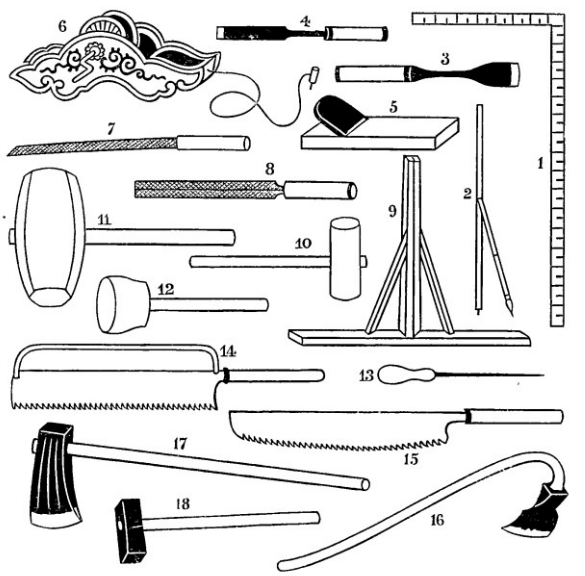

FIG. 101.—CARPENTERS' TOOLS. 1, Square and Measure; 2, Compass formed of bamboo stems, with a brush in one arm; 3, 4, Chisels; 5, Plane; 6, Line, which runs out over blackened cotton-wool; 7, 8, Files; 9, T-Square and Plummet; 10, 11, 12, Mallets; 13, Awl; 14, 15, Saws; 16, 17, Forms of Axe; 18, Hammer. After a native drawing.

Figure 137 Japanese carpenter's tools.
Source: Dresser 1882, 265.

I already mentioned the basic principles of bambooworking in chapter 4 and reproduced McClure's lists of traditional tools (Table 1) and their main working principles needed in the context of bamboo processing before industrialization. In what follows, in addition to my discussion in chapter 4, I will focus on Spörry's (1903, 36) account of bambooworking, which lists that bamboo was cut, split, bent, curved, split up and flattened, carved, stained, burned, etched, smoothed, or polished and varnished. The art and craft of bambooworking, as Spörry (ibid.) relates, was less defined by a sophisticated tool kit than by the craftsperson's skill, patience, and exact observation. Concerning the tools required in the field of bambooworking, Spörry (ibid., 39–40) gives the following enumeration of tools: saws (for cross-section, longitudinal cut, and round cut), a saw file, an iron hammer, a chisel, a gouge, knives, four machetes, a *suji-oki* (a tool to mark bamboo using a thread), a drill, drawing plates (for thin bamboo strips), planes, a bending wood, brushes, a graver for carving, burins, drilling bits (round pointed, triangular pyramid, square pyramid, hollow and sharp-edged, three-toothed point), rice chaff, stingray skin, horsetails (*Equisetum*), leaves, seeds of *Gardenia jasminoides*, white vegetable wax, white and dark lacquer, and varnish. These tools and materials may be classified into tools for shaping (saws, knives, etc.), edge and surfacing tools (chisel, gouge, planes, etc.), measuring tools, boring tools (drill, drilling bits), and sanding tools.[67] All the abovementioned tools of vegetable or animal origin were intended for sanding as a kind of sandpaper. Some tools, not to mention the bamboo knife, had multiple purposes and may be classified in more than one category. Thus, a knife can be operated as a shaping tool for splitting, as a surfacing tool to smoothen bamboo's outer wall, or as a tool to drill holes. Figure 137 is a sketch of the carpenter's tools. Despite the fact that these tools were primarily used for tree wood, this toolkit demonstrates the versatile tools' design and functionality. What is more, the compass (*2* in the same figure) is made of bamboo stems with a small diameter in which lead is installed.

Use of Bamboo Culms' Lightness and Length

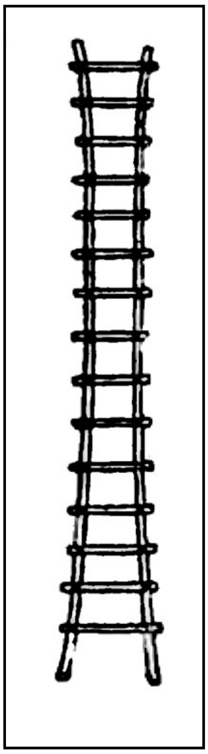

Figure 139 Bamboo ladder. *Source*: Morse 1917b, 102

Figure 138 *Title*: Saucepan brush made of bamboo. *Artist*: unknown *Date*: unknown, acquisition date 1960 *Source*: British Museum *Accession No.*: As1960,10.334

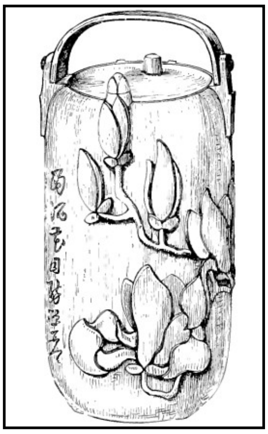

Figure 140 A sachi bottle made of two bamboos. *Source*: Dresser 1882, 459

What is more, due to bamboo stems' length and lightness, they were crucial for constructing numerous things. The construction of flags, lantern holders, spears, and ladders are only some examples concerning bamboo's length and lightness. In old Japan, flags of different kinds and purposes were visible parts of Japanese culture, symbolizing a sovereign's territory, used in religious processions when carried by a flag holder, or more profane, to indicate a commercial store.

In many cases, the flag was mounted on a movable part of a bamboo pole fixed on the upper end of a flagstaff. These flags were of different dimensions, and especially the large ones were only limited by the natural

[67] Unfortunately, Spörry does not display these tools in his book. For additional information about their use and Japanese names, see Spörry (1903, 37–41) or Brauen (2003).

length of a bamboo stem or the weight a flag holder could carry. In order to resist the strong winds, which often occur in Japan as a consequence of typhoons, flagstaffs were designed in the way that “loops on the side of the flag hold it in position, and as the wind blows the whole affair revolves on the pole” (Morse 1917a, 90). The natural length of bamboo and its lightness make bamboo also a perfect material forconstructing ladders, which must be light although long so that a single person can carry them. It is for this reason that bamboo ladders still are typical in present-day Vietnam. In earlier times, fire brigades in Meiji Tokyo deployed bamboo ladders and long bamboo poles to which lanterns were fixed. Morse (1917a, 132) writes that the fireman’s ladder was built from strong bamboo that, despite its great length, was light, stable, and serviceable so that the fireman carrying it could quickly run through the narrow streets. Bamboo ladders were most commonly straight, but occasionally the bamboo poles’ ends were bent outward, as depicted in Figure 139. This bending provided a broader base, making the ladder even more stiff and stable (ibid., 102). Since old Edo had a labyrinth-like layout, it was difficult to locate the fires, but since most buildings were one or two-story structures, Edo’s firemen raised ladders on which they climbed for better view allowing them to locate the fire. Dresser, who attended a fire brigade’s exercises, depicts the firemen’s acrobatic movements on the bamboo ladder as follows:

> The next day I hear at Tokio that the firemen are exercising, and that the sight is worth seeing, so I make my way to the ground. The exercises consist mainly in causing ladders to stand in a vertical position by the aid of hooks which grasp the ‘rounds,’ and are driven into the earth, and in the performance of strange acrobatic feats. One man ascends a ladder, and stands in an inverted position, with his head on one of the side uprights; another ascends and, grasping one of the side supports with both hands, maintains himself in a horizontal position; another holds on by his feet, and while his body extends laterally from its support brandishes in both hands a chopping instrument such as is used for destroying walls when a fire is spreading. (Dresser 1882, 34)

As Dresser’s comments affirm, the bamboo ladder was stiff and light, enabling the fireman to even perform acrobatic stunts on them. Another utilization of large structures based on bamboos length and lightness is exemplified by the Akita Kanto festival, where a single person holds up to one hundred lanterns fixed to a long bamboo culm.

Bamboo’s Spring Power and Flexibility

Bamboo’s characteristic spring power and flexibility were also successfully exploited to design tools for woodworking and grinding. Morse (1886, 42–43) notes that Japanese craftspersons chose bamboo for gluing wood pieces and for producing veneers. For this purpose, one end of a bundle of bamboos was fixed firmly to a ceiling or support while its other ends pressed on the wood. A similar device was also designed for paper-polishing, as illustrated in Figure 143 and described by Morse:

> A smooth, convex porcelain disk was on the end of a bamboo pole, the other end of which was fastened to the ceiling, the bamboo being greatly curved, as the ceiling was only seven and a half feet above the floor while the bamboo was ten feet long. This brought great pressure on the burnisher, and all the man had to do was to pull the end of the bamboo back and forth on the paper. (ibid., 1917a, 373)

Many other devices drew on bamboo's property to resist bending, as revealed by the fan detailed in Figure 141 and Figure 144, which was intended to separate the chaff from the rice grain or to fan dust out of rice. Morse, elucidating its operating principle, explains that "a man holds the upright handles, which are made of a continuous piece of bamboo, and moves his hands in and out as if he were working a pair of bellows; this movement opens and closes the fans, which are shaped like butterflies' wings" (ibid., 1917b, 69). Another object whose working principle was based on bamboo's flexibility and property to generate a counter-pressure when being bent was a device invented for self-massage. Figure 142 shows a person sitting on the ground and massaging herself/himself. The contrivance consisted of a curved bamboo at whose end a large wooden ball was fixed. By holding the loop over one's shoulder, the masseur moved the curved bamboo back and forth so that the wooden ball would knead her/his back (ibid., 1917a, 318).

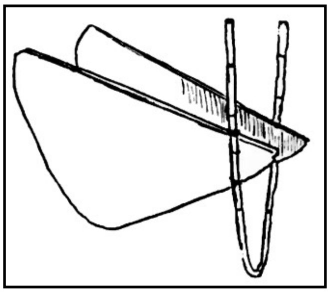

Figure 141 Bamboo fan.
Source: Morse 1917b, 69

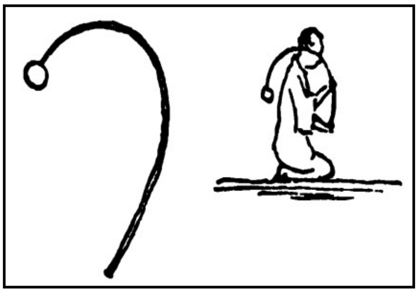

Figure 142 Massage ball.
Source: Morse 1917a, 318

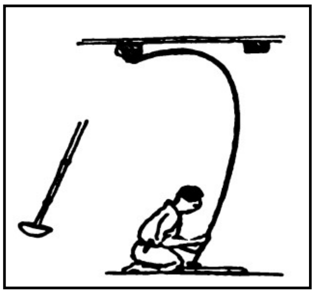

Figure 143 Utilizing bamboo's spring power.
Source: Morse 1917a, 373

The utilization of bamboo's flexibility was also practiced in the construction of toys and other mechanical constructions. As Morse (1917b, 80) points out, Japanese craftspersons developed different mechanical operating principles involving bamboo strings and springs. He, for instance, describes a mechanical toy (illustrated in Figure 145), in which a mouse eats from a dish underneath its head, and in doing so, drops its tail. Morse outlines its working principle: "The bamboo spring on the side keeps the mouse in an attitude of head and tail up, by strings that run up from the stand below. The moment you press the spring the string is loosened, the head and tail drop, the head going into a little ring of bamboo which represents a dish" (ibid.).

Concerning the bending and curving of bamboo, Spörry comments on the use of fire and fat for this purpose. According to him, thin bamboo tubes about two fingers thick could be bent as desired. After selecting the suitable pieces, the latter were rubbed with oil or grease at their bending point and then turned over a coal fire. The heat caused the bamboo pole to become flexible. The workpiece then had to be bent quickly into the desired shape as long as it was warm and flexible. In contrast, very thin tubes are naturally bendable and did not need further treatment with oil or grease (Spörry 1903, 83). As described in chapter 4.2, I observed similar treatment in Xuan Lai village.

Figure 144 *Title*: Winnowing fan made of bamboo, cane, and paper.
Artist: unkown
Date: unkown, acquisition date 1960
Source: British Museum
Accession No.: As1960,10.433

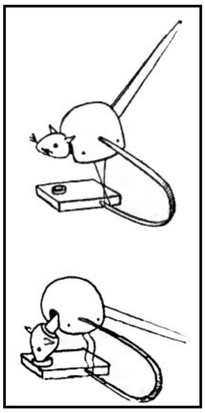

Figure 145 Mechanical toy using a bamboo spring.
Source: Morse 1917b, 80

9.4.3. Bamboo's Tubular Structure: Water Pipelines and Other Uses

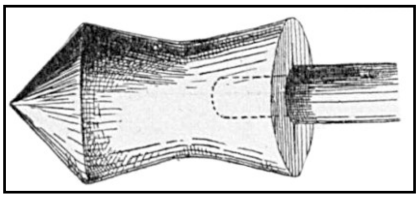

Figure 146 Fushi-Nuki.
Source: Spörry 1903, 39

In what follows, I will take a closer look at bamboo's inherent material property and its use for the creation of tubes conveying water, steam, or smoke. In Meiji Japan, water was used in local pre-industrial manufacturing (e.g., paper production) and was essential for daily Japanese household activities such as washing and bathing, laundry, and cooking. There were a variety of ways and materials to transport water to households in Edo Japan, as proved by the water system of Tokyo. Kanda, the center of Tokyo in Meiji Japan, had a water system consisting of underground conduits and pipes made of red pine, whereas earlier systems had been made of stone, earth, and other woods and bamboos (Hanley 1998, 109). Since the government was responsible for maintaining the water system, its efficiency was so high that households were continuously supplied with fresh water (ibid.). Having water directly in the kitchen reduced the time and effort of carrying water from one place to another. Morse (1886, 187) speculates that high quantities of water were consumed in Japanese kitchens, exemplifying the abundance of water. And in case the wells were located outside the house, a trough was placed beside the well, filled with water, and connected by a bamboo pipe to a big water tank inside the kitchen. As a result, people saved time and effort since they did not have to transport water from one place to another.

To prepare long bamboo pipes, Japanese bambooworkers invented special tools to remove the inner septae of bamboos. One is called *fushi-nuki* (illustrated in Figure 146), and the other is called *fushi-hari*. According to Spörry, the *fushi-nuki* was affixed to an iron bar, had a conical shape at its head, and was 6.2 cm in length with a diameter of 3.3 cm. While this tool was necessary to break through the diaphragms, the *fushi-hari*, which had a funnel-shaped indentation at the front and a sharp edge, was used to remove the remaining parts of the node wall attachments inside the bamboo tube (Spörry 1903, 39).

Figure 147 gives a clearer view of the various joints and methods used in building a water pipeline infrastructure. Bamboo pipelines were often connected by wooden blocks or posts composed of oak and chestnut wood (*a – f* in Figure 147) (ibid., 50). The choice of wooden blocks as joining elements for the bamboo pipelines exploited wood's property of swelling when in contact with water, thus acting as a perfect seal. A second way was to insert bamboo pipes into other bamboo pipes (*h, i, k, n* in Figure 147), while a third way was to bring the ends of two bamboos together, but without being plugged in each other (*g, l* in Figure 147). And finally, as indicated in the joint *m* in Figure 147, a bamboo culm was cut close to a node. Since its septum was kept, a small hole was drilled in this septum, and the bamboo stem was set up vertically. Water, then, poured from this little hole into an opening of another bamboo section.

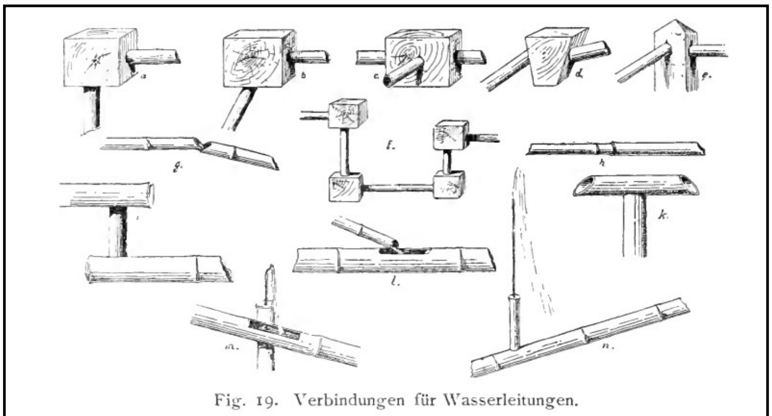

Figure 147 Joints for water pipes.
Source: Spörry 1903, 50

Figure 148 is a sketch by Spörry that illustrates some supports for water pipelines. Except for the x-shaped bamboo support

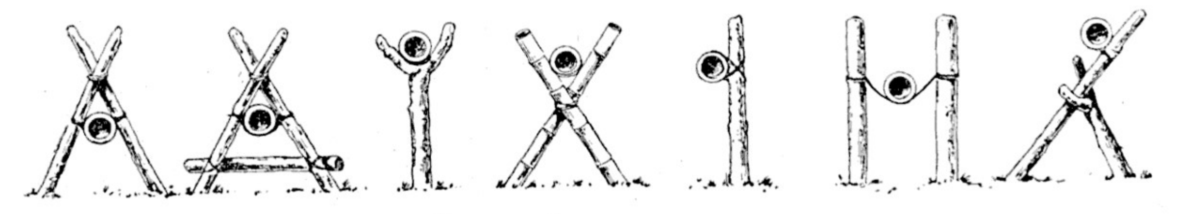

Figure 148 Supports for water pipelines.
Source: Spörry 1903, 48

in the middle of the Figure 148, all other variants were built of wood. The reason for using wooden supports instead of bamboo is that bamboo decomposes more quickly than wooden poles, especially when stuck into the ground and continuously in contact with moisture.

In Vietnam, I observed similar bamboo-to-bamboo joints still in use in present times. Using bamboo for water conduction is quickly done, environmentally friendly, and cheap. However, bamboos may crack and lose water. In this case, the damaged pipelines must be replaced or, as I observed in Vietnam, repaired using plant fibers—a method also noted in Japan by Spörry (ibid., 48). As to the whole irrigation system's lifespan, Spörry (ibid., 50) indicates that it had to be replaced after approximately three years.

Water was often transported directly from the source to a household or, occasionally, through aqueducts erected to ensure a constant water supply. Figure 149 depicts such an aqueduct that supplied a single household. As can be seen in the same figure, water is transported through a semicircular bamboo and pours into a wooden box resting on a plate that is fixed on top of a tripod. And in the next step, water is conveyed into another bamboo, set in the lower part of the wooden container.

Villages or, as mentioned above, even towns applied the same principle. In some cases, the water conduction system's length might have been several hundred meters, and it was vital

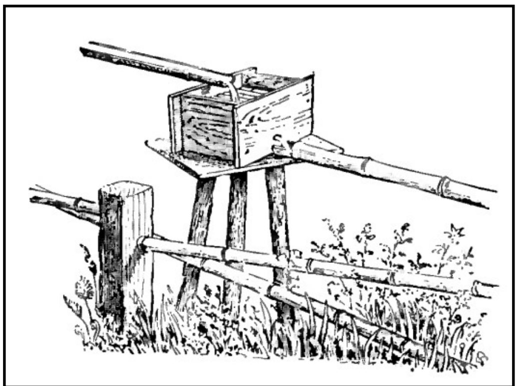

Figure 149 Aqueduct at Miyajima, Aki.
Source: Morse 1886, 301

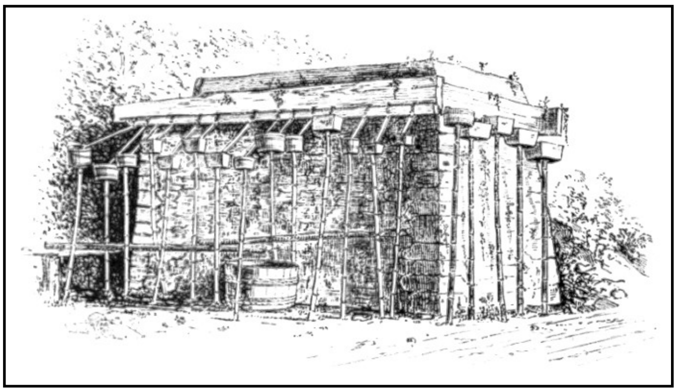

Figure 150 Aqueduct reservoir at Miyajima, Aki.
Source: Morse 1886, 300

to diminish the loss of water from the source to the destination point. Morse (1886, 299) mentions that bamboo pipes conveyed water to Kyoto from the nearby mountain brooks. He also notices a means of water supply that he observed at Miyajima on the Inland Sea. In this case, as can be seen in Figure 150, the farmers erected a shallow water tank that rests on a platform of stones. Water pours into the tank through bamboo pipelines and is transported through underground bamboo pipelines (called *take-hi*), as the subsequent description by Morse illustrates:

> The water is brought, by means of bamboo pipes, from a mountain stream at the western end of the village. The water is first conveyed to a single shallow tank, supported on a rough pedestal of rock. The tank is perforated at intervals along its sides and on its end, and by means of bamboo gutters the water is conveyed to bamboo tubes standing vertical,—each bamboo having at its top a box or bucket, in which is a grating of bamboo to screen the water from the leaves and twigs. These bamboo tubes are connected with a system of bamboo tubes underground, and these lead to the houses in the village street below . . . . It was an old and leaky affair, but formed a picturesque mass beside the mountain road, covered as it was by a rich growth of ferns and mosses, and brightened by the water dripping from all points. (ibid.)

This water tank has nineteen aboveground bamboo poles and provided water to at least nineteen households without any mechanical effort but water's flow properties. Interestingly, in this sketch, the boxes or buckets resting on the upper end of the aboveground bamboo poles seem not to be fastened to the tank but only held in position by the stiffness of each bamboo stem. Morse gives no additional information about how the underground bamboos were connected.

In sum, water conduction is determined i) by the flow properties of water and its capacity to overcome certain degrees of sloping and gravity and ii) by the bamboo pipelines in which the water is transported. Hence, the system achieves its end on the principles of natural laws (water flow and gravity) and uses longitudinal bamboo pipes and wooden blocks to redirect the water flow. This means of water transportation is fundamental and simple, and in terms of functionality, it fits its purpose perfectly and is a sustainable means of water supply without the need for artificial water pumps or the like. Furthermore, and as mentioned above, the supply of a household by water pipelines and aqueducts meant a less laborious and less energy-intensive water supply in comparison to wells.

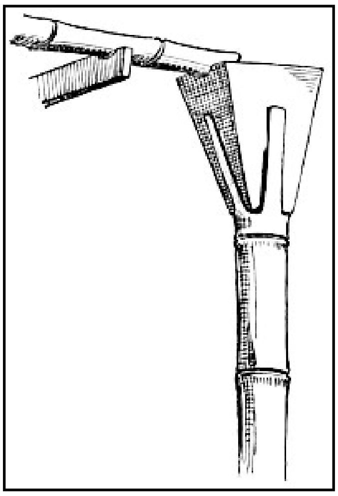

Figure 151 Gutter.
Source: Morse 1886, 83

Bamboo was also used to construct rain gutters and rainwater pipes. Such an installation can be seen in Morse's sketch in Figure 151, which depicts a rain gutter composed of a large bamboo split lengthwise and whose diaphragms have been removed. The gutter leads to the wooden hopper on the top of a vertical bamboo pipe, the upper end of which was crafted in such a way that four long strips of the culm remained. A hopper is then placed in this opening and fastened without any additional material but by the four bamboo strips' natural pressure.

Morse observed another way a bamboo pole served for water conduction in Tokyo's fish market. In this case, a bamboo pipe was plugged into the lower end of a big water tank that was constantly filled with fresh seawater. The bamboo pipe was perforated at intervals, and by virtue of the water pressure in the tank, the water spurted into shallow buckets in which marine animals were kept (see Figure 152). This contrivance did not only supply the kept animals with fresh water but also aerated the water regularly to keep the animals alive (ibid., 1917a, 36).

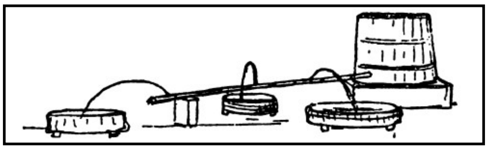

Figure 152 Perforated bamboo tube.
Source: Source: Morse 1917a, 36

In the context of bathing, Morse (1886, 204) mentions the use of bamboo tubes or flues to connect two separated bathtubs and enable the water to circulate freely. Another use of bamboo in the domain of bathing is noted by Shigemi, who writes that "in well regulated baths, near the cold-water enclosure is a hot water cistern, constantly fed through a bamboo pipe with boiling water" (1889, 35).

Bamboo was not only reduced to conveying water. It has outstanding properties to transport liquid and gaseous substances and found its place in many pre- and early industrial processes as a natural tube. Large stems of *Phyllostachys bambusoides*, amongst other large bamboos, were employed in Japan instead of copper or iron (Nawohito 1889, 34). For instance, it was employed in a contrivance for camphor production, as detailed in Figure 153. Steam, generated by the fire underneath the camphor fumes, passes through a piece of bamboo (*B*) into the cooling apparatus (C), and another bamboo pipe (B') continuously pours water over the cooling apparatus (C) (Rein 1889, 148).

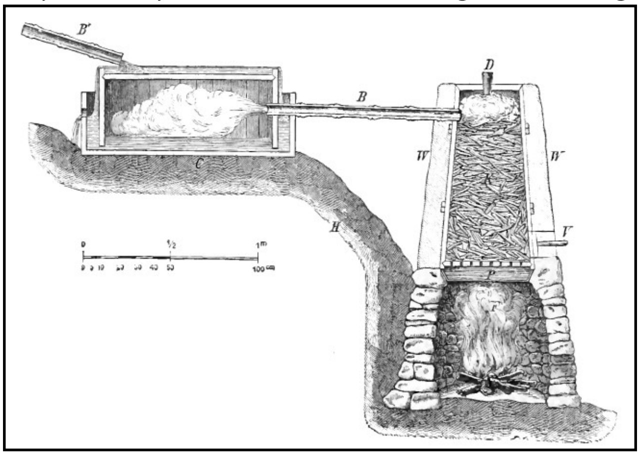

Figure 153 Apparatus for producing camphor.
Source: Rein 1889, 148

A Japanese tobacco pipe is another example that illustrates how people benefited from bamboo's hollowness. Figure 154 is a Japanese smoking pipe that is made of bamboo. Many pipes were a compound of a small metal bowl, a mouthpiece, and a bamboo stem (Dresser 1882, 23). The specimen in Figure 154 is made entirely of one piece of bamboo. The pipe is created by one culm section and its naturally attached culm branch that is bent. Hence, its bowl, chamber, draught hole, shank, and mouthpiece are one.

Figure 154 *Title*: Japanese smoking pipe.
Artist: unkown
Date: unkown, acquisition date 1960
Source: British Museum
Accession No.: As1960,10.497

As these examples demonstrate, people made use of bamboo to convey water, as in the case of water pipelines or rain gutters, steam, or smoke. Bamboo's cylindrical form, I suggest, was of major significance in shaping the design, creation, and use of tools and contrivances. Hence, people's inventiveness was grounded, to some extent, on bamboo and its functional integration into objects, tools, or devices. On the whole, using bamboo as a pipe does not require a complex toolkit, machinery, or precise knowledge or skill. It is bamboo's inherent structure and its simple implementation as raw material that stands out in terms of practicability and functionality that are indispensable for many pre-industrial constructions.

9.4.4. House, Roof, and Fence Construction

"The Japanese relationship with nature has historically hovered between two poles: resistance through the use of inventive technology, and flexibility or accommodation to recurring earthquakes, floods, typhoons, and fire" (Genadt 2019, 1). Accordingly, whenever the Japanese erected constructions, they still had to consider the disastrous and severe effects of environmental forces and anthropogenic hazards such as a fire. An aspect that tragically became present on March 11, 2011, when a severe earthquake struck the Tōhoku region, followed by a tsunami. In Deal's view, the consideration of disastrous effects meant that "Japanese houses were often built as temporary, adaptable structures rather than permanent, fixed dwellings" (2006, 342), because Japanese peasants, craftsperson, builders, and architects were forced "to rethink and implement the concept of resilience in their built environment" (Genadt 2019, 1).

As elsewhere, before the spread of industrial materials, a large proportion of houses in East and Southeast Asia was initially fabricated by using natural resources such as bamboo (for the roof construction, walls, or floor), palm leaves or grasses (for the roof covering), wood (for beams, slats, and pillars), and stones (as a foundation for pillars). Then as now, in monsoon regions, many houses are constructed as stilt-houses or at least some distance off the ground. This principle allows rainwater to pass easily underneath the floor and air to circulate freely and so prevents the floor from decay. While stilt-houses were most commonly constructed in tropical and subtropical zones, houses in regions with a temperate climate were often built directly on the ground. This style was and still is, for example, the case in northern Vietnam, parts of China, Korea, and Japan. In the latter cases, the houses must satisfy specific requirements. Compared with houses in the tropical or subtropical climate zone, they had to be much more weatherproof and withstand cold temperatures. Moreover, houses in Japan had to be earthquake-proof, and "architectural resilience was achieved by balancing pliability in some buildings with a combination of ductility and rigidity in others, making the urban agglomerations and the nation as a whole resilient and prosperous" (ibid.). Therefore, particularly residential houses must have a light structure that can resist earthquakes much better than solid, stone-made houses.[68]

In what follows, I will highlight bamboo's use in the construction of townspeople's houses (called *minka*) and the roofs of peasants' houses. Rather than giving a profound analysis of traditional Japanese houses, I shed light on only bamboo-related aspects.[69] The townspeople's houses in Edo Japan, as analyzed and assessed by Hanley, "were built in styles and technologies

[68] Alongside earthquakes, fires and tsunamis periodically endangered inhabitants and their houses in urban areas. In 1855 and again in 1923, for instance, Tokyo was hit severely by two very destructive earthquakes that destroyed vast parts of the town. In 1923, less than a half-century after Morse visited Tokyo, a 7.9 magnitude earthquake struck the Kantō region and destroyed nearly half of Tokyo. This earthquake, known as the Great Kantō earthquake of September 1, 1923, was followed by a tsunami and great fires. While the wooden houses could resist the earthquake well compared to brick houses and modern buildings, which were not yet reinforced with concrete and the first constructions to collapse, they were at greater risk from fire (Schencking 2008, 299). Since the earthquake destroyed vast parts of the water main, fires could spread quickly to the wooden houses without any chance to extinguish the fires. It is estimated that more than 100,000 people died, and that more than two million people were made homeless (ibid., 296). Even though Tokyo has gone through numerous natural disasters in its history, the authorities decided to rebuild Tokyo and saw this as a chance to develop a new modern urban metropolis. After years of struggle, Tokyo was reconstructed, but half of Tokyo was again reduced to ashes because of American firebombing only some twenty years later. In present-day Tokyo, little architectural evidence of Tokyo's remote past remains due to the natural calamities and the carpet bombing during World War II, as well as due to the efforts of the authorities to rebuild a modern Tokyo. Therefore, Morse's and Spörry's depictions of Japanese houses and their structure, constructional methods, and material components are valuable sources for analyzing some aspects of bamboo's relevance for pre-industrial Japanese architecture and the built environment.

[69] For the specific style and function and historical development of townspeople's houses, see Hanley's elaboration on that subject (Hanley 1998, pp. 25–50) or Morse (1886).

developed in the fifteenth and sixteenth centuries, which were diffused throughout the country-side as families increased their wealth and could afford the building materials, tools, and the specialized carpenters to construct larger, better-quality dwellings" (1998, 28).

Hanley (1998, 28) mentions that the doors of townspeople's houses were increasingly made of wood during the seventeenth century and replaced the former wattle doors made of split bamboo. In contrast to woodcraft that requires sophisticated iron tools, as presented in the sketch of a carpenter's toolkit displayed in Figure 137, bamboo can be worked on and processed in a versatile way using knives only. Hence, the improvement of the carpenter's tools enhanced the workability of wood and, thus, the replacement of bamboo doors with wooden ones. In this context, Nagahara and Kozo remark that the introduction of large saws from China (*oga* or *ogabiki*) alongside the innovation of planes (*daikanna*) stimulated the progress and design of house construction a great deal (Nagahara and Kozo 1988, 90).

Hanley (1998, 31) confirms this view and believes that the *minka*'s homogenous design in the seventeenth century goes back to tools and carpentry techniques introduced mainly from China but only gradually disseminated in Japan. Accordingly, rather than an indigenous Japanese invention, the style and construction method alongside the applied tools and techniques came from overseas. Later, during the Tokugawa period, the *shoin* house style was developed and disseminated. In contrast to the earlier *minka* style, *shoin* style houses were well enclosed and made more use of prefabricated boards than whole logs required to erect posts and beams after introducing Chinese carpenter's tools (ibid., 32). To resist monsoon rains and the cold temperatures during winter, builders used a bamboo side framing made of bamboo splits and plastered it as an outer wall—a method that spread during the seventeenth century (ibid., 28) and is illustrated in Figure 155.

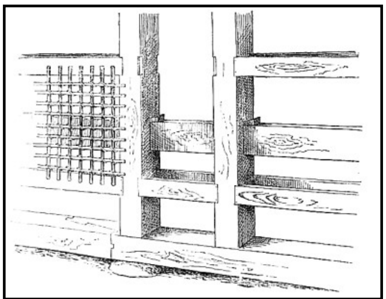

Figure 155 Side framing.
Source: Source: Morse 1886, 14

In the late Meiji era, as Spörry (1903, 41) mentions, Japanese residential houses never consisted exclusively of bamboo, nor was bamboo the main element, since wood was the preferred material. Morse (1886, 48) also highlights that Japanese houses were predominantly made of wood, remain unpainted, and usually one-story. The residential house had a simple, vertical framing and remained upright without foundations. To stabilize the framing, the upright posts were connected by a short horizontal timber joint to which a bamboo lathing was fixed (see Figure 155) (ibid., 32). In the Meiji era, Japanese houses had no cellar or any excavation

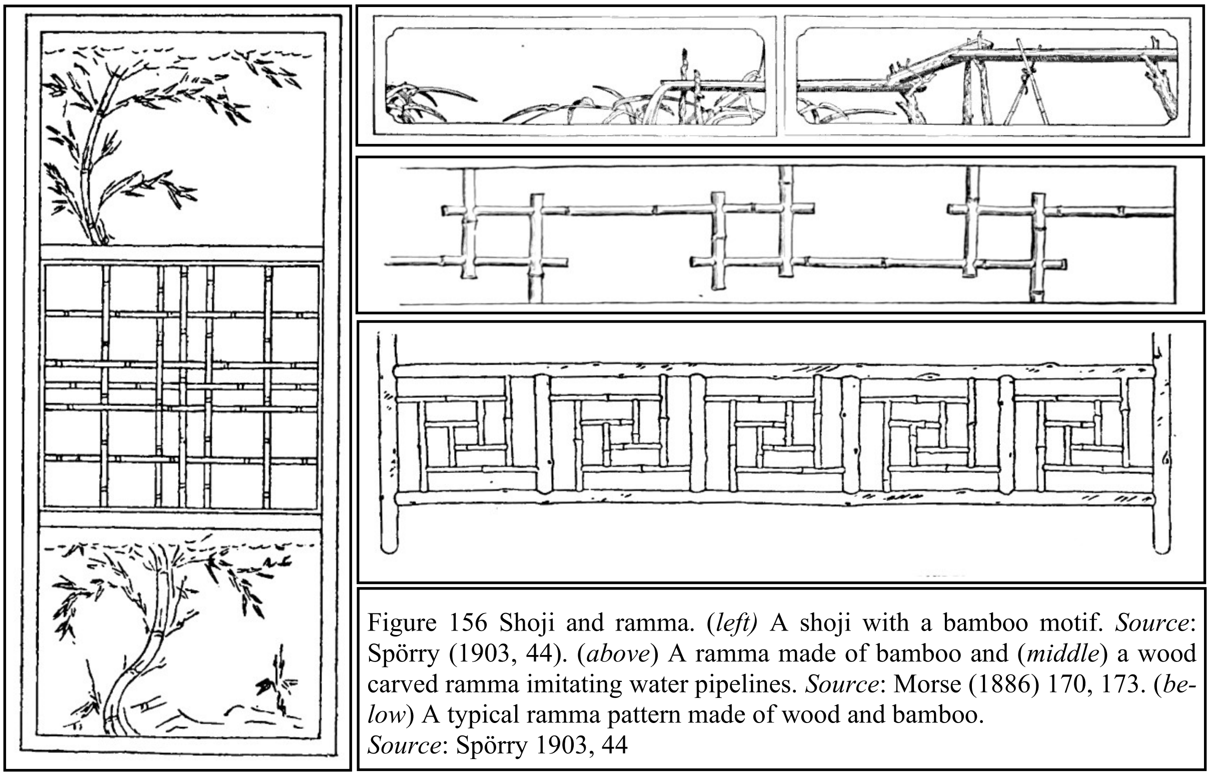

Figure 156 Shoji and ramma. (*left)* A shoji with a bamboo motif. *Source*: Spörry (1903, 44). (*above*) A ramma made of bamboo and (*middle*) a wood carved ramma imitating water pipelines. *Source*: Morse (1886) 170, 173. (*below*) A typical ramma pattern made of wood and bamboo.
Source: Spörry 1903, 44

beneath the house and rested on columns without a deep foundation. The reason for this design lies in the flexibility of its columns, which make houses more earthquake safe since they allow a building to sway rather than to buckle when struck by an earthquake.

What was curious for Westerners visiting Japan in the pre-Meiji and early Meiji era, and entering traditional Japanese houses for the first time, was the interior arrangement and absence of furniture Westerners were accustomed to find in their homes. Thus, in Japanese homes there were "no chairs, table, or other articles of furniture," and likewise "no chimney, no stove, no attic, no cellar, no door even, only sliding screens" (ibid., 1917a, 7–8). Japanese also had no beds but pillows they kept in their cabinets and unwrapped at bedtime.

Probably, the most peculiar feature of traditional Japanese houses was the way persons partitioned the rooms using permanent or sliding screens. The outside frame of these partitions was manufactured from wood, while bamboo was occasionally used as a sliding screen. The movable partitions (*fusuma*) separated two rooms and were covered on each side by thick paper. For its ornamental value, as Morse remarks, "brown sheaths of bamboo shoots [were] worked into the paper, producing a quaint and pleasing effect" (1886, 127). For the purpose of adding extra decorative quality, in one case, the paper cover of the *fusuma* was replaced by a composition of light and dark bamboo combined with heavily-grained wood and a dark cedar (ibid., 128–129). The permanent partitions (*shoji*) were, in principle, similar to the *fusuma* but in the outer parts of the house and, so, substituted windows. One specimen is shown in the left part of Figure 156. The structural appearance of Japanese residential houses meant for Dresser "almost to live an out-of-door life, the house being rather a floor raised above the ground with a substantial roof than a series of rooms properly enclosed by substantial side walls" (1882, 23).

Another component of traditional Japanese houses was the space between the ceiling and the horizontal beams, called *ramma.* It was an ornamental piece hung above the screens and functioned as a type of small window. The *ramma* designs were innumerable "with patterns of birds, flowers, waves, dragons, or other objects cut out in perforated wood" (Morse 1886, 169–170) or geometric designs and forms. Figure 156 provides a clearer idea of the *ramma.* The upper sketch shows a wood-carved bamboo aqueduct, a typical scene in the countryside, which illustrated the water conduction system discussed above. The sketch in the middle of Figure 156 is a *ramma* fashioned from bamboo tubes inserted in each other to provide a simple but graceful geometric form. And the sketch of a *ramma* below presents a typical pattern made of bamboo and wood.

Bamboo's Use for Roof Constructions

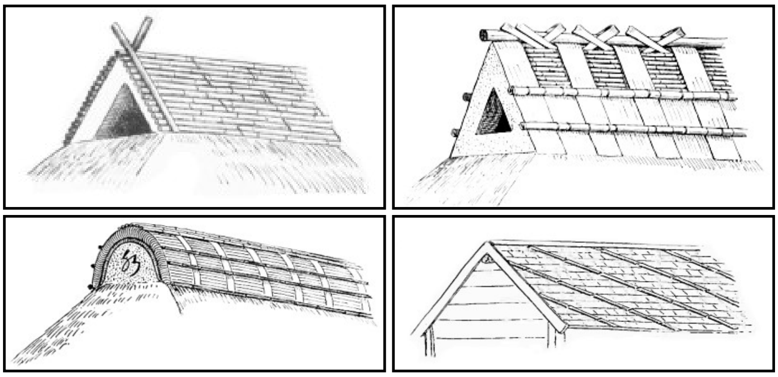

Figure 157 Various roof styles using bamboo. (*upper left*) Crest of thatched roof. (*lower left*) Bamboo-ridge of thatched roof. (*upper right*) Crest of thatched roof with a bamboo yoke. (*lower right*) Bamboo fixing shingles.
Source: Morse 1886, 102, 95, 81, 104

As the uppermost portion of houses, the roof provides protection against rain, wind, and sun. Different materials are employed for this purpose all around the world, and countless shapes and designs of roofs existed and still exist. In southern Japan in the late nineteenth century, roofs of villagers' houses were thatched using organic sources such as reed, straw, or *Sasa* bamboo (Spörry 1903, 43). Morse, highlighting bamboo's application in thatched roof constructions, introduces different bamboo-ridge and roof construction types that he observed in Musashi province. The thatched roof in the upper left drawing in Figure 157 is described by Morse as follows:

> It is first covered with a layer of small bamboos; then narrow bands of bamboo or bark are bent over the ridge at short intervals, and these are kept in place by long bamboo-strips or entire bamboos, which run at intervals parallel to the ridge. These are firmly bound down to the thatch. In some cases, these outer bamboos form a continuous layer. The ends of the ridge, showing a mass of projecting thatch in section, is abruptly cut vertically, and the free border is rounded in a bead-like moulding and closely bound by bamboo, appearing like the edge of a thick basket. (Morse 1886, 95)

In another type of roof making, called *Mikawa* roof, large bamboo stems were chosen to cover and sheathe the thatch, while rafter poles at the end of the rooftops fixed the horizontal bamboo sheathing (ibid., 101) (see lower left sketch in Figure 157). The third type of roof, illustrated in the upper right-hand sketch in Figure 157, had a unique style and was, according to Morse, thought to be very solid and long-lasting and described by him in the following terms:

> The ridge roof was large and sharply angular. Resting upon the thatch, from the ridge pole half way down to the main roof, were bamboos placed side by side, parallel to the ridge. Upon this layer of bamboos were wide saddles of bark a foot [wide] . . . reaching down to the main roof. On each side of the ridge roof, and running parallel to the ridge, were large bamboo poles resting on the saddles, and bound down firmly with cords. On the sharp crest of the roof rested a long round ridge pole. This pole was kept in place by wide bamboo slats, bent abruptly into a yoke, in shape not unlike a pair of sugar tongs, and these spanning the pole were thrust obliquely into the thatch. (ibid., 103–104)

The most striking feature of this roof type is the employment of bamboo slats in the form of a yoke. For this purpose, the bamboo slat was bent in the shape of a loop to fix the ridge roof.

Some peasant house roofs were covered with shingles. For the purpose of additional reinforcement and protection against strong winds and to fix the shingles to the roof, bamboos of larger diameters were nailed diagonally across the roof (see the bottom right sketch in Figure 157), and bamboo nails were used to fix the shingles to the wooden lath frame (ibid., 81, 79). In other cases, not illustrated here, a continuous sheathing of large bamboos covered the ridge-roof, and in the case of the roof types of the farmer's houses in Osumi, layers of bamboo covered the upper section of the roof, as shown in the sketch of the house in Figure 158 (ibid., 101, 72–73). By and large, villagers made use of long bamboo poles to create watertight, renewable, organic, and quickly made roof types.

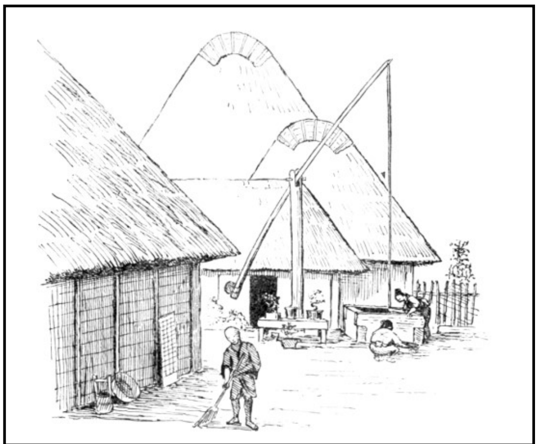

Figure 158 Farmer's houses in Osumi. *Source*: Morse 1886, 73

Bamboo Fences

To ensure more privacy and separate the house from the street and protect oneself and one's property, many houses in Japanese towns were surrounded by bamboo fences. Figure 159 illustrates a typical bamboo fence approximately two meters in height. The bamboos of the fence in this photograph were arranged very compactly so that no view from the outside could penetrate inside. Fences were also designed to subdivide the garden or for decorative purposes. In many cases, bamboo was the primary material to build fences—as demonstrated by the Civil Code of Japan related to the installation of fences mentioned in chapter 9.3.1. Figure 159 also depicts, besides the bamboo fence, a group of Japanese musicians with their different musical instruments, some of which were made of bamboo.[70] Figure 120 shows a simple bamboo fence that served as an enclosure for bamboos and trees.

Besides their functional aspects, bamboo fences also represented aesthetical and cultural aspects. Yoshikawa (2010) lists more than twenty-five different fence styles in contemporary Japan, a significant portion of which was invented a long time ago so that it is impossible to determine when precisely the first fences emerged. However, picture scrolls indicate that in the Heian period (794–1185), various bamboo fences were already familiar, though it is unclear whether individual styles first emerged in Japan or China (Yoshikawa 2010, 5). A striking aspect of bamboo fences is implicated in bamboo's comparatively fast deterioration. On the one hand, bamboo fences' relatively short life span is an economic disadvantage compared to other, more durable materials. When exposed to sun and rain, bamboo fences decay rapidly and must be renewed partly or entirely at brief intervals, and this is why they are nowadays often considered less valuable and too costly.

Figure 159 *Title*: Japanese Musicians.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.875.3.18

On the other hand, bamboo fences were desired since they represent the impermanence of life because their lifespan bears witness to the transitoriness and the flow of life. In the words

[70] Bamboo's hollow form is essential for the construction of musical instruments, and its contribution to the development is discussed in chapter 7.4.7 in relation to the musical instruments of the Bahnar people. Though a description of Japanese musical instruments would reveal bamboo's relevance in the domain of music, ceremonies, and rituals, I shall not elaborate on this aspect due to the limited scope of this chapter.

of Yoshikawa, "the life of a bamboo fence consists of a short 'green' period, followed by a long 'light brown' period, and then decay and death—an existence that eventually vanishes, in which one finds the taste of Japanese *wabi* (austerity)" (ibid., 4). Hence, a bamboo fence symbolizes nature's lifecycle; something is born, lives, and dies. The lifespan of human-made artificial objects (like that of the bamboo fence) figures the impermanence of life and is a frequent theme in Daoism and Zen Buddhism.

Despite their functionality and popularity, as Yoshikawa (ibid., 6) emphasizes, bamboo fences have been restricted to ordinary residential houses, temples, and huts but never encompassed grand buildings such as palaces. In my view, threefold reasons could explain this. First, bamboo was regarded as the material of ordinary people, who frequently chose bamboo to build fences. Thus, given the ubiquity and easy availability of bamboo, wealthy persons might have been interested in distinguishing themselves from ordinary people and preferred other materials like stone and wood. Second, while bamboo fences guaranteed a certain level of protection, stone walls would have provided greater protection. Third, and as explained above, bamboo fences deteriorate fast, whereas stone walls represent a certain kind of longevity, which might have symbolized the respective sovereign's longevity.

9.4.5. Bamboo in Diverse Fields: From Household Goods to Agriculture and Fishing

Many applications, tools, contrivances, or objects made from bamboo could be found in Japanese households. With the intention to provide a more comprehensive picture of bamboo's integration in Japanese material culture, I will mention some of these things. However, despite my efforts to describe the interconnection of bamboo and Japanese people, and although I mention a plethora of things utilized in various domains of everyday life, my description is limited due to the ubiquity of bamboo. The tools and devices that I discuss below appear simple, but they often stood out due to their practical utility and demonstrated the heterogeneous uses of bamboo and its entanglement in Japanese society's daily life. To this extent, these things were essential for the functioning and maintenance of a relatively high living standard during the Meiji era. This is, amongst others, established by Hanley (1997, 22), who, by presenting information about health and hygiene standards in the United States, Europe, and Japan in the mid-nineteenth century, reveals that the Japanese lifestyle before industrialization was equally high.

Body Hygiene: Bath Tubes, Sinks, Tower Racks, Combs

Figure 160 *Title*: Home Bathing.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.700.4.27
* Photo modified by the author for clearer representation.

Maintaining one's bodily cleanliness is not only essential for aesthetic reasons but also for health issues. Many tools relating to personal body hygiene and required for activities such as taking frequent showers or baths, washing one's hands, washing clothes, combing one's hair, or wearing shoes, are made of or require bamboo. Hanley (1997), who compares Japan's body hygiene with the United States and Europe during the Meiji era, points out that bathing was much more regular and part of daily routines in Japan in contrast to the former. At the same time, the Japanese usually drank boiled water in the form of tea and so ensured that it is safe to drink; and collected their night soils as a valuable fertilizer and, in so doing, protected rivers from contamination (ibid., 22, 99, 111).

As elsewhere, bathtubs were essential containers needed for personal hygiene and were a vital amenity of Japanese households. A widespread form common in late nineteenth-century Japan is detailed in Figure 160. Its components and function are described briefly by Morse. "On one side," he says, "a chamber of copper is introduced at one end near the bottom of the tub, the mouth having a frame of stone, or of clay or plaster" (Morse 1886, 203) in which the firewood is placed. Then, as performed by the woman on the left in the photograph, the fire was started utilizing a bamboo tube. Using a bamboo tube to encourage fires to spread by adding human-induced oxygen is a very simple but effective method and due to its efficacy and bamboo's ubiquity common, for instance, among the Bahnar and in rural Vietnam.

What else is of interest in the same figure is the attachment of long bamboo strips as reinforcement of the two wooden buckets on the ground in front of the bathtub. Bamboo was selected for reinforcing buckets and containers due to its availability and superior physical properties (such as tensile strength, compression strength, or flexibility). However, when industrially fabricated products and the availability of iron increased, bamboo was soon replaced. As the photograph shows, the buckets and the bathtub consist primarily of vertical wooden laths, which are fastened by twisted bamboo strips. Since the bathtub was of approximately 1 m diameter and 1 m height, strips of bamboos about 3 to 4 m long were needed to encircle the bathtub. Other examples of bamboo's use as reinforcement are demonstrated by the big water container in Figure 150 and the water bucket and vegetable container in Figure 133.

Another use of bamboo related to body hygiene is its employment as raw material for constructing sinks of washing areas. According to Morse (1886, 208), bamboos with smaller diameters were arranged adjacent to each other and fixed on the ground as a kind of floor with openings. The washing person could stand on this bamboo floor, and water found its way through the spaces between bamboo culms to the channels and poured into the ground. Besides its functionality, the bamboo sink indicates bamboo's mechanical strengths since it easily bears loads induced by humans' weight.

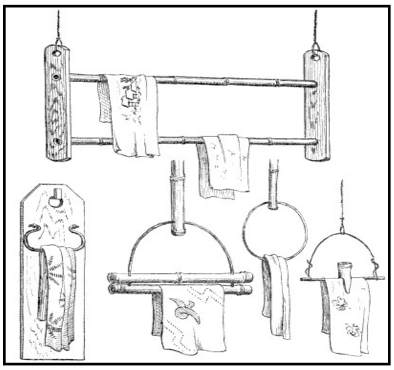

Figure 161 Forms of towel racks. *Source*: Morse 1886, 209

In his first book related to Japanese house interiors, Morse (1886) mentions the ubiquitous use of bamboo for towel racks. As indicated in the sketch in Figure 161, various towels hang on bamboo towel racks with different designs. As elsewhere, towels were used as hand towels, bath towels, or kitchen towels and became more popular only when cotton production increased during the seventeenth century. Some towel racks are described by Morse as follows:

> The simplest kind is in the shape of a ring of bamboo suspended by a larger bamboo, to the end of which it is attached. Another form, and a very common one, is a yoke of bamboo, the lower ends of which are firmly secured to a larger bamboo, confining at the same time a piece of bamboo which slides freely up and down on the yoke, and by its own weight resting on the towel which may be thrown across the lower bamboo. Another form consists of a loop of bamboo suspended to the side of a board which is hung against the wall. (ibid., 209–210).

These forms of towel racks represent a portion of an arrangement of Japanese house interiors and how the various towel racks were designed based on bamboo's physical property. While some were produced utilizing (almost) unmodified bamboo stems, others, as in the case of the ring, were crafted from a bamboo strip and tied to a bamboo stem.

In the following, I will give three last, but nonetheless important examples related to body hygiene and health. Japanese people produced their toothbrushes on the basis of bamboo's long fibrous structure. Dresser (1882, 460) mentions that by hammering a bit of a bamboo stem's end, the end is rendered fibrous and formed a proper toothbrush.

Figure 162 *Title*: Comb made of bamboo.
Artist: unknown
Date: unknown, acquisition date: 1960
Source: British Museum
Accession No.: As1960,10.369

Figure 163 *Title*: Pair of sandals made of bamboo, rope.
Artist: unknown
Date: unknown, acquisition date: 1960
Source: British Museum
Accession No.: As1960,10.405.a-b

Haircare and combs were equally essential for body hygiene and to comply with social regulations about aesthetics and self-care. Figure 162 shows a comb made of bamboo, which impressively exemplifies how finely bamboo can be split in the longitudinal direction. Like elsewhere, people required footwear for hygienic reasons.

Geta, the traditional Japanese sandal, typically had a solid base made of wood, bamboo, or other plant materials and was formed in such a manner that the person wearing it was elevated from the ground. Though one could not run due to this footwear's construction, its elevation meant the feet were protected from cold and dirt, particularly on days with rain and snow—one *geta* bamboo specimen is shown in Figure 163. The pair of sandals in this figure is made of bamboo half-sections and ropes.

Inside the Kitchen: Chopsticks and Kitchen Utensils

Chopsticks, typically a pair of equal-length sticks, are necessary kitchenware in many South and Southeast Asian countries and Japan's primary eating instrument. According to Shorkar (2018, 9), chopsticks originate from China—first records mention their use during the Shang Dynasty (1600 BCE)—and gradually spread throughout South and Southeast Asia after 500 CE. Then chopsticks became significant kitchen utensils in Vietnam, Japan, Korea, Cambodia, Laos, Nepal, Malaysia, Myanmar, Singapore, and Thailand—in countries known to have endemic bamboos.

The pair of chopsticks is held in one's hand while its ends are pushed together to grasp the food. Using chopsticks requires motor sensitivity, which is why, in Vietnam, only children at the age of four to five are thought to be capable of handling them properly. One can differentiate between three different chopsticks concerning the degree of difficulty when eating with them. The simplest ones are rectangular at their tips, the difficult ones are round, and the intermediates ones are also round, but with notches at their ends (Shigemi 1889, 22).

Chopsticks are traditionally fashioned from bamboo, wood, iron, or sometimes of ivory and porcelain, and nowadays also from plastic. Due to bamboo's long fibers and since it can be split easily in longitudinal directions, the earliest versions were probably made of bamboo. Furthermore, chopsticks were quickly produced, and since bamboo is a renewable organic material, bamboo chopsticks were much cheaper than precious metal.

The working principle of chopsticks can also be found in other applications, as Morse's description indicates:

> a pair of iron chopsticks is used to pick up live coals; the cook uses a pair to turn his fish or cake; the jeweler uses a delicate pair of ivory chopsticks in putting together a watch; and on the street one notices the rag-picker and scavenger with a pair of chopsticks three feet long with which he picks up rags, paper, etc., from the street and drops the material into a basket carried on the back. (Morse 1917a, 34)

Although consisting only of two longitudinal sticks, chopsticks are very functional and enhance humans' bodily capabilities. One can touch hot things (coal and a hot meal), work more precisely (using chopsticks as a kind of tweezer as in the case of the watchmaker), or extend one's limbs (rag-picker).

Aside from having a functional purpose, chopsticks also have a symbolic meaning in China. For instance, chopsticks are given as gifts for honeymooners to wish a newly married couple a child soon (Shorkar 2018, 9). Chopsticks are also integral to South and Southeast Asian table manners while eating. In ancient China, as Shorkar (ibid., 10) mentions, chopsticks were seen as essential for people to eat and act in a *civilized* manner, and conventions regulated their use. As Shorkar further states, in contemporary China—and equally in Vietnam and Japan—waving with chopsticks in the air, playing with them, utilizing them as drumsticks, or other uses except for food is undesirable.

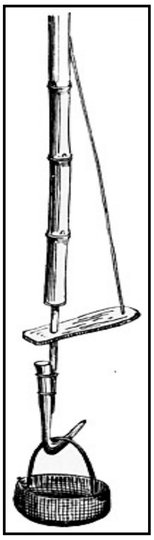

Figure 165 Ji-Zai. *Source*: Morse 1886, 192

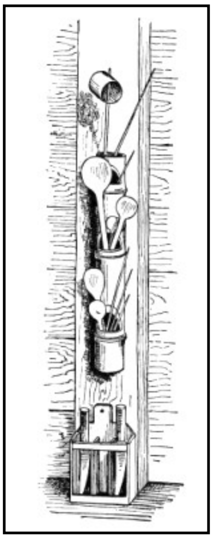

Figure 164 Bamboo rack and knife case. *Source*: Morse 1886, 192

Other kitchen utensils were also made of bamboo, such as the bamboo rack installed in many residential houses to sort kitchen utensils. It consisted of a large bamboo attached to a wooden pole and had several openings in its walls so that utensils, including spoons, chopsticks, spatulas, or water ladles, could be put inside. Figure 164 provides a clearer idea of that device and shows a knife case below the bamboo rack.

Figure 166 *Title*: Japanese ladle made of bamboo.
Artist: unknown
Date: unknown, acquisition date 1960
Source: British Museum
Accession No.: As1971,12.76

In traditional Japanese houses, the open fireplace was in the center of the house. As detailed in Figure 165, kettles were suspended over the fireplace by iron chains or bamboo (called *Ji-Zai*), and food cradles were installed over the fireplace. These cradles were filled with fish or meat and cured by the fire's ascending smoke (Morse 1886, 191–192). Bahnar people also apply a similar method to cure fish, skins, bamboo shoots, or bamboo strips for weaving (see, for instance, my discussion in chapter 7.4.4.1). Since the open hearth produces constant smoke, adequate ventilation is essential to prevent a poisonous atmosphere in the room. As Dresser (1882, 22) points out, Japanese residential houses were well ventilated due to their light construction.

Bamboo in Basketry and Other Handicrafts

Bamboo was widely used for any kind of weaving and particularly in basketry, as a way to create three-dimensional structures. There is no limit to creativity in the design of woven bamboo baskets with countless braiding and patterns. Figure 134, Figure 133, Figure 170, and Figure 171 represent in detail the miscellaneous objects, including baskets, containers, brooms, sieves, or riddles crafted from bamboo. Figure 133 shows a vegetable peddler with bamboo baskets of diverse kinds and shapes filled with vegetables. Figure 171 displays a seller of baskets who offers numerous baskets, spoons and chopsticks, bamboo curtains, towel racks, steam trays, brooms, and other bamboo articles. Figure 134 and Figure 170 likewise illustrate numerous bamboo baskets and containers. Spörry (1903, 110–111) also lists a plethora of woven bamboo objects (some of which are displayed in Figure 170 and Figure

Figure 167 *Title*: Bamboo spoons.
Artist: unkown
Date: unkown, acquisition date 1960
Source: British Museum
Accession No.: As1960,10.357-359

171), such as baskets for fruits, vegetables, gifts, shopping, fish, charcoal, or tea. Dresser, being fascinated by Japanese basket weavers' skills, portrays the bamboo baskets' beauty and efficacy as follows:

> The Japanese are the best basket-makers in the world, and they alone have raised the manufacture to an art industry. They make baskets which are not only useful but beautiful, and many of them must be classed as true art objects. Their forms are carefully considered, the patterns into which the bamboo is worked are beautiful, the contrast of open work with solid is duly appreciated, and the handle is often of most dainty character, while its curve almost invariably forms a pleasant contrast with the lines of the other parts of the work. (Dresser 1882, 454)

The work of craftspersons making umbrellas, lanterns, baskets, hats, fences, sturgeons, brushes, brooms, and toymakers would have been almost unthinkable without bamboo (Spörry 1903, 115). As shown in Figure 169 and Figure 168, bamboo was essential for the umbrella maker and paper lantern maker. In both cases, bamboo formed the tangible background of both objects and professions. As mentioned above concerning the development of the tea ceremony and its aesthetics and the formation of *mingei* during the 1920s, bamboo and products derived from it were valued and adored for many reasons.

Accordingly, well-known master-apprentice lineages refined and transmitted the knowledge, techniques, and skills required to create bamboo baskets and passed them down through the ages. During the twentieth century, as part of the *mingei movement*, individual basket makers reinterpreted old traditional methods and aesthetics and began creating new imagi-

Figure 168 *Title*: Umbrella Maker.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.700.4.37

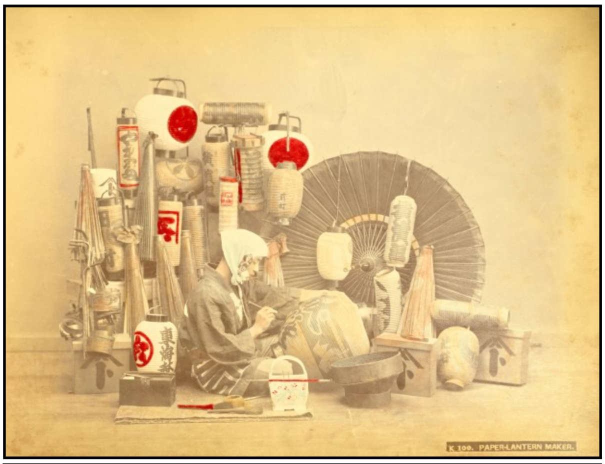

Figure 169 *Title*: Paper Lantern Maker.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.875.3.13

native forms and vases (Boudine 2018, 3). In post-war and contemporary Japan, many bambooic objects of high artisanal quality are admired for their ornamental and decorative value and conceived as an expression of fine and contemporary art.

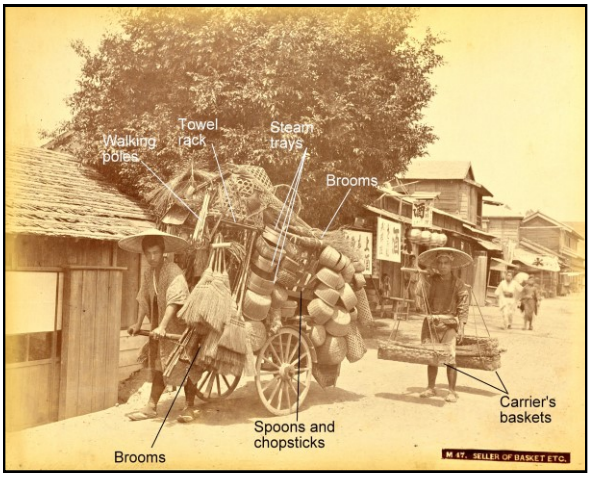

Figure 170 *Title*: Basket seller.
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: Monash University. Monash Collection Online
Accession No.: 110

Figure 171 *Title*: Seller of Baskets, Etc.,
Artist: Attributed to Kusakabe Kimbei
Date: 1870s - 1890s
Source: The J. Paul Getty Museum, Los Angeles
Accession No.: 84.XA.875.3.14
* Labeled by the author

Bamboo in Agriculture and Fishing

Before industrialization, Japanese society mainly consisted of farmers who spent considerable time on agricultural work, particularly the extensive rice field cultivation, which involved and required enormous collective labor. However, besides rice, farmers cultivated a variety of plants, fruits, and vegetables, and in doing so, crafted and used a plethora of bamboo tools and objects.

Bamboo's role in Japanese agriculture is highlighted by Spörry, who mentions numerous tools and applications that I will summarize in this paragraph. One device, called *mame-koki* (an object in the shape of a large bamboo comb), was crafted to pick *daizu* beans. The beans were then washed and cleaned after the harvest in a bamboo sieve. Bamboo was also used to produce almost all kinds of foliage and grass rakes. A freshly sowed field was covered with bamboo twigs as a warning to prevent others from walking on the farmland. Seedlings were protected against dogs and rabbits by makeshift bamboo hedges. Straw men with large bamboo hats were erected on the fields and functioned as scarecrows. And further protection against birds was achieved by the clattering of bamboo segments, which were fastened with long strips to a residential house or watchtower; when set in motion, they scared birds and thus prevented them from feeding off the farmland. For the irrigation of fields, water was conducted through treadwheels made of water containers built from sections of thick bamboo stems. Bamboos were also used as supports for young trees, crossbars for whole rows of trees, trellises, bean-poles, arches, and windings for ornamental and climbing plants. Moreover, shelters in the form of three- and four-sided pyramids or square frames were covered with bamboo stakes and straw mats to protect plants (Spörry 1903, 112–114).

Since the ocean surrounds the Japanese peninsula and many rivers cross the country, its inhabitants found ways to catch fish using various fishing devices and equipment. Some of which were simple fishing rods, fishing traps, or fishing nets. In many cases, and as still in evidence in present-day Vietnam, fishing nets were lashed to bamboo stems and cast into the water. Morse (1917a, 114) described one specific way in which the fishnet was arranged on two long bamboo stems in such a manner that both ends were attached to a framework that was fastened to the boat hull. In pushing the framework towards the water, the bamboo stems entered the water and simultaneously submerged the fishing net. With the reversal of this movement, the fisherman pulled the net out of the water, and all the fish caught in the net were easily tipped into the boat.

9.5. Bamboo's Part in People's Everyday Life

Throughout history, people used various natural materials to shape their material culture to produce innumerable things needed for daily life. Wood was probably the most used renewable material on a global scale, but nature offered humans another worthwhile material along with wood, namely, bamboo. Having discussed the various ways bamboo encountered Japanese people in Meiji Japan, it is evident that bamboo's ubiquity in Japanese material culture was tantamount to an insoluble enmeshment of bamboo in the daily routines of people. Mundane bamboo objects constituted many aspects of Japanese material culture in the Meiji era. Moreover, bamboo was an indispensable component of ritual and ceremonial activities, most vividly expressed by the Japanese tea ceremony. Bamboo was thereby not only an object of the tangible but equally of the intangible culture. Then as now, bamboo is a popular motif in art, painting, and literature and is a symbol of harmony between humans and nature. As before, bamboo is embedded in many customs, and people still perceive bamboo as a symbol of integrity, resilience, and adaptability. In Japan and other East and Southeast Asian countries, bamboo stands for a human's resoluteness, its straightness connotes sincerity, while its hollowness represents modesty, and the cleanness of its culms characterizes purity.

Materiality is fundamental to understand the social existence of humans in coexistence with the nonhuman other. Therefore, any discussion of the *social* that omitted the material aspects of life would be implausible and only partially true. Human action is related to tangible things surrounding us. And in pre- and Meiji Japan, a large part of these things was created from bamboo. If we broaden the definition of technology as something that is connected to industrial technology towards a more open term that would encompass pre-industrial craftwork, then pre-industrial Japanese material culture reveals much about the people's knowledge and interaction with the materials they had at hand. In this chapter, I predominately delved into bamboo's practical and functional relevance for daily routines to provide insights about how people used, interacted with, and manipulated bamboo and so shaped their lives and material surroundings. Above all, the design of bambooic things and the material culture related to bamboo were partly shaped by bamboo and the properties inscribed in it. Accordingly, while people were shaping bamboo, bamboo was equally shaping the people.

This chapter aimed to demonstrate how people's activities were mediated through tactile things. It thus discussed objects, constructions, contrivances, and tools mainly isolated from other things since they stand for themselves, having their own working principle and purpose, and demanded a particular use as expressed by certain activities. On the other hand, it is the entirety of things crafted from bamboo that surround humans and affect the material aspect of people's everyday lives and moreover represent the uniqueness of the human-bamboo relationship. In this respect, though I devoted attention to individual bambooic things, these things were part of a larger whole and representatives of Japanese people's inventiveness and their bamboo culture. In the same way, the craftspersons' and peasants' inventiveness, creativity, ideas, skills, and knowledge of how to work on bamboo, are manifested in ordinary everyday tools and objects.

Overall, bamboo was distributed through and used in many domains of life, and local bamboo culture flourished before the advent of industrialization: Japanese craftspersons and peasants had developed unique bambooic objects to carry out any daily activity, be it in agriculture, fishing, basketry, firefighting, body hygiene, the household, water supply, or the like. In doing so, Japanese people developed a resource-efficient material culture and, as Hanley concludes from her findings, compared with Western technology in the nineteenth century, Japanese material culture was not inferior to the West if measuring not the number of goods and commodities but the quality of life the material culture offered (Hanley 1998, 53). However, Westernization, industrialization, the introduction of new technologies and goods, and the development of a consumer society, amongst other things, had a profound impact on Japanese material culture and people's lifestyles and contributed much to the gradual decline of Japanese bamboo culture and bamboo's use in an everyday context.

On the basis of this chapter's findings, one can conclude that bamboo contributed much to the everyday lifestyle of Japanese society and facilitated manual labor, and provided practical solutions for everyday problems by its very nature.

10. Bamboo Cultures in the Americas and Africa Throughout History

Even though this work focuses mainly on the bamboo cultures in East and Southeast Asia, one should not forget that bamboos are equally endemic to other world regions, such as the Americas and Africa. Accordingly, overlapping with bamboo's natural distribution, people in the Americas and Africa integrated bamboo into their material cultures in pre-colonial (pre-industrial) times, in the recent past, and even in the present. In other words, wherever bamboo is and was endemic, people use(d) it in one way or another. In this light, this chapter addresses primarily bamboo's use by people native to the Americas and Africa.

First of all, bamboo's occurrence is unequally distributed in the Americas and Africa. Throughout the Americas, twenty-one genera occur naturally and encompass approximately 430 species of woody bamboos, nearly forty percent of them belonging to the *Chusquea* genus (Judziewicz et al. 1999, 55–63). In North America, only three bamboo species are distributed and were originally confined to the southeastern and, to a lesser extent, to the southwestern United States (Cirtain 2010, 8). In South America, in contrast, a wide variety of woody and herbaceous bamboos occur naturally. While only five species are endemic to continental Africa, thirty-two genera are naturally distributed in Madagascar (Bystriakova et al. 2003, 10).[71] These numbers, however, only give a general indication of the endemic bamboo species and do not reveal much about the extent to which bamboo was spread in a particular country or region.

Moreover, the mere number of bamboos does not correlate with bamboo's relevance for material cultures—as exemplified by the use of only a few bamboo species by the Bahnar people (see chapter 7.4.1), the Awa people as discussed by Loving (see chapter 7.5.2), as indicated by the three most valuable bamboo species in pre-industrial Japan (see chapter 9.4.1), or, as shown below, in relation to North America where pre-Columbian people created endless bambooic things even though having less than three bamboo species at their disposal. What is more, bamboo's current distribution does not correspond to its distribution prior to colonization. In many countries throughout the Americas and Africa, bamboos were reduced drastically. For instance, in North America, less than two percent of the natural distribution of bamboo is left, which is why bamboo was regarded as *critically endangered* in the late twentieth century (Noss et al. 1995, 80). A similar decline can be documented for Madagascar, where the distribution of bamboo is only a fraction of its original range (Bystriakova et al. 2003, 13). In the United

[71] For more details see chapter 2.5.1 where I discussed bamboo's worldwide distribution, and Figure 12.

States, the decline of bamboo's distribution is caused by early European settlers and their descendants' clear-cutting of bamboo groves to gain farmland and later dam projects flooding remaining bamboos on riverbanks.

Diseases, colonization, and warfare caused a massive decrease in the indigenous population and, together with the introduction of new tools and materials, led to a loss of bamboo-related material cultures. The bamboo plant's loss and the decline of traditional bamboo handicrafts, in turn, led to a meager scientific interest in bamboo's contribution to biodiversity and its role in environmental conservation and its part in people's material culture. This lack of scientific interest is, however, not limited to the United States. As demonstrated by Hidalgo-López (2003, xiv) for Colombia, almost no technical or scientific specification about bamboos was published until the late 1960s, even though Colombia is well-known for its rich bamboo diversity and even though people went on using bamboo until very recently. Thus, a systematic understanding of how bamboo contributed to the plant-based technological solutions and development of pre-Columbian people is still lacking. As a consequence, despite the importance of bamboo for the development of societies in the Americas, there remains a paucity of evidence on the extent to which bamboo was part of people's daily activities and part of their built environment—even though historical accounts provide some insights concerning this issue. In contrast, understanding the link between bamboo and people will help to retrace the human-bamboo relationship and how people used bamboo to meet their needs.

Accordingly, this chapter's underlying goal is to clarify how people in both the Americas (North America and South America) and mainland Africa embedded bamboo in their everyday material culture. Thereby, and in line with my definition of material culture in chapter 5.4.1 and bamboo culture in chapter 5.4.2, I took a closer look at the tangible bambooic things that people in the Americas and Africa produced or used. Thus, this chapter's underlying question was to ask which bambooic artifacts, tools, or houses existed in pre- and post-Columbian Americas and pre- and colonial Africa. In this context, I follow the socio-material theories (practice theory and ANT) approaches to things introduced in chapter 5.2, which advocate taking account of nonhuman entities' intrinsic material and physical properties and how humans develop(ed) together with and through things. To that extent, I am principally in line with Schatzki's understanding of social ontology according to which "social life inherently transpires as part of nexuses of human practices and material arrangements" (Schatzki 2003, 84), including a wide variety of entities such as humans, tools, artifacts, mundane objects, nonhuman animals, organisms, and the like.

On the other hand, and as also explained in chapter 5.2, I transcend Schatzki's practice theoretical approach and social ontology since my epistemological view revolves not in every case around the human actor but is generally open to all kinds of entities. From an empirical point of view and by following ANT's symmetric approach, my interpretation of historical sources and textual analysis was deliberately open to nonhuman entities and explicitly to nonhuman animals' actions and material use. It is this epistemological openness that allowed me—albeit very briefly—to investigate the connection of bamboo to wildlife habitat and biodiversity and the bamboo groves' inherent biological aspects alongside Native Americans' agricultural methods and bamboo culture in chapter 10.2.2.1, and in chapter 10.2.2.2, to study nonhuman animals' actions related to bamboo and thereby return to my discussion of intentional action in chapter 5.3.1. This endeavor—that is, to take account of nonhumans—would have hardly been possible from a practice theory viewpoint since the latter tends to have the human practitioner at its theoretic center, ignoring actions that are not immediately linked with humans.

Hence, the combination of socio-material theories (namely, practice theory and ANT) as social ontologies defined by either their human-centered or symmetric approach was instructive in setting the framework for my methodological approach, interpretation of (primary and secondary) textual sources, and research findings. And, at the same time, to transcend the bifurcation of the world that pervades the Western intellectual tradition.

Nonetheless, my general focus in this chapter lies on the human-bamboo relationship and takes a closer look at bambooic things as part of humans' surroundings. Therefore, by aiming to clarify my research question, I attempt to reveal insights into some aspects of bamboo's part in material cultures and how bamboo's very materiality affected people's lives. As a result, in my presentation of bambooic tools and goods in pre-industrial Americas and Africa, I highlight the physical-mechanical characteristics of the bambooic things and depict how they relate to bamboo's inherent properties. And, in doing so, I follow Ingold's critique of Aristotle's hylomorphism (chapter 5.3.3), arguing that in the "field of forces, the form emerges as a more or less transitory equilibration" (Ingold 2012, 433). In other words, the creation of things is always associated with the given properties of raw material, and, consequently, the scientific analysis of people's use of human-made things (agricultural tools, mundane objects, houses, rafts, weapons, and the like) must take a closer look at the material property of these things deriving from the raw material's intrinsic physical-mechanical properties and how people exploited or enhanced these properties. For this purpose, I studied historical accounts concerning the use of bamboo.

The following chapter (10.1) discusses my methodological approach and evaluation of the primary and secondary sources used to elucidate this topic. After that, chapter 10.2 conceives and examines the development of indigenous people's material culture in the Americas as *isolated* from other world regions until the arrival of Europeans in the late fifteenth century. Giant bamboo culms washing up on the Azorean islands or mainland Europe were held as evidence for countries lying further west. In this context, I shall give a concise account of bamboo's part in *discovering* the Americas (10.2.1).

Following this introductory part, chapter 10.2.2 is mainly concerned with bamboo's use by pre-Columbian people in what is now the United States. After describing bamboo species endemic to the United States and bamboo groves' ecological role for wildlife conservation and some criticisms of a European perception of the Americas as *pure* and *untouched* (in chapter 10.2.2.1), chapter 10.2.2.2 explores, as mentioned above, bamboo's significance for animals' material culture by way of two short examples. After that short excursion to the nonhuman use of bamboo, I depict bamboo's use by native people in the southern regions of the United States from the eighteenth century to the first decades of the twentieth century (10.2.2.3).

Afterward, I indicate bamboo's involvement in Ecuador as a placeholder for discussing bamboo's part in South America's material culture (chapter 10.2.3). The first section of chapter 10.2.3.1 discusses bamboo's use before the pre-Columbian era by means of archaeological findings and radiocarbon analysis of museum artifacts. The second section refers to the early accounts of Alexander von Humboldt and Aimé Bonpland and their description and observation of bamboos in the first decades of the nineteenth century. Then, by way of Ecuador, the next chapter (10.2.3.2) addresses how some traditional techniques involving bamboo are still maintained by some people.

In chapter 10.3, after describing the loss of bamboos and its consequences on humans and wildlife in chapter 10.3.1., I shall demonstrate how people in various regions of Africa utilized bamboo from the late eighteenth to the early twentieth century (chapter 10.3.2).

The reader should bear in mind that this dissertation is mainly based on the study of East and Southeast Asian bamboo cultures in present times and throughout history. Thus, a complete discussion of bamboo cultures in the Americas and Africa lies beyond my scope. On the other hand, since this thesis intends to make a crucial contribution to research on the human-bamboo relationship throughout human history by demonstrating its ties in all world regions, scrutinizing bamboo's part in the Americas and Africa will reveal insights into bamboo's global material history and its general contribution to people's material cultures.

10.1. Methodology and Literature Review

Awareness of bamboo's part in indigenous people's material culture is not recent. Historical accounts by early Europeans describe certain techniques and tools involving bamboo from their very arrival.[72] However, there is a relatively small body of literature in history, the history of technology, or anthropology that is explicitly concerned with bamboo and its use before European colonization and colonial times. Only in recent decades have scholars gradually revealed some insights concerning bamboo's part in people's lives throughout history.

Concerning my research goal of this chapter, which aims to portray bamboo's part in the material culture of indigenous people, I conducted a textual analysis of primary sources to obtain first-hand information and secondary sources containing valuable information—thus, this chapter is the result of research work in the field of history. The primary sources consisted principally of historical accounts that allowed me to investigate the bambooic objects and the built environment surrounding native people and, so, to evaluate bamboo's part in material cultures. Secondary sources of various academic disciplines (such as archaeology, biology, or architecture) provided the necessary background knowledge to delve into the characteristics of bamboo-based or bamboo-related material cultures. Overall, I preferably draw on text-based written records and, in comparison to the other parts of the present book, I (except for one photograph) could not make use of photographic illustrations, for most of this chapter is concerned with a time when photography was non-existent or just beginning to evolve.

[72] Concerning the denomination of the indigenous peoples of the United States, many different terms exist at present. In this chapter, I shall use the predominantly the term *Native American* and occasionally *First American* to emphasize that people before the Europeans populated the United States. In a similar sense, and following my definition of the terms *indigenous* and *ethnicity* in chapter 6.1, I will also use the terms *indigenous people* or *ethnic group*. In contrast, I consider the terms *Indian* or *American Indian* as questionable because both could also refer to the inhabitants of India. Moreover, and although it would be crucial to differentiate between the different ethnic groups and their respective proper names, referring to an ethnic group's name remains challenging due to the lack of information provided by historical accounts. Simultaneously, using the terms *Native American* or *indigenous people* to describe and summarize pre-Columbian cultures as generalized catchall terms is not intended to neglect people's various cultures, languages, belief systems, and the like.

The literature I refer to likewise hardly provides sketches or other types of images which would have provided visual information that could help depict certain bamboo tools or techniques implicating bamboo. Moreover, due to this dissertation's limited scope, I could not study museum archives concerning bambooic artifacts, which could have clarified some tools and mundane artifacts in terms of form and shape. Nonetheless, my analysis, evaluation, and interpretation of historical source material and critical review of secondary sources provided a solid groundwork to discuss the distribution of bamboo cultures in the Americas and Africa, even though not complete and rather fragmentary. Furthermore, in line with my specification in chapter 5, my methodological starting point is driven by socio-material theories. Thus, analyzing the historical records meant to query the role of bamboo in the various encounters with humans' actions. My approach was to put special emphasis on bamboo's part in people's material cultures. Hence, the present chapter's presentation of bamboo is primarily based on a bamboo-centric approach as part of the human-bamboo relationship in order to study the material history of bamboo in connection with the Americas and Africa. Moreover, I consider the human history related to bamboo as an "activity-embracing nexuses of practices and arrangements" (Schatzki 2003, 85) and attempted to identify and describe bamboo-related activities whenever possible.

What is more, primary sources that were written by European traders, explorers, conquistadors, and scientists and published during the colonial era are, of course, problematic due to the biased views of many authors. While some authors were outright racists, others had little or no knowledge or interest in native people, their language, immaterial and material culture, or society. Nonetheless, these firsthand accounts offered valuable clues to interpret bamboo's ancient use in pre-colonial and early colonial times despite some shortcomings and their authors' prejudices. Secondary sources added further information to this topic and contributed much to my discussion of the utilization of bamboo.

By and large, comprehensive works that discuss local people's material culture during the first periods of the Columbian era are rare and only give partial insights into local people's material culture and bamboo's use. Concerning Africa, one can state that little was known about Africa until the so-called Scramble for Africa beginning with the Berlin Conference of 1884, and Westerners' interest in the continent's topography, geography, natural resources, and native people's (material) culture and social structure increased only gradually.

The main historical accounts that I examined concerning the Americas are primarily from the early eighteenth century until the first part of the nineteenth century—a time when some aspects of traditional local material culture still survived. The historical accounts used to study bamboo's part in the lives of people native to Africa, which I examined for this chapter, were published from the 1870s to the 1920s. In the following, I present the literature in connection with the three continents: North America, South America, and Africa.

Concerning North America, I confined my study to the people native to the United States and their use of bamboo and examined books written in French and English. One early historical account with ethnographic descriptions of Native American life was written by the francophone ethnographer and historian Antoine-Simon Le Page du Pratz, who lived in the French colony of Louisiana from 1718 until 1734—a time where Europeans sparsely inhabited Louisiana. Seventeen years after returning to France, he published his memories in articles and later in 1758 as a comprehensive book entitled *L'Histoire de la Louisiane*. On the one hand, Le Page du Pratz was interested in local customs and languages; he spoke the Natchez language of Creek and Cherokee peoples of Oklahoma and learned much about Native Americans' culture. On the other hand, he was a slaveholder and responsible for the captivity and exploitation of enslaved Africans (Van Horne 2017, Usner 1979). Nevertheless, Le Page du Pratz's descriptions of Native American lives are worthwhile in retracing bamboo's connection to local ethnic groups.

A further early work entitled *The Natural History of North Carolina* (first published in 1723) was written by John Brickell, who lived in North Carolina in the early eighteenth century. Although his book is "somewhat grotesque and largely compiled" (Robinson 1916, 230) with many racist comments, it still sheds light on bamboo's use prior to its large-scale disappearance.[73]

Another, more comprehensive book is James Adair's *The History of the American Indians* (1774). Adair, an Irish trader who lived in the first half of the eighteenth century in the southwest of the later United States, highlights some aspects of the material culture and the daily life of Native Americans during his time and helped outline some techniques and objects involving bamboo.

Scholars studying the Native American peoples' (material) cultures in the early twentieth century after the establishment of anthropology, such as the American anthropologist John R. Swanton, discuss bamboo's integration in indigenous people's everyday life, although not thoroughly interested in bamboo's part in these societies. Thus, while Swanton's *Source Material*

[73] Brickell describes Native Americans as *poor creatures* or *miserable men* who should be judged and instructed by ordinary planters and missionaries (1737, v).

for the Social and Ceremonial Life of the Choctaw (1931) provided only some details of rituals related to bamboo, his later, comprehensive work, *The Indians of the Southeastern United States* (1946), provided many relevant aspects associated with Native American people's immaterial and material culture and bamboo's part in it and was vital for compiling this chapter.

Platt et al. (2001) and Platt et al. (2009) discuss the botanic aspects of bamboo in North America in their articles *Canebrake Fauna: Wildlife Diversity in a Critically Endangered Ecosystem* (2001) and *Native American Ethnobotany of Cane (Arundinaria spp.) in the Southeastern United States: A Review* (2009). In another article, entitled *Canebrakes - An Ecological and Historical Perspective* (1997), Steven G. Platt and Christopher G. Brantley examine historical records concerning bamboo's pre-Columbian distribution and use by indigenous people. Through the study of historical accounts from the early eighteenth to the twentieth century and contemporary works, these three articles provide a comprehensive overview of how Native Americans' lives were associated with bamboo, how early Europeans encountered bamboo groves, and how the bamboo groves' destruction affected and still affects the wildlife and environment. Overall, these works offered many significant insights into bamboo's relevance for humans and the ecology.

Concerning the South American bamboo cultures, I studied fewer sources due to this thesis's limited scope. Nonetheless, by referring to Jorge A. Morán Ubidia, an Ecuadorian architect studying Ecuador's past bamboo culture, and his article *The Use of Bamboo in Ecuador: Past, Present, And Future* (1985), I outline traces of pre-Columbian bamboo cultures in South America using the example of Ecuador. Strydonck et al.'s short but insightful text *Dating Precolumbian Museum Objects* (1992), in which the authors discuss their findings based on radiocarbon determination of the age of pre-Columbian bamboo looms of the Inca, helped to clarify the long-lasting use of bamboo before European colonization.

Since *Guadua* species stand out due to their superior material qualities, I used Alexander von Humboldt and Aimé Bonpland's *Plantae Aequinoctiales* (1806) to outline these bamboo species' characteristics and uses in addition to Judziewicz et al.'s seminal work *American Bamboos* (1999) and Bystriakova et al.'s book *Bamboo Biodiversity* (2003), which also revealed insights concerning the significance of *Guaduas* in South America. Finally, Oscar Hidalgo-López's *Bamboo. The Gift of the Gods* (2003) provided valuable information about South American and Columbian bamboos and their contemporary use.

The discussion of bamboo in Africa remains very sketchy and only intends to indicate bamboo's use in some regions. In this light, after providing a general overview of bamboo's distribution in continental Africa and Madagascar using Bystriakova et al.'s *Bamboo Biodiversity* (2003), I confined my research to three historical accounts. One is Georg Schweinfurth's *Im Herzen von Afrika* (1874), the others are George T. Basden's *Among the Ibos of Nigeria* (1921) and Theo Kassner's *My journey from Rhodesia to Egypt* (1911). Georg Schweinfurth was a Baltic German botanist and ethnologist who traveled up the Nile starting from Khartoum from 1868 to 1871. Like other travelers through this region, he was able to observe various uses of bamboo that he partially depicts in his two-volume book published in 1874—at a period when European colonialism was not spread throughout Africa as much as in later decades. George Thomas Basden (1921) was a missionary who lived in Nigeria from 1900 to 1935 and studied Igbo people's society and culture. Although Basden's book is full of racist comments, emphasizing the *primitive instincts* of the black people, it sheds some light on how Igbo people used bamboo and points out some aspects of bamboo concerning vernacular architecture. Wilhelm Kassner, a German geologist and plant collector who traveled through Southern and East-Central Africa, also mentions some usages of bamboo and, in doing so, sheds light on bamboo's use in colonial mainland Africa.

10.2. Bamboo in the Americas

Homo sapiens, the ancestor of modern human, settled about 50,000 years ago from Africa to Asia and subsequently populated the rest of the world. New studies about the settlement of the Americas suggest that *Homo sapiens* migrated to northern America between 13,000 and 30,000 years ago (Goebel et al. 2008, 1,500) by crossing Beringia—a prehistoric landmass, which connected Siberia and Alaska until rising sea levels submerged the last existing corridor in about 11,000 years ago (Boyer 2016, 2–3). From that time on, a gene flow between humans of the Americas and the rest of the world was interrupted, as was any cultural and technological exchange. So a divergent development started at this time and both the Americas and other world regions developed autochthonous material and bamboo cultures separated from other bamboo cultures in East and Southeast Asia or Africa. Furthermore, since early *Homo sapiens* arrived from cold climatic regions (northern North America) where no bamboo existed at all, bamboo's use in the pre-colonial Americas was not linked to any prior use of bamboo but must have evolved on its own.

10.2.1. A Side Note on the *Discovery* of the Americas

Even though many pre-Columbian transoceanic contact theories claim that different global regions (such as South and East Asia, Africa, or Polynesia) had contact with the Americas or even landed in the Americas, Columbus's *discovery* of the Americas in 1492 had the most profound impact on people on both sides of the Atlantic but particularly to the history of the Americas.[74] Europeans introduced new materials, animals, plants, technologies, their customs, worldviews, and Christianity as well as diseases which were until then unknown for those who inhabited the pre-European Americas. Being in touch with all these new things originating from the *Western Hemisphere* changed the lives and cultures of people native to the Americas.[75] Simultaneously, European colonization affected many people's lives due to the invaders' brutality and hegemonic power. The colonizers fought and ruled over the indigenous people's very lives and existence.

With regard to the *discovery* of the Americas, bamboo and the Gulf Stream played a prominent role. According to the French historian Lorgues de Roselly, who quotes Antonio de Herrera y Tordesillas (a Spanish chronicler, historian, and writer born in 1549 and died in 1626), King Alfonso V, who was interested in natural sciences, accidentally found a few canes of colossal dimensions which strong tides had brought to the beaches of the Azores (Roselly de Lorgues 1878, 157). And according to Humboldt, quoting the same source, Columbus' brother-

[74] For instance, the Viking Leif Eriksson found land westwards of Greenland some 500 years earlier than Columbus. Excavation started in the 1960s gave evidence of a Viking settlement in Newfoundland around 1000 CE (see, for instance, Nydal (1989). Speaking of discovery here implicates two aspects. On the one hand, one might say that the interest and belief of land existing further East and their exploration is a personal accomplishment and indeed a discovery. On the other hand, one cannot discover an entire continent that already existed, though it was unknown to Europeans.

[75] The term *Old World*, specifically meaning the world commonly known in Europe (Europe, Asia, and Africa), in contrast to the term *New World,* including the continental landmass of North and South America, can be conceived as geographic and culturally distinct regions. Notwithstanding the fact that both terms could be useful expressions to identify a demarcation between material cultures, belief systems, technologies, worldviews, and the like, *prior to* the encountering of both world regions and even though both terms are still frequently used in academic writing, they remain problematic terms for at least two reasons, first, due to the European ethnocentric coining of these terms. Second, due to the false perception of the Americas as pristine or virgin lands, though this *New World* was inhabited for more than 10,000 years and modified by its people. In this sense, to avoid a biased language, I shall use the less tainted terms *Eastern Hemisphere* or Europe and *Western Hemisphere* or *the Americas* instead of *Old World* or *New World* to characterize the regions and the subsequent changes.

in-law found these "strange reeds" along with two corpses of indigenous people, which "attracted the attention of the Genoese navigator [Columbus], who conjectured, that both came from a continent situate towards the west" (1818, I, 59).[76] In another passage, Humboldt highlights the Gulf Stream's significance in the *discovery* of the Americas and points out that "the Gulf Stream furnished the genius of Christopher Columbus with certain indications of the existence of western regions" (ibid.).

But why was it bamboo and not for example a tree trunk, washed up in western Europe, on the Azores, that indicated the existence of a landmasses further west and a maritime travel route to the west? First, trees were known in Europe, but the (giant) bamboo plants were not. Finding the latter, therefore, naturally aroused the curiosity and interest of navigators searching for a sea route to India. Second, since the main difference between bamboo culms and tree stems in terms of buoyancy and water displacement lies in bamboo's characteristic air chambers; in contrast to trees, the air enclosed in bamboo's internodes transforms the bamboo pole into a perfect buoy, floating on water and enabling its transport for long distances. Third, many bamboos throughout the world are well adapted to alluvial zones and grow close to rivers and riverbanks due to their rhizomes' anatomical structure and large air channels in the bark of several bamboo species (Liese and Tang 2015, 242; Kuehl 2015, 108). Given bamboos' occurrence close to rivers, assuming that large bamboo culms fell into the river water, these culms might have been swept along by the current of the rivers and reached Europe on the Gulf Stream. A fourth fact which might have led to bamboo washing up in the east is related to many bamboo plants' gregarious flowering and a subsequent die-off of thousands of bamboos at one time, which probably increased the chance that a tiny part of countless culms arrived in the east, transported by the Gulf Stream. For instance, dead culms of *Guadua aculeata*—a very durable bamboo species with up to twenty meters in height endemic to Mexico and regions adjacent to the Gulf of Mexico—might have been carried by rivers into the Gulf of Mexico and transported eastwards by the Gulf Stream. Then, found by Europeans, these unknown, extraordinary giant hollow stems must have been held by navigators and natural scientists to be evidence of land in the west.

[76] According to Humboldt, it was Columbus's brother-in-law "Peter Correa, governor of Porto Santo, [who] found on the strand of this [Azorean] island pieces of bamboo of an extraordinary size, brought thither by the western currents" (1818, I, 28).

10.2.2. Bamboo in North America

North America can be thought of as the northern subcontinent of the Americas. Hence, writing about bamboo's use in North America in this chapter, as indicated in the heading, would include Canada, Mexico, and Central America (including present-day El Salvador, Costa Rica, Belize, Guatemala, Honduras, Nicaragua, and Panama). Thus, areas where bamboo is widely spread. However, studying bamboo culture in all these countries would go beyond the scope of this chapter. Therefore, the chapter focuses on the distribution of bamboo limited to one region, namely, the areas that later became the southern states of the USA. My restriction to the United States is simply due to the prevailing existence of English and French historical accounts, necessary to demonstrate bamboo's part in indigenous people's life.

There are three bamboos endemic to the United States, and all belong to the *Arundinaria* family. In pre-Columbian times, these bamboos occurred mainly in the southeastern regions of the United States. The most valuable bamboo was *Arundinaria gigantea*, also known as *river* or *giant cane* because of growing up to ten meters with seven centimeters in diameter; less valuable but still crucial for specific purposes were *Arundinaria tecta*, with its vernacular name *switch cane*, which reaches a height of about two meters and wall diameters of up to two centimeters; and *Arundinaria appalachiana,* which is commonly known as *hill cane* and attains heights of half a meter to one meter and a culm diameter of up to six centimeters (Cirtain 2010, 8; Tripplet et al. 2006).[77]

Regarding the distinction of these bamboos, one should keep in mind that few historical accounts distinguish between them and comment on their different characteristics. One who draws a distinction between the large and small bamboo was Le Page du Pratz. He describes *Arundinaria gigantea* as thick as a wrist (with a height up to five and a half meters) and accounts that it mostly grew in moist places. In contrast, the other two species had a lower growth height with less thick culms. Indigenous people predominantly used *Arundinaria gigantea* to create the vast majority of their bambooic objects, such as mats, sieves, small boxes, and other items of everyday utility, and exploited *Arundinaria tecta's* and *Arundinaria appalachiana's* hard

[77] These bamboos are found in North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia (Tripplet et al. 2006, 80). The analysis of historical accounts about bamboo shoots as a source of food gives information about bamboo's natural occurrence. Swanton (1946, 293) lists the distribution of vegetable foods and ethnicities in the southeastern United States by analyzing references in the literature. According to him, bamboo sprouts were eaten in Virginia and North Carolina, but not in South Carolina and Florida.

culms to produce the versatile and important bamboo knives (Le Page du Pratz 1758, 58) and various kinds of arrows (Brickell 1737, 35).

10.2.2.1. Environmental Modifications: Growth and Loss of Bamboo Groves Throughout History and The Effects on Biodiversity

People's adaptation to and exploitation of the environment affected and modified nature, including the fauna, flora, landscapes, and bamboo's very existence, and was associated with both the human population and settlement density. When Europeans and Native Americans came into contact with each other, hundreds of thousands of native people inhabiting the later Unites States died due to their non-resistance to European diseases. Their population declined to just ten percent by 1650 compared to 1495, while the Europeans' population increased subsequently but still was not significant by 1750. As the Native American population declined, so did indigenous agriculture and settlements, giving nature time and space to recover from anthropogenic modification. These declines and nature's subsequent recovery are explanatory of why Europeans perceived the North American landscape and the environment as pure, wild, almost untouched, or virgin—particularly when entering the hinterlands of America about 250 years after Columbus's landfall.

Thus, the endless horizon of the Americas, if compared to overcrowded European landscapes, led to the description of the *new* land as an untouched paradise—not realizing that nature had recovered after the indigenous people's depopulation (Denevan 1992, 379–381). This one-sided Western perspective of nature and landscape is criticized by the US geographer William Denevan (1992), amongst others, and critically paraphrased with the term *pristine myth.* In reality, indigenous people had changed their surroundings with different agricultural methods and intensities. "By 1492," as Denevan put it, "Indian activity had modified vegetation and wildlife, caused erosion and created earthworks, roads, and settlements throughout the Americas" (1992, 379). So, the pre-European environment and landscape of the Americas had already been *modified* by indigenous people before the Europeans' arrival.[78]

[78] Concerning the impact of pre-Columbian people on the environment, Kowtko (2006, 6) points out that Native Americans frequently used burning methods to clear the land and to gain and maintain prairie environments. As a result, people's annual burning methods renewed the grasses but equally developed resilient roots and, according to Kowtko's (ibid.) conclusion, as a consequence, expanded grasslands became a predominant vegetation environment in vast parts of North America. See also my discussion about the modification of the environment in chapter 7.3.

Consequently, like many other plants, the distribution of bamboo groves was linked to an anthropogenic modification of the environment by pre-Columbian people. In this context, and in relation to the United States, Platt and Brantley (1997, 13) note that the decline of the indigenous population alongside their harvest of bamboo needed for their material culture in connection with the decline of shifting cultivation—and thus, the method to clear bamboo groves by fires to gain agricultural farmlands, which indirectly confined bamboos' natural spread—facilitated a relatively fast recovery from human interferences and led to an expansion of bamboo groves, supported by bamboo's rhizome system allowing a fast and aggressive spreading. As a result, particularly those bamboo stands growing close to abandoned Native American settlements and fields could re-cover the landscape and build dense thickets (ibid.). Finally, bamboo groves got even thicker than they were under modification by Native Americans.

Europeans and their descendants initially adapted some indigenous people's uses of bamboo and valued a bamboo area for livestock grazing (ibid., 1, 14) but subsequently bamboo was seen as an obstacle to travel across the country and to agricultural use, as bamboo covered fertile land that hindered their use as farmland. Due to its density, a thicket of several thousands of culms of *Arundinaria gigantea* was called *canebrake*, composed of the two words *cane*, which could encompass stems of reeds and bamboos, and the term *brake*, meaning *thicket*, *understory*, or *place overgrown with bushes*. According to many historical accounts written by early European settlers (see my comments on this in chapter 10.2.2.3), these canebrakes (or bamboo groves) were almost impassable and dominated many landscapes in the United States' southeastern regions.

However, even though bamboos grew and covered swaths of land, bamboos disappeared in a relatively short period of time when Europeans began a massive destruction of bamboo, caused by "a combination of overgrazing, altered burning regimes, and agricultural land-clearing" (Platt et al. 2001, 2)—though it was a laborious undertaking to clear-cut bamboo.[79] While the aboveground bamboo culm is easily cut, the underground rhizomes have to be dug up or destroyed since they store valuable nutrition that would keep the aboveground plant alive. Despite bamboo's resilience, only a few bamboo areas survived European settlers' interference, finding protection in low-lying lands along rivers until dam constructions in the recent past destroyed their last remaining refuges (Platt and Brantley 1997, 15).

[79] For a more detailed description of how European stockmen and settlers affected bamboo's habitat and growth, see Platt and Brantley (1997).

The massive destruction of canebrakes not only destroyed the basis for bamboo's part in material culture but also led to the extinction of many animals. And until recently, scientific disinterest in bamboo resulted in a fragmentary knowledge of bamboo groves' biological aspects and their contribution to biodiversity in the United States. To fill this gap, Platt et al. (2001) studied historical and contemporary sources to reconstruct the ecosystem of canebrakes and their part in wildlife habitats. The authors state that, even though the occurrence of animals in canebrakes is not very well studied, "50 species were documented in cane habitats, including 23 mammals, 16 birds, four reptiles, and seven invertebrates" (Platt et al. 2001, 10). Many animals, which were specialized in bamboo, were defenseless against the loss of canebrakes so that their population diminished, while others could adapt to other ecosystems (Platt et al. 2001, 11). Judziewicz et al. (1999, 77) report that at least three bird species, which relied on bamboo seeds and found shelter in the canebrakes, became extinct with the *Arundinarias*' destruction and decline. Different strategies for canebrake restoration were followed, however, so that bamboo groves provide shelter and cover for animals again and can help re-establish a wildlife habitat (Cagnon 2007, 102–108).

10.2.2.2. Animals' Use of Bamboo

As mentioned above, bamboo is essential for wildlife habitats and its surrounding environment. Some animals' existence is (or, before their extinction, was) dependent on bamboo groves, while other animals need(ed) bamboo for specific purposes. Discussing the beaver's and bear's use of bamboo below alongside my discussion of human bamboo culture in this section is intended to provide an insight into the nonhuman animals' integration of bamboo in their lives. Following my critical discussion of the problematic conception of humans as self-contained beings contrasting with (nonhuman) animals and by highlighting the commonality of humans and animals in terms of developing, learning, and becoming (Ingold 2000) in chapter 5.2, and Beth Preston's (2019) thoughts and comments on the beaver's intentional creation of constructions together with Lewis H. Morgan's emphasis on "the beaver's architectural skills" and "how beavers form their environment" (1868, 18) in chapter 5.3, my discussion of bamboo's utilization by animals is intended to underline, albeit very briefly, bamboo's part in animal material cultures or at least bamboo's use for specific purposes.

One example which illustrates how beavers used bamboo was observed and commented on by le Page du Pratz (1774, 241–242), according to whom the joists of the beaver's cabin were made of timber, whereas the flooring was made of bamboo and grass. By using bamboo for his construction, the beaver benefited from bamboo for at least three reasons. First, on the strength of bamboo's natural buoyancy, making it a suitable material for solid flooring. Second, due to *Arundinaria gigantea*'s ubiquity and distribution close to riverbanks, the beaver could collect needed construction materials, which involved short transportation distances. And third, the relatively easy cutting of bamboo culms due to their low material density owing to bamboo's hollowness reduced the time required for cutting, especially compared to the greater effort required for tree wood.

Concerning the beavers' construction and abilities, Morgan points out that "the dam, the lodge, the burrow, the tree-cutting, and the artificial canal; each testifying to his [the beaver's] handiwork, and affording us an opportunity to see the application as well as the results of his mental and physical powers" (1868, 18). Overall, the beaver is capable of constructing a network of various structures using trees' and bamboos' inherent material properties by means of its body composition to control the flow of water and create a shelter.

Adair (1775, 309) gives another example that reveals how a bear constructed its den by using tree branches and large bamboo branches for its hibernation. Bears generally den in various places and are well adapted to their surroundings but need to be protected from the wind, water, and sunlight during hibernation. According to Adair (ibid.), bears raised tree branches to a suitable height and covered the den's top with large bamboo twigs and leaves (*Arundinaria gigantea*). A bear's use of bamboo branches and leaves for this purpose is most probably linked to bamboo's evergreen foliage during winter, in contrast to deciduous trees, and provided an excellent foliage cover, sufficient to hinder raindrops' and sunbeams' penetration and, so, to protect the bear from disturbance during its hibernation.

Consequently, animals' creation of bambooic things, though different in quality and quantity, resembles humans' use in the manner that both transform a natural material into an intentionally employed thing necessary for a special purpose. In doing so, humans, as well as animals, exploit bamboo's material and botanical properties. Bamboo's buoyancy, for instance, is used by the beaver to build his constructions and by humans to build floats. Likewise, bamboo's green foliage, used by the bear to cover its den, finds a corresponding use by humans as exemplified by using bamboo foliage as shade to protect children from sunrays (see Loving [1976, 542] and the Awa people's use of bamboo twigs for shade).

10.2.2.3. The Use of Bamboo by Native Americans

Our knowledge about the bamboo cultures in the Americas is mainly confined to historical accounts, mainly written by Europeans with their biased, Eurocentric perspective on indigenous peoples' (im-)material culture and, to a lesser extent, to data from preserved artifacts and archaeological excavation. So, a comprehensive study of ancient pre-Columbian material and immaterial cultures must consider the Western perception of the so-called *New World* and Europeans' biased view concerning the pre-Columbian lives of people native to the Americas. Given that the native peoples of the southeastern United States had a close relationship with bamboo, why is little known about it? According to Platt et al. (2009, 279–280), the reason for this lack of knowledge is the fact that authors of historical records did not examine the material culture concerning bamboo's use very well. For this reason, any description of an ancient bamboo culture, relying on historical records, will remain fragmentary because the examined data is already incomplete and based on its author's biased perspective. On the other hand, historical accounts lay the groundwork for scientific analyses of ancient indigenous people's lives and, thus, enable contemporary scholars to reconstruct bamboo-related material aspects of some traits of indigenous people's everyday lives and their use of mundane objects.

At the beginning of the eighteenth century, even though the number of European settlers was relatively low, European goods and tools had already arrived in the Americas' hinterland. Due to the fact that science and the technology of metals in the pre-European Americas was not well developed—in spite of naturally occurring metals like gold, silver, and copper; no alloy was common—the indigenous material culture was based on naturally occurring materials, which explains why pre-Columbian Americans were particularly interested in Western iron tools.

Consequently, people native to North America bartered Western goods such as knives, axes, and guns, with their own products such as deerskin, buffalo skin, or furs. This trade, however, had major effects on Native American material culture and lifestyle, involving new tools for hunting and warfare or tools to work on wood and bamboo, for instance. Unsurprisingly, then, iron replaced many pre-Columbian tools because of having better material properties. So, for instance, the head of the widely used tomahawk (a single-handed ax), which was initially made of stone, was replaced by iron, as was the case with the traditional spearhead, originally made of flint and used by many indigenous people such as the Natchez people (Swanton 1946, 583). Needless to say, tools that relied on bamboo were gradually replaced by Western tools, too.

In other cases, Western devices and tools were rebuilt with local materials. One specific case involving an adaptation of Western technologies and knowledge in metallurgy by Native Americans, where bamboo was utilized to replicate bellows, is discussed by Swanton. According to him, Native Americans' replication and use of bellows for processing silver and copper were most probably introduced by Europeans. Concerning bamboo's utilization, Swanton mentions that the bellows were "made of a piece of cane narrowed to a small point at one end and fitted at the other with a mouthpiece of tinhorn or some other suitable material. Through this, they [Native Americans] were enabled to concentrate the breath on the metal, the latter being laid on one piece of flint and struck with another" (1931, 43).

By and large, what is known about Native American's bamboo culture is minimal. However, according to Platt and Brantley, in pre-European times and still when European settlements were few, Native Americans of southeastern United States maintained bamboo "near villages to supply raw material for construction of dwellings, fences and other structures, and for a wide array of weapons and personal items" (1997, 13). Based on their findings and their literature review, Platt et al. further state "that Native Americans used cane for a multitude of purposes . . . [which] permeated virtually every aspect of tribal life" (2009, 279). Swanton makes some other significant comments concerning bamboo's use in the late nineteenth century:

> Cane supplied one of the most important of all raw materials. Besides the use of its seeds, . . ., it was employed in making baskets and mats; as building material; in making fishing crails and traps, spears, and arrows; as backing for wattle walls; in making beds in houses and in the construction of corncribs; as a substitute for the shuttle in weaving; as knives and torches; in the "spiral fire" at Creek councils; in making boxes, cradles, sieves, fanners, hampers, blowguns, blowgun arrows, shields, stockades and fences, rafts, litters, flageolets, counters, drills, and tubes through which to blow into the medicines; as pipes to blow the fire in burning out mortars and in smoking; and sometimes a section was employed to hold braids of the hair. (Swanton 1946, 244–245)[80]

[80] Even though the term *bamboo* was already known in the eighteenth and midst nineteenth century, there is a general problem in many historical accounts and "ethnohistorical literature, [where] the vernacular names 'cane' and 'reed' are used interchangeably" (Platt et al. 2009, 272). In view of that fact, Swanton continuously uses the term *cane* in his work instead of bamboo; other authors used reed and cane equally, leading to confusion.

This summary of bamboo's uses in North America reminds one of the miscellaneous uses of bamboo in Asia. Other ethnic groups, such as the Yoeme (or Yaqui), living in what is today the northwestern Mexican state of Sonora and southern Arizona, also "fashioned cane into a great number of articles, including mats for roof and wall materials, household compound fences, sleeping mats, cutting instruments, spoons, and shelves as well as numerous ceremonial items" (Pritzker 1998, 135). Other ethnic groups, residing in the southeastern part of the United States, also exploited bamboo as "raw material, used in making baskets and mats, houses, arrows and darts, containers, musical instruments, and many other items" (ibid. Pritzker 519) and occasionally used bamboo to create beds and rafts, cane spears, arrows, and harpoons (ibid., 527, 555, 573). In my view, the implication is that—even assuming that the use of bamboo may not have been quite as extensive as that of other ethnic groups described in this book—the bamboo consumption must have been substantial, as both the built environment and items of everyday use were made of bamboo.

By aiming to show some other traits of the Native American bamboo culture, the following sections will provide a snapshot of bamboo's part in material culture by enumerating some of bamboo's miscellaneous utilizations. For a better systematic representation, bamboo's various usages will be grouped into categories highlighted in italics and discussed below in the following order: 1) *Bamboo Groves and Shifting Cultivation;* 2) *Bamboo Rafts;* 3) *Tools and Weapons for Warfare, Hunting, and Fishing* (including *bamboo shields, bamboo knives, tools for hunting and fishing, driven hunts, blowguns, deerstalking,* and *bear hunting);* 4) *Illumination Using Bamboo;* 5) *Bamboo Weaving Products (*including *basketry, mats, beds, bamboo wattling as a covering for a deceased person,* and *granaries);* and finally, 6) *Bamboo Culms and Bamboo Groves as Cover, Defense, and Ambush (*including *palisade* and *canebrakes as cover, defense, and ambush).*[81]

1) Bamboo Groves and Shifting Cultivation

Bamboo is commonly known to improve soil fertility and serves as an indicator when planning new plantations. In this context, Le Page du Pratz (1758, 176) emphasizes bamboo's part in southeastern Native Americans' agricultural system. According to him, the indigenous

[81] Not all of bamboo's uses mentioned in the historical accounts are described in detail but will be mentioned at this point. According to Le Page du Pratz (1758, 310, 177, 179, 175), bamboo was used as a simple tube to ignite fire; as a cradle for children made of straight pieces of bamboo; as crucial material to create sieves of different sizes and shapes; and bamboo was used as a building material for houses.

inhabitants knew about bamboo's positive effect on soil nutrition and quality. This is why native people set bamboo groves on fire to prepare new fields for corn plantation by applying the shifting cultivation method that enriched the soil with valuable ashes. Before starting with the clearance, however, the bamboo culms had to be cut or felled using a pickax to make them lose their high moisture content. Finally, after some days of drying, entire canebrakes were set on fire (ibid.). Since bamboo's subterranean rhizome system remains unaffected by the above-ground flames, the plant strives to develop new shoots for keeping the plant alive. For that reason, subsequently, emerging shoots must be weeded to decrease the competition of bamboo plants with the planted crop for nutrition, water, and sunlight. Simultaneously, as Le Page du Pratz (1774, 165) correctly noted, young shoots are quite easily removed due to their soft material density compared to mature woody culms. Overall, choosing shifting cultivation and its inherent burning method facilitated a transformation of bamboo or tree-covered areas into fertile farmlands compared to an exhaustive bamboo- or tree-felling using axes.

2) Bamboo Rafts

One of the earliest records concerning the hinterland of the United States was written based on an exploration of North America's interior during the first European expedition from 1539 to 1543, led by Hernando de Soto (a Spanish explorer and conquistador). Later, a committee chaired by Swanton published the records as *The Final Report of the United States De Soto Expedition Commission* in 1939. Although the explorers passed through areas in which bamboo plants naturally occurred, and even though they had contact with many native people, little information about bamboo is given. However, two examples of bamboo's use that were documented are discussed at this point and in the section below.

During the De Soto Expedition, the Spanish invaders had to cross many rivers and needed transport vessels. Swanton, referring to the chronicles, mentions that in October 1540, the Spanish wanted to cross the Alabama River and asked a local ethnic group for canoes who explained they had no canoes but suggested building rafts of bamboos and dry wood (Swanton 1956, 50). As mentioned above, bamboo is a typical companion of river environments, and the enclosed air in its internodes predestine bamboos to be used in the construction of watercraft. So, knowing the advantages of bamboo in the manufacture of rafts, and due to bamboo's availability, the indigenous people recommended the Spanish to construct bamboo rafts. Concerning the construction of bamboo rafts, about thirty culms with an average diameter of five centimeters must have been needed to build a raft one and a half meters in width since the river cane (*Arundinaria gigantea*) has a maximum culm diameter of six to seven centimeters.

3) Tools and Weapons for Warfare, Hunting, and Fishing

Bamboo was used for a wide range of weapons for warfare, hunting, and fishing, enabling people to conduct warfare but also to meet their basic needs.

Bamboo shields: One early description of bamboo as a material for defense is made by Rodrigo Rangel, who was part of the De Soto Expedition. Rangel depicts an encounter with several thousand Native Americans in the borderland of what is today Mississippi, Alabama, and Tennessee. He writes that the indigenous people gathered "on the other bank of the river . . . to defend the crossing, . . . all with shields [*escudos*], which were made of canes joined together, so strong and so tightly sewn that a crossbow would scarcely pierce them" (Rangel 1993, 301). Indeed, bamboo's natural composition due to its silicified outer wall makes it suitable for protection against arrows and similar projectiles. Eventually, there is also the question of material availability to arm a large number of warriors with shields. Using one culm of *Arundinaria gigantea*, which reaches about six meters in length and six to seven centimeters in diameter, would be sufficient to produce a shield of sixty centimeters in width and height and to equip a warrior with a bamboo shield. Moreover, due to bamboo strips' extraordinary tensile strength, it could also be that bamboo culms were arranged side by side and fastened by means of bamboo bark.

Bamboo knives: Another ubiquitous and daily used bamboo tool was the bamboo knife, made of sharpened splits of the culm wall of *Arundinaria tecta* and *Arundinaria appalachiana*. Swanton points out that the bamboo knife was a sharp tool and "made a bad wound and cut meat like steel" (1931, 41). In general, bamboo knives cut very well until they get dull and need to be resharpened or, wherever a natural abundance of bamboo is found, quickly replaced by new ones. Nevertheless, the subsequent introduction of Western iron knives that the French brought along with them increasingly replaced bamboo knives (Le Page du Pratz 1758, 167).[82]

[82] The bamboo knife's use and cutting properties are part of my discussion concerning its use by Awa people in chapter 7.5.2.

Adair (1775, 233) notes that bamboo knives were also used for suicide since European diseases took a severe toll on Native Americans, and especially smallpox killed hundreds of thousands of people. According to Adair, many who saw themselves disfigured and thus hopeless used, among other tools and methods, a sharp-pointed bamboo or bamboo knife to stab themselves.

Tools for hunting and fishing: Hunting knowledge depends on the natural environment, the prey, and available materials and techniques. Accordingly, a pre-Columbian "hunter had to school himself in many areas: climate, weather conditions, tracking, animal behavior, species interaction, and geography" (Kowtko 2016, 106). Moreover, in many cases, the hunter must have special knowledge of how to produce a plethora of hunting tools on the basis of bamboo. While the pre-Columbian hunting and fishing equipment described below may appear simple, one must consider that simple tools and techniques involve other qualities, such as a hunting tool's skillful production and handling. Likewise, these tools often stand out in terms of practicability and functionality. Their relevance is epitomized by their appropriateness, an aspect that is discussed in chapter 6.2.3 concerning the categorization of tools and techniques as simple or complex.

What is more, bambooic tools or weapons made by Native Americans naturally had to recognize the material-technical properties of bamboo and its strong and weak points, the fabrication (time and effort), and the handling of tools. Accordingly, and as mentioned by Ingold, a rigid matter-form model, as postulated by Aristotle's hylomorphism, would fail "to acknowledge, on the one hand, the variability of matter—its tensions and elasticities, lines of flow and resistances—and, on the other hand, the conformations and deformations to which these modulations give rise" (2012, 433). Likewise, the handling of tools and the use of mundane objects must acknowledge the things' material properties and bodily involvement.

Bow and arrow, for instance, rely on bamboo's flexibility and straightness but require skillful use and special training. In general, hunting with a bow and arrow, in contrast to bamboo spears that require the hunter to stand upright, enables one to "crouch and hide, giving him the advantage of surprise . . . [and it is] this weapon system [that] represented the longest distance range and most deadly accuracy available to . . . hunters" (Kowtko 2006, 92). Le Page du Pratz (1758, 168) notices that Native Americans' arrows were made of the hard wood of small bamboos. While some arrows were specially designed for hunting birds, others were adapted to catch fishes, and some were upgraded with bone fragments to hunt bears and deer or to injure or kill human opponents. Young bamboo culms of less than one-centimeter diameter, when cut to a particular length, are suitable for producing arrows due to their straightness and round shape. Although prefabricated by nature, it would have required further treatment to obtain accurate arrows, including cutting, trimming, smoothing, heating, bending, drilling, or binding.

While hunting with bamboo bow and arrow could be performed by a single hunter, other hunting methods required the cooperation and coordination of several hunters, as in the case of driven hunts. One possibility of this hunting method was to set bamboo groves on fire in order to force animals that found cover in the bamboo groves to leave their refuge. Once the bamboos were burning, the game, startled by smoke, fire, and the noise of exploding bamboos, tried to escape the bamboo groves. The hunters, in turn, controlled the possible escape routes so that the escaping animals were killed with more ease and effectiveness (Swanton 1946, 313; Brickell 1737, 13, 85).

Concerning bamboo's utilization for catching fish, Adair (1775, 403) reports that Native Americans caught fishes using long creels made of bamboo and hickory splinters that taper to a point. He further writes that "long sharp-pointed green canes, which are well bearded, and hardened in the fire" (ibid.) were also used as harpoons to spear fish. Brickell (1737, 85, 365) mentions that angling rods were made of bamboos and reeds, and fishgigs (harpoons), similar to Adair's description, were also made of bamboo. Brickell (ibid., 367) also comments that after catching fishes, bamboo hurdles (like a gridiron) were used to dry fish over a constant fire. Another fishing method, mentioned by Adair (1775, 404), was carried out with nets made of hemp and green elastic bamboos, and only the ends were used while diving in the water. This fishing tool made use of bamboo's natural resilience to bending forces and was used to open the net abruptly during diving and to expand the net and catch the fish based on bamboo's response to bending.

Another hunting weapon used by Native Americans to chase small animals was the blowgun. While the blowgun itself was made of bamboo and exploited bamboo's hollowness, its small arrows, as Swanton (1946, 586) writes, were also made of bamboo slivers.[83] The blowgun's use and effectiveness are testified by the following quote from a European observation in the late eighteenth century:

[83] See also my discussion of bamboo's dissemination throughout the world in chapter 5.6.

> A very straight cane, eight or nine feet long, cleared of its inward divisions of the joints; in this they put a small arrow, whose one end is covered one-third of the whole length with cotton or something similar to it: this they hold nearest their mouth and blow it so expertly as seldom to miss a mark fifteen or twenty yards off and that so violently as to kill squirrels and birds therewith. (Romans 1775, 77)

Brickell (1737, 145) describes another example in which bamboo was employed to catch snakes. According to him, some Native Americans used a long cane with a red woolen cloth at its end to remove the teeth of rattlesnakes and used it in the following manner. The snake, provoked by the upper end of this stick, was forced to bite the woolen cloth, and at the moment when the snake bit, the stick was immediately pulled back fast enough that the snake lost its teeth.

Deerstalking: As indicated so far, hunters used bamboo to create several hunting weapons exploiting its straightness needed for arrows, its hollowness for blowguns, its flexibility required for bows, or its great length employed to make harpoons. Another way whereby hunters profited from bamboo splits' stiffness, lightness, and flexibility is mentioned by Le Page du Pratz, who writes that hunters used split bamboo pieces to create a loose structure required for camouflage for deerstalking, allowing a hunter to disguise himself as a deer in order to approach game unnoticed. For this purpose, the hunter made use of a deer's head and skin. The latter was "stretched out with several hoods made of split canes, which . . . [were] kept in their places by other [bamboo] splits placed along the inside of the skin so that the hand and arm . . . [could] easily pass inside" (1774, 242). The bamboo structure can be thought of as a skeleton based on bamboo's lightness and flexibility that could be carried by a hunter. Simultaneously, this camouflage method provided more mobility and flexibility for the hunter's arms, making it easy to handle the bow and arrows. In the words of Ingold, "the experienced practitioner's knowledge of the properties of materials . . . is not projected onto them but grows out of a lifetime of close engagement in a particular craft" (2012, 434). Thus, the hunter and his use of hunting weapons related to bamboo results from his entanglement with the bamboo's physical-mechanical qualities and his bodily involvement.

Bear hunting: As demonstrated by the following examples, Native Americans also used bamboo for bear hunting. In this context, Le Page du Pratz (1758, 87–88) notes that when indigenous hunters found a bear resting in a hollow tree trunk, they started to crack dry bamboo culms with their feet, then set fire to them and threw them into the hole of the trunk where the bear was hibernating. Due to bamboo's long fibers, cracked bamboos produce frays at their ends. These frays, in turn, are easily lit and used immediately on the spot. The same hunting method was also observed and described by the French colonial officer and farmer Jean-François-Benjamin Dumont de Montigny (1753, 79), who reports that hunters used a long bamboo pole (up to nine meters) at whose end they fixed a liane or string with dried bamboo sections that were lit, held over the tree trunk, and then dropped into the bear's den. Startled and threatened by fire, the bear was forced to leave its den and easily captured and killed by hunters. Since the den's entrance holes were mostly situated in the higher sections of the tree trunk, a sufficiently long bamboo culm, or several culms inserted into each other to achieve greater lengths, meant that burning firewood could be thrown into the tree trunk with little effort. By contrast, the production of a corresponding length from tree wood would have involved greater effort.

4) Illumination Using Bamboo

Regarding the earliest applications of bamboo to produce fire and light, Bales states that five thousand years ago, pre-Columbian Native Americans were already fabricating bamboo bundles and using them as torches to find desired minerals when exploring caves (Bales 2007, 16). In a similar way, bamboo was used for illumination in the early twentieth century—although commonly known to be a fire-resistant material, mature and dry bamboos, if tied together, provide sufficient light. Swanton mentions that Creek people used bamboos for illumination in their residential houses. And in another passage, Swanton (1946, 426) explains that Creek people put bamboo torches spirally around a pole for better illumination during gatherings and, whenever needed, replaced the burned bamboo culms with new ones. Further back in the past, according to Le Page du Pratz (1758, 376), up to two hundred bamboo torches were lit to illuminate larger gatherings such as big feasts. Montigny (1753, 203) made similar observations and reports that a bundle of bamboo (with a thickness of 180 centimeters and a height of more than seven meters) was fixed to posts and lit. When more lighting was required, several such posts and bamboo bundles were erected at a distance of two and a half meters to another post and lighted.

5) Bamboo Weaving Products

Basketry: The last maintained indigenous handicraft necessitating bamboo and still preserved in the first half of last century, Swanton (1946, 41) concludes, is found in the field of basketry. And according to Bales (2007, 16), Cherokee people, who commonly used *Arundinaria gigantea* in the pre-Columbian era to produce bamboo baskets of different sizes and shapes, still practice their traditional basketry in North Carolina. In pre-Columbian times, however, many Native Americans produced and used baskets for countless purposes, as exemplified by the various baskets such as scrap baskets, knife baskets, load baskets, dinner baskets, medicine baskets, medicine gathering baskets, or baskets for sifting corn (Swanton 1946, 41). In his account, Adair depicts the indigenous art of basket weaving as follows:

> They [Native Americans] divide large swamp canes, into long, thin, narrow splinters, which they dye of several colours, and manage the workmanship so well, that both the inside and outside are covered with a beautiful variety of pleasing figures; and, though for the space of two inches below the upper edge of each basket, it is worked into one, through the other parts they are worked asunder, as if they were two joined a-top by some strong cement. A large nest consists of eight or ten baskets, contained within each other. Their dimensions are different, but they usually make the outside basket about a foot deep, a foot and a half broad, and almost a yard long. (Adair 1775, 413)

Swanton (1946, 40–41) points out that Native Americans collected suitable bamboos during winter to obtain bamboos with better qualities since culms collected in the summer months tended, in general, to become more brittle and were less useful for basketry. He further writes that the culms' outer skin was split off using a knife to gain higher flexibility of the raw material and that, in some cases, single- or double-woven baskets were dyed using organic materials such as roots or walnuts.

Mats: Bamboo mats are equally products of bamboo weaving and served mainly as a kind of floor, functioning as a resting, working, or sleeping place, or as a cover for houses. As elsewhere in the world, the Native American peoples' house style depended on the surrounding environment, climate conditions, the existing natural materials and techniques, and people's mode of economy. Though tepees, traditionally made of animal skins upon long wooden poles, are commonly associated with Native Americans, they were far from common among all ethnic groups. In the north of French Louisiana, for instance, palmetto leaves, bark, and rush were used as materials to cover houses, and further south, "the universal material was cane, and cane mats were employed particularly all along the lower Mississippi, . . . [and] hung sometimes both on the outside and inside" (Swanton 1946, 421–422) of houses, while in lower Mississippi even "the walls and roofs of the temples both outside and in[side] were covered with them" (ibid., 602). In other cases, however, roofs and walls were sometimes made of bamboo culms instead of bamboo mats (ibid., 1931, 39). Needless to say, while bamboo mats could be easily prefabricated on the ground and, if desired, disassembled and transported elsewhere, using round bamboo poles for the same purpose would require much more material and time. Accordingly, bamboo mats represent an economical way of covering the roof.

Beds: Some Native American beds, as detailed by Swanton and Adair, were made of bamboo culms, animal skins, and other vegetable plants. And, depending on the respective region, people produced slatted frames from long bamboo splinters fastened to the bed frame (Adair 1775, 420, Swanton 1946, 422, 602), which took advantage of the flexibility of bamboo culms and ensured a comfortable rest and sleep.

Bamboo wattling as a covering for a deceased person: Brickell (1737, 381–382), attending a funeral of a Native American ethnic group, describes a bamboo weaving on which a deceased person was laid and that served as a kind of coffin with woven reeds and bamboo culms surrounding the dead body.

Granary: Bamboo mats and poles were, as depicted by Le Page du Pratz (1758, 365–366) for the Natchez people, also essential for constructing round granaries similar to the shape of tuns. Since seeds and grains attract animals, particularly mice and rats, granaries had to be designed in such a manner that they prevented the intrusion and endangerment of the staple food by such animals. For this reason and to keep the grain unaffected by groundwater and moisture, as explained by Le Page du Pratz, storehouses were erected at sixty centimeters distance from the ground by means of bamboo poles. Moreover, while the granary interior was made of bamboo mats and protected the valuable grains, round bamboo culms surrounded the bottom and the granary's sides and added further protection. Concerning the granary's design, Le Page du Pratz (ibid.) further notes that rats had difficulties climbing up them due to bamboo's smooth skin and round shape. And even though rats have tough teeth, they could not bite through the culm wall due to bamboo's hardness caused by its silicified surface.

6) *Bamboo Culms and Bamboo Groves as Cover, Defense, and Ambush*

Palisade: As observed by Pierre Le Moyne d'Iberville, a French soldier and colonial administrator who explored the south of French Louisiana with interruptions from 1699 to 1701, Bayogoula people, when threatened by their enemies, protected their settlement by erecting a bamboo palisade around their village. Concerning the palisade's construction, Iberville notes that each culm had a distance of three centimeters to the next culm and that the palisade had a height of three meters. He also states that the entrance was not visible, but that access was afforded through an opening to enter the village and, after stepping inside, Iberville and his men took a seat on a kind of bamboo grid (*clayes de cannes*) (Margry 1875–86, vol. 4, 168–169). Iberville's description emphasizes bamboo's strategic use for defense and resembles other strategic defense walls and palisades in Asia or South America.

Canebrakes as cover, defense, and ambush: Besides the culms harvested to build palisades for strategic military aspects, the canebrakes themselves were also central for defense and ambush, as evidenced by Rangel (1993, 267), who notes that during the De Soto Expedition, Native Americans used canebrakes as an ambush, hideout, or place to attack the European invaders.

In this context, Adair (1775, 273–274) mentions that Muskogee and Chickasaw-speaking Native Americans once built their camp in a small place of clear land surrounded by a dense swamp cane for better protection. Moreover, and as also mentioned by Adair, the thick bamboo groves were often impassable and "sometimes two or three miles over, and a hundred in length, without any break either side of the stream" (ibid., 309). In this context, Edwin James, who assisted Stephan Harriman Long (an American army explorer and topographical engineer) during his explorations in parts of the United States in the early nineteenth century, gives an impressive description of the density and impassability of the canebrakes:

> On arriving at the Arkansa, we waited a short time for our canoe, in which we crossed our heavy baggage, and then swimming our horses, we ascended the bank in search of a place to encamp, but soon found ourselves surrounded by a dense almost impenetrable cane brake, where no vestige of a path could be found. In this dilemma, no alternative remained, but to force our way forward by the most laborious exertions. The canes were of large size, and stood so close together that a horse could not move forward the length of his body without breaking by main force a great number of them. Making our way with excessive toil among these gigantic graminea, our party might be said to resemble a company of rats traversing a sturdy field of grass. The cane stalks, after being trod to the earth, often inflicted, in virtue of their elasticity, blows as severe as they were unexpected. It is not to be supposed our horses alone felt the inconvenience of this sort of travel. We received frequent blows and bruises on all parts of our bodies, had our sweaty faces and hands scratched by the rough leaves of the cane, and oftentimes, as our attention was otherwise directed, we caught with our feet and dragged across our shins the flexible and spiny stalks of the green briar . . . . On the following

> morning, after several hours spent in most laborious traveling, like that of the preceding day, we found ourselves emerging from the river bottom, and, to our great satisfaction, exchanging the cane brakes for open woods. (James 1823, 181–182)

As James explains, the canebrakes were not only impassable but had to be crossed with vigilance, especially when passing through them with horses. In sum, early European settlers avoided the canebrakes for two reasons. First, because of being afraid to be attacked by Native Americans, and second, because of the difficulties and the effort needed to cross the bamboo thickets.

10.2.2.4. The Characteristics of Material Cultures Based on Single Sources

So far, this chapter has discussed bamboo's part in material cultures and wildlife habitats and pointed out some uses of bamboo by Native Americans of the United States. In this light and due to bamboo's miscellaneous uses in pre-Columbian times, Platt et al. "consider it appropriate to describe the southeastern Indians as having a 'bamboo culture'" (2009, 279). Overall, bamboo was not part of all Native American people's material culture since bamboo's natural distribution was mainly limited to the southeast of the United States. Other valuable organic and inorganic sources (such as plants, trees, animals, shells, or stones) were equally important for local material cultures. Generally speaking, some pre-Columbian material cultures relied on versatile sources, but others developed sophisticated material equipment by focusing on one source. Considering bamboo's use by Native Americans, it would most probably belong to both categories, even though versatile applications mentioned in this chapter speak in favor of the second case. Therefore, as mentioned above by quoting Platt et al.'s (ibid., 279) emphasis on Native Americans' bamboo culture, the material basis of some ethnic groups was built on bamboo and led to a flourishing bamboo culture because the majority of tools and utensils were made from this one material. And what is true for bamboo, as the main material source establishing a certain kind of material culture, was also true for those Native Americans who met most of their needs by exploiting an animal, namely, the buffalo. In this context, Stacy Kowtko, who scrutinizes the nature and environment in pre-Columbian American life, discusses the significance of animal sources by exemplifying the importance of buffaloes for Blackfoot people—a buffalo hunting ethnic group—as follows:

> Almost everything they [Blackfoot people] needed could be provided by that one animal. Besides being cooked, the meat could also be dried into jerky or pemmican, a protein-rich

> food that would store for years. Bones became tools, horns turned into liquid containers, muscle sinew stretched into a thread, and hair proved to be perfect braiding for clothing. Hooves served as musical instruments or were boiled down for glue. Tanned hides were perfect for protective clothing as well as for tepee skins. Few areas of North America enjoyed such a singular resource treasure like the buffalo. (Kowtko 2006, 12)

This short example vividly portrays how people's very lives and the buffalo were intrinsically interwoven and how indigenous knowledge and technology developed on the basis of a single source and, thus, contributed much to a versatile material culture formed mainly by means of a single source. This focus on one material epitomizes how, depending on the environment (encompassing plants, animals, or landscapes), humans developed specific knowledge of how to use natural resources in their surroundings.

Once, buffaloes were spread almost all over the United States (except for the West Coast), and many Native American ethnic groups hunted buffaloes to meet their needs. While buffaloes had a total population of several million in the early nineteenth century, their population was diminished to less than a thousand towards the end of the nineteenth century (Hornaday 1889). On the one hand, the United States government wanted to destroy the livelihood of those Native Americans depending on buffaloes to weaken their power. On the other hand, European settlers took advantage of the buffalo's meat since it was very cheap and abundant, particularly in contrast to beef meat and easily hunted with firearms. On the ground of these facts, the moment the buffalo population declined, the material culture and lifestyle of those Native American people relying on buffaloes changed drastically.

Similarly, the elimination of bamboo groves affected people's livelihood and everything else connected to it (such as wildlife, watersheds, or landscape). Platt et al. (2009, 280) state three main reasons concerning the decline of the bamboo culture in the United States. First, European materials, tools, and artifacts were regarded as superior to the ones used by Native Americans and thus reduced indigenous tools' importance (e.g., steel knives replaced bamboo knives, firearms the traditional weaponry and particularly bamboo weaponry, or metal pots wooden or bambooic containers). Second, the forced relocation of Native Americans of the southeastern states to places without bamboo led to a loss of native people's ethnobotanical knowledge and material culture. And third, the overgrazing and clearance of bamboo areas by settlers deprived the Native Americans of the bamboo resources they needed to maintain their bamboo culture (ibid.). On these grounds, the massive destruction of bamboo groves took away the opportunity for Native Americans to maintain their lifestyle and livelihood. What remains unmentioned by Platt et al. is the disastrous effects of European colonization on Native

Americans, which meant not only the decline of their population but also the long-term and continuing destruction of their material cultures. In any case, when bamboo *died*, autochthonous knowledge and technology *died,* too, as well as some Native Americans' material and immaterial cultural heritage.

10.2.3. Bamboo in South America

It is estimated that about 430 woody bamboos species are endemic to the Americas and a large number of these bamboos are native to South America, which has the richest bamboo diversity in the Americas (Judziewicz et al. 1999, 55–63). Overall, bamboos are distributed from lowland forests to the mountain regions of the high altitude of the Andes but particularly around the equator.

As mentioned regarding the ethnic groups' use of bamboo in North America, pre-Columbian people's inclusion of bamboo in their material surroundings predominantly depended on whether the area they lived in or crossed overlapped with bamboo's distribution area. In contrast to North America, however, South America was able to preserve its abundance of bamboo, and, even though affected severely by massive deforestation and other human interferences, bamboo is still part of many landscapes, particularly in the less modified areas in the Amazons.

Hence, bamboo's ubiquity in South America contributed to a rich bamboo diversity as part of material cultures. In view of this fact, it cannot be the task of this chapter to take a closer look at all these bamboo cultures throughout South America. Equally, a full discussion of bamboo's part in the daily activities of people limited to a single country and period would go beyond the scope of this chapter. Nonetheless, and despite these restrictions, the objectives of this chapter are to outline bamboo's part in South America's material history using the example of Ecuador.

Hence, this chapter will briefly discuss some aspects of bamboo's use in the remote past through archaeological findings in coastal regions of Ecuador and museum artifacts attributed to the Inca Empire. Then, by examining historical records, the chapter addresses bamboo's use in Ecuador and neighboring countries, and towards the end of the chapter, I shall outline bamboo's use in the recent past. This chapter is therefore much more qualitatively representative than quantitatively exhausting—it does not claim to cover bamboo cultures all over the continent. Moreover, as demonstrated above concerning the bamboo culture in North America, historical accounts (predominantly written by male Western authors) shed some light on bamboo but do not provide a precise or profound presentation of people's material cultures prior to European colonization and during the colonial era.

10.2.3.1. The Use of Bamboo in Pre-Columbian and Pre-Industrial Times

Compared to inorganic materials like stone or metals, bamboo is less durable and decomposes, just like any organic material, relatively fast. In view of this fact, it is an arduous undertaking to trace and describe ancient people's material cultures that were primarily based on organic materials. Simultaneously, and due to the fact that, except for the Maya script of the Maya civilization, writing systems were unknown in the Americas before the Europeans' arrival, little data and information is available to afford insights into bamboo's part in people's daily activities before Columbus's landfall in the Americas. Unsurprisingly, the study and research into pre-Columbian material cultures is not so much the subject of historians and anthropologists; rather it falls into the domain of archaeologists who have found methods and ways to identify ancient societies' artifacts, ideas concerning the use and fabrication of artifacts, and materials ancient people had at their disposal.

One standard method for age determination of ancient objects is the radiocarbon dating (or 14C method) of artifacts containing organic materials. Developed in the 1940s, carbon dating had a profound impact on archaeology and, since its invention, has been frequently used by archaeologists. In brief, by employing carbon dating, scientists have the opportunity to study objects of the distant past. So, conclusions about the age of museum artifacts from pre-Columbian times revealed some insights about some objects' age.

Radiocarbon dating is used by Strydonck et al. (1992), amongst others, to study museum objects originating from the Inca Empire, namely, bamboo components of Inca looms.[84] According to their findings, the measured bamboo samples from three different looms were fabricated between 1,055 and 1,325 years ago. While the oldest specimen is dated between 654–690 CE, the second oldest is estimated for the time between 683–872 CE, and the latest one between 964–1029 CE (ibid., 1992, 928–929). Although no direct conclusions can be drawn about the processing and distribution of these looms, which kind of bamboo species were used for them,

[84] The objects studied by Strydonck et al. orignate from Peru and were part of the collection of the Belgian Royal Museum of Art and History in Brussels.

and how bamboos were processed, the evidence that bamboo was used as early as the seventh century suggests that bamboo may have been part of the Inca culture long before Europeans arrived in the Americas. Simultaneously, it is most likely that bamboo's use was widespread throughout the Inca Empire, which encompassed part of what is today Ecuador, Bolivia, Peru, Argentina, Colombia, and Chile, and thus coincided with the natural distribution of bamboo in these areas.

Some other evidence of bamboo's use dates back much further than the Incas' looms. Archaeological excavations confirm that bamboo was used in Columbia and Ecuador 5,000 years ago and was used for many purposes, such as building material for house construction, as musical instruments, or for ceremonies (Salgado et al. 1993). Morán Ubidia (1985, 65) outlines other archaeological evidence about bamboo's use in present-day Ecuador. According to him, the oldest pieces of evidence of bamboo's use date back between 8900 and 9400 BCE.

As summarized by Morán Ubidia, who studied historical graphics and written accounts concerning the use of the *Guadua* species in Equador, *Guadua* was intrinsically involved in pre-Columbian life and played an incomparable part in "the entire history of pre- and post-Columbian cultures of the coastal region of Ecuador" (ibid., 84). Referring to his study of firsthand information, Morán Ubidia (ibid. 69–75) testifies that people benefited from *Guadua*'s ubiquity and its superior material qualities and that the pre-Columbian people embedded *Guadua* in many domains of life. According to his findings, people built bamboo rafts and boats; drank fresh water enclosed in the *Guadua*'s internode that served as a healthy water supply and provided a hygienic bacteria-free water source when traveling through rain forests; and also used *Guadua* as a crucial building material to construct many components of local people's houses; and even built churches after the arrival of Europeans. As mentioned by Antonio De Ulloa (a Spanish naval officer, scientist, and administrator) and Jorge Juan (another Spanish mathematician, scientist, naval officer, and mariner), bamboo played a crucial role for local people inhabiting the region of Guayas close to Guayaquil city, Ecuador. According to their observations, bamboo was a vital building material for residential houses:

> The principal and most common materials used in buildings on these rivers, are canes, whose dimensions, and other particulars shall be taken notice of in their place. These also form the inward parts, as walls, floors, and rails of the stairs; the larger houses differ only in form of the principal pieces, which are of wood. Their method of building is, to fix in earth, eight, ten, or twelve pieces of wood, more or less, according to the dimensions of the house, forked at the top, and of a proper length, all the apartments being on the first story, without any ground floor. Beams are then laid across on these forks, at the distance of four or five yards from the ground. On these beams canes are laid in such a manner as to form a kind of rafters, and over these boards of the fames canes a foot and a half in breadth, which form as firm and

> handsome a flooring as if of wood. The partitions of the several apartments are of the same materials, but the outer walls are generally laticed, for the free admission of the air. The principal beams of the roof of large houses are of timber, the rafters of cane, with smaller, in a transverse direction, and over these, vijahua leaves. Thus a house is built at very little expense, though containing all the necessary conveniencies. With regard to the poorer sort, every one's own labour suffices to procure him a habitation. He goes up a creek in a small canoe, and from the first wood cuts down as many canes, vijahua, and bejucos [a vine-like climbing plant of the genus *Mikenia*], as he wants, and, bringing the whole to the shore, he makes a balza or float, on which he loads his other materials, and falls down the river to the place where he intends to erect his cottage. After which, he begins his work, fastening with bejucos those parts which are usually nailed; and, in a few days, finishes it in the completed manner. Some of these cottages are almost equal in dimensions to those of timber. (Juan and Ulloa 1748, IV, 180–181)

As this description suggests, bamboo was essential for the construction of common houses, for four reasons in particular. First, bamboo was abundant. Second, bamboo was a suitable material for making roofs, walls, and floors. Third, rivers facilitated transport without requiring draught animals or long marches. And fourth, bamboo could be worked with basic tools and techniques.

Concerning the use of bamboo by early Europeans, Judziewicz et al. state that European descendants initially learned from indigenous people how to use bamboo "to satisfy basic necessities: shelter, fuel, and transportation, as well as the creation of musical instruments, arts, and crafts" (1999, 88). At the same time, Western technology, commodities, and knowledge changed many native people's lifestyles and contributed to the decline of their material culture. This decline, however, was accompanied by marriages between Europeans, Africans, and indigenous people and, therefore, led to further fusions and mixed populations and cultures, which is why terms such as *traditional* or *indigenous*, in this case, remain slippery terms.

One early scientific description of *Guadua*, dating some three hundred years after Columbus's arrival to the Americas, was published by the two young naturalists Alexander von Humboldt and Aimé Bonpland as an outcome of their exploration through the Neotropics (today Venezuela, Cuba, Colombia, Peru, Ecuador, and Mexico) from 1799 to 1804. At that time, only a few things were known about Asian bamboos in the Western academic world, and even less was known about South American species. In their seminal book *Plantae Aequinoctiales* (1806), published shortly after their return to Europe, Humboldt and Bonpland describe the *Guadua* bamboo as offering the same advantages in terms of use as the already known bamboos of India. They emphasize that the *Guadua* was used as a construction material for houses and walls and indicate that furniture and house components, including beds, tables, and doors, were made of bamboo and that local people chose bamboo as a favorable construction material because of its durability and lightness, making it easy for transport (Humboldt and Bonpland 1806, 66). In his personal narratives, published twelve years after *Plantae Aequinoctiales*, Humboldt depicts *Guadua*'s multipurpose use once again in the following terms: "The knots, or rather the interior cells of the trunks of bamboos, supply ladders; and facilitate in a thousand ways the construction of a hut, and the fabrication of chairs, beds, and other articles of furniture, that compose the wealth of a *savage*" (Humboldt 1818 (4), 226–227, emphasis added). Though biased by his European culture as superior to the peoples native to the Americas, Humboldt acknowledges the manifold uses of bamboo, its importance for local people, and a certain creativity inherent in bamboo, and how all these aspects contributed to form the bamboo-based material culture.

On the basis of their observations, Humboldt and Bonpland (1806, 66) cite the following four advantages of *Guadua*: First, *Guadua*'s culms are easily and quickly felled and transported over long distances. Second, *Guadua* bamboos require little work and are used unmodified as hollow tubular poles or as longitudinal splits for many purposes. Third, *Guadua*'s wood has superior qualities in terms of duration, which, according to the authors, could be compared to that of the best tree wood. Fourth, due to *Guadua*'s extraordinary material properties, it was suitable material for residential house roof construction. According to the authors, thick *Guadua* bamboo roofs offer protection not only from rain but likewise from sun rays and heat—keeping a cool and pleasant temperature inside the house even in the hottest part of the day. Attracted by *Guadua* bamboo's beauty, Humboldt describes its remarkable appearance as follows:

> Its leaves' form and disposition give it a character of lightness, which forms an agreeable contrast with its height. The smooth and glossy trunk of the iagua is generally bent towards the banks of rivulets, and waves with the slightest breath of air. Whatever be the height of the reed in the south of Europe, it can give no idea of the aspect of the arborescent gramina, and, if I might presume to refer to my own feelings, I should assert, that the bamboo and fern tree are, of all the vegetable forms between the tropics, those which most powerfully strike the imagination of the traveller. (Humboldt 1818, III, 38–39)

Humboldt's enthusiasm and advocacy for bamboo's beauty reminds one of some similar statements about Asian bamboos by Asian poets and Western travelers (as, for instance, discussed in chapter 9.3 concerning the beauty attributed to Japanese bamboos and vividly expressed in poems, sayings, and tales).

Since the Andes Mountains form a continuous running mountain range along the entire western part of South America, as elsewhere, people designed various bridges such as pedestrian suspension bridges to cross rivers or connect two mountains. In this context, Humboldt comments on bamboo's use for the construction of bridges and describes a bamboo chain bridge that he observed in Ecuador's inland. According to his observation, one bridge was "a hundred and twenty feet long, and seven or eight broad . . . [and] the great ropes were covered transversely with small cylindrical pieces of bamboo . . . [of which] people of South America made use long before the arrival of the Europeans" (1814, II, 73). Humboldt's observation is also approved by Judziewicz et al. (1999, 95), who emphasize that *Guadua* species were still the most used material for constructing bridges in the second half of last century.

All the abovementioned examples that depict bamboo's manifold utilizations reinforce the assumption that bamboo's inherent properties play a decisive role in creating and developing a given society's or group's material culture. In consequence, on a global scale, bamboo-based material cultures throughout history had many commonalities but also major differences. According to Bystriakova et al., "the Americas have never had a 'bamboo culture' in the way that Japan and China may be said to have had" (2003, 17). This distinction may be correct concerning the characteristics of the bamboo culture in Chinese and Japanese agricultural societies and among lowland inhabitants. Equally, bamboo cultures such as that of the Bahnar differed from the material culture and uses of bamboo of the lowland Kinh—a fact that also applies to China, where the people in Yunnan Province developed other forms of agriculture and bamboo cultures compared to the Han in lowland areas. Differentiation between the bamboo cultures of East and Southeast Asia and the Americas must acknowledge that the former region has itself various bamboo cultures that share many commonalities with those developed in the Americas.

As already mentioned in relation to North America, great disastrous effects on autochthonous people's traditional living were caused by the military superiority and the hegemonic power of the European conquerors and their oppression of the indigenous peoples. Overall, domination by the conquistadors had devastating effects on the preservation of indigenous peoples' traditional immaterial and material culture. Thus, the pre-Columbian culture disappeared little by little in almost every region. Indigenous people adapted to Western cultures by force. According to the social anthropologist John Rashford (1995, 395), this forced adoption of Western culture contributed to a general lack of interest in bamboo in the *Neotropics* until the end of the twentieth century. A development that has been accelerated by deforestation and by clearcuts of bamboo groves to satisfy the demand for more agricultural land.

10.2.3.2. The Use of Bamboo in the Recent Past

Concerning bamboo's use by indigenous people, it appears that some people still maintain bamboo as part of their traditional lifestyle. As already stated two decades ago by Londoño, bamboo shaped some indigenous people's traditional material culture in Venezuela and was used "for building homes and for making various household utensils" or, as in the case for other indigenous groups in the northern fringe of South America, some indigenous communities used bamboo "for making lances, bows, arrowheads, arrow shafts, knives and fishing harpoons" (2001, 17, 12). Whether or not these ethnic groups still maintain their traditional ways involving bamboo cannot be examined at this point to any great extent. However, some aspects of traditional bamboo cultures may have survived to the present day, especially in remote regions. What is certain is that people living in urbanized areas preserved some traditional techniques involving bamboo until the recent past. In this context, Morán Ubidia (1985, 77), who examines dwellings of peasants living in Ecuador's coastal regions of the late twentieth century, testifies that local people's residential houses were built as an outcome of the experience of people's ancestors and that these houses best suit local climate conditions.[85] Nonetheless, due to the effects of industrialization and the availability of industrial goods, the remaining traditions that involved bamboo declined simply because people adapted to new working principles and methods, industrial goods and technologies, and the like. As a result, bamboo disappeared at many places, and it is still increasingly disappearing from the everyday life of peasants and townspeople. On the other hand, in the twentieth century, people living in the plains still utilized bamboo (*caña*) for house construction and many other things, as demonstrated by the following quote from Morán Ubidia:

> They use it whole (*rolliza*), cut longitudinally in half (*guacay* or *latén*), in longitudinal sections from 6 to 8 cm wide (*latas*), in pieces 3 to 5 cm wide (*latillas*), or simply open and flattened (*caña* picada). Necessities other than houses are also made of caña; corrals, chicken pens, storage areas for grain, and objects for domestic use such as well covers, lattice frames, fishing instruments, small furniture, and poles or pruning hooks for tall fruit crops. The latter are made of bamboo poles which have been straightened by heating. (ibid.)
>
> Today's boats preserve their traditional form, using strong, flexible bamboo as masts and rudders. The people know that one way to keep river banks from collapsing and subsequently eroding their land is to plant caña on the banks. If they need water they use an open caña to collect the rain that falls from their roof; they know that to work with bamboo they only need a machete to cut it down, open it, clean it, and transform it into the object they need. They traditionally follow the custom of cutting caña during the waning moon, at low tide, so that it will be stronger and last longer. They drink water from its cañutos for its medicinal effects

[85] Since Ecuador's population is marked by ethnic diversity, using the term *ancestors* is somewhat troublesome due to the fact that two-thirds of Ecuador's current population has European-indigenous roots.

> and know how to transport along rivers enormous quantities of caña which they call *plantillas*. Bamboo helps them cultivate bananas; they support the fruit with sections of bamboo called *cujes*. Musical instruments such as flutes, marimbas, and so on are also of bamboo, as are toys such as *palos encebados* and the frames for children's kites. When "civilization" arrives they also use bamboo as poles for electrical wires and as tall bases for television antennas. (ibid., 80)

As one can see, bamboo appeared in the form of artifacts for daily life. It was used to protect against erosion, as construction material and medicine, to create musical instruments or toys, and, similar to contemporary Vietnam or Laos, bamboo poles were used as electricity masts. In the case of the city of Guayaquil, Morán Ubidia estimates that in 1985 "approximately 600,000 inhabitants lived in bamboo houses, or had in their buildings elements of this material" (ibid., 81).

Judziewicz et al. also discuss bamboo's use in the last decades of the twentieth century and claim that bamboos (such as *Guaduas*) were used for animal husbandry, particularly in rural areas, and served as a construction material for "livestock sheds and corrals, drinking and feeding troughs and chutes for livestock" (1999, 95). Moreover, bamboos had diverse uses in gardening, for instance, for "greenhouses, and staking posts for tomatoes, peas, prickly pear cacti, and other plants" (ibid.). Due to bamboo's flexibility and easy workability, it was used to fabricate household goods such as baskets and furniture and was needed for different kinds of artwork. Concerning the economic value of bamboos, Judziewicz et al. state that "the most commonly employed species include *Apoclada, Aulonemia queko, Chusquea scandens, Elytrostachys, Guadua angustifolia, Otatea acuminata, Rhipidocladum racemiflorum,* and *Rhipidocladum geminatum,* as well as species of *Merostachys*" (Judziewicz et al. 1999, 100–101; Londoño 2001, 4).

Despite the fact that bamboo contributed much to human livelihoods, and although many traditional uses of bamboo are maintained in South America, scientific interest in bamboo has only existed since the 1960s. As in the case of Colombia, for instance, Hidalgo-López notes that no Columbian botanists, agronomists, and forestry universities were concerned with studying bamboos. Therefore, almost no technical or scientific data or information was published until the late 1960s (2003, xiv). [86] This is surprising because, as evidenced in this chapter, *Guadua angustifolia* contributed much to the societal and economic development of Colombia, and people in urban and rural areas benefited from *Guadua angustifolia*'s superior material

[86] For a more comprehensive depiction of *Guadua angustifolia Kunth* concerning its biology, silviculture, material properties, economic values, and the like, see Arbelaez Arce et al. 2001.

qualities, using it as building material to construct houses, stables, bridges, aqueducts, and the like (ibid.). The reason for that lack of interest is, according to Hidalgo-López (ibid.), rooted in bamboo's perception as a less valuable material attributed to poor people. As a result, and although South America has a high diversity of woody and herbaceous bamboos, bamboos in South America still do not have considerable economic importance compared to East and Southeast Asian countries (Londoño 2001, 4).

10.3. Bamboo in Africa

After a brief outline of bamboo's ancient and current distribution in Africa, this chapter gives a few references to bamboo's use by people native to Africa. It is limited to the time between the 1870s and the 1920s and confined only to a few historical accounts. As a consequence, this chapter neither makes an attempt to provide a comprehensive review of bamboo cultures in Africa nor can it sufficiently consider all aspects of bamboo-related material cultures since—as mentioned earlier about the Americas—any attempt to describe the various African bamboo cultures would go beyond the scope of this chapter. Therefore, by scrutinizing some aspects of bamboo in people's lives in early colonial Africa, I can only provide a cursory and superficial glimpse of bamboo's intricacies in humans' material lives.

10.3.1. The Loss of Bamboo in continental Africa and Madagascar

As elsewhere, bamboo is very well adapted to the rainforest belt and grows predominantly close to riverbanks and swampy areas in Africa (INBAR 2006, 4). However, only a few woody bamboos are endemic to mainland Africa in contrast to Madagascar. While thirty-two woody bamboos are considered endemic in Madagascar, only five species of five different genera grow naturally in continental Africa (Bystriakova et al. 2003, 10). Mainland Africa's relatively low diversity of bamboos is caused by climatic conditions in prehistoric times that did not affect Madagascar, which is why the latter has a greater abundance of bamboo species (ibid., 10–12).[87] Nowadays, bamboo's pre-Columbian distribution in mainland Africa and Madagascar

[87] One early and detailed work that examines African bamboos' distribution in the early twentieth century was published by the Belgian botanist Émile A. de Wildeman. In his article *Les bambous en Afrique* (1921), he

has decreased significantly due to deforestation. In Ethiopia, for instance, it is estimated that about sixty-six percent of the Ethiopian landscape was covered by forest or savanna woodlands in pre-colonial times, but today only about seven percent are left (Kelbassa et al. 2000, 6). Reasons for deforestation are the increase in population, and the need for agricultural land, building materials, and firewood (Kassahun 1998, 3). As a consequence, amongst other countries, Ethiopia suffers from diverse intensifying problems such as "environmental deterioration, ecological crises, massive soil erosion, low biological productivity and widespread plant, animal, and human diseases" (ibid.). Unsurprisingly, bamboo remained mainly at places with natural impassibility hindering the cutting of bamboos. As demonstrated by Bystriakova (2003, 13, 17) for Madagascar, only a percentage of the original bamboo groves remain. The loss of bamboo means not only the loss of plant material necessary for people's traditional material culture. The loss of bamboo groves also involves, as mentioned earlier, a drastic intervention in and disturbance of wildlife and its associated ecological environment. Accordingly, predominantly those animals depending on bamboo groves are particularly vulnerable when bamboos are clear-cut, such as the bamboo lemur and a rare turtle living in Madagascar's bamboo groves.

10.3.2. Bamboo's Use in Pre-Colonial and Colonial Africa

As mentioned earlier in chapter 10.1, I shall point out the use of bamboo in colonial Africa on the basis of three historical accounts, beginning with the German botanist and ethnologist Georg Schweinfurth's (1874) book. Based on his journey from 1868 to 1871, starting from Khartoum and following the Nile upstream, Schweinfurth (1874, I, 178) describes personal experiences, African landscapes, fauna and flora, and the native people he encountered. Though Schweinfurth was not specifically interested in bamboo, he mentions some aspects involving bamboo, referring to an area that is now the northern part of contemporary South Sudan. He records, for instance, that houses in this region were sometimes entirely made of bamboo and reed, and that the cone-shaped roof rested on a kind of wickerwork made of bamboo and that the latter was coated with clay on the inside. Furthermore, Schweinfurth (ibid.) notes that roofs were light but watertight and did not require heavy posts to hold the walls in place. Although Schweinfurth does not clarify the characteristics or vernacular names of bamboos, he refers probably to

discusses as an outcome of his literature review the geographic distribution of different species of endemic African bamboos, as well as the introduction of non-African bamboos and their potential economic value.

Arundinaria alpine since this species is endemic to South Sudan and throughout many regions belonging to the Afrotropical realm.

According to hearsay, Schweinfurth (ibid., 237) further writes that some bamboos produced seeds after flowering and that these were eaten by local people and often served as a substitute for corn in times of famine. In another passage, Schweinfurth (ibid., 287, 290) mentions that Bongo people (an ethnic group living in South Sudan) used bamboo to fabricate musical instruments and baskets. Furthermore, Schweinfurth (ibid., II, 255) emphasizes the relevance of bamboo thickets as a natural habitat for animals and says that wart hogs fed on bamboo sprouts and that the seeds of bamboo attracted birds, and that sparrows built their nests in high bamboo stands.

Wilhelm Kassner, a German geologist and botanist traveling through present-day Zimbabwe, Uganda, Rwanda, and the Democratic Republic of Congo (DROC), states that local ethnic groups in the northwest of Lake Kivu, which lies on the border between the DROC and Rwanda, used bamboo for their huts, arranging them "in a circle with bamboo screens round the small entrances" (1911, 163). During his journey through the Kibara Mountains in the south of the DROC, Kassner observed: "a well-made bamboo bridge spanning the Lukafu River" and another "bamboo bridge over the Luishi River" (ibid., 63, 71). Concerning the distribution of bamboo, Kassner (ibid., 215, 71) claims that bamboo was naturally distributed in present-day southern DROC and occurred in areas near rivers and on mountain slopes and that those bamboo groves formed inaccessible bamboo thickets further north in the Rwenzori Mountains, which are located on the border between DR Congo and Uganda. Moreover, Kassner mentions how some groups of Konjo people, who lived in what is now southwest Uganda, trekked up the mountains to collect bamboo culms necessary for many needs:

> The Wakonjos [Konjo people] who live below on the grassy slopes come up to these heights for the bamboo canes, which they slide down the slopes, and use for building huts, for making cattle enclosures, and for hedges to protect them against the wind. The brown scale-like leaves on the stems near the ground are used for roofing the huts, which look very neat and pretty. (ibid., 215)

Concerning bamboo's deadwood contribution to biodiversity, Kassner indicates that "the decayed canes hung over, and the fallen ones were strewn in disorderly profusion, and covered with moss, ferns, orchids, begonias, and other fleshy vegetation" (ibid.). Kassner's observation underlines the decaying bamboo culms' role for biodiversity conservation since many other organisms nourish and grow on the culms.[88]

Figure 172 Igbo people thatching a roof using palm leaves and bamboo culms for the roof structure.
Source: Basden 1921, 169.

As mentioned in chapter 7.4.7 in relation to Bahnar people's and other people's musical instruments, bamboo offers excellent possibilities for constructing various musical instruments due to its structure. As a result, people in different regions of the world have used bamboo to make similar wind and percussion instruments. In the northeast corner of the DROC, Kassner (ibid., 252) attended a feast and observed how local people built musical instruments, such as large drums, whistles, and trumpets, using bamboo. Though he does not elucidate these musical instruments in detail, his brief reference proves similarities in bamboo's interregional use.

Georg Basden (1921), a British missionary in Nigeria, studied, amongst other things, Igbo's people's language and culture and describes some of bamboo's uses by the Igbo people, notably for canoes, roofs, musical instruments, and house construction. Basden's observation and comments on Igbo people's house construction—a traditional Igbo bamboo house construction is shown in Figure 172—resemble the abovementioned description by Schweinfurth. Moreover, it is also similar to the manner in which Bahnar peoples built their houses (see chapter 7.4.4.1). All have in common that the roof construction benefits from bamboo's light weight and easy workability, while further similarities are the absence of (iron) nails and the use of bamboo poles as rafters and laths for the roof on which palm leaves are thatched.

[88] An aspect that is, according to my knowledge and research, neglected by biologists or conservationists. Similar to fallen dead trees or branches, as decomposition gradually progresses, deadwood (or coarse woody debris) serves as an ideal nesting, development, feeding, or overwintering habitat for a large number of animals and plants and also protects them from predators.

Today, Igbo people live mainly in contemporary southern Nigeria; and even though their ancient homeland, the Igboland, was “among the areas of West Africa that experienced the most intensive slave-trading activities during the seventeenth and nineteenth centuries” (Oriji 1986, 121), parts of the traditional architecture and some “roofing techniques and skills survived into the colonial and postcolonial periods with some modification” (Chukwu, 2015, 10).

10.4. Concluding Remarks on Bamboo in the Americas and Africa

This chapter’s underlying goal was to portray bamboo’s part in the material aspects of life in the Americas and Africa. Accordingly, I did not attempt to find out to what extent bamboo was involved in people’s nonmaterial culture, belief system, social structure, language, and the like. Likewise, due to the limitations of this chapter, an issue that was not addressed comprehensively was how people worked on bamboo and which techniques peoples utilized to manipulate bamboo culms. Certainly, a discussion of both topics would have offered more insights into how bamboo was incorporated into people’s everyday actions. The greatest weakness of this chapter, however, is the lack of varied sources that might have helped to describe and circumscribe bamboo culture in greater depth. On the other hand, despite its exploratory nature, this chapter offered some insights into bamboo’s part in the Americas and Africa and clarified some aspects concerning the extent to which non-Asian bamboo cultures existed in pre-European times, during colonial times, and in the recent past.

As this chapter has revealed, bamboo has been used in a variety of ways at different times in many regions of the Americas and Africa. The numerous examples involving bamboo given in this chapter suggest that bamboo has a material history that extends far beyond the borders of Asia and that, separated by centuries, people in Asia, Africa, and the Americas utilized bamboo in similar ways. The most striking thing, however, is that people in all continents knew how to take advantage of bamboo’s extraordinary properties to create useful everyday objects and houses. “To understand materials,” as Ingold puts it, “is to be able to tell their histories—of what they do and what happens to them when treated in particular ways—in the very practice of working with them” (2012, 434). However, interpreting bamboo’s material history must also take account of humans’ bodily and mental involvement in the creation and use of bambooic things. In this light, the chapter is intended to provide insights into the material history of bamboo as part of a broader human-bamboo relationship and, thus, as part of human history.

Moreover, the portrayal of the bamboo culture in the United States has proven that the development of bamboo cultures does not necessarily depend on a high diversity of species. *Arundinaria gigantea*, for instance, was quite sufficient for the emergence of a diverse bamboo culture in the United States. Regarding South America, it can be argued that *Guadua* played a key role in people's bamboo culture and stood out in comparison to all other bamboos due to its exceptional material properties.

What is more, bamboo, in addition to its importance for humans, has a key role in wildlife and the environment that can hardly be put into words. By and large, nonhuman animals' use of bamboo is usually the field of biologists, and bamboo groves' relation to biodiversity and ecology would likewise be ascribed to biology or geography. However, from an analytical open view, such as that proposed by ANT, one is inclined to analyze broader, spatially and temporally extended networks, including nonhuman and human entities and their relatedness. As explained above in connection with the loss of bamboo cultures in the United States due to the decline of the Native American population, the loss of shifting cultivation was associated with a modification of the landscape that provided space and time for nature to recapture the environment, which, in turn, led to an extension of bamboo groves and an increase in biodiversity. And, in the long term, the subsequent regrowth and spread of bamboo groves affected the actions of European settlers, who regarded the impassable canebrakes as obstacles hindering them from crossing the country easily, which resulted in the massive destruction of canebrakes. This destruction, in turn, profoundly impacted the material culture of Native Americans relying on bamboo. To summarize, on the strength of a broad spatial-temporal analysis of human actions and nature, it becomes clear that both are intermingled and affect each other.

Overall, it can be said that bamboo should be understood as part of a trans-regional, even global, human history. If taken together, these results suggest that there is an association between humans and bamboo since bamboo helped people across all continents to meet their needs. This human-bamboo relationship, in turn, is characterized by human ingenuity and creativity and bamboo's material properties.

Part D: Research Results and Conclusion

11. Summary and Research Findings

The present book is the product of historical and anthropological work with its entry points in bamboo's multifaced character and appearances in connection with theories originating from various disciplines. In sum, this work has analyzed three central themes: i) the constitution of various human-bamboo relationships, ii) the characteristics of bamboo-related or bamboo-based material cultures and technologies, and, finally, iii) bamboo's material history by an account of people's everyday life and enmeshment with bamboo in the past and present. Therefore, the imperatives for this work were to review existing theoretical and research literature on these three themes and to provide, from a cross-disciplinary viewpoint, a wide-ranging critical review of relevant literature on issues concerning the manifold ways in which humans are interconnected with bamboo in material and natural surroundings. And, as an outcome of this review, to reflect research across a range of topics and to probe taken-for-granted suppositions about the social as well as to develop my own methodology in order to study the interconnectedness of humans and bamboo. By and large, this thesis is based on history and the history of technology, anthropology, material culture studies (which is itself an interdisciplinary field), and socio-material theories related to sociology and philosophy (and the philosophy of technology).

My research goal and central discussions revolved around the multifaceted interrelations of humans and bamboo. For better clarity, I subdivided the present work into four main parts (Part A, B, C, and D) and subsections since each part was focused on different issues and perspectives related to my research and the corresponding research questions. In what follows, I will briefly summarize and reiterate the chief findings of the first three parts and the associated chapters in order to lay the foundation for a general, concluding discussion of the human-bamboo relationship, bamboo cultures, and bamboo's material history through a cross-cultural comparative perspective on the interrelation of people and bamboo.

Part A was concerned with the anatomy and processing of bamboo and highlighted bamboo's botanical, chemical, physical, and mechanical properties. This part was a result of my literature research in biology and civil engineering and my personal, hands-on experience and practical engagement with bamboo in bamboo workshops in Berlin and Vietnam. Furthermore, my observations during my trips to Vietnam, Thailand, and Laos (from March to August 2012 and from March to May in 2018), provided further insights into how people process bamboo by simultaneously taking into account bamboo's fundamental characteristics. I have shown how traditional bambooworking is related to bamboo's inherent tubular structure and how bamboo's natural design affects the production and use of bambooic things and the built environment. In sum, Part A was conceived to provide general background knowledge for the other parts of this thesis.

Part B explored the theoretical assumptions necessary to evaluate how humans and nonhumans encounter each other. It provided the theoretical background to develop crucial concepts and hypotheses required to conceptualize the human-bamboo relationship. As discussed, the debate about the constitution of social phenomena has gained fresh prominence in recent decades, with many arguing that things and nonhuman entities (including ideas, concepts, processes, and the like) have a bearing on the social. Thus, chapter 5 was a review of literature that puts special emphasis on the coexistence of nonhumans as part of the social life. Against this background, my principal question was whether a re-evaluation of the social sphere, if understood as a field consisting of humans and nonhumans enmeshed in practices and activities, would provide valuable theoretical and methodological approaches required to interpret the human-bamboo relationships.

Therefore, I examined various socio-material theories that highlight the enmeshment of humans and nonhumans as, for instance, Schatzki's (2003) *site of the social* (or practice-arrangement nexus), ANT's *actor-network* concept (Latour 2005), or Ingold's *meshwork* (2012). Simultaneously, I attempted to clarify if these theories are helpful for my research while demonstrating the shortcomings of traditional Western dualistic thought. In doing so, I attempted to find alternatives that do not *a priori* limit the *social* to the self-confined human being or humans' action and interaction within a sphere of human society. Moreover, I have shown that socio-material theories and their distinct social ontologies (encompassing the nonhumans) offer epistemological openness that is useful to detect nonhumans' effects on the social life of humans. I also scrutinized concepts of materiality (things, objects, artifacts, or naturefacts) from various perspectives and explained how (inanimate and animate) things are able to maintain, transform, influence, confine, or enable the social.

What is more, I stated that agency can be attached to nonhuman things and that humans and things can conflate to hybrid, heterodox entities. In this context, I emphasized the role of things and demonstrated that material arrangements form the prerequisite for human practices. As shown by the literature I examined, socio-material theories (and their distinct but more or less flat social ontologies) provide essential theoretical hypotheses and methodological toolkits that have been instrumental to analyze bamboo cultures and human-bamboo relationships. In sum, socio-material theories provided the epistemological and methodological entry points to discuss human-thing relationships in this work. Simultaneously, their underlying interest in re-introducing nonhumans into the social sphere was fundamental to developing my understanding of the terms *material culture* and *bamboo culture*, which was also necessary to interpret bamboo's role in the material aspects of people's lives.

Based on my critical examination of the terms *technē* in contrast to the industrially connoted term *technology* (in chapter 5) and *indigenous knowledge* and *indigenous technology* (in chapter 6), one purpose of both chapters was to demonstrate how different notions of technology determine our perspective on human-thing relations and tool use, and how human-centered studies on tool use help to unravel the characteristics of the human being as a tool-using animal if technology is understood as interwoven with human practices.

Finally, since the issue of development and progress is a controversial and much disputed subject within the field of history and anthropology, I scrutinized whether concepts of well-being are a preferable alternative to unilineal modernization theories and definitions of progress. I explained that Buen Vivir argues for a holistic approach to indigenous people's lives and recommends indigenous life be acknowledged as embedded in a socio-material-natural setting. In this context, I underlined the advantages of Buen Vivir in contradistinction to Western thinking and monocausal science and market-bound developmental programs. I also identified commonalities between Buen Vivir and post-humanist social ontologies, such as ANT.

Part C was concerned with historical and contemporary bamboo cultures. Generally speaking, this part aimed to explore the characteristic properties of small-scale and large-scale bamboo-related or bamboo-based material cultures. While chapter 7 paid particular attention to contemporary small-scale societies, the other chapters of Part C scrutinized historical societies' relation to bamboo.

Since bamboo is the most common substance of the material surroundings of Bahnar people, I was interested in studying study the Bahnar people's various interconnections with bamboo in chapter 7 and investigated their bamboo culture's linkage to shifting cultivation. For this reason, I employed ethnohistorical methods and combined the study of historical records and other researchers' ethnographic work with my own observations and findings during my field trip in 2012 and 2018 that I conducted amongst Bahnar people who live in the Central Highlands of Vietnam. In view of this, my general approach was guided by socio-material theories and corresponding methodologies as discussed above. My principal question was thereby associated with the characteristics of the bamboo culture of Bahnar people, which I conclude is an appropriate plant-based technology. Moreover, my observation of bambooic things and objects, technical actions, the built environment, and my interest in the context of bambooworking caused me to scrutinize the characteristics of the human-bamboo relationship. My main questions were: how do Bahnar people use bamboo? What kind of bambooic things do they generate? How to they produce these things? How is bamboo culture related to the lives of Bahnar people? How can socio-material theories help an anthropologist or historian to interpret the material aspects of humans' lives? Against this background, I studied bamboo's multiple manifestations as a plant amongst other plants, raw and construction material, and how bambooic human-made things were produced and used. As an outcome, I compiled a comprehensive list of bambooic tools and objects to demonstrate the richness of the Bahnar bamboo culture.

One prominent issue revolved around the question of how the human body is involved in the processing of bamboo. Based on my observations of Mr. Ninh's work with tools and bamboo (as a raw material), I introduced the term *bodycraft* as a more extensive concept by analogy with the term *handi*craft. Overall, the former is more holistic and takes into account the entire human body involving one's arms, legs, hands, feet, or mouth and is a more appropriate term to analyze how people produce things. Moreover, following Ingold's (2000) emphasis that the production of things always corresponds to a material's property and that the generation of things is not the product of the human mind alone, I demonstrated that the production of things (or form giving) is a co-production of a material and its inherent qualities alongside the human mind and body and her/his immersion with all human senses in an activity.

Guided by the theoretical assumptions of practice theory and its practice-centered ontology, another question of great interest was concerned with how social practices and daily activities of Bahnar people are determined by the conflation of bambooic tools and objects and the human. As testified by the various *professions* of Mr. Ninh, it became clear that bamboo is part of many human-bamboo interrelations of swiddeners and the material bedrock to perform practices and that bamboo is fundamental for the constitution of wider material assemblages. Then, following ANT's post-humanist position, I followed the various entities' movements as part of actor-networks. This, I exemplified by the association of shifting cultivation and the Bahnar bamboo culture and the Bahnar house. Overall, ANT's symmetric approach provided a methodological toolkit that helped me understand how heterogeneous entities are connected in mutual relationships and how they create, generate, maintain, and stabilize spatial-temporal actor-networks.

Since both theories have certain shortcomings—such as practice theory's focus on the human practitioner and ANT's overemphasis on nonhumans' agency—the integration of both in my research supplemented both theories and benefited from their strengths. Moreover, I attempted to underscore each theory's analytical scope (and some shortcomings) by the example of the Bahnar people's material aspects of life and nonhuman-nonhuman connections as well as how both theories contribute to an analysis and interpretation of reciprocal associations of human-thing entities and other arrangements. Similarly, I clarified how both theories offer answers on the question of where to locate the social, namely, in the material setting revolving around the human practitioner (as postulated by practice theory) and in networks with no central subject but instead throughout the associations between its members (by following ANT's perspectives and as exemplified by the actor-network revolving around the bamboo house and the ShiCu network).

As also demonstrated in this chapter and as explained above, the Bahnar do not determine their lives and future entirely alone. External actors profoundly impact the lives of Bahnar people and of other ethnic minorities. For this reason, I reviewed the literature concerning the Central Highlands' history and the Bahnar peoples' historical background. I discussed the various actors' influence on highlanders and particularly on the Bahnar people's lives. Against this background I elaborated on the effects of highland dwellers' lives, such as the early anthropologists' studies and perception of ethnic minorities, the First Republic's thinking of highland dwellers as *backward people*, the Socialist Republic of Vietnam's socialist ideas of progress, and the latter's later striving for agricultural development and market-driven economic progress in terms of *Đổi Mới*.

As my literature review revealed, the lives of subsistence-based or subsistence-oriented people, such as the Bahnar, have been considerably influenced by the various external actors and factors, including state policy, environmental change, market liberalization, introduction of permanent agriculture, in-migration, modernization programs, Vietnamization, and the like. Since the Bahnar swiddener's life is intimately connected to self-determination and the natural environment, I sought to find concepts of well-being that pay more attention to the Bahnar people's environment-friendly and plant-based technological solutions alongside their worldview and understanding of them and their perception of nature. Hence, I stated that Gudynas's (2011) concept of Buen Vivir is very promising since it proclaims, similar to ANT's posthumanism, an expansion of the social towards nonhuman entities and a re-introduction of nature into the sphere of the social. Consequently, I pointed out that the Buen Vivir concept is more valuable for a holistic interpretation of the human-bamboo relationship than one-sided, dualistic models.

Chapter 8 is divided into three main subsections and was concerned with bamboo's connection to Chinese pre-industrial material culture and mainly driven by my literature review of historical sources and secondary texts. The first section (chapter 8.1) was concerned with the general question to what extent bamboo's inherent structure is linked to Chinese material culture. I described a plethora of tools, devices, and techniques that demonstrate how Chinese peasants and craftspeople took advantage of bamboo's hollowness, springiness, or tensile strength to generate bambooic things.

The second section (chapter 8.2) took a closer look at bamboo's contribution to the spread of two central inventions: papermaking and gunpowder. As demonstrated in this part, bamboo tablets shaped how early Chinese was written but were substituted by bamboo paper, which became the chief material for pulp production. Bamboo was also instrumental for the development of Chinese military technologies and means of war. Many military weapons were developed that exploited bamboo's natural length, hollowness, lightness, or stiffness. Later, firearms were developed that took advantage of bamboo's cylindrical shape because the latter provided an essential foundation for converting gunpowder's explosive power into powerful explosive force. Overall, the development of bamboo-based firearms established new weaponry, reshaped military strategies in China, and had global impacts on warfare due to the distribution of gunpowder and firearms.

The third section (chapter 8.3) was primarily concerned with the bamboo-related material culture of Chinese peasants in pre-industrial times and scrutinized the characteristics of bambooic tools and mundane objects, which were the prerequisite to perform everyday activities. The same section also asked how human-thing entities can be analyzed as hybrid entities from a practice theory or ANT perspective. As demonstrated by this chapter, bamboo was intrinsically woven into Chinese peasantry's everyday life and agricultural work and, in many cases, instrumental for the Chinese peasants' material culture. Moreover, my theory-driven discussion of the plow and plowing and the latter's interlinkage with the human body and other entities underlined the hybridity and heterodoxy of human-thing conflations and was intended to represent other human-thing, human-tool, or human-bamboo(-thing and -tool) relations in the further course of this dissertation.

Chapter 9 discussed constellations of people and bamboo in pre-industrial Japan and examined bamboo's role in immaterial culture (including art, language, ceremonies, gardening, aesthetics, and bamboo's symbolic meaning) and material culture (including the tangible things people produced, used, and consumed in their everyday lives). In this connection, I questioned how people benefited from bamboo's intrinsic material properties, and I explored the question of which (movable and immovable) bambooic things surrounded people, and what these things could tell us about pre-industrial Japanese lifestyles and livelihoods. As this chapter has demonstrated, bamboo was enmeshed in many relations with the Japanese immaterial and material culture and people's daily, ordinary routines, and cultural and ceremonial activities. Bamboo represented a symbol of integrity, resistance, and modesty in Japan and was a much-valued motif in art, poetry, and sayings. At the same time, bamboo was an integral part of people's life-worlds from diverse socio-cultural backgrounds. Moreover, bamboo facilitated manual labor and provided practical solutions for everyday problems. Many pre-industrial technological solutions profited from the usefulness of bamboo. Generally speaking, Japanese people shaped bamboo, and bamboo shaped Japanese material culture. Unsurprisingly, then, bamboo's material history was intrinsically interwoven with Japan's socio-cultural and technological history before the advent of industrialization and the spread of industrially produced tools and technologies.

What is more, ANT's perspective concerning the human-nonhuman entities' enmeshment and its material-semiotic approach was instrumental in my description of the Japanese tea ceremony. In my view, the tea ceremony unites a wide-ranging set of entities, including ideas of aesthetic value (as expressed by *ikebana*, the arrangement of flowers, and garden design), the paraphernalia needed to carry out the tea ceremony (such as bamboo dippers, spoons, stirrer, spatula, and the like), the human body, and the performances of its participants (assigned to and expected from the host and her/his guests). As shown by the tea ceremony, ANT provides a methodological approach to re-describe and analyze distinct details of people's practices because it traces the social as an outcome of associations of humans alongside nonhumans. In this context, I demonstrated that the material presence of bambooic objects is fundamental to perform (the non-verbal) actions associated with the tea ceremony.

Chapter 10 was once more engaged with the role of mundane objects and tools as part of material action and explored how bambooic things aggregate various aspects of social life. Thus, through the study of historical records and secondary sources, this chapter's underlying question was to interrogate which bambooic artifacts, tools, mundane objects, or constructions existed in the pre- and post-Columbian Americas and pre- and colonial Africa. As shown by the various examples demonstrating the human-bamboo enmeshment of Native Americans in North America and that of other indigenous people in South America and Africa, bamboo's material history is something that developed in Asia as well as in the Americas and Africa and sometimes—as in the case of precolonial North America—a bamboo culture's diversity is based on only a few bamboo species, as expressed by the manifold uses of bamboo. In sum, I have demonstrated that bamboo cultures were part of the Americas and Africa and indicated their commonalities with bamboo cultures elsewhere.

Chapter 10 also indicated the relevance of bamboo for wildlife biodiversity and demonstrated how nonhuman animals, such as the beaver, use bamboo to build an artificial environment.

11.1. The Human-Bamboo Relationship: A Global Perspective

The present work discussed the various aspects of human-bamboo relationships through an account of a wide-ranging epoch- and time-spanning description of bamboo cultures of small-scale and large-scale societies. As became clear, bamboo accompanied people in multiple ways and was fundamental for establishing bamboo-related or bamboo-based material cultures and crucial for the development of proto-industrial technologies in China as well as for local, indigenous technologies related to a subsistence-oriented or -based economy. As mentioned above, I attempted to analyze and interpret bamboo's role in different societies' everyday lives by gaining data from historical records and anthropological fieldwork in order to prove that people in different world regions benefited in many ways from bamboo and that they made a living through their exploitation of bamboo.

Nonetheless, one should keep in mind that every study of a past and present material culture must emphasize its subject matter's variability and transformation and also acknowledge each society's material cultures' uniqueness in time and space. Thus, a case study of bamboo's use by a particular group, such as the Bahnar people, is only to a limited extent transferable to the whole ethnic group or other ethnic groups. A local bamboo culture is local in the literal sense. Hence, any description of a given human-bamboo relation is only meaningful if considering its interconnection to people's culture, social relations, natural environment, technological knowledge, economic system, and the like—even though sharing cross-cultural and intra-regional similarities with other societies.

As shown in this work, bamboo cultures and bamboo's material history are not confined to a specific region. On a global level, bamboo cultures developed independently of each other. For instance, the bamboo cultures in the Americas developed separately from the rest of the world, and the bamboo cultures in Africa also developed (most likely) independently of other world regions. And, if we take a closer look at Asia, one must come to the same conclusion.

Yet, the bamboo cultures of highland dwellers practicing shifting cultivation share many commonalities, as exemplified by the bamboo culture of the Bahnar people in Vietnam and the Awa people in Papua New Guinea. Given the fact that both ethnic groups had barely any contact with each other, it raises the question of the spread of bamboo-related technological solutions. Since the Central Highlands of Vietnam and the highlands of Papua New Guinea are separated by the Pacific Ocean with a linear distance of over 4,500 km, it is barely possible that both ethnicities exchanged techniques of bambooworking or specific designs of bambooic things and tools. In consequence, bamboo-related indigenous technologies must have evolved separately from each other—not, however, if this hypothesis is confined to a subregional scope. Thus, on a local scale it is most likely that neighboring ethnic groups exchanged ideas about how to work bamboo. This is, for instance, vividly illustrated by the bamboo-based roof construction of Rông community houses, common among many ethnic minorities in the Central Highlands of Vietnam.

Moreover, the bamboo cultures of indigenous people in the Americas and Africa have some common features with the bamboo culture of Bahnar or Awa people. Hence, indigenous peoples of the Americas, Africa, and Asia used bamboo in similar ways. They used bamboo to build houses and to produce woven mats, weapons, hunting tools and fishing equipment, fences, cooking containers, rafters, musical instruments, baskets (for household, transport, or agricultural work), and the like.

Furthermore, small-scale societies' bamboo cultures also share many commonalities with large-scale societies' bamboo cultures, as exemplified by various bambooic things common amongst, for instance, Chinese, Japanese, or Bahnar, such as bamboo containers, agricultural tools, baskets, hunting tools, fences, and the like.

In the case of small-scale societies such as the Bahnar, whose economy is subsistence-based or -oriented, bamboo constitutes the material background of many more activities than in large-scale societies like China or Japan. For the latter—though still fundamental for local bamboo technologies and material cultures—bamboo was one crucial material alongside wood or iron (and other organic and inorganic materials not described in detail).

If taken together, my research results suggest an intimate connection between humans and bamboo for both pre- and nonindustrial small-scale and large-scale societies, as attested by the ways different people throughout the world exploited bamboo to meet their basic needs. They developed certain kinds of human-bamboo relationships, which are the outcome of human ingenuity and creativity and bamboos' inherent physical-material properties. In other words, human life and history are equally influenced by humans' actions and nonhumans. As pointed out by Michael:

> Humans are fabricated—in language, through discursive formations, in their various liaisons with technological or natural actors, across networks that are heterogeneously comprised of humans and nonhumans who are themselves so comprised. Instead of humans and non-humans we are beginning to think of flows, movements, arrangements, relations. It is through such dynamics that the human (and the non-human) emerges. (Michael 2012, 1)

Thus, independently of whether nonhumans fall into the category of the natural or technological realm, they are interwoven with human existence. In this sense, the human-bamboo relationship is characterized by its heterogeneity involving various connections. In sum, human-bamboo hybrids unfold in a realm that overlaps nature, technology, culture, and society and between object and subject.

Comparing the various literature related to bamboo cultures of small-scale and large-scale societies in Asia, the Americas, and Africa alongside my data gained through fieldwork among the Bahnar people leads to an intriguing theoretical point: bambooic things, tools, objects, the human-made built environment, and actions related to bambooic materials, have the capacity to shape the social life of people and, in doing so, are part of the social sphere. Consequently, a rethinking and reconceptualization of how different things impact human history and existence provide significant insights into people's life.

11.2. Inadequacies of Previous Studies, Shortcomings of This Study, and Recommendations for Further Research

Much of the research of other scholars on bamboo's contribution to humankind's socio-cultural and technological development and people's material cultures has been descriptive in nature, and very little was found in the literature that takes a closer look at the human-bamboo relationship from a socio-material position. Moreover, no reliable data was found about the association between humans and bamboo in a global perspective, and little data was found in terms of small-scale societies' connection to bamboo. I have already outlined the findings and shortcomings of previous research and theory in the respective chapters, so I will not reiterate them in detail. In my view, the lack of literature on the human-bamboo relationship exists because things, as part of the social, have been neglected in Western science. It is a neglect that has its origins in the prevailing dualistic view, which is predominantly focused on the self-contained human being. As a result, not much attention was given to tangible things and even less to bamboo.

Yet, as demonstrated by this work, practice-centered ontologies of practice theory or ANT's interest in the effects of nonhumans change the view of the role of matter and things. Although things are still not fully established in the humanities and related disciplines, the idea that things modify people's practices has become more prominent, as illustrated by the number of works in connection with socio-material theories or the cross-disciplinary field of material cultures studies. But, as shown in this book, by following socio-material theories' recommendation and emphasis on the potential agency of nonhumans in relational networks or material arrangements one can obtain a crucial analysis and description of nonhumans' agency as part of the social. In view of this, one is able to unravel insights into how bamboo, as a nonhuman entity, affects people's lives and how bamboo cultures are related to material aspects of people.

Against this background, the present work attempted to fill the gap in research concerning the human-bamboo relationship, bamboo's part in material cultures, and, lastly, to provide a more theory-driven discourse of bamboo's material history based on my theory-driven approach and study of historical records and secondary sources alongside the data gained from my fieldwork that demonstrated the relevance of socio-material theories in terms of the analysis of bamboo-centric research.

Nonetheless, certain shortcomings accompanied this work. First of all, I studied wide-ranging topics related to the enmeshment of bamboo of many societies throughout time and space. This circumstance has limited each chapter's scope since delving into the multiple aspects of any small-scale or large-scale society's human-bamboo relationship would be a comprehensive work in itself. For instance, the study of bamboo's contribution to ancient China's technological development would fill a sizeable volume, and other books would be required to discuss the Japanese, American, or African bamboo cultures. Thus, even though I was tempted to study many historical sources, I could not encompass all the relevant literature at my disposal, and language barriers also hindered the study of first-hand information. What is more, my anthropological fieldwork was relatively short and provided only an overview of Bahnar peoples' bamboo culture.

In view of that, one potential problem is that the scope of my thesis may be too broad, and my limited study of the body of literature related to each chapter's topic remains uncomprehensive. Nonetheless, my aim to study bamboo from different perspectives to discover bamboo's use throughout time and space would hardly be possible without deliberately confining this work's thematic scope. Thus, shifting the focus from one to another bamboo technology or bamboo culture gave this work the underlying structure, and it is hoped that my research findings will contribute to a deeper understanding of bamboo's part in human history and present societies.

In summary, the study of different bamboo cultures, as carried out in this thesis, arose in the interest of my quest for a global study of the material history of bamboo and the human-bamboo relationship. Thus, the present work provides a far-reaching and inclusive idea about how humans shape(d) bamboo and how bamboo shape(d) human societies. Moreover, the present work's findings contribute in several ways to our understanding of bamboo and provide a basis for further research and investigation that will hopefully add further information through case studies and ethnographic work.

Furthermore, I believe that my research contributes a great deal to an understanding of multiple, hybrid bamboo cultures of past and contemporary societies, and I hope that this thesis lays a substantial foundation for further studies about the human-bamboo relationship and bamboo's material history. Further comparative studies on bamboo that are equally driven by socio-material theories could help to study bamboo's relevance for other peoples in history and the present.

Lastly, as held by the concept of Buen Vivir or ANT, a conceptual model of human life and nature should be less anthropocentric in order to overcome the current limitations of dualistic worldviews and facilitate a more holistic approach to the study of the human-bamboo relationship. In sum, such an approach would bring a greater depth to data collected by taking a closer look at the nonhumans and would help to understand the complex connections between humans and bamboo.

11.3. Outlook

As proven by this work, *bamboo* is still part of people's economies and local technologies. On the whole, material cultures and bamboo cultures are dynamic rather than static, and so is the very nature of bamboo, which is by no means predetermined once and for all. In fact, bamboo has undergone various reinterpretations at different times. If we look at the techno-history of bamboo and its recent industrial exploitation, we will immediately notice that industrial utilization denaturalizes bamboo by transforming bamboo's cylindrical hollow form into wood-glue compounds and thus into glued boards. As a result, the intimate historic connection between humans and bamboo was disrupted with the beginning of the industrial age. The new, composite material made of bamboo is equivalent to a uniform and standardized material with more or less the same properties that are needed by the bamboo industry for mass production. Yet, since bamboo is the fastest growing woody plant and valued as a sustainable substitute for timber, increasing bamboo plantations and bamboo production could relieve the pressure on our ecosystems and bamboo industries could help in the supply of sustainable everyday goods.

At the same time, historical and present bamboo cultures could be helpful to re-design bamboo products of everyday use not only for people already using bamboo but also where bamboo's use has decreased. Many things could be substituted by bambooic things that were replaced by plastic or metal products, such as baskets, furniture, fences, lamps, kitchen utensils, and the like. Or, in the domain of architecture and civil engineering, the promotion of bamboo-based houses, bridges, fences, and the like, would help to re-establish bamboo in many regions. As a result, bamboo plantations would contribute to carbon sequestration and slow or reduce atmospheric carbon dioxide pollution.

Finally, based on this work's underlying goal that attempted to analyze bamboo's multi-faceted interrelations with humans and the characteristics of space- and time-spanning human-bamboo relationships, I propose the following relevance of my research:

First, the investigation of human-thing relationships is a continuing concern within the anthropogenic sciences, and the study of the human-bamboo relationships, as presented in this work, hopefully provides fresh insights into human-thing relationships in general and lay the foundation for further studies on bamboo's part in human lives.

Second, my examination of the material history of bamboo and its relation to humankind's (technological) development provides crucial knowledge of the past, which can help to understand how societies developed and how the past still affects the present.

Third, in view of the current global ecological crisis, a revisit of bamboo's positive effects on the surrounding ecosystem and landscape, wildlife, biodiversity, environmental conservation, soil erosion, or carbon storage promises many opportunities to tackle ecological problems—though attention was only briefly devoted to this issue, preserving traditional bambooworking and bamboocrafts and indigenous people's bamboo cultures provides many ecological advantages because bamboo is a renewable and sustainable plant and forest product.

Fourth, the findings of ancient and contemporary bamboo cultures can, on the one hand, encourage preservation of existing traditional bamboo cultures, bamboocrafts, and bambooworking techniques and, on the other hand, promote a revival or extension of bamboo's use as renewable plant material in postindustrial societies' material cultures and help to establish ways of sustainable living.

Fifth, the study of contemporary bamboo cultures of the Bahnar people reveals much about the significance of bamboo in association with shifting cultivation and environmental conservation, and how traditional indigenous people's lifestyle, indigenous knowledge, and cultural identity are connected to bamboo. Thus, if we take a closer look at traditional bamboo cultures, we will notice that their economy and material culture are environmentally friendly and sustainable since they rely on bamboo's natural abundance and regrowth habits. Hence, acknowledging the significance of traditional bamboo cultures and bamboo technologies, such as those of the Bahnar people, would help to preserve a sustainable way of bamboo-based living that has already been sustainable for centuries. Moreover, recognizing the relevance of bamboo for many ethnic groups in the Central Highlands of Vietnam and on a global scale would encourage environmental conservation. This, in turn, would reduce the loss of forests and likewise reduce humans' carbon footprint. What is more, maintaining bamboo groves would ensure wildlife biodiversity, protect endangered land, transform eroded land to fertile soil, and secure the necessary raw material for people who are dependent on bamboo.

On the whole, the findings of the present work's anthropological part suggest re-interpreting the relevance of bamboo for people engaged in subsistence-oriented economies. Governmental policies and local NGOs should regard bamboo as an essential sustainable resource that helps rural people to meet their needs. Therefore, environmental conservation and the acknowledgment of each ethnic group's lifestyle, livelihood, and traditional agroforestry systems could promote awareness of ethnic groups and their indigenous knowledge. Policymakers should help maintain and improve Bahnar people's lives, protect them from the threats of deforestation and the loss of bamboo, and the problematic effects of in-migration, Vietnamization, and the free market. Instead, policymakers should support bamboo plantations in community forests and promote a socio-economic development based on people's bamboo cultures and local people's knowledge of bamboo and simultaneously protect the environment.

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