Aquatic Adaptations in Mesoamerica

Subsistence Activities in Ethnoarchaeological Perspective

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Archaeopress Pre-Columbian Archaeology 15

Archaeopress Publishing Ltd
Summertown Pavilion
18-24 Middle Way
Summertown
Oxford OX2 7LG

www.archaeopress.com

ISBN 978-1-78969-911-1
ISBN 978-1-78969-912-8 (e-Pdf)

Cover:
Top - Ceramic plate by Catherine Bony, Patamban, Michoacán, Mexico.
Bottom - Tarascan fishermen at Lake Pátzcuaro, Michoacán, Mexico. Photo by Hugo Brehme, 1923 (courtesy of Teresa Rojas Rabiela).

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In memory of Jeffrey R. Parsons: scholar, colleague, and friend.

There are many traditional activities hovering on the edge of extinction that deserve... recording in Mexico and throughout the world. Few scholars appear to be much interested in studying the material and organizational aspects of these vanishing lifeways, and archaeologists may be virtually alone in making such efforts as do exist. In one sense this... is a plea to others to undertake comparable studies elsewhere while there is still a little time left to do so.

Jeffrey R. Parsons (2001:xiv).

Contents

Preface

The term 'aquatic adaptations' refers to the subsistence strategies that ancient Mesoamericans implemented to survive and thrive in their environments. In this book, I discuss the natural settings, production sites, techniques, artifacts, cultural landscapes, traditional knowledge and other features linked to human subsistence in aquatic environments. Specifically, the present study is based on analyses of the following activities: fishing, hunting, gathering, and manufacture, including salt-making and intensive agriculture. In addition, I examine the main aspects of my own research on the Mesoamerican aquatic lifeway from a perspective based on ethnoarchaeology and ethnohistory.

To borrow a phrase from Jared Diamond (2012:24), this is 'a small book about a big subject'. The story behind the research that led to my writing this book began in 1996, when I embarked on a long-term study of salt production in aquatic environments in two areas of Michoacán: the Lake Cuitzeo Basin and the lagoons on the coast of Michoacán and Colima. One thing led to another, and after a number of years I shifted my focus from salt-making to the aquatic lifeway in Michoacán, again at Lake Cuitzeo, and later adding the case of Lake Pátzcuaro for comparative purposes. The books *La sal de la tierra* (Williams 2003, 2015, 2018) and *La gente del agua* (Williams 2014a, out of print) provide bases for the present volume, as do other books and numerous articles that I have written over the years (see the Bibliography). Below I mention all the people and institutions that have supported my work over the years and ultimately made the present book possible. I also mention the colleagues who helped me by providing information and advice, sharing illustrations, and in many other ways. First and foremost, I would like to thank the salt-makers, fishers, basket-makers and various other artisans who contributed to my research in the field.

The library and laboratory research necessary for writing this book and many of the books and articles mentioned above was conducted at Tulane University, first during a sabbatical year (1998-1999) that I spent as a Visiting Scholar at the Middle-American Research Institute. This stay at Tulane was made possible by a grant from Conacyt and a Fulbright Exchange Program Fellowship. The main result of my sabbatical in Tulane was the book *La sal de la tierra*, which was awarded the Alfonso Caso Prize (by the National Council for Culture and the Arts, and the National Institute of Anthropology and History, in 2005). My time in New Orleans was a memorable experience thanks to the southern hospitality of my friends Dan and Nancy Healan, Ruth and George Bilbe, and others.

In 2000, I received financial support from the Universidad de Colima to carry out fieldwork in the salt-making areas of the coast of Michoacán and Colima. This was made possible by the late Dr. Beatriz Braniff, Director of the Center for Anthropological Research of Colima University.

In 2003, I conducted fieldwork in the salt-making areas near Araró and Simirao in the Lake Cuitzeo Basin. This was made possible by a grant from the Foundation for the Advancement of Mesoamerican Studies, Inc. (FAMSI).

In 2007, I returned to the field, this time to work with the fishers, artisans and other informants in several towns within the Lake Cuitzeo and Pátzcuaro basins. This was possible thanks to the financial support I received from the Center for Research on Ecosystems (UNAM, Morelia campus). Thanks are due to Dr. Patricia Ávila for making the funds available.

In 2011, I found myself back in Tulane, where I spent another sabbatical year, this time as a Visiting Scholar in the Department of Anthropology, again supported by Conacyt. Results of this stay at Tulane were the books *La gente del agua* (Williams 2014a) and *Water Folk* (Williams 2014b), as well as the article 'Reconstructing an Ancient Aquatic Lifeway in the Lake Cuitzeo Basin, Michoacán, Mexico' (Williams 2014c).

Acknowledgments

The following colleagues provided useful comments and advice during the time I spent writing the present book (February-October 2020): Dean Arnold, Edwin Barnhart, Alexandra Biar, Kristi Butterwick, Blas Castellón, Susan T. Evans, Jeff Parsons, Helen Pollard, Heather Richards-Rissetto, Teresa Rojas Rabiela, Alfred Siemens, Yoko Sugiura, David Wright, and Andrea Yankowsky. Last but not least, I thank my colleagues at the Centro de Estudios Arqueológicos, especially Magdalena García Sánchez, Rodrigo Esparza and Blanca Maldonado. Also thanks to my son Teddy, who took most of the photos at lakes Pátzcuaro and Cuitzeo included in Chapter II. He also made adaptations to most of the maps and drawings.

Chapter I

Introduction

As we will see in this book, the term 'aquatic adaptations' refers to the subsistence strategies that ancient Mesoamericans implemented to survive in their environments. Here I discuss the natural settings, production sites, techniques, artifacts, cultural landscapes, and other features linked to human subsistence in aquatic environments; in particular, the following activities: fishing, hunting, gathering, and manufacture, including salt-making and intensive agriculture. In these pages I examine the main aspects of research in this field, focused primarily on the Mesoamerican aquatic lifeway, from a study perspective based on ethnoarchaeology and ethnohistory.

On the topic of human adaptation to the environment, Mark Sutton and E.N. Anderson (2004) hold that 'beginning some time in the distant past, culture[1] began to influence human development, changing the relationship of humans to their environment from one of strict biology to a mixture of biology and culture. Over the millennia, culture has become more complex and influential in human affairs, and the role of biology has diminished' (p. 85).

Although Sutton and Anderson recognize that 'humans still require a certain level of nutrition, have physical limits to their physiological adaptations, and are still subject to the rules of biological evolution... [today] biology plays only a minor role in human adaptation, and now most of the problems posed by the environment have to be solved through the mechanism of culture' (p. 85).

Sutton and Anderson further state that 'much of the ecological work relating to humans has centered on diet and subsistence... on human biological ecology. Subsistence is not simply a list of foods but a complex system that includes resources, technology, social and political organization, settlement patterns, and all of the other aspects of making a living. Subsistence is one of the vast complexities of human behavior largely related to culture' (p. 85).

In the following pages I will describe the various strategies that underlaid the distinct cultural adaptations to aquatic environments that existed in ancient Mesoamerica, beginning with the aquatic lifeway.

[1] The concept of culture as understood by anthropologists has been difficult to reconcile with an archaeological perspective. In this book, I follow Patty J. Watson's definition of culture (based on the writings of Robert Redfield), as 'an organized body of conventional understandings manifest in art and artifacts which, persisting through tradition, characterizes a human group' (Watson 1995:683).

The Mesoamerican Aquatic Lifeway

Mesoamerica was the only civilization in history that was bereft of any kind of domesticated livestock; despite this condition, however, Mesoamerican foodways were among the most complete in ancient times. Most large, potentially-domesticable animal species in the New World became extinct some 12,000-17,000 years ago, right around the time that humans began to appear on the continent (indeed, it has been suggested that early humans contributed to the extinction of Pleistocene fauna) (Diamond 1999).

The domestication of cattle, horses, pigs, sheep, or other animals in the Neolithic (*ca.* 7000-2000 BC) in the Old World allowed human populations to considerably broaden the range of exploitation of their environment, since the anatomical adaptation of ungulates (primarily ruminants such as cattle, sheep, goats, and camels, among others) to a diet high in cellulose and low in proteins gave humans an indirect way of exploiting cellulose-rich plants, especially grasses and the boughs and leaves of bushes (Harris 1977:220). This complex centered on domesticated animals (that in addition to meat provided hides, wool, milk, and energy for field labors) never emerged in pre-Hispanic Mesoamerica. While this fact certainly had far-reaching implications for technology and culture, its primary impact was on the diet of ancient Mesoamericans. According to Jeffrey Parsons, the lack of domesticated herbivores obliged those peoples to look for alternative foodways. And this meant exploiting non-agricultural resources, such as the aquatic animal and plant species that complemented basic agricultural products thanks to their high protein and nutrient content (Parsons 2010, 2011).

Parsons (2006) developed an analytical perspective to illustrate the dependence of Mesoamerican peoples on a wide range of natural resources of aquatic origin (apart from agriculture) for their daily sustenance. He holds that non-agricultural resources from many lakes in Mesoamerica, particularly salt and edible insects (and perhaps algae as well), were so energetically- and economically-important as to attract large numbers of people to engage full-time in their extraction, processing, and distribution. Such an attraction would necessarily have been significant in sociopolitical terms. In Parsons' opinion, the beds and swampy shores of lakes should be considered in much the same way as agricultural land when we attempt to evaluate pre-Hispanic productive potentials and carrying capacities (Parsons 1996:442).

Teresa Rojas Rabiela provides another important point of view for this discussion, since she believes that few regions in the Americas had non-agricultural food resources as abundant as those of the Basin of Mexico, where fishing, bird-hunting, salt production, and the capture of turtles, frogs, salamanders, small crustaceans, mollusks, and diverse insects and their larvae, as well as algae and other aquatic plants, all contributed to enriching the diet and subsistence of inhabitants from very early times. Each one of these activities has its own character and history, which can be reconstructed in part thanks to archaeological, historical, and zoological studies. Of course, the knowledge and remembrances of present-day inhabitants are another invaluable source of information on local flora and fauna (Rojas Rabiela 1998; Williams 2014a).

These abundant aquatic species represented a great natural wealth that had consequences for the sociopolitical organization of such Mesoamerican states as the Aztecs and Tarascans, who lived in ecological settings characterized by numerous large lakes, rivers, streams, springs, marshes, and other bodies of water.[2] Because they had no domesticated cattle, Mesoamericans developed subsistence strategies which produced an aquatic lifeway that was unique in the ancient world (Diamond 1999; Weigand 2000). According to Sugiura *et al.* (1998), this 'aquatic mode of subsistence' may be defined as a system that articulates all activities linked to processes established between human groups and their means of production. Thus, it is a specific response and interrelationship between people and their bio-physical surroundings that develops to ensure their survival and reproduction as a group. The aquatic mode of subsistence is part of a broader system that consists of an ecotonal lakeside zone where two structurally-distinct ecosystems –one aquatic, the other terrestrial– interact to produce an abundance of natural species.

The exploitation of this lakeside zone did not require complex technology; rather, it was based on the appropriate management of empirical knowledge related to exploitable resources, and on a set of basic tools or artifacts. The inhabitants of lakeside areas were not limited to exploiting the aquatic environment, for they widened their sphere of action to include the surrounding alluvial soils, indispensable for agriculture, and the forests beyond them (Sugiura *et al.* 1998).

In some areas of Mesoamerica, such as the Basin of Mexico and parts of Michoacán, several elements of indigenous life, particularly those related to the sphere of material culture associated with an aquatic mode of subsistence, were not greatly-modified by Spanish influence after the Conquest. In fact, most of the techniques, tools, and artifacts survived into the early decades of the 20th century (García Sánchez 2004). On the basis of historical and ethnographic sources, an aquatic lifeway can be characterized by three basic subsistence activities: (a) fishing, including not only fish but also many other edible aquatic species, such as insects; (b) hunting, which includes semi-aquatic species such as birds and reptiles, among others, as well as land animals that dwell in the lakeside area and the nearby forests and hills; and (c) gathering, which involved aquatic species (both edible ones and others used for manufacture, such as reeds) and land species, thus encompassing a broad variety of wild resources (animal, vegetable, and mineral) (García Sánchez 2004). To these three activities we must add the manufacture of all kinds of artifacts and elements that are indispensable for the adaptation and reproduction of human social groups.

There is a great similarity worldwide in the nature of the tools, implements, and procedures used to obtain and process aquatic resources. In order to carry out these activities, a whole range of artifacts exists for cutting, scraping, perforating, grinding, gouging, boiling, and storing. These implements would have to be manufactured or procured, and then maintained or curated, repaired, and replaced when broken or worn out. Likewise, other artifacts were needed to manufacture or repair such infrastructure elements as fishnets, traps, ropes, baskets, bags, boats, shelters, and vessels (Parsons 2006; Williams 2014a).

Because of the dearth of protein derived from domesticated animals, the ancient Mesoamericans had to rely on a wide spectrum of wild foods, including fish, plants, and insects. The amount and variety of wild species was staggering, as we will see later in this book. This allowed the native populations to meet all the requirements for a complete, healthy diet. Mesoamerican peoples also developed complex and sophisticated systems of agriculture based on such major crops as maize, beans, chili peppers, pumpkins, and innumerable highland and tropical grains, fruits, and vegetables that, together with many wild species of flora and fauna, made up one of the most nutritious and complete diets in the world (Weigand 2000).

However, as a consequence of the lack of animal protein, the Mesoamerican diet had a salt deficit. Because common salt (sodium chloride) is an essential mineral for human existence, it became a strategic resource, and salt-making techniques were highly-evolved and sophisticated throughout Mesoamerica (Andrews 1983; McKillop 2019; Parsons 2001; Williams 2015). Salt is not preserved in the archaeological record, so we have to look for indirect evidence of salt production, as we will see in Chapter III.

[2] According to Chacón *et al.* (2006:142), Michoacán has one of the greatest concentrations of water sources in Mexico, including 11 natural lakes, 260 reservoirs, 44 rivers, 1,200 springs, 21 underground aquifers, and 6,335 extraction wells and chain-pump wells.

Another key aspect of the aquatic adaptations in Mesoamerica discussed in this book is intensive agriculture in aquatic environments, like the *chinampas* of the Basin of Mexico and the raised fields, canals, and terraces of the Maya area and other parts of Mesoamerica.

Ethnoarchaeology

For purposes of this study, we use the definition of the term ethnoarchaeology proposed by William Longacre; that is, the study *by archaeologists* of the variability in material culture and its relationship with behavior and organization among present-day societies, to be used in archaeological interpretation (Longacre 1991). Longacre stresses the condition that such research must be carried out by archaeologists, since most sociocultural anthropologists and ethnographers usually do not record the systematic and quantitative data that is indispensable for archaeological interpretation, nor do they have the archaeologist's training or sensibility toward variability in material culture (Longacre 1991).

Several general principles, however, must be followed to ensure that the ethnographic analogies developed will be useful in archaeological reasoning; a topic that has been discussed by Nicholas David and Carol Kramer (2001). The subject and source cultures, for example, should be similar regarding variables likely to have affected or influenced the materials, behaviors, states, or processes being compared. If the source culture is the historic descendant of the subject culture, there is a greater intrinsic likelihood that similarities between the two will exist. However, cultural descent itself must be regarded as a problematic concept. The range of potential source models for comparison with the subject data should be expanded to include ethnography, ethnohistory, oral history, and archaeology in order to obtain as representative a range as is practically possible. However, owing to the inevitable elements of inductive reasoning and subjectivity involved in testing, deductive certainty can never be fully achieved (David and Kramer 2001:47-48).

Archaeological research usually focuses on material culture; that is, the remains of sites and objects from the past (houses and other buildings, activity areas, artifacts, food remains, funerary contexts, and so on) that have survived into the present, though their makers have disappeared, usually without leaving a historical record of their customs, the challenges they faced, or the strategies they devised to resolve them (Williams 2005). However, material culture in archaeological contexts is, by definition, *static*, and usually lacks the information required for an interpretation from a *dynamic* perspective, as Lewis Binford (1983) has pointed out. Archaeological facts by themselves can only tell us things that, despite their evident significance, cannot respond to the demands of a well-rounded ethnographic description. Therefore, the ethnoarchaeological perspective is indispensable for gaining a dynamic and processual view of the past since it allows us to make observations on current social actions (ethnographic context) and their material consequences (archaeological context).

A whole series of questions related to the archaeological record can only be resolved through processual research that goes beyond the archaeological record; for instance, how a context was formed by behavior within a cultural system; how a cultural system produced material (i.e. archaeological) remains; and, finally, the kinds of cultural variables that determine the structure –as opposed to the form and content– of the archaeological record (Schiffer 1995).

Ethnographic analogy cannot inform us as to prehistoric behavioral patterns in the absence of some modern counterpart. Since archaeologists' knowledge of present-day cultural systems is usually incomplete, broadening their ethnographic data base will allow them to formulate alternative models of behavior that would be difficult to conceive simply through logic or intuition (or imagination). Ethnographic models help us suggest hypotheses that can be tested, and are relatively free of ethnocentric bias. Thus, a comparative approach toward ethnoarchaeology should both complement, and go beyond, simple analogy (Gould 1978).

According to Binford (1981), the challenges that archaeologists face consist in relating archaeological remains to our ideas about the past, using the empirical world of archaeological phenomena to generate ideas concerning the past and, simultaneously, applying these empirical experiences to evaluate the ideas that emerge. Archaeological theory deals with the field of past events and conditions, and strives to explain why certain events and systems were generated in antiquity. Its area of interest deals with cultural systems, their variations and the way in which they might have passed from one state (ethnographic or systemic) to another (archaeological). However, it is important to bear in mind that our entire knowledge of the dynamic aspect of the past must be inferred by linking ancient events to current phenomena through anthropological research carried out beyond the strictures of the archaeological record, so as to obtain elements for analysis and comparison primarily through ethnographic analogy. Binford underlines this dynamic relationship between the (ethnographic) present and the (archaeological) past with the following words: 'The archaeological record is a contemporary phenomenon and observations we make about it are not "historical" statements' (p. 23). We need sites that preserve for us the things from the past, but we also need theoretical tools to

give meaning to these things when they are found. This requires a kind of research that cannot be conducted with the archaeological record itself. Therefore, if we intend to investigate the relationship between statics and dynamics, 'we must be able to observe both aspects simultaneously; and the only place we *can* observe dynamics is in the modern world, in the here and now' (p. 23).

Binford (1981) was seeking a precise medium for identification, as well as effective instruments for measuring the properties of past cultural systems; in other words, 'Rosetta stones' that would make it possible to translate observations of the static context into statements that incorporate dynamics. To achieve this, he proposed pursuing a new paradigm: constructing a 'middle-range theory'. Middle-range theory is what links an observation to a paradigm, ontology or philosophy. It is a theory of substantive phenomena, of human behavior in its cultural and social context. But it is just one link in a long chain of inferences that run from general theory to observation, and must always be susceptible to verification (Shott 1998).

For Michael Schiffer (1988), the irreducible core of archaeology is the effort to determine and explain the relationships between human behavior and material culture at every moment and in all places. The principles behind material culture in a dynamic context are known as 'correlates' and they are discovered through ethnoarchaeology or comparative ethnography (p. 469). Michael Shott (1998) points out that archaeologists are not concerned with *reconstructing* the past, since the past no longer exists but, rather, with *inferring* its nature from the material record they observe in the present. Archaeologists have access to assemblages and contexts that were created by formation processes; therefore, the dominant theory in this realm should be called 'formation theory' (pp. 310-311).

In one attempt to refer to the phenomena of formation and transformations in relation to the presentation of archaeological contexts and materials and the theory of information production in archaeology, Luis Felipe Bate (1998) proposed the term *teorías mediadoras*, or 'mediating theories'. These theories pertain to the links between the substantive subject of the research and its manifestation in archaeological data (p. 106). Mediating theories constitute a necessary medium for organizing, and then validating, the procedures through which we infer the history of concrete societies. The facts or empirical data at the archaeologist's disposal for observation are always contemporaneous to the observer, 'otherwise it would not be possible to establish a relationship of knowledge' (pp. 106-107).

One goal of the present study of aquatic adaptations in Mesoamerica is to provide ethnographic models for archaeological interpretation. This is of the utmost importance, for archaeology is the only social science where one cannot directly observe the object of study; that is, cultural behavior in the distant past. Arriving at a plausible interpretation of the archaeological record requires bearing in mind the various terms found in the archaeological literature, such as 'bridging arguments' (Wylie 2002); 'middle-range theory' (Binford 1983); 'mediating theories' (Bate 1998); and 'formation theory' (Shott 1998), for they refer to approaches through which ethnographic fieldwork helps the archaeologist relate a cluster of activities and cultural behaviors (in this case, the aquatic lifeway) with a particular assemblage and other diagnostic features of material culture and cultural landscapes that can aid in the interpretation of the archaeological record through analogy. The critical role of the ethnoarchaeological approach is further underscored by Grahame Clark's (1939) *dictum*: 'Material culture has meaning only in relation to society'.

One final word about the role of ethnoarchaeology as a tool for understanding the human past has to do with the nature of scientific research and the philosophical implications of theory-building in scientific endeavors, including archaeology. Some 50 years ago Imre Lakatos (2016) wrote that 'science consists of long periods of "normal science", paradigm-based research, where the task is to force nature to fit the paradigm. When nature refuses to comply, this is not seen as a refutation, but rather as an anomaly. It casts doubt, not on the ruling paradigm, but on the ingenuity of the scientists... It is only in extraordinary periods of "revolutionary science" that... refutations occur'.

Lakatos proposed a middle road between these extremes –'normal science' and 'revolutionary science'– in which 'the basic unit of appraisal is not the isolated testable theory, but rather the "research program" within which a series of testable theories is generated...A program progresses theoretically if the new theory solves the anomaly faced... by the old and is independently testable, making new predictions'. In Lakatos' view, 'a program progresses empirically if at least one of these new predictions is confirmed'. Conversely, 'a program degenerates if its successive theories are not theoretically progressive (because it predicts no novel facts), or not empirically progressive (because novel predictions get refuted)'. Lakatos claimed that the history of science typically consists of 'competing research programs'. The conclusion reached contemplates 'a scientific revolution [that] occurs when a degenerating program is superseded by a progressive one'. In essence, Lakatos thought that a hypothesis would eventually be substituted by another hypothesis, which would in turn be subject to refutation through ongoing scientific research.

In the case of archaeology, Bruce Trigger (2006) has stated the following thoughts, echoing in part Lakatos' ideas: 'It is a fundamental tenet of science that nothing is significant by itself but only in relation to hypotheses; hence only theories can explain phenomena... Scientists must search for order, most often in the form of systemic properties, that facilitate the construction of explanations' (p. 27). The goal pursued by many scientists 'is to discover mechanisms that account for how things work and have come to be as they find them... A scientific viewpoint treats the idea of absolute, unchanging truth as a dangerous and absurd illusion... scientists... acknowledge that they are unable to transcend the limitations of their data and what they are capable of perceiving at any particular point in time' (p. 27). Therefore, investigators should 'expect that in due course every scientific theory will be altered and probably become outmoded' (p. 27).

Binford (1983) made another salient point concerning inference in archaeology when he argued that 'each new study... results in the generation of more facts... but they are all statements about the archaeological record alone. In the absence of robust methods for inference, all that can be accomplished is the gathering of more and more facts, whose significance in terms of past behavior is unknown' (p. 76). Only on rare occasions have archaeologists established methods for justifying the inferences advanced during their research. One such method would be middle-range research, often based on ethnographic observations. Binford thought that 'studies of the archaeological record provide the stimulus for research in the modern world which, in turn... can render our archaeological observations into accurate statements about the past' (p. 76). In conclusion, he wrote that 'in order to make inferences archaeology needs to develop middle-range theory... divorced from the theories about past behavior which we seek to evaluate. Archaeology, in general, has failed to realize that in order to refute or support theories it requires a strong body of inferential techniques, warranted independently of its theories about past dynamics' (p. 213).

The present study attempts to generate new data and interpretations through ethnographic analogy and ethnohistorical information, with the ultimate purpose of understanding aquatic adaptations in ancient Mesoamerica.

Ethnohistory

In addition to ethnoarchaeology, ethnohistory offers an important perspective for the present study. Here, ethnohistory is understood to include oral history, since we conducted interviews with many local informants during fieldwork (Williams 2014a, 2014b, 2014c, 2020a). Both historians and anthropologists have long used oral history to obtain information that is crucial for understanding many aspects of daily life, particularly those which have subsisted over long periods of time (García Sánchez 2005).

Ethnohistory is a branch of anthropology that studies non-European cultures (particularly indigenous ones) from any period (especially the pre-Hispanic period and the 16th century) using written sources, though it also permits the use of such auxiliary sources of information as oral tradition, archaeological data, and linguistic evidence, with the aim of presenting a complete history that takes into account the cultural and social systems of the peoples under study (Wright 1994:380).

Phil Weigand's (1994) view of the role of ethnohistory in anthropological research, particularly in Western Mexico, is pertinent to the present study. According to Weigand, the word 'ethnohistory' is usually defined in a simple way as the writing of a comprehensive history dealing with an *ethnos*, such as the Huichol or Purépecha. This history usually strives to include a combination of historical sources, oral histories, historical mythologies, and anthropological data. This history is frequently written from within the ethnic group we are dealing with, from their perspective, or at least including their point of view. One of the main goals of this approach consists in giving a 'people without history' (following Eric Wolf 1982) a history that is more in keeping with their own perception of time and reality.

Using the techniques of ethnology –in the earliest sense of the word– as well as archaeology and history (both documentary and oral), a cultural and social history of an area is defined and outlined for the first time, and later explored in detail. In this way, the approach becomes regional and often acquires a multi-ethnic character by analyzing inter-ethnic and multicultural dynamics through time in the context of extant political and economic structures. Ethnohistorical research requires a multidisciplinary approach in which several disciplines come together to offer a more holistic view of a society, a landscape, or human nature (Weigand 1994).

The indispensable role of ethnohistory in Mesoamerican studies has been further underscored by Kenneth Hirth (2016), who used an ethnohistorical approach to examine the structure of the Aztec economic world based primarily on early colonial written sources. A small amount of archaeological information was also used, but only as supplemental data. Hirth's goal was to focus on 16th-century sources to construct a plausible model of Aztec economic structure. In essence, he set out to exploit the historic sources 'with the goal of

developing as complete and comprehensive model of pre-Hispanic economic behavior as realistically as possible... The focus on historic sources has made it possible to produce... an archaeologically informed model of Nahua [i.e. Aztec] economy that can be directly evaluated in future research using the direct historical approach' (p. xiv).

Another example of ethnohistorical research in Mesoamerica comes from Frances Berdan (2014), who presents a vivid portrait of the landscapes and lifeways that existed before the Spanish Conquest. Berdan holds that thanks to written sources and archaeological fieldwork we know that there were many natural environments in the Aztec realm of central Mexico, including swamps, lakes, forests, and high mountains that 'provided varied natural resources and offered different potentials for human use. Natural resources were highly localized. The lakes and swampy marshlands yielded abundant plants and animals... including reeds, tuberous plants, algae, insects and insect eggs, frogs, salamanders, turtles, several species of fish and their eggs' (p. 52). No less important were 'small crustaceans, and vast numbers of waterfowl and their eggs' that people used to take from the lakes and marshes (p. 52). If we add to this long list of aquatic resources the numerous farming techniques of the Aztecs, such as agricultural terraces, aqueducts (pp. 78-79) and lakeside planting fields called chinampas (pp. 79-81) – amply described by ethnohistorical sources and studied by archaeology– we will understand the considerable importance of these and other aquatic adaptations for the survival of the Aztecs and most other peoples of the Mesoamerican ecumene, as I explain below.

Aquatic Adaptations in Mesoamerica

We have seen in previous pages that the activities that allowed the pre-Hispanic people to adapt to the different Mesoamerican environments often took place within an aquatic lifeway that relied on fishing, hunting amphibians, reptiles and other aquatic animals, as well as wild game, gathering plants, insects, and other resources gathered from the countryside, and the manufacture of a vast assemblage of household items and tools. Intensive agriculture in aquatic environments was also extremely important for people's survival in virtually all areas of the Mesoamerican *ecumene,* including the ones discussed in this book: Michoacán, the Basin of Mexico, the Alto Lerma River Basin, and the Maya area.

If we analyze aquatic adaptations and their modifications over a long period of time in Mesoamerica, we see how human ingenuity allowed our ancestors to thrive in distinct ecological settings, and how adaptive strategies became more complex with the passage of time. First, during the Paleoindian period (*ca.* 12000-8000 BC), small bands lived by exploiting the natural wild resources that the landscape offered (see discussion in Williams 2020b: Chapter III).

The ecological conditions faced by the early settlers of the New World were starkly different from those of today. Colin Renfrew and Paul Bahn (2000) tell us how during the Pleistocene 'as world temperatures fell, ice sheets –or glaciers– expanded, mantling large parts of the Earth's surface and lowering world sea levels' (p. 125). The end of the Ice Age resulted in widespread extinctions of big-game species in the New World. Renfrew and Bahn tell us that 'there are two main sides of the big-game extinction debate. One group of scholars... believes that the arrival of people in the New World and Australia, followed by overexploitation of prey, caused the extinctions. New data from Australia have provided some support for this view' (p. 252). There is, however, another view, in which 'climatic change is the primary cause... All big-game species weighing over 1000 kg as adults (the mega-herbivores) disappeared from the New World, Europe, and Australia, as did about 75 percent of the herbivore genera weighing 100-1000 kg, but only 41 percent of species weighing 5-100 kg, and under 2 percent of the smaller creatures' (p. 253).

There is a 'compromise theory' which holds that 'it was in the first place human overexploitation that led to the disappearance of the mega-herbivores, which in turn caused a change in vegetation that led to the extinction of some medium-sized herbivores... It is certain that the removal of mega-herbivores must have radically affected the Pleistocene environment' (p. 253).

The end of the Pleistocene period some 10,000 years ago brought about small changes in climate that triggered 'changes in local topography and flora and fauna' (Evans 2004: 71). After the extinction of big game, the subsistence strategies of the groups of hunters and gatherers who lived in Middle America had to change in order to adapt to the new conditions. Hence, new species became the primary targets: 'Smaller game (deer, rabbits), fruits like cactus prickly-pears, and seeds from grasses and seed pods. Processing these foods required new kinds of tools, and ground stone milling tools were added to the [older] toolkit of flaked and fluted points, knives, and scrapers' (p. 71).

Lewis R. Binford wrote about post-Pleistocene adaptations in his book *An Archaeological Perspective* (1972). Binford holds that 'the archaeological remains of the immediately post-Pleistocene period are... characterized over wide areas [of Europe] by the appearance of small, highly specialized flint implements; these occur frequently on later sites in the coastal and riverine regions in the context of the

systematic exploitation of aquatic resources' (p. 421). Binford goes on to mention several generalizations that are helpful in distinguishing the Paleolithic from the following period (Mesolithic). He describes major changes in numerous aspects of material culture and social organization worldwide: (1) A major shift in the centers of population growth; (2) a fundamental change in the form of stone tools, favoring smaller artifacts; (3) greater geographic variety in cultural remains, suggesting more specific and specialized responses to local environmental conditions; (4) a considerable increase in the exploitation of aquatic resources, such as fish and waterfowl; and (5) the greater abundance of small game in the archaeological record (p. 425).

According to Binford (p. 427), Gordon Childe (1956 [1981]) was the first to provide a set of testable propositions as to the conditions under which food-production was achieved, while Robert Braidwood (1967) engaged in seeking the field data to test those propositions. The results of these new perspectives, though focused on the Old World, are also relevant for Mesoamerica and other cultural areas of antiquity, as discussed by Kent Flannery (1986).

Susan Evans (2004) holds that in the Archaic period (*ca*. 8000-2000 BC) new grinding tools made of polished stone 'represent a technological revolution for emerging Mesoamerican culture' (p. 71). This period was characterized by a process of increasing sedentary life and growing sociocultural complexity that elsewhere in the world was known as the Neolithic revolution (Braidwood 1967; Childe 1956; Clark 1977). During the Archaic period in Middle America 'foragers became increasingly adept at securing food from plants... The Archaic began with a foraged diet that was balanced but would have been exotic to our modern palates (antelope meat, seeds from mesquite pods), and ended with foods familiar to all of us' (p. 72), like beans, squash, chili peppers, and many others that were cultivated by farmers living in villages.

Before farming became the prevalent way of life, hunting and gathering peoples lived directly off the land, killing game, fishing where possible, and gathering wild foods such as plants and insects. We have no historical or ethnographic accounts of these wandering peoples, so in order to understand their customs and lifeway we have to look for analogical models in the modern world. Jared Diamond (2012) calls hunter-gatherer societies 'non-exclusive societies' because 'recognized borders don't exist, and land ownership just becomes increasingly vague as one moves increasing distances from one's core area... neighboring groups receive permission to visit your territory... for... different purposes —especially to obtain food and water at certain seasons or in certain years' (p. 45). By the same token, 'you can obtain permission to visit your neighbor's territory when you are the one in need, so the arrangement becomes an exchange based on reciprocity and mutual benefit' (p. 45).

There are few ethnographic studies of contemporary hunters in Mesoamerica, so we do not have much comparative data on which to make analogies that would allow us to understand subsistence activities in the pre-Hispanic past. The ethnographic information collected by Politis (2007) among the Nukak of the Amazon rainforest (south-eastern Colombia), however, has a wealth of detail on which to elaborate an –at least tentative– interpretive model of hunting activities.

Politis wrote that the Nukak form one of 'several present-day groups in the Lowlands of South America who maintain... a hunter-gatherer way of life; however, this fact need not imply that they do not practice –or have not practiced– some type of small-scale horticulture' (p. 325). Politis further states that 'the multiple dimensionality of Nukak territory highlights the practical problems that archaeologists face when reconstructing the territory of past hunter-gatherers. Most approaches to the subject involve an explicit and implicit reductionism: territory is equated with band territory', and the main way of defining and analyzing the territory 'is understood to be through the study of the resource structure... knowing how and when resources are available and whether or not bands exploit them allows conjectures to be made about myriad cultural aspects, from mobility to post-marital residence' (p. 329).

Polity's study of the Nukak 'demonstrates the shortcomings of these assumptions; for the Nukak their territory is much more than resources... From the immediate surroundings of the camp, to distant places occupied by ancestors generations ago but that can be visited by the Nukak at any time, everything is considered to be in some way or other "their territory"'. From this perspective, Politis concludes that 'the territoriality of the Nukak intersects the economic, the social, and the ideational' (p. 329).

Following a purely Binfordian approach, Politis identified two categories according to the type of displacement hunters had to perform to find prey: 'logistical mobility' and 'daily foraging expeditions'. In the first, there is only limited mobility; for example, most of the members of a band stay in their camp, while a small group –usually made up of adult men– travels considerable distances and establishes camps that are only occupied for a few nights (p. 170). On the other hand, in the daily foraging expeditions, trips are made within the area surrounding the residential camps in order to obtain food, raw materials, and information

on a wide variety of topics related to the group's subsistence and social reproduction. These trips can be made by a single person, or by a maximum of eleven hunter-foragers. These foraging expeditions usually do not have a well-defined purpose in advance, for example hunting, collecting honey, fruits, etc., but several options are generally considered, according to the area where the hunters make camp, the season of the year, the type of goods they need at that time, and the social context. Politis tentatively proposes a radius of one kilometer to delimit the immediate area around the residential camp where such foraging expeditions are conducted, usually without any prior planning or organization (p. 174).

According to Politis, both types of activity are practically invisible in terms of their material remains, as the only clear archaeological indicators of logistical travel 'are the small temporary campsites occupied overnight. Almost nothing remains of them except for the campfire and a bit of food scraps. The other activities outside the camp, both daily foraging trips and logistical trips, also result in very little refuse material.' These elements, when they appear, include 'darts or fragments of darts in places where the hunts have taken place [and] ...occasionally the broken tip of a spear that was damaged ...some fallen trees, and very few other things' (p. 185).

The jungle environment where Politis carried out this research certainly does not facilitate the observation of material remains from hunting and gathering, but the ethnographic data collected are still invaluable for understanding the dynamic and *processual* aspects of forming a systemic context related to hunting and gathering such biotic products as plants, small reptiles, edible insects, and so on.

Further examples of hunter-gatherers and their subsistence patterns come to us from the Great Basin in the western United States. In order to understand the challenges faced by people living in aquatic environments, and to know their ways of coping with their ecological setting –including material culture– we can turn to ethnographic and ethnohistorical data. Catherine Fowler (1980) presents ethnographic data on subsistence and settlement systems pertaining to lake- and marsh-based Northern Paiute groups in the Great Basin (western Nevada), including the Pyramid Lake and Walker River cultures. The ethnographic sources she studied, dating from the late 19th and early 20th centuries, discuss the native lifeway around Carson Lake, Pyramid Lake, and other wetland areas in the Great Basin. Fowler focused her study on the native diet, as reported in her ethnographic accounts. Thanks to this information, we know that 'on the lower Carson... at least 36 species of waterfowl and wading birds were taken for food, as were eggs for most and occasionally young... In addition, at least 12 species of marsh/mud flat plants provided food resources... as did 30 lower valley plant species... and 21 from the uplands... thirty-one species is the minimum food count for mammals, along with 14 land birds and... their eggs' (p. 18). Among the species exploited there were eight insects and four fishes identified with native names. These figures are only for those products linked directly to subsistence, and do not count sources of medicines, manufactures, and other products that were taken from the marsh areas.

This marsh habitat was apparently not sufficiently abundant to allow people to ignore plants, mammals and other resources in the nearby valleys and uplands. However, among the unique aspects of the lower Carson 'were the sheer numbers and variety of waterfowl and water plants, and the proximity... of late-fall ripening seeds... These... extended the normal season for seed harvesting well into December... The opportunity for resource exploitation was certainly there, even if we cannot assess if the full potential of the region was ever realized' (p. 18).

At Stillwater, there were extensive fisheries that stress the importance of fishing. This activity was a year-round pursuit 'for men ... while the women... were gathering summer seeds from temporary camps... or collecting pine nuts... the men continued to go back and forth from their camps to the river to fish' (p. 18). According to the ethnographic accounts Fowler studied, 'when people were camped in the Stillwater Range taking pine nuts, the men went back to the marshes periodically for fresh supplies of waterfowl' (p. 20).

In contrast to the above examples, the new agricultural lifeway that developed slowly and appeared in a recognizable form in the late Archaic period in Mesoamerica (*ca.* 2000 BC) required people to live permanently in a single locality to attend their crops. The first permanent settlements in the archaeological record consisted of small villages with few indications of economic or political stratification, but an incipient reliance on wild plants that eventually would be domesticated.

Zohapilco is an example of an Archaic-period hamlet, located on the shores of Lake Chalco, in the southern end of the Basin of Mexico. Christine Niederberger (1981) conducted archaeological excavations at Zohapilco, unearthing abundant ancient botanical and zoological remains, as well as evidence of human industries that constitute the first testimony of occupations in the area between the sixth and second millennia BC. Niederberger discusses several hypotheses concerning the processes and conditions under which sedentary

life was established in this region, while also examining the possibility of a pre-agricultural, sedentary way of life at Zohapilco. In addition, she attempts to define some significant points in the progressive development and change in the relationships between humans and plants in the Basin of Mexico from the sixth millennium onward.

Lake Chalco was a body of water that once covered an area of some 110 km^2, but was completely drained at the beginning of the 20th century. The riparian soils in this part of the basin have preserved numerous archaeological testimonies of pre-Hispanic life, and archaeological evidence for occupation during the early Holocene and Formative periods is particularly dense on the fossil lake beaches. The archaeological phase called Playa spans the period from 6000 to 5300 BC, so the Playa phase coincides with an exceptional flourishing of biota in the southern part of the Basin of Mexico with a wide variety of fauna and flora.

The lake shores were the natural habitat of fish-eating birds, and were densely-covered by many types of plants, including sedges (Cyperaceae), rushes (*Juncus*), cattails (*Typha*), and flowering species (Sparganiaceae). Floating or submerged aquatic plants were also part of the local botanical inventory (p. 82). In the lake basin, alluvial soils were rich in humus and characterized by a high water table, so they constituted a favorable environment for wild cereal clusters like amaranths, chenopodiums and the genus *Zea.* Niederberger mentions 'the remarkable preservation... of abundant plant remains such as grains of *teosinte* (a close relative of maize, known as *Zea mexicana*)' (p. 82).

Mammal remains recovered from the archaeological excavations at Zohapilco include white-tailed deer (*Odocoileus virginianus*), rabbit (*Sylvilagus cunicularius*), the genus *Canis* (dog or coyote), Mexican voles (*Microtus mexicanus*), small rodents (Heteromyidae), and cotton rats (*Sigmodon* sp.). Excavators also found numerous bone remains of fish, belonging to three groups (all freshwater): white fish and *charales* (*Chirostoma*), yellow fish (*Girardinichthys*), and cyprinids (minnows or carp).

Among reptiles, the typical lake turtle of Chalco (*Kinosternon* sp.) is well-represented in archaeological contexts, as are over 3,000 small bone remains of the amphibian *Ambystoma*, called *axolotl* by the Aztecs, who savored its eel-flavored flesh. Playa sediments also contain numerous remains of indigenous lake birds, like the Mexican duck (*Anas diazi*), and many migratory bird species that arrive from the north in the winter, including Canada geese (*Branta canadensis*), numerous species of ducks, like shovelers (*Spatula clypeata*), redheads (*Aythya americana*), pintails (*Anas acuta*), and mallards (*Anas platyrhynchos*), as well as cinnamon teals (*Querquedula cyanoptera*), pied-billed grebes (*Podilymbus podiceps*), and white grebes (*Aechmophorus* sp.) (p. 83).

Niederberger's archaeological research allowed her to present a hypothetical reconstruction of the ancient ecology at the Zohapilco site, which revealed that three exploitable biotopes coexisted in the Lake Chalco Basin: (a) the forest environment with its wild fruits and plentiful fauna; (b) the alluvial and riparian zone with fertile soils and high water table that favored the growth of wild grasses and other useful plants; and (c) the aquatic environment, rich in plant and animal resources. These biotic associations are remarkable for both the presence of abundant regular resources and the predictable distribution of periodic resources, especially between the rainy and dry seasons. All these unique characteristics made a sedentary way of life possible well before the development of a truly efficient agriculture (p. 84).

Niederberger (1976) conducted an intensive study of all archaeological assemblages derived from her excavations at Zohapilco, noting that 'the study of the successive lithic industries found in an archaeological context is aimed at showing the relationships between a human group and its ecosystem, and the interactions between the technological achievements and the whole cultural system' (p. 55). Niederberger's excavations turned up '5,115 lithic artifacts, of which 81% were of flaked stone, 15% of polished stone, and 3% are mixed artifacts (showing both flaked and polished areas)' (p. 57).

After analyzing all the materials found at the site, Niederberger concluded that 'the cultural assemblage defining the Playa 1 and 2 phases is dated at *ca.* 5500-3500 BC. It is characterized by remarkable equilibrium and stability. The site reached its maximum biotic development during this time, and was permanently occupied by communities that exploited the forest and aquatic resources, both perennial and seasonal' (p. 278). The presence of grinding tools suggests the exploitation of several cereal species that were endemic on riparian and alluvial soils, including the genus *Zea*. Surprisingly, the existence of an early inter-regional network of contacts is shown by the direct acquisition or exchange of raw materials, such as obsidian.

The Zohapilco archaeological phase (at the end of the Archaic period, *ca.* 2500-2000 BC) pertains to a period characterized by changing socioeconomic structures. There is a marked development of a subsistence economy geared toward the *production* of agricultural resources, as seen in the increase in the size and quantity of *Zea* pollen and the standardization of grinding tools. The density of the finds of these tools suggests a certain degree of nucleation in the settlement

pattern. Finally, evidence for the modeling and firing of pottery suggests that the roots of Formative culture began in the Zohapilco phase, while the following archaeological phase –Ayotla, *ca.* 1250-1000 BC– reveals a consolidation of a subsistence economy that relied entirely on agriculture, beginning *ca.* 1360 BC (p. 278).

Another example of cultural development in the Archaic period comes to us from Chantuto, an ancient settlement on the Pacific littoral in the southern state of Chiapas. Barbara Voorhies (1976) conducted archaeological research on a prehistoric society that flourished on the Chiapas coast during the third millennium BC. Her project was conducted from the perspective of prehistoric anthropology, and the main goal was 'to reconstruct, insofar as possible, the sociocultural system of the prehistoric society' (p. 1). Voorhies' fieldwork had five major objectives: (1) to determine the comparability of the aceramic strata at the five sites located in the study area; (2) to ascertain the food preferences of the ancient inhabitants throughout the annual cycle, and whether they had a mixed economy (e.g. foraging and fishing); (3) to reconstruct the demographic structure of the prehistoric Chantuto population; (4) to assess the nature of population mobility in accordance with the exploited resources; and (5) to study the possible relationships between the Chantuto people and other cultures in different habitats; for example, through exchange systems with peoples in the nearby highlands.

One particularly important aspect of Voorhies' work was her study of the present-day environment. The study area is located within the geographical region known as Soconusco (from the Aztec toponym, *Xoconochco*), a flat, low-lying plain on the Pacific coast (near Chantuto). According to Voorhies, 'the climax vegetation... is tropical rain forest which gives way to seasonal forests and savannahs toward the coast... Coastal swamps occur along the seaward margin of the Soconusco. These swamps... consist of mangrove vegetation associated with lagoons and tidal channels' (p. 17). Voorhies focused her archaeological work on five prehistoric shell middens located on a broad strip of mangrove forest that runs parallel to the shoreline.

That mangrove-estuarine community was subject to seasonal periodicities. 'These cyclic events could have had major effects on the habits of the Chantuto people... There are many kinds of periodicities within the Chantuto ecosystem, but this discussion is restricted to seasonal periodicities that directly affect the food supply or the food-chain pattern and volume of biomass in the zone' (p. 23). The cyclical patterns of local populations will be discussed by groups in the following paragraphs.

(1) Reptiles. Turtles and iguanas are two kinds of reptiles collected for food by current inhabitants. Most of these animals inhabit the zone continuously, but their availability and use as food are seasonal. There are four distinct types of turtles in the study area, but the two species preferred by local hunters are locally known as 'casquito' (*Kinosternon cruentatum*) and 'tortuga de río' (*Chrysemys grayi*). During the laying season (March-April) the females of *Kinosternon* move onto well-drained land, and at this time the residents of La Palma (a village in the study area) burn the nesting sites to uncover the turtles with their eggs. Other turtle species are also hunted seasonally at different times of year.

Collecting iguanas is also a seasonal activity. The green iguana (*Iguana iguana*) usually inhabits trees or water where its capture is difficult. Its eggs are highly-valued by humans as food, so this animal is hunted during the laying season (February-May). In summary, the present-day inhabitants of the Chantuto area collect local reptiles more frequently during the months of February through April than at other times of the year.

(2) Crustaceans. The seasonal cycles in the life history of shrimp have a profound influence on village life. Periodically, schools of shrimp enter the estuarine-lagoon system, and the whole economy of the villagers is closely-tied to this event. This pattern may have its roots in the ancient past.

(3) Birds. The avifauna of the study area is incredibly varied and abundant. These birds exhibit many types of seasonal cycles, some of which may be important to humans. Without doubt, the most striking periodic event is the seasonal presence of migratory waterfowl (Anseriformes). These birds can have a great impact on a human population because their seasonal presence can provide a large input of energy. The numbers of migratory waterfowl in the wintering grounds are remarkably large for approximately six months of the year, from September to March.

(4) Fish. Seasonal changes presumably occur within fish populations. Though still little-studied, they apparently involve annual shifts of range within the littoral zone.

(5) Clams. In an attempt to understand the ecological and cultural aspects of one of the main sources of food-procuring activities among the Chantuto people, Voorhies conducted an ethnoarchaeological study of a clam-processing industry in Costa Rica that relies on traditional techniques and, therefore, may shed light on ancient clam-gathering and processing activities on the Chiapas littoral (Voorhies and Martínez-Tagüeña 2016).

The goal of that research was to use observations of activities carried out by contemporary clam procurers and processors to better comprehend similar practices

in the ancient shell-mounds of coastal Chiapas. Voorhies (1976) reports that the cores of these shell-mounds consisted overwhelmingly of shells of the marsh clam *Polymesoda* sp., which were left behind between 7500 and 3500 years ago by the ancient Chantuto people, who were foragers before becoming farmers, as we have seen. According to Voorhies and Martínez-Tagüeña (2016), 'the discovery of a modern analog to the ancient archaeological sites provides an unparalleled opportunity to test inferences about the past, as well as to investigate aspects of the clam fishery that are not accessible from the archaeological record alone' (p. 2).

Although clam-collecting is a year-round activity, it is scheduled according to the tides, which are controlled by the lunar cycle. Clams are harvested during spring tides in astronomical numbers: approximately 160,000 clams would be collected on a 'good day' (p. 7). Cooked clam meat lasts only for one day unless salt is added as a preservative. Only sea salt, obtained by boiling sea water, is used. Nowadays, fishers buy this salt, but they once produced their own. Of course, sun-drying is another way to preserve clam meat (p. 14).

Marsh clams in Costa Rica are collected throughout the year with a peak during the dry season, while archaeological *Polymesoda* shells from the Tlacuachero shell-mound in Chiapas (see Figure 222) indicate that they were harvested only during the wet season, not all year-round as had been the case earlier. This finding is consistent with the optimal foraging prediction made by Voorhies and Martínez-Tagüeña (2016:14).

(6) People. The inhabitants of La Palma exhibit a seasonal periodicity in residence location and patterns of subsistence procurement that is in phase with the presence of young shrimp in the estuary-lagoon system. Voorhies (1976) reports that 'shrimp are the single most important species of the region for the economy... and their yearly arrival in the inland waters triggers a prompt response by their human predators. At first people shift from fishing to shrimping, and as the shrimp season progresses the animals become larger and bring a higher price in the market. Between March and May many villagers, especially the men, occupy campsites that are close to the shrimp-rich lagoons' (p. 27).

Voorhies concludes her report by stating that the minimal time of occupation for the Chantuto shell-mounds was determined on the basis of a series of radiocarbon age determinations pertaining to the late Archaic period, from 3000 to 2000 BC. Ethnographic analogy suggests that a possible mixed economy would have combined the gathering of aquatic resources with the cultivation of food plants. Although we lack plant or pollen remains, the artifact assemblage reported from the region includes indicators of agriculture, such as the *manos* (handstones) and *metates* (querns) found in the Chantuto phase assemblage (p. 97).

Most resources were procured from the marine estuary and lagoon systems, with the most important food items being marsh clams, fish and reptiles, while shrimp may also have contributed significantly to the diet. Some animal bones indicate that food was procured from the inland region as well, but did not contribute a large proportion of the diet. In short, the archaeological evidence available for the subsistence pattern of the Chantuto people indicates an unmixed economy based on the procurement of estuarine animal resources, as well as terrestrial plant and animal products that were available through trade networks (p. 98).

The residence pattern of the Chantuto people consisted of periodic and perhaps seasonal occupations. The huge amount of shell remains in the middens points to a large volume of clam meat that was procured over a long period of time. It is likely that some clam and fish meat was exported to inland communities, perhaps after being dried or preserved with salt.

The simplest way to reconstruct the settlement pattern is based on ethnographic analogy. At the time of Voorhies' fieldwork (early 1970s), the littoral zone supported a population of permanent inhabitants. Most of these people lived in the village of La Palma, but some resided in isolated homesteads. In addition, the number of inhabitants in the zone increased dramatically during the shrimp season when mainland villagers would occupy temporary encampments. In summary, in Voorhies' reconstruction of the residence pattern of the Chantuto people, some permanent residents lived within the zone, with periodic influxes of mainland dwellers that may have occurred on a seasonal basis.

Archaeological Implications

The aquatic lifeway reported by Voorhies from the Chiapas littoral during the Archaic period is reminiscent of transitional processes involving hunter-gathering peoples who eventually turned into sedentary communities with well-developed agriculture. This transition took place in the context of climatic change millennia ago, as explained by Binford (1983) in the following passage: 'The archaeological record indicates that the widespread shift from hunting and gathering to agricultural strategies is largely a phenomenon of the post-Pleistocene period... the arguments advanced to account for this involve the loss of mobility... as a consequence of demographic packing' (p. 208). Binford examined how 'population densities achieved among hunters and gatherers vary in relation to environment

throughout the world', finding that the greatest densities occurred 'in the temperate zone, not in the tropical rainforest or in the desert... Once [people] with this potential existed in the temperate zone there would have been a build-up of population... [sometimes] to the point where density-dependent effects came into operation' (p. 209).

It is likely that 'discernible population growth would occur among hunters and gatherers in certain environments... as the number of persons in the group increased, perhaps there are simply too many mouths to be fed with the available stored fish' (p. 210). Competition for resources would separate and segment people, and as the region filled up, bands would have little or no option about where to move next. 'By packing the region with people, mobility is restricted and resource exploitation becomes concentrated. Packing, in fact, thwarts the normal strategy of hunters and gatherers to use mobility as a source of security' (p. 211). Among the responses to this problem, according to Binford, is a change in the kinds of food resources utilized. The hunter who formerly killed big game and put up the meat for storage now finds he must rely on animals of smaller size like ducks, or fish, or in certain areas even shellfish, as we saw in Chantuto. Eventually, people were drawn away from large animals and towards plants. A distinct set of strategies now comes into play in the following scenario suggested by Binford: (1) there is a switch to alternative animal species, often aquatic ones; (2) human dependence on plants increases; and (3) population continues to grow in an environment that offers no exit options. As a consequence of these ecological and cultural processes, 'consumer demand increases within a space that is now constrained: some form of intensive production system (i.e. agriculture) now becomes mandatory' (p. 211). Binford holds that in different regions of the world, including Mesoamerica, North America, and parts of temperate Europe, 'increased sedentism facilitated by aquatic exploitation seems to have anticipated the adoption of agriculture' (p. 212).

Another opinion on the topic under discussion was put forth by Joseph B. Birdsell (1968), who held that Pleistocene populations probably consisted of tribal units distinguished by dialect differences. If there were exceptions, they would probably 'be based upon some influence which tends to minimize distance as an isolating factor, such as a concentration of food resources. In a statistical sense, the... size of the... tribe in the Pleistocene can be estimated as 500 persons, although the variance will be considerable' (p. 233). Because human behavior is, at the same time, both adaptive and flexible, the composition of local territorial groups and the details of their relations with neighboring groups can be expected to vary from one region to another.

According to Birdsell, the food resources available to a human group 'may be the most important single determinant of local group size and composition. Where plant and animal resources are largely raised locally and comprise wide variety of forms, the size of the exploitive [human] groups will be small... [in cases] where food resources are more concentrated, the [diet] becomes more specialized and local group structure frequently changes' (p. 234), in some cases reaching several hundred persons. When substantial food resources are concentrated either regionally or seasonally, local groups take on a quite different nature, usually increasing in size and the level of sedentism.

Based on anthropological, historical, and biological evidence, Robin Dunbar (2010) wrote that 'most hunter-gatherers live in complex societies that operate at a number of levels. The smallest groupings occur at temporary night camps and have between thirty and fifty individuals' (p. 25), while the largest group is normally the tribe itself, usually a linguistic group numbering between 500 and 2,500 people. In between these two levels is a third group, the clan, which may usually have a mean size of 153 individuals. This figure is significant because 'in traditional societies, village sizes seem to approximate this [number], too. Neolithic villages from the Middle East around 600 BC typically seem to have contained 120 to 150 people, judging by the number of dwellings' (p. 27), and the estimated size of Medieval English villages also seems to have been about 150. These calculations are important when one is considering the levels of demographic density and subsistence requirements (i.e. hunting and gathering versus agriculture) of social groupings.

I have already mentioned the Archaic period aquatic adaptations studied by Niederberger (1976, 1981) at the Zohapilco site. Niederberger (2017) discovered 'for the first time, levels of human occupation of the early post-Pleistocene epoch... the evidences recovered from the... shores of... Lake Chalco-Xochimilco... seem to indicate the... transition to a farming economy, different from those... of Tehuacán's [Puebla] semiarid region' (p. 252), where people relied on a 'semi-nomadic' lifeway to adapt to a region with shifting resources in different ecological niches and seasonal variability. In contrast, at Lake Chalco 'the transition from a gathering economy to a... food-production economy took place in the context of a precocious sedentary way of life, thanks to the permanent existence in the surrounding environment of a wide and diverse range of wild resources' (p. 252). The inhabitants of this lake area during the Playa phase (*ca.* 6000-4500 BC) had access to three distinct biotopes: (1) forests that provided numerous mammals and other animals; (2) rich alluvial soils with a high water table where people could experiment with growing wild seeds and other plants; and finally (3) the aquatic environment, where fish, amphibians, reptiles and

water fowl were superabundant. It is important to underscore the fact that most –if not all– of these resources were available year-round.

In the Zohapilco cultural phase (*ca*. 2500-2000 BC), we see a tool assemblage characteristic of a new lifeway that was increasingly dependent on cultivation as opposed to hunting and gathering. The artifacts of the Zohapilco phase consisted of small obsidian flaked artifacts (Niederberger 2017: Figure 127a) and grinding tools, such as querns (Figure 127b) and *manos* or handstones (Figure 127c), which were probably used to process cereals and other edible plants, both wild and domesticated.

The assemblage described by Niederberger (2017) for the Zohapilco phase is a harbinger of the Formative period in the Basin of Mexico. Niederberger defines the Formative as a time 'marked by the consolidation of a farming economy and the development of certain... arts like making pots of fired clay' (p. 257). In Niederberger's opinion, 'the Zohapilco cultural phase marks the beginning of this period in the basin...Indeed, one sees a clear acceleration of the development of agriculture... the relationships of dependence over certain plants... reach in this level an irreversible status' (p. 257). The new domesticates include amaranth (*Amaranthus leucocarpus*), chili peppers (*Capsicum annum*), *chayote* (mirliton, *Sechium* sp.), pumpkin (*Cucurbita* sp.), and tomato (*Solanum* sp.), while maize grains pertaining to this archaeological phase are larger and three times more abundant than in previous phases (p. 257).

As for the tool assemblage associated with this cultural phase, Niederberger describes obsidian artifacts she calls 'microliths' that are found in greater numbers and, apparently, come from a wider variety of geological sources than during earlier periods. Second, an abundance of grindstones and their standardized forms is characteristic of this phase. The assemblage also includes stone containers of high quality. The skilled workmanship involved in these objects would indicate the existence of a specialized craft (p. 258).

The end of the Archaic period did not come abruptly. What we see in the archaeological record is a gradual transition toward a period with much larger population densities, fully-dependent on agriculture, and exhibiting a higher level of social organization. The Formative spans from *ca*. 2000 BC to AD 300. Evans (2004) tells us that 'the Formative... witnessed the crystallization of the Mesoamerican culture complex as a set of distinctive traits and behavioral patterns. At the start of the Formative... we find small autonomous agricultural villages... established in certain key regions... around 1500 BC a transformation begins, moving... away from the egalitarian ethic of autonomous tribal villagers' (p. 99). By the fourth century BC, all of Mesoamerica was inhabited by 'societies based on differential rankings of individuals and whole groups... under political formats of chiefdoms and states, where the few ruled over the many, and extracted goods and services from them' (p. 99).

Eventually, after many generations of living in settlements in constant expansion, larger villages or towns emerged with a stratified social system and mutually-exclusive, defended territories that arose under a combination of conditions that in Diamond's (2012) opinion included the following criteria: 'First, defended territories require a population sufficiently large and dense that some people can be spared to devote time specifically to patrolling boundaries... Second, exclusive territories require a productive, stable, predictable environment within which the territory-owners can... usually [find] most or all of their necessary resources' (p. 43). In third place on Diamond's list is the condition that 'the territory must contain some valuable fixed resources or capital improvements worth defending... such as productive gardens, groves of fruit trees, or fishing weirs or irrigation ditches requiring much effort to build and maintain' (p. 43). The last point requires that 'group membership must be rather constant, and neighboring groups must be largely distinct, with little migration between groups', excluding perhaps 'movements of unmarried young people (more often women than men) leaving their natal group in order to marry into another group' (p. 43). Diamond's ideas are based on fieldwork in New Guinea, but can be of help in understanding similar processes in other parts of the world, including Formative Mesoamerica. Because of their greater number of people and higher level of social complexity, emerging chiefdoms relied on intricate codes of conduct and formalized leadership, as opposed to the egalitarian ethos of most societies of earlier times.

The prime example of a Formative-period complex society in the New World is, without doubt, the Olmec culture of the Gulf of Mexico. According to Evans (2004), this was the first culture in Mesoamerica 'to establish visually impressive ceremonial centers, which signal to us some important features of complex society... We... recognize in great Olmec (and later) sites a considerable investment of labor and materials, in the service of a great design... Olmec art depicts individuals who would have led the elite, commanding the lives of workers and the crops of farmers' (p. 100).

Richard Diehl (2004) addresses the role of the Olmecs in the context of the early Mesoamerican ecumene by stating that 'pristine civilizations were the earliest civilizations in their respective regions, cultures that developed... without any older models to guide their development' (p. 12). Here, the author includes the Egyptians of the Nile Valley, the Sumerians of

Mesopotamia, the Indus civilization in present-day India and Pakistan, the Shang culture in China, the Chavín culture of the Andes, and the Olmecs of Mesoamerica. Diehl states that the Olmecs were the only one of these complex cultures 'that evolved in a lowland tropical forest environment [and this] makes them an important case study in the evolution of civilization' (p. 12). The Olmecs are best known among early New World cultures for their artistic achievements, 'particularly their spectacular large stone monuments and exquisite small objects carved from jadeite and other semi-precious stones... Olmecs were the first Native Americans to erect large architectural complexes, live in nucleated towns and cities, and develop a sophisticated art style executed in stone and other imperishable media' (p. 12).

Because Olmec villages and towns were larger and more complex than any settlements in the past, the subsistence strategies had to be more robust and reliable, and offer food security for the population. In discussing Olmec diet and subsistence, Diehl (2004) states that 'ordinary Olmecs, like many ancient peoples, enjoyed a diet as good and perhaps much better than that of their modern descendants' (p. 85). Linguistic reconstructions of the ancient Olmec language, called proto-Mixe-Zoquean, have given us 'a basic vocabulary for the language that contains numerous... food terms. These include maize, cacao, squash, tomato, bean, sweet potato, manioc, cotton, and tropical fruits such as *chayote*, *guava*, *zapote*, and papaya' (p. 85). Many of these plants were identified among archaeological remains, together with 'remnants from the harvest of the adjacent swamps and river, including clams, turtles, catfish, gar, snapper, and crocodiles, as well as bones of deer and domestic dog' (p. 85). All these wild foods and aquatic products helped sustain Olmec populations, but 'maize was the Olmec staple, the core element of the diet' according to Diehl (p. 85). The Olmec lived in a remarkable region. Their 'heartland extended from the Gulf of Mexico to the crests of the sierras (mountains) of Oaxaca and Chiapas, and the Isthmus of Tehuantepec in the south... the environment varies from one part of [the Olmec territory] to another, but the entire region is hot, humid, and blessed with plentiful plant and animal life' (p. 19). In this natural habitat 'rivers, streams, and lagoons influence every aspect of life... rivers were... significant sources of fish, turtles, caimans, manatees, mollusks, river shrimp, and other high-quality protein foods... Finally, the region's most productive farmlands have always been the natural levees that receive fertility-restoring silt after each flood' (p. 20).

During the Middle Formative in southern Mesoamerica, the Olmec culture was the most advanced in terms of social complexity (Coe 1981). Apart from a sophisticated agricultural technology, the Olmecs achieved high levels of civilization in such areas as art and architecture, thanks to the abundant natural resources in their environment and the people's ability to exploit a vast array of aquatic landscapes, primarily the rivers and swamps that abound in the lowlands of the Gulf of Mexico. This aquatic orientation was highlighted by Michael Coe, who wrote that Olmec culture depended for its survival on the resources provided by their watery realm.

Coe (1981) used the phrase 'the gift of the river' to highlight the important role of the Coatzacoalcos River in Veracruz in the rise of Olmec civilization. In Coe's view, 'San Lorenzo Olmec civilization, which flourished... from 1200 to 900 BC, was literally "the gift of the river"... In this hot, humid area there is no strongly marked dry season... so agriculture can be carried on throughout the year' (p. 15). Coe wrote that 'abundant remains of *manos* and *metates* make it certain that the San Lorenzo Olmec were corn farmers, although... they probably planted a good deal of manioc as well as beans, squashes, and a host of other cultigens' (p. 16). Archaeological and ethnographic studies (e.g. Coe and Diehl 1980) around the great Olmec site of San Lorenzo showed that 'the Olmec mainly relied for their animal protein on fish, turtles, and dogs... Turtle hunting was and is an important activity, usually pursued while fishing... Thus, the abundant animal protein available to the ancient Olmec was as much a gift of the river as were the prized river levee soils' (p. 17). Coe (1981) sums up this aspect of the local cultural ecology by saying that 'the rise of Olmec civilization was probably remarkably similar to that of ancient Egypt' (p. 19), in that both were heavily dependent on irrigation agriculture and a wide variety of aquatic food resources.

According to Tanya M. Peres (2017), the Olmec heartland in the modern states of Veracruz and Tabasco is dominated by aquatic landscapes. 'Fishing, travel, transport, and trade via watercraft were essential parts of daily life... archaeofaunal, iconographic, and biological data about human-animal relationships during the Formative period in the Gulf coast lowlands [show that] aquatic environments were reliable sources of physical sustenance for the Olmec... and fresh-water fish, turtles and local and migratory water birds made up the daily diet' (p. 1). Peres describes a watery world where 'the marine, estuarine, and fresh-water animal resources... were incorporated into the Olmec and [later] lifeways, belief systems, ideological expressions, and foodways' (p. 1).

Tanya Peres *et al.* (2010) used paleo-botanical, ethno-botanical and zooarchaeological data from the Olmec site of Tres Zapotes to address the following questions: 'Did different social status groups eat different foods, and if so, what were they eating?, and Why do these

differences occur?' Answering these questions 'requires a consideration of both temporal and spatial patterns in the faunal and floral data. These data span the Formative period... [in] southern Veracruz (1400 BC-AD 300)' (p. 281). Peres *et al.* analyzed the 'data based on social context, with reference to the following categories: elite domestic and administrative areas... ceremonial and/or mortuary deposits... and non-elite domestic deposits' (p. 281).

The study of Olmec foodways conducted by Peres *et al.* (2013:126) arrived at the following conclusions: (1) Aquatic species became less important in the rural diet as farmers focused more on maize production. In contrast to the rural pattern, people in urban centers, especially the non-elites, ate large quantities of aquatic animals, while two important terrestrial species – deer and domesticated dogs– were probably reserved for the elites and ceremonial purposes. (2) Aquatic animals comprised over 60% of the minimum number of individuals identified at San Lorenzo, while at Tres Zapotes they comprised as much as 62-67%. At other Olmec sites in the same area, aquatic fauna, though less abundant, was far from negligible, reaching between 11 and 20% of the faunal assemblage. Clearly, aquatic species were highly-important, reliable sources of protein for these people. (3) The success of the maize-based agricultural economy on the Gulf Coast during the Formative period relied greatly on additional protein derived from aquatic animals, as well as domestic dogs.

Peres *et al.* (2010) discussed the paleoethnobotanical assemblage at Tres Zapotes on the basis of macro-remains from flotation samples (p. 284). Maize (*Zea mays*) and bean (*Phaseolus* sp.) were both identified at this site, where maize kernels and cupules appear in greater quantities than beans. Fruits from several tree species seem to have contributed to the diet at Tres Zapotes, including sapote (*Pouteria sapote*), coyol (*Acrocomia mexicana*), and coyol real (*Scheelea liebmanni*) (p. 284).

These authors go on to say that 'in addition to the fresh edible fruit... the seed from the sapote fruit has a variety of uses, all of which entail grinding into a powder which is then used as an additive for foods, medicines, soaps or cosmetics, or to fix colors on painted gourds' (p. 285). The coyol palm is widely-used throughout Mexico and Central America, since coyol fruits are 'high in fat protein and caloric value... [and so] can be used for a variety of purposes, including food, medicine, and wine production'. Meanwhile, coyol real 'produces fruits that are hard and fibrous, yielding one to three oily seeds... the coyol real is a valuable source of vegetable oil... and its palm fronds can be used for thatching' (pp. 285-287).

Because the archaeological record tells an incomplete story, it is profitable to turn to ethnographic studies about the lifeways of the local population of the Olmec area, like those by Coe and Diehl (1980) conducted among the villagers of Tenochtitlan, Veracruz. Coe and Diehl write that 'plants and their products are the foundation of economic life in Tenochtitlan' (p. 69). Although the major emphasis in agriculture is on maize cultivation, secondary and minor crops, as well as the exploitation of wild plants, also contributed numerous foods, medicines, and raw materials. The use of plants for medicines, for example, is well-established: Coe and Diehl report 66 plant species with medicinal properties in the area around Tenochtitlan (1980: Appendix 1).

These authors further inform us that 'secondary crops include beans (*Phaseolus vulgaris*), which are a very important item in the Tenochtitlan diet', as are squashes and gourds: 'At least six varieties of squash (*Cucurbita pepo*) and three of gourds (*Lagenaria siceraria*) are cultivated here', while chayote (*Sechium edule*) 'is cooked as a side dish or as a component in a soup' (pp. 82-83), and 'local farmers grow two varieties of manioc (*Manihot esculenta*)... [as well as] four varieties of sweet potatoes (*Ipomoea batatas*)'. Another important resource is *jícama* (*Pachyrryzos erosus*), 'a leguminous plant cultivated for its edible tubers'. *Malanga* (*Xanthosoma violaceum*) 'a relatively rare crop today, was cultivated more widely in the past' (p. 84). Chili peppers (*Capsicum frutescens*) are a minor crop in the area, as are tomatoes (*Lycopersicon esculentum*) (p. 86). The list includes several species of cultivated trees; seven examples are reported by Coe and Diehl, but there are many more (p. 87).

Coe and Diehl mention a 'tremendous diversity of natural flora in the area... Many wild plant foods are available... at different times of the year. Today these foods are casual supplements which add variety to the diet, but they may have been much more significant in pre-Columbian times, before the introduction of Old World domesticated fruits and other plants' (p. 91).

All this information goes a long way towards strengthening the idea that aquatic adaptations were instrumental in the rise and prosperity of Mesoamerican civilization from its inception until the latest periods. Aquatic adaptations were still important many centuries after the Olmec period in most areas of Mesoamerica. An example of aquatic strategies is described by Niederberger (2017), who wrote that the chinampas of the southern lake area of the Basin of Mexico were part of an intensive horticulture system that was one of the most productive farming techniques in all of the pre-Hispanic New World. This agricultural system had reached its peak by the time of the Spanish invasion (1520), encompassing an area of some 120 km^2 that was covered by canals and chinampas or long, narrow cultivation platforms (p. 93).

According to Niederberger, many plants were grown on the chinampas, including herbs called *quelites* that

were an indispensable component of the indigenous diet. Among the species of quelites grown here were *uitzquílitl* (*Cirsium mexicanum*), *xoxocoyolli* (*Oxalis angustifolia*), and *uitloquílitl* (*Bidens pilosa*), whose taste resembled basil (p. 97).

Of all the plants cultivated on the chinampas during the pre-Hispanic period, we only know those that were most important for the indigenous farmers in the context of native markets and the tribute economy of the early sixteenth century. One of the most important plants grown in those artificial plots on the lake surface was amaranth, called *huautli* in Nahuatl (*Amaranthus leucocarpus*), whose seeds played a fundamental role both as food and as a ritual offering. In some places, such as Mixquic (a town near Lake Chalco in the Basin of Mexico), wide areas of the chinampa fields are still devoted to growing amaranth, which is used to make *alegrías*, a typical Mexican sweet made of amaranth seeds, honey, and fruit (p. 97).

Niederberger (2017) studied the early historical sources written by both the indigenous people who lived in this part of Mesoamerica, and the Spanish conquistadors. There, she found information on many of the plants that were grown on the chinampas, including amaranth, maize, tomato, chili peppers, pumpkin, and salvia. But the farmers did not limit themselves to growing food plants on the chinampas, for flowers were also important, as revealed by such place names as Xochimilco, which means 'place of flowers' (p. 98). The chinampas produced many different kinds of flowers, both ornamental and medicinal. Niederberger provides the following list (Table 1).

Table 1. Flowers grown on the chinampas during the sixteenth century (after Niederberger 2017:99).

Nahuatl name	**Meaning or English name**	**Scientific name**
Cempoalxóchitl	Twenty flowers	*Tagetes erecta*
Oceloxóchitl	Tiger flower	*Tigridia pavonia*
Cacaloxóchitl	Crow flower	*Plumeria acutifolia*
Acoxóchitl	Dahlia	*Dahlia coccinea*
”	”	*Dahlia excelsa*
”	”	*Dahlia pinnata*
Omixóchitl	Agave	*Polianthes tuberosa*

According to Niederberger, the *chinampero*, or chinampa farmer, 'makes his home for himself and his family amongst the chinampas that belong to him... the cultivation of chinampas has some resemblances with the *culture de case*, since the chinampas represent a stable possession, and their maintenance requires... skill and... great care. The soil is constantly tended and is fertilized with household refuse' (p. 99).

Thanks to the fact that farmers lived in close proximity to their plots, no time was wasted going from home to work and back. Likewise, 'the combined advantages of a high-yield farming space and aquatic transportation allowed the farmer up until 1900 to take his produce directly to the consumers and the marketplace' (p. 100). Chinampa agriculture is discussed at length in Chapter IV.

Over the course of millennia, aquatic adaptations – including intensive agriculture based on chinampas, for example– evolved in Mesoamerica and other civilizations of the ancient world. This phenomenon has been explained from several perspectives, as discussed by Bruce Trigger (2003), who claims that 'many evolutionary theories treat population pressure as the driving force behind more intensive food production and the development of more hierarchical societies, including early civilizations... These theories assume that population pressure characterized all early civilizations and that people submitted to taxation and political authority only if they had nowhere else to go' (p. 283). This idea is the basis for the so-called 'Asiatic mode of production', which was proposed to explain the rise of civilization in key areas of the world such as China, Mesopotamia, and Mesoamerica (Wittfogel 1957).[3]

Trigger notes that agricultural land was naturally circumscribed in numerous areas of high civilization, including the Valley of Mexico, Peru, Egypt, and Mesopotamia. 'In highland Mexico and Peru, arable land, located mostly in valleys, was limited, and relocation from one valley to another would have been socially and politically difficult for farmers' (p. 283).

Another argument for intensification is that as populations increased in density 'and suitable land

[3] The basic ideas behind the Asiatic mode of production have not lacked critics, including Gary Feinman (2006), who pointed out that in the Oaxaca Valley, as in other areas of the Mesoamerican highlands, it is not possible to argue that large-scale irrigation played an important role in the origin and development of the state. In fact, Feinman argued that the most powerful states could have been based on quite simple farming techniques. These ideas have been corroborated in the Andes, both in the Bolivian highlands (Stanish 1994) and on the coast of Peru (Billman 2002). Beyond the New World, Karl Marx considered the island of Bali, Indonesia, as the best example of the Asiatic mode of production. However, it has not been possible to find a direct link between irrigation and social evolution there (Lansing 1987).

was developed to sustain higher levels of production by means of drainage, terracing, and irrigation, such land became an investment that its owners would not willingly abandon. They would submit to authority and taxation if necessary to retain possession of their farms, and supported rulers who offered their holdings protection against claims' by others (pp. 283-284).

For Trigger, the intensification of food production was indeed closely correlated with increasing population density. Therefore, 'the investment of more labor in agricultural production is indicated archaeologically by hydraulic works, including various forms of irrigation, which were intended to bring more land under cultivation and would have permitted more abundant crops to be grown in most areas than rainfall agriculture alone. Drainage schemes also brought more land under intensive cultivation' (p. 284). Agricultural terraces could vary 'from simple works designed to limit soil erosion... to... carefully irrigated and drained artificial fields such as those... of the Andes' (p. 284).

My discussion of aquatic adaptations in Mesoamerica has touched upon many subsistence activities, such as fishing, hunting, gathering and manufacture in aquatic environments, as well as agriculture, but salt production is another important activity in Mesoamerica discussed here in association with aquatic environments: lakes, coastal lagoons, underground brine deposits, and so on.

Diamond (2012) has stated that 'today, salt comes from a salt-shaker on every dining table and ultimately from a supermarket, is cheap, and is available in essentially unlimited qualities. Our bodies' main problem with salt is to get rid of it, which we do copiously in our urine and in our sweat. The average daily salt consumption around the world is about 9 to 12 grams' (p. 415).

According to Diamond, 'traditionally... salt didn't come from salt-shakers but had somehow to be extracted from the environment... Our main problem with salt then was to acquire it rather than to get rid of it. That's because most plants contain very little sodium, yet animals require sodium at high concentrations... As a result, while carnivores readily obtain their needed sodium by eating herbivores' (p. 415), for herbivores obtaining that sodium was not easy. While human hunter-gatherers who consumed much meat met their daily salt requirements with ease, most farmers had a daily salt intake below three grams. 'Hence traditional peoples crave salt and go to great lengths to obtain it... New Guinea Eastern Highlanders... whose diet consists up to 90% of low-sodium sweet potatoes' told Diamond 'of the efforts to which they used to go to make salt a few decades ago...They gathered leaves of certain plant species, burned them, scraped up the ash, percolated water through it to dissolve the solids, and finally evaporated the water to obtain small amounts of bitter salt' (p. 416).

Finally, Diamond recounts how 'with the rise of state governments, salt became widely available and produced on an industrial scale (as it still is today) from salt-water drying pans, salt mines, or surface deposits. To its use as a seasoning was added its use... to preserve food for storage... Salt cod and salt herring became fixtures of the European diet, and salt became the most traded and most taxed commodity in the world' (p. 417).

I have mentioned that in Mesoamerica common salt (sodium chloride) has always been a strategic resource of primary importance. In pre-Hispanic times it was used mainly for human consumption, but after the Spanish conquest it became, as well, an important commodity for silver-processing and cattle-raising. We know that salt from many towns in key areas was paid as tribute in the early Colonial era, and ethnohistorical sources concerning salt production in Mesoamerica have yielded information on the amounts paid by each town in the first half of the sixteenth century. Contemporary salt-producing sites and methods are also of interest to archaeologists, since salt is not preserved in the archaeological record and we need additional information to enhance the 'archaeological visibility' of salt-making activities, for example archaeological features and artifacts (e.g. earth mounds, canals, and specialized pottery types) connected to this activity (Williams 2015).

My research on traditional salt-making (Williams 2003, 2015, 2018), on the aquatic lifeway (2014a), and on traditional manufactures (2014b, 2014c, 2017) is based on the following assumptions: (1) subsistence activities were essential for the existence and reproduction of societies; (2) each activity has its own set of tools and work spaces; (3) ethnographic analogy can aid in understanding activities in systemic context and, by inference, in archaeological context; (4) ethnoarchaeology and ethnohistory can aid in producing a theory that will help define the ancient tool assemblages and cultural landscapes linked to the aforementioned subsistence activities in ancient times.

Content and Structure of this Book

This book contains six chapters. Chapter I, the Introduction, sets the stage on which the topics of the remaining chapters play out by explaining how aquatic adaptations in Mesoamerica contributed a remarkable environment where local populations thrived through many centuries. The first topic discussed is the Mesoamerican aquatic lifeway, including the many strategies that were adopted to take full advantage of a bountiful natural landscape. The lens I used to observe this unique universe, or ecumene, is forged

by ethnoarchaeology and ethnohistory. In addition to fishing, hunting, gathering, and manufacture, many other activities, such as salt-making and aquatic agriculture, are encompassed in the concept of aquatic adaptations in Mesoamerica. The chapter closes with a discussion of the archaeological implications of the ethnographic and ethnohistorical data presented.

In Chapter II I deal with the aquatic lifeway in Michoacán, discussing the natural resources and subsistence activities that we find in the 16th-century sources that describe aquatic subsistence in this part of Mesoamerica. This discussion also touches upon theoretical aspects of ethnographic analysis and its role in archaeological interpretation.

The natural environment of the Lake Pátzcuaro Basin is described in detail, as a backdrop to the ethnographic information on subsistence activities in this aquatic environment. The discussion is organized around four activities, already mentioned, that still play important roles in local Tarascan culture and economy: fishing, hunting, gathering, and manufacture. The goal is to discover the 'archaeological markers'; that is, the artifacts, features and landscapes associated with the aquatic lifeway in the present, and through extension, their reconstruction in the archaeological past.

Common salt, or sodium chloride, has been indispensable for humankind from the earliest days of prehistory to the present. In Chapter III I discuss salt production in Mesoamerica, paying special attention to the tool assemblages and cultural landscapes associated with producing this strategic resource. Salt has played an extremely important role in nutrition and food preservation throughout the world, and Mesoamerica is no exception. In this chapter I discuss salt production first in Michoacán (the Lake Cuitzeo Basin and the coast of Michoacán and Colima), later in the coast of Guerrero, and then in the Basin of Mexico and Puebla. The aspects of salt-making that most interest me are the tool assemblages and cultural landscapes in ethnographic and historical perspective. The aim here is to discover, by means of analogy, the material culture and physical settings of salt production in antiquity, since salt itself is not preserved in the archaeological record, and we need secondary information to identify this important component of pre-Hispanic culture and economy.

Chapter IV is devoted to a discussion of aquatic subsistence in the Central Mexican Highlands, namely the Basin of Mexico and the Alto Lerma River Basin. This discussion revolves around the natural resources and pre-Hispanic subsistence strategies, as understood through the lens of ethnoarchaeological research and historical sources. An equally important topic of interest involves pre-Hispanic aquatic agriculture in the Basin of Mexico, primarily intensive farming techniques and features such as terraces, canals, raised fields –chinampas– and others.

The environment and natural resources of the study area are discussed as a general framework for the ensuing discussion of the aquatic subsistence activities examined in previous chapters. Finally, I discuss the 'archaeological markers' or diagnostic elements of material culture linked to the aquatic lifeway.

The Maya Area is the focus of discussion in Chapter V which, once again, highlights patterns of subsistence in aquatic environments. The narrative of this chapter takes into account the geographical and ecological differences between the Maya highlands and lowlands, and the ways in which local cultures adapted to these contrasting environments. Select examples of pre-Hispanic cities in the Maya Area are examined in order to understand the link between demographic density and intensive agriculture, following the general Mesoamerican pattern of land reclamation and water management that we saw in the Basin of Mexico and the Tarascan area in previous chapters.

Finally, in Chapter VI I present a summary discussion of the topics explored throughout the book, and the general conclusions of my research in this field. I close the volume with a reflection on the challenges for future ethnoarchaeological research in Mesoamerica and other areas of the world.