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CHAPTER 6

Final Thoughts

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6.1 Starchy foodways prior to the advent of European invasions

Carbohydrates have been fundamental components of most diets throughout history (Larbey 2018). Certainly by the time people reached the Americas, preferences, values, and habits surrounding different starchy foods had formed. Undeniably, the influence of sensory characteristics has always been present when humans consume food, but they likely differentiate between social groups (Epstein et al. 2009). As people moved into the Greater Caribbean the ways to process plants were transported with them, such as grinding plants with handstones (Pagán-Jiménez 2007a:48-49; Rodríguez Ramos 2005; Rodríguez Ramos 2010; Rodríguez Ramos et al. 2013). Perhaps these culinary practices became habituated.

The starchy plant remains identified throughout this dissertation emphasize meal habituation (Appadurai 1986:241), yet suggest some culinary practices varied between sites. The plants used to prepare meals were chosen from a broad spectrum of possibilities. However, poisonous plants were used at every case study site investigated. There are a few possibilities regarding how these potentially poisonous foods were deemed edible. Small bits of the poisonous plants could have been tasted to check for alkaloids (Hastorf 2016:24). Alternatively, watching other animals interact with the plants and the foods produced to see if and when they were safe to consume. This would be similar to what was done with zamia bread and fly larvae in the Greater Antilles (when the larvae grew to a certain size it was understood the zamia poison was neutralized) (Las Casas 1909:60). As well as watching animals (domestic Eurasian fauna) die from drinking the water after washing grated zamia, as was done in The Bahamas during colonial times (Gifford 1912:100). Perhaps during precolonial times, zamia and manioc and their culinary products were fed to domesticated or managed mammals during different processing steps to see when they were safe to eat.

6

Culinary identities may be united and discussed during the preparation and consumption of commensal meals (Carr et al. 2018). In northwestern Dominican Republic, it appears Indigenous Peoples of La Luperona and El Flaco created variations of similar meals using shells and clay griddle kitchen tools. While the ingredients may have slightly varied between these sites, the methods of preparing meals using bivalve shells and clay griddles were similar. Plants may have been "pre-cooked" before being processed further. This culinary practice could have eased further plant manipulation, or been used to modify flavors and incorporate the resulting product into a larger recipe. Alternatively submitting a plant organ to direct fire could have been viewed as a way to release/exterminate other substances or entities. According to Pané et al. (1999:26), everything was animate and many spirits were entangled with botanical foodways. During the late precolonial period in these spaces that we now refer to as El Flaco, La Luperona, Palmetto Junction, LN-101, and Barillas, there were nuanced differences regarding plant ingredients at the site level and more homogenous culinary practices from regional perspectives.

6.2 Local site culinary practices

Percentage presence or ubiquity analysis does not indicate a plants contribution to diet, but it is a way to quantify this type of data and display potential uses of these plants while generating inferences of access, processing, and other culinary practices. For example, due to the ubiquity of maize and manioc recovered from the LN-101 site, it is possible the people working or living at this site predominantly processed these starchy plants with the sampled artifacts (Figure 6.1). However, the sample size from LN-101 was too small to indicate or suggest patterns of intensely used plants. In contrast, from this dissertation's larger sample size, the ubiquity analysis of El Flaco suggested many households had access to maize and perhaps it was a preferred or valued plant ingredient incorporated into their culinary practices (Figure 6.2).

To emphasize, yet again, clay griddles were multipurpose and not only used to prepare manioc. From the La Luperona griddle samples the use of zamia was the most ubiquitous (Figure 6.2). However, zamia was not recovered from the shell artifacts, which suggests zamia was prepared a different way at La Luperona perhaps using lithic, coral, or wooden tools for this function. In the comparison of griddle use, La Luperona was the exception for an absence of both manioc and maize remains. Yet, from the La Luperona shell artifacts, there was starch potentially identified as manioc. Thus, without sampling multiple types of artifacts the breadth of plant use at these sites would not be revealed. La Luperona had sweet potato starches recovered from shell artifacts that had signs they were processed in hot and humid cooking environments. Thus, it seems some sweet potatoes were lightly baked before being peeled.

The Palmetto Junction assemblage demonstrated provisioning, access, and use of primarily manioc on the sampled griddles, but there was less ubiquity of recovered manioc starch remains on the sampled shell artifacts. The shell artifacts yielded evidence for the use of several types of yam, which were absent from the Palmetto Junction sampled griddle assemblage. Thus, if starchy remains are not recovered from certain types of sampled artifacts it does not mean those plants were absent or insignificant parts of culinary practices. On the contrary, the plant remains ubiquitously recovered from multiple types of artifacts at one site are more likely to have been situated within culinary practices to the point of social habitus[14].

In the Barillas site case study, there was evidence of several ways of processing plants. It is not possible, for now, to infer economic or cultural significance of one plant over others at the site or regional levels. For doing so at different chronological and geographical scales, the study of many other types of artifacts or at least a larger number of samples must be considered. Regarding foodways, it is possible to propose that culinary practices at the Barillas site prepared multiple types of botanical foods on griddles, in *ollas*, and used clay plates (perhaps for serving) (Fig. 6.3). Based upon the enzyme degraded chili pepper remains, we believe the operational sequences involved in the preparation of salsas were practiced. The residues of chili pepper, maize, and manioc on the same griddle may indicate the preparation of *tortillas* and/or breads mixing both maize and manioc flour in combination with the addition of spicy flavors.

[14] …*habitus* through which the creator partakes of his community and time, and that guides and directs, unbeknownst to him, his apparently most unique creative acts (Bourdieu 2005, 226).

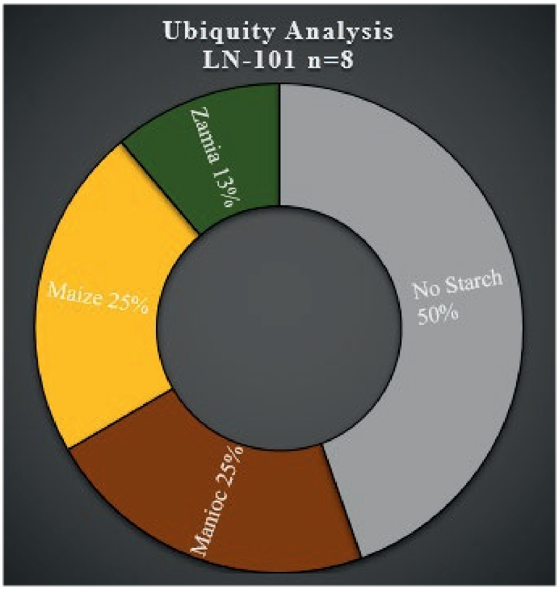

Figure 6.1
Visualized ubiquity analysis for the LN-101 site, Long Island, The Bahamas.

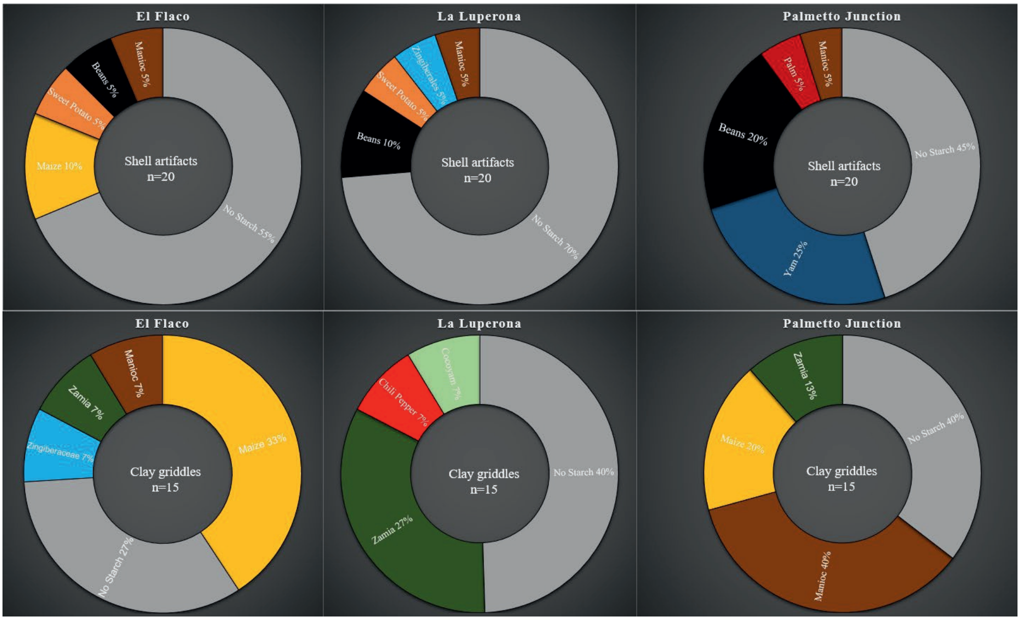

Figure 6.2
Ubiquity analysis for El Flaco, La Luperona, and Palmetto Junction archaeological sites per artifact type.

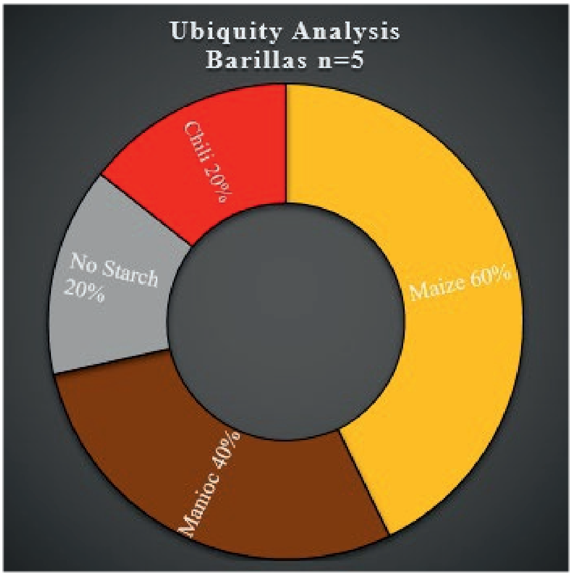

Figure 6.3
Visualized ubiquity analysis for the Barillas site, Nicaragua.

6.3 Regional views of botanical culinary practices

The plant remains found on both shells and griddles in this dissertation include maize, manioc ginger (Zingiberales), and zamia. Because these plant remains were recovered from multiple stages in the food production process, they were likely incorporated within successful culinary practices that were a part of mobility and exchange. These factors combined could suggest the cultural importance of these plants to the people who transported and consistently used them. This type of ubiquity where the plant remains are recovered from multiple artifacts and multiple islands could suggest a scenario of botanical cultural staples.

The use of wild (or semi-managed) plants, including various geophytes, and domesticated seed plants were consistently identified from each sites sampled artifact assemblage. The crops that had to be cultivated by humans and were exogenous to the Greater Antilles and the Bahama archipelago further support intense commitment to production, processing, and likely exchange by the Indigenous Peoples at these sites. Consequently, the evidence of these plants used at the sites in the northern Caribbean suggests they were a part of transported landscapes from other areas brought to these islands. During the late precolonial period, there was a dynamic engagement with poisonous plants, wild vegetation, and cultivated plants at each site studied here in the Greater Caribbean. In addition, the sampled artifacts demonstrate the plants were processed using an assortment of kitchenware, some were used with hot and humid cooking environments, and others processed plants heated in dry cooking environments (Table 6.1).

Table 6.1
Summarized findings of dissertation with interpreted culinary practices per plant type on kitchenware

		Archaeological site				
		LN-101	**El Flaco**	**La Luperona**	**Palmetto Junction**	**Barillas**
Plant types identified	**zamia**	microlith	clay griddle-	clay griddle+	clay griddle	
	manioc	shell- microlith+	shell clay griddle-	shell	shell clay griddle-+	clay griddle- clay *olla*
	sweet potato		shell	shell-		
	yam				shell-+	
	cocoyam					
	beans		shell-	shell+	shell-	
	palm				shell	
	chili pepper			clay griddle+		clay griddle
	maize	shell- microlith	shell- clay griddle-+		clay griddle-+	clay griddle-+ clay plate
	Zingiberales		clay griddle	shell		

Interpreted culinary practice -= Humid heat damage += Dry heat damage

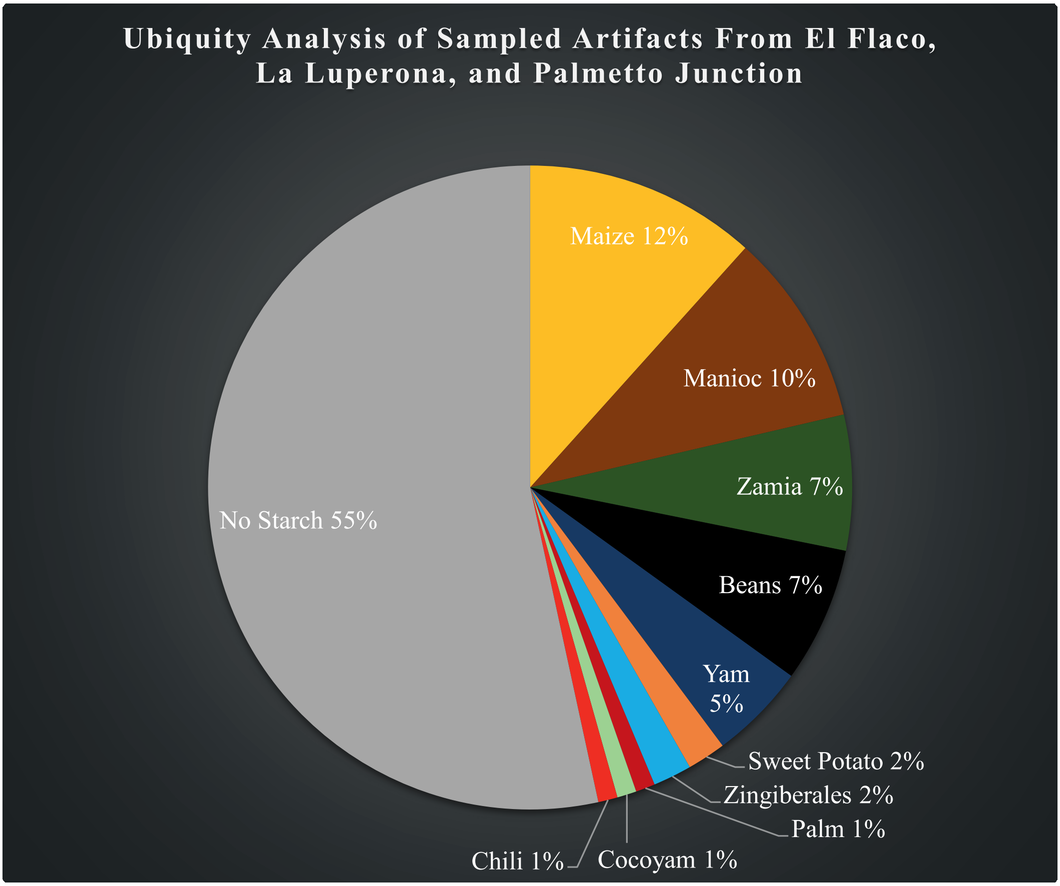

Figure 6.4
Visualized ubiquity analysis for three of the investigated northern Caribbean sites.

Culinary practices have the power to completely change the taste of food. Specific tastes delineate dishes, meals, cuisines, and sometimes group identities. Cuisines may be conservative, in terms of the consistency and limited variation of plant types. This conservatism could be based upon cultural memories of past meals created with specific culinary practices, available technologies, imbedded bodily gestures, or certain ingredients. When ingredients are used consistently, they may eventually become a reminder of personal or group identity. Repetitively adding combinations of ingredients associated with specific culinary practices creates regional cuisines that were constructed around specific core tastes. For example, flavors from three of the northern Caribbean sites in this study incorporated tastes from zamia and manioc, as well as sweet potato, beans, and maize (Table 6.1 and Figure 6.4). However, sweet potato was not recovered from the sites located in the Bahama archipelago, which may be due to sample size, preservation, or alternatively, the sites in the Bahama archipelago could have

6

had different culinary practices and prepared sweet potato with different types of kitchenware. This proposition is probable because sweet potato was recovered from other types of clay vessels at Palmetto Junction (Ciofalo and Graves 2018). Likewise, maize remains were not recovered from the sampled La Luperona artifacts, which does not mean maize was not prepared at this site, but it was absent due to different culinary practices. Finally, because maize, manioc, zamia, and Zingiberales remains were recovered from both shell artifacts and clay griddles it is possible these types of plants contributed towards regional culinary identities.

From a microbotanical view, Indigenous Peoples of the northern Caribbean had access to and used a diverse breadth of plants. The picture of culinary practices is becoming more robust and more diverse particularly with the identifications of Zingiberaceae at El Flaco, Zingiberales at La Luperona, and several types of yam as well as an exogenous palm at Palmetto Junction. Palmetto Junction and LN-101 both had remains of zamia recovered and identified, which is novel evidence for the Bahama archipelago. The meals created with these plant ingredients were possibly imbedded in the cultural memories of Indigenous Peoples. However, the foodways including exogenous plants at the case study sites from the insular Caribbean were likely translocated from other areas of the Greater Caribbean. In fact there is evidence for similar methods of preparing some of the same plants in Panama (Dickau et al. 2007; Piperno 2009), Nicaragua (Ciofalo et al. 2020a), French Guiana (Pagán-Jiménez 2012), and Venezuela (Perry 2002a; Perry 2005). These findings contribute more evidence for the deliberate use of plants in the Greater Caribbean and the discovery of culinary practices at the case study sites.

6.4 Reconsidering late precolonial botanical foodways

Because of the nature of archaeology, we must always rely on incomplete data sets and snapshots of precolonial lifeways. As archaeobotanists push forward, there are revealing pictures of human-plant interactions for nutritional sustainment. However, more than caloric needs and simple dietary reconstructions, a foodways approach for archaeological investigations helps expose social lives and enables discussions of economies, politics, as well as symbolic features of meals (Dietler 1996; Dietler 2007; Hastorf 2016; Pagán-Jiménez 2013).

The findings of this dissertation contribute towards a growing database of identified starchy plants, their quotidian and possible uses on special occasions of the past. Because there was a focus on the ~500 years prior to the advent of European invasions, an enhanced comprehension of time-space systematics as they relate to Greater Caribbean culinary practices during this period has been proposed. In the case studies, we incorporated discussions including interpretations of cultural niches, related human-plant adaptation strategies, and transported landscapes based upon the inferred culinary practices.

Perhaps the findings that are due primary attention include limestone microliths processed poisonous plants, which included the first certain identification of manioc in The Bahamas (Ciofalo et al. 2018). Clay griddles from El Flaco, La Luperona, and Palmetto Junction were multipurpose, which included the first evidence of manioc (cassava bread) being prepared on clay griddles in the insular Caribbean (Ciofalo et al. 2019). Shell artifacts from these three sites were used to prepare manioc but not zamia (Ciofalo et al. 2020b). However, zamia was prepared with a shell at the LN-101 site (Ciofalo et al. 2018). With the first attempt at analyzing starchy residues from clay Griddles in Nicaragua we can state they and other types of clay vessels from the Barillas site were multipurpose and used in diverse culinary practices.

6.5 Summary and implications of primary outcomes

The culinary practices in the Greater Caribbean incorporated plants, which nurtured, supported, and enabled people to function during their daily lives and on special occasions. Not all types of plants that were processed with shells were cooked on clay vessels, which mean there was likely a host of other kitchenware that culinary practices entangled. Culinary practices at the LN-101 site had a limited use of clay vessels. Preparing food without clay vessels is a practice that has continued from pre-ceramic times in the Greater Caribbean (Boomert 2019; Pagán-Jiménez et al. 2015; Sturtevant 1969). Similarly, the Barillas site has suggested that intensively processed botanical meals were prepared without the use of shells, which was probably due to the distance of the site from the coast and access to other raw materials for kitchen tools. LN-101, El Flaco, La Luperona, and Palmetto Junction incorporated both exogenous domesticates and endogenous wild or semi-managed plants into their culinary repertoires.

Humans are not just the sum of their genetic traits but rather integrated wholes into the groups and areas they live within, containing suites of practices interacting with their environments (Earle and Christenson 1980; Smith 2015). Some patterns recognized from the insular Caribbean case studies were consistent with transporting exogenous plants into new environments and proceeding to produce meals from those plants possibly for multiple generations. The variations of culinary practices inferred through this dissertation presumably relate to the level of resolution, but the data appears to suggest varied preferences and culinary practices delimiting yam and beans, at least from these sampled griddles (Ciofalo et al. 2019). Which is why it is essential to sample more than one type of artifact. The sampling strategy enabled the diversity of plants used and variations of culturally constructed niches to be revealed.

Sampling shell, lithic, and clay artifacts and analyzing them for starch content effectively supported the established utility of this method for providing novel insights into precolonial culinary practices and associated foodways (Berman and Pearsall 2008; Pagán-Jiménez 2007a; Pagán-Jiménez et al. 2015; Perry 2004; Piperno and Holst 1998). More specifically, the application of this approach to artifacts recovered in association with earth ovens, a previously unreported feature in The Bahamas and clay griddles, a previously unreported artifact type in central Nicaragua produced results that suggested patterns of intensive food processing activities at sites in the Greater Caribbean. Advantages of starch analysis include its ability to produce direct evidence of human-plant interactions as well as the ability to recover botanical remains from plant species that do not produce pollen and/or have few phytoliths.

The demonstration of starch preservation and recovery from limestone artifacts, underscores the implicit argument that such artifacts are worthy of more detailed investigations because they may reveal patterns of resource procurement. This was likely a local adaptation to the absence of high quality lithic materials in addition to possibly unique botanical culinary practices of the Bahama archipelago. The identifications of maize recovered from several types of artifacts throughout the case studies contribute additional lines of evidence supporting other recent studies (Chinique de Armas et al. 2015; Corteletti et al. 2015; Morell-Hart et al. 2019; Pagán-Jiménez et al. 2015), which suggests many precolonial households had access to maize in the Greater Caribbean.

Each case study produced evidence for physical changes of starches represented by damage caused from particular scenarios of culinary practices. These findings combined with the presence of earth ovens in The Bahamas and clay griddles in central Nicaragua offer views of culinary practices that were previously unknown at those sites (Ciofalo et al. 2020a; Ciofalo et al. 2018). Overall, this contributes to richer understandings of Greater Caribbean foodways by moving beyond early European writings, which distort the relative importance of certain staple crops over others and clearly failed to capture the diversity of plants and culinary practices used amongst precolonial communities in these areas. Reconstructions of Caribbean foodways have been pushed beyond relying upon ethnographic analogies and ethnohistorical written sources (Laffoon et al. 2016; Mickleburgh et al. 2019; Mickleburgh and Pagán-Jiménez 2012; Pagán-Jiménez 2007a; Pagán-Jiménez et al. 2005; Pagán-Jiménez et al. 2015). This must continue to be the way forward because there are lost, forgotten, or changed culinary practices for which an archaeobotanical approach to their reconstructions provides substantial insights based upon empirical evidence (Pagán-Jiménez et al. 2016; Pearsall 2018; Piperno 1998a).

The starchy shell residue analyses reported direct evidence for a diversity of plants processed with bivalve shell artifacts from four archaeological sites in the Caribbean (Ciofalo et al. 2018; Ciofalo et al. 2020b). The main points of those case studies included: 1) bivalve shell artifacts in the Caribbean were previously assumed to have been used almost exclusively to process manioc, while the results demonstrated many starchy plants were processed; 2) use-wear (wear trace) and lack of use-wear on shell artifacts are not always reliable indicators of plant processing, and therefore an interdisciplinary approaches should be used; 3) worldwide, shell artifacts should receive more attention from residue analysts seeking to investigate ancient foodways (Ciofalo et al. 2020b).

6.6 Limitations

A primary concern for archaeobotanical investigations is always organic preservation, especially in the tropics (Babot 1996). For example, preservation conditions may inhibit the recovery of macrobotanical remains and the recovery of plant microfossils—pollen, phytoliths, or starch—from sediments, cooking vessels, or other kitchenware artifacts. In conjunction with the issue of preservation is the general lack of reports on failed microbotanical recoveries (Hernandez 2015). Because of the limited amount of reported failures, the causes of failures have not been properly assessed. Additional studies that report success and failure to recover starch associated with starch preservation, extraction methods, including artifact contexts are needed to increase comprehension of ideal starch recovery parameters. The inability to recover starch remains could be a true representation that the artifact never contacted starchy plant matter (evidence of absence), or possibly an indication that during artifact use and post depositional processes microfossils were removed or destroyed (absence of evidence). Furthermore, other plants without diagnostic microbotanical remains, with few starches produced, such as squash (*Cucurbita* spp.), pineapple (*Ananas comosus* L.), fruit trees in the sapodilla family (Sapotaceae) (Newsom and Wing 2004), could be undetected but still have been a part of foodways. In addition, there was an absence of use-wear analysis in this dissertation, which has the possibility to complement and bolster results related to the lithic and shell artifacts (Barton et al. 1998; Breukel 2019; Lammers-Keijsers 2007; Walker 1980).

For some scholars, a reason for caution with starch analysis is that starch taphonomy is not well understood (Barton and Matthews 2006; Barton and Torrence 2015; Delwen 2006; Henry et al. 2011; Louderback et al. 2015). However, archaeologists are teaming up with chemists, soil scientists, and cell toxicologists to improve our understanding of post depositional factors affecting starch taphonomy (Barton 2009; Barton and Matthews 2006; Hutschenreuther et al. 2017; Zavareze and Dias 2011). There are many taphonomic issues that starch researchers must approach and question. To address these issues a combination of proxies from other research fields, including soil chemistry, chemical biology, food science, and ancient starch research should be consulted. An issue with artifact deposition and starch recovery is that so many factors play a role in taphonomic preservation, such as the type or combination of plants processed with the artifact (Hutschenreuther et al. 2017), microcontexts of artifact deposition, soil moisture fluctuations, soil texture, pH (Haslam 2004), bacteria, fungal, and enzyme varied environments (Barton 2009). It is impossible to recreate the specific archaeological contexts for experimental analysis. However, experiments have provided information on which postdepositional processes affect starch recovery, such as excavation, curation, and lab procedures (Henry 2015; Mercader et al. 2018).

Another limitation includes the acknowledgement that extinct plant species may be represented in the archaeobotanical record but not able to be added to the reference collection (Appendix) and thus become unidentified (Newsom 2008). However, the only case study with a statistically significant proportion of unidentified starches (40%) was from Chapter 2- Late precolonial culinary practices: Starch analysis on griddles from the northern Caribbean, thus it is likely this limitation has been marginalized (Ciofalo et al. 2019). The success of starch analyses is greatly influenced by reference collections, excavation procedures, the contexts of recovered artifacts, and methods for starch extraction because they all may affect recovery, identification, and interpretations. Despite admitted limitations, all samples processed for starch analysis have been retained for preservation and future microbotanical, aDNA, or unconceived analyses. An ideal interdisciplinary research design focused on core archaeobotanical questions should include several analytical techniques for recovering data with a robust representation of the botanical spectra includes analyses of macrobotanical, microbotanical (pollen, phytolith, and starch), aDNA, and chemical (Henderson et al. 2007; Mann et al. 2018; Pearsall 2015; Pestle and Laffoon 2018; Piperno and Holst 1998; Santiago-Rodriguez et al. 2013; Ziesemer et al. 2015). This dissertation would have benefitted from further integration into an interdisciplinary research design from the beginning, but due to multiple factors including timing, schedules, and funding it was not possible for each case study to have the same interdisciplinary design.

6.7 Future research

Discussions with colleagues at the Faculty of Archaeology and above all Dr. Jaime Pagán-Jiménez, have led to several concrete ideas on how to advance the field of archaeobotanical investigation. Future research goals include expanding research geographically (global tropical archaeobotany), diachronically (early colonial archaeobotany), and methodologically, by investing more effort into integrating macrobotanical, other microbotanical analyses, and more experimental archaeology. This expansion of research will also help integration into interdisciplinary research projects.

Certain types of artifacts from the Greater Caribbean region, such as flaked lithics, lithic griddles, and coral artifacts have not been extensively sampled and analyzed for starch content. It is these types of artifacts that should be further investigated, which would generate a more robust picture of precolonial foodways in the Greater Caribbean. These future investigations would be particularly suitable in the Bahama archipelago, which is notorious for limited geological resources for tool making and an abundance of coral artifacts recovered from archaeological sites (Keegan 1997 45,55,59). Furthermore, coral artifacts possibly used as abraders are commonly recovered from Ceramic Age archaeological contexts throughout the Caribbean. It would also be insightful to spot sample or divide samples taken from shell artifacts to increase the disciplines comprehension of where starch preserves on shell tools.

The study of archaeobotanical remains recovered from dental calculus persists as a key area for expounding a new research line. Previous studies of starch residues from dental calculus remains were compelling but some of them lacked sophisticated interpretations of cultural practices (Boyadjian et al. 2007; Hardy et al. 2009; Li et al. 2010; Power et al. 2018; Power et al. 2015; Tao et al. 2015), which is certainly possible from more in depth studies, analysis, and experiments to better understand compound processing starch damage patterns (Johnson and Marston 2020; Li et al. 2020; Liu et al. 2015; Mickleburgh and Pagán-Jiménez 2012; Piperno and Dillehay 2008; Valamoti et al. 2008; Wesolowski et al. 2010). It would be ideal to continue along this path of interpretations using a data set generated from human dental calculus remains because starch recovered from dental calculus had a more intimate and thus direct correlation to the persons recovered human remains.

Because foodways is an immense investigation approach containing a plethora of research topics, an overarching project of human-plant interactions would need a multifaceted research design to integrate key analytical techniques. First, identify the human remains with the greatest number of separate dental calculus deposits and sample each tooth for starch and phytolith remains, which has the possibility to effectively determine how representative each tooth's dental calculus was of the assemblage of preserved microbotanical remains. This procedure is novel and vital for advancing microbotanical interpretations. Second, from a statistically significant amount (30%) of burials sample dental calculus for starch, phytolith, as well as dental enamel for analysis of carbon ($\delta^{13}C_{en}$) isotope values, and aDNA remains (Henry et al. 2011; Henry and Pipemo 2008; Mickleburgh et al. 2019; Modi et al. 2020; Nieves-Colón et al. 2015; Power et al. 2018; Roberts et al. 2018). These sampling and analysis strategies are reflexive enough to be effectively applied to multiple regions and periods with archaeologically recovered human remains.

Through other archaeological, paleoethnobotanical, and ecological techniques evidence of past anthropogenic environmental modifications can be recovered. Sediment cores should be targeted both within and outside settlement areas to generate temporal resolution of multi-proxy analyses. The cores may be sampled and analyzed for phytolith, pollen, and macrofossil remains as well as possibly aDNA (Crowther et al. 2018; Faegri et al. 1989; Gugerli et al. 2013; Piperno et al. 2009; Watson et al. 2013). The results can reveal human-plant management activities in various degrees, such as intentional dispersal of agroeconomic taxa, intentional vegetative environmental destruction, and other anthropogenic effects on their environments (Castilla-Beltrán et al. 2018; Hooghiemstra et al. 2018; Siegel et al. 2015). Phytolith analysis of these cores can also determine the types of vegetation that existed before human arrival (McMichael et al. 2012; Pearsall 2002). The ability of these integrated research methodologies enables comprehension of cultural and natural botanical landscape modifications (Bush et al. 1989; McMichael et al. 2015; Pagán-Jiménez et al. 2020; Parducci et al. 2015; Pearsall et al. 2016). Archaeological data should be compared with contemporary anthropological data from the study regions, which can provide a more complete picture regarding how landscapes were and are managed by ancient and modern societies (Jean 2019). Finally, conceptions concerning what extent anthropogenic modifications changed ecologies may be created. The datasets from these analyses and subsequent interpretations will improve research methodologies, create a more refined understanding of ancient lifeways, and provide inferences regarding human-plant interactions.

6.8 Final remarks

This dissertation has painted a dynamically diverse picture of Indigenous Caribbean Peoples' culinary practices. The results provided significant insights into culturally constructed niches of the case study areas that involved clay vessels, limestone artifacts, and bivalve shells. There were discussions of human-plant adaptation strategies that involved exogenous plant translocations. Each chapter helped demonstrate that culinary practices from these case study sites incorporated poisonous and non-poisonous plant manipulation to produce edible meals.

6.8.1 Proposed phytocultural organization

A combined phytocultural system can be proposed for the case study sites that had recovered remains of manioc, sweet potato, beans, chili peppers, yams, and maize. At some time, these plants were transported to the Greater Antilles and the Bahama archipelago for:

1) The development of house gardens "*conucos*", which produced maize, beans, possibly together with manioc and other fruity or spicy plants such as chili pepper. It was these gardens where experimentation and cultural acceptance of exotic plants conceivably occurred they were integrated as significant culinary sources (Boivin et al. 2012).

2) The use of open plots for the production of maize and manioc, which are efficient in sunny areas.

3) Tropical dry forest management for the procurement or management of zamia and yam.

4) In addition, the use of clay vessels, limestone tools, and shell kitchen tools for the production of a diverse array of plant-based meals. Interpretations also offer further explanations regarding how cultural niches were constructed i.e. how and which plants were prepared with the kitchen technology to reproduce successful culinary practices that offered modes of stability in dynamic environments.

Earlier preconceptions viewed microliths as associated with manioc processing in the Greater Caribbean (DeBoer 1975; Lathrap 1970; Roosevelt 1980:235), clay griddles as exclusively entangled with the production of manioc flatbread in the insular Caribbean (DeBoer 1975; Rouse 1992; Wilson 2007), and clay griddles as exclusive producers of maize *tortillas* in Nicaragua (McCafferty 2011). Yet, these supposed "manioc-only" artifacts have consistently had multiple plants identified from their microbotanical remains, but usually an absence of manioc starch residue (Berman and Pearsall 2008; Pagán-Jiménez 2008; Pagán-Jiménez 2009; Pagán-Jiménez 2013; Perry 2002a; Perry 2005; Rodríguez Suárez and Pagán-Jiménez 2008). However, during this research, manioc starch grains were recovered from eight out of 47 sampled griddles. Regarding clay griddles from the Greater Caribbean region, the new total is now 13 out of 82 that were used to process manioc (Bel et al. 2013; Ciofalo et al. 2020a; Ciofalo et al. 2019; Hellemons 2018; McKey et al. 2010; Pagán-Jiménez in Oliver 2014; Pagán-Jiménez in Ulloa Hung 2014:115,138; Pagán-Jiménez 2008; Pagán-Jiménez 2009; Pagán-Jiménez 2011a; Pagán-Jiménez 2011b; Pagán-Jiménez 2012; Rodríguez Suárez and Pagán-Jiménez 2008). The survey from this dissertation also identified manioc from four shell artifacts that brings the total to four out of 63 shell artifacts sampled, analyzed, and reported for starch content from the insular Caribbean (Ciofalo et al. 2018; Ciofalo et al. 2020b; Pagán-Jiménez 2007b). While previous assumptions considered manioc a staple cultigen (Rouse 1992:12, 84, 133; Wilson 2007:83, 109, 160), starch investigations could not support this idea and instead demonstrated broad-spectrum plant use in the Greater Caribbean (Mickleburgh and Pagán-Jiménez 2012; Pagán-Jiménez 2007a; Pagán-Jiménez et al. 2015; Perry 2005). We must remember that starch analysis helps us interpret "cultural" staple plants (i.e. plants preferred, targeted, or used ubiquitously) regardless of their presumed dietary contributions.

The remains of plant complexes recovered from the case study sites in the northern Caribbean suggest vibrant culinary practices were carried out for centuries emanating from human-plant interactions that likely originated in other areas of the Greater Caribbean (Isendahl 2011; McKey et al. 2010; Oliver 2001; Pagán-Jiménez in Oliver 2014; Pagán-Jiménez et al. 2015; Piperno 1998b). The recovered starch remains from Nicaragua also evince that a diverse plant complex and dynamic culinary practices were used that involved at least clay griddles, *ollas*, and plates to prepare plants in both humid and dry cooking environments. This study has invalidated the preconception that griddles were tools used exclusively for the production of maize *tortillas* in pre-Hispanic Central America, thereby nuancing culinary practices in this region (Ciofalo et al. 2020a).

The information generated from these case studies argues for a continued comprehensive application of starch research, particularly in research areas with limited organic preservation. The identified remains of a diversity of cultigens that were exogenous to the case study areas was generally consistent with previous findings and interpretations of transported landscapes, signifying access, procurement, management, and other culinary practices that involved plants which were transported to the case study areas (Berman and Pearsall 2008; Dickau 1999; Pagán-Jiménez 2013; Pagán-Jiménez et al. 2019; Rodríguez Ramos et al. 2013). Diverse starchy meals were prepared at the five case study sites. The more sites investigated and artifacts analyzed, the greater the possibilities are for revealing evidence of diverse and dynamic culinary practices. These culinary practices were rooted in the deep history of the Greater Caribbean (Dickau 2005;

Pagán-Jiménez et al. 2015; Pearsall 2006; Perry 2002b; Piperno and Holst 1998). This dissertation has enriched our understandings of Indigenous Caribbean Peoples' foodways during the late precolonial period by contributing to the discoveries of culinary practices at these sites, which helped illustrate a picture of phytocultural complexes that were framed by elements of culinary identities. Hopefully, it was conveyed how identifying culinary practices has the potential to reveal one of the most vital junctures ever produced by a cultural niche — the humanization and literal devouring of the botanical landscape. This discussion does not include the final words on surveying starchy foodways in the Greater Caribbean, research will continue. However, the reconstructed starchy culinary practices may be reflected upon, celebrated, and enjoyed.

6.9 References

Appadurai A (1986) The social life of things: Commodities in cultural perspective. Cambridge University Press, Cambridge

Babot MP (1996) Soils of the Humid Tropics. In: Richards PW (ed) The Tropical Rain Forest: An Ecological Study. 2nd edn. Cambridge University Press, Cambridge, pp 256-272

Barton H (2009) Starch granule taphonomy: the results of a two year field experiment. In: Haslam M, Robertson G, Crowther A, Nugent S, Kirkwood L (eds) Archaeological Science Under a Microscope: Studies in Residue and Ancient DNA Analysis in Honour of Tom Loy, vol 30. ANU Press., Canberra, Australia, pp 129-140. doi:10.22459/TA30.07.2009

Barton H, Matthews PJ (2006) Taphonomy. In: R. T, H. B (eds) Ancient starch research. Left Coast Press Inc., Walnut Creek, California, pp 75-94

Barton H, Torrence R (2015) Cooking up recipes for ancient starch: assessing current methodologies and looking to the future J Archaeol Sci 56:194-201 doi:10.1016/j.jas.2015.02.031

Barton H, Torrence R, Fullagar R (1998) Clues to stone tool function re-examined: Comparing starch grain frequencies on used and unused obsidian artefacts J Archaeol Sci 25:1231-1238 doi:DOI 10.1006/jasc.1998.0300

Bel M, van den, Pagán Jiménez JR, Fronteau G Le Rorota Revisité: Résultats Des Fouilles Préventives Au PK 11, Route Des Plages, Île de Cayenne. In: Berard B (ed) Actes Du 24 Congres de l'AIAC, Martinique, 2013. International Association for Caribbean Archaeology, pp 189-209

6

Berman MJ, Pearsall DM (2008) At the crossroads: Starch grain and phytolith analyses in Lucayan prehistory Lat Am Antiq 19:181-203 doi:Doi 10.2307/25478223

Boivin N, Fuller DQ, Crowther A (2012) Old World globalization and the Columbian exchange: comparison and contrast World Archaeology 44:452-469 doi:10.1080/00438243.2012.729404

Boomert A (2019) The first settlers: Lithic through Archaic times in the coastal zone and on the offshore islands of northeast South America. In: Hofman CL, Antczak AT (eds) Early Settlers of the Insular Caribbean Dearchaizing the Archaic. Sidestone Press, Leiden, pp 123-130

Bourdieu P (2005) Postface to Erwin Panofsky, Gothic Architecture and Scholasticism. In: Hoslinger BW (ed) The premodern condition: Medievalism and the making of theory. Chicago University Press., Chicago, pp 221-242

Boyadjian CHC, Eggers S, Reinhard K (2007) Dental wash: a problematic method for extracting microfossils from teeth J Archaeol Sci 34:1622-1628 doi:10.1016/j.jas.2006.12.012

Breukel TW (2019) Tracing interactions in the indigenous Caribbean through a biographical approach : microwear and material culture across the historical divide (AD 1200-1600). PhD, Leiden University

Bush MB, Piperno DR, Colinvaux PA (1989) A 6,000 Year History of Amazonian Maize Cultivation Nature 340:303-305 doi:DOI 10.1038/340303a0

Carr G, Sørensen MLS, Viejo-Rose D (2018) Food as Heritage. In: Lightfoot E, Liu X, Fuller DQ (eds) Far from the Hearth Essays in Honour of Martin K. Jones. McDonald Institute for Archaeological Research, Cambridge, pp 145-152

Castilla-Beltrán A et al. (2018) Columbus' footprint in Hispaniola: A paleoenvironmental record of indigenous and colonial impacts on the landscape of the central Cibao Valley, northern Dominican Republic Anthropocene 22:66-80

Chinique de Armas Y, Buhay WM, Rodríguez Suárez R, Bestel S, Smith D, Mowat SD, Roksandic M (2015) Starch analysis and isotopic evidence of consumption of cultigens among fisher–gatherers in Cuba: the archaeological site of Canímar Abajo, Matanzas J Archaeol Sci 58:121-132 doi:10.1016/j.jas.2015.03.003

Ciofalo AJ, Donner NR, Hofman CL, Geurds A (2020a) Uses of pre-Hispanic kitchenware from central Nicaragua: Implications for understanding botanical foodways Archaeological and Anthropological Sciences 12:13 doi:10.1007/s12520-019-00955-9

Ciofalo AJ, Graves DL (2018) Cookware and Crockery: a form and functional view from the Southern Bahamas. Paper presented at the Society for American Archaeology 83rd Annual Meeting, Washington, DC,

Ciofalo AJ, Keegan WF, Pateman MP, Pagán-Jiménez JR, Hofman CL (2018) Determining precolonial botanical foodways: starch recovery and analysis, Long Island, The Bahamas Journal of Archaeological Science-Reports 21:305-317 doi:10.1016/j.jasrep.2018.07.022

Ciofalo AJ, Sinelli PT, Hofman CL (2019) Late Precolonial Culinary Practices: Starch Analysis on Griddles from the Northern Caribbean Journal of Archaeological Method and Theory 26:1632-1664 doi:10.1007/s10816-019-09421-1

Ciofalo AJ, Sinelli PT, Hofman CL (2020b) Starchy shells: Residue analysis of precolonial northern Caribbean culinary practices Archaeometry n/a doi:10.1111/arcm.12524

Corteletti R, Dickau R, DeBlasis P, Iriarte J (2015) Revisiting the economy and mobility of southern proto-Jê (Taquara-Itararé) groups in the southern Brazilian highlands: starch grain and phytoliths analyses from the Bonin site, Urubici, Brazil J Archaeol Sci 58:46-61 doi:10.1016/j.jas.2015.03.017

Crowther A, Prendergast ME, Fuller DQ, Boivin N (2018) Subsistence mosaics, forager-farmer interactions, and the transition to food production in eastern Africa Quatern Int 489:101-120 doi:10.1016/j.quaint.2017.01.014

DeBoer WR (1975) The archaeological evidence for manioc cultivation: a cautionary note American Antiquity 40:419-433

Delwen S (2006) Modified Starch. In: R. T, H. B (eds) Ancient Starch Research. Left Coast Press Inc., Walnut Creek, California, pp 205-216

Dickau R (1999) Paleoethnobotany of the Lake Managua Region, Nicaragua. MA, University of Calgary

Dickau R (2005) Resource use, crop dispersals, and the transition to agriculture in prehistoric Panama: evidence from starch grains and macroremains. PhD, Temple University

Dickau R, Ranere AJ, Cooke RG (2007) Starch grain evidence for the preceramic dispersals of maize and root crops into tropical dry and humid forests of Panama Proc Natl Acad Sci U S A 104:3651-3656 doi:10.1073/pnas.0611605104

Dietler M (1996) Feasts and commensal politics in the political economy: food, power, and status in prehistoric Europe. In: Wiessner P, Schiefenhövel W (eds) Food and the status quest: An interdisciplinary perspective. Berghahn Books, Providence, pp 87-125

Dietler M (2007) Culinary Encounters: Food, Identity, and Colonialism. In: Twiss K (ed) The archaeology of food and identity, vol Occasional Paper. vol 34. Center for Archaeological Investigations, Southern Illinois University, Carbondale, pp 218-242

Earle TK, Christenson AL (1980) Modeling change in prehistoric subsistence economies (Studies in archaeology). Academic Press, New York

Epstein LH, Temple JL, Roemmich JN, Bouton ME (2009) Habituation as a determinant of human food intake Psychol Rev 116:384-407 doi:10.1037/a0015074

Faegri K, Kaland PE, Krzywinski K (1989) Textbook of pollen analysis. John Wiley & Sons Ltd., Chichester, United Kingdom

Gifford JC (1912) The Everglades and other essays relating to southern Florida. Everglade land sales co.,

Gugerli F, Alvarez N, Tinner W (2013) A deep dig--hindsight on Holocene vegetation composition from ancient environmental DNA Mol Ecol 22:3433-3436 doi:10.1111/mec.12356

Hardy K, Blakeney T, Copeland L, Kirkham J, Wrangham R, Collins M (2009) Starch granules, dental calculus and new perspectives on ancient diet J Archaeol Sci 36:248-255 doi:10.1016/j.jas.2008.09.015

Haslam M (2004) The decomposition of starch grains in soils: implications for archaeological residue analyses J Archaeol Sci 31:1715-1734 doi:10.1016/j.jas.2004.05.006

Hastorf CA (2016) The social archaeology of food: thinking about eating from prehistory to the present. Cambridge University Press, Cambridge

Hellemons A (2018) Dietary change through Colonisation: A comparative research on starch grains from El Flaco (13th to 15th century A.D.) and La Vega (1495-1564), Dominican Republic. Bachelors, Leiden University

Henderson JS, Joyce RA, Hall GR, Hurst WJ, McGovern PE (2007) Chemical and archaeological evidence for the earliest cacao beverages Proc Natl Acad Sci U S A 104:18937-18940 doi:10.1073/pnas.0708815104

Henry AG (2015) Formation and taphonomic processes affecting starch granules. In: Marston JM, Guedes JDA, Warinner C (eds) Method and theory in paleoethnobotany. University Press of Colorado, Boulder, Colorado, pp 35-50

Henry AG, Brooks AS, Piperno DR (2011) Microfossils in calculus demonstrate consumption of plants and cooked foods in Neanderthal diets (Shanidar III, Iraq; Spy I and II, Belgium) Proc Natl Acad Sci U S A 108:486-491 doi:10.1073/pnas.1016868108

Henry AG, Pipemo DR (2008) Using plant microfossils from dental calculus to recover human diet: a case study from Tell al-Raqa'i, Syria J Archaeol Sci 35:1943-1950 doi:10.1016/j.jas.2007.12.005

Hernandez N, Marie (2015) Archaeological Starch Preservation and Methodological Parameters: Where Does Qaraqara Fit? , Master's thesis, Ohio State University

Hooghiemstra H et al. (2018) Columbus' environmental impact in the New World: Land use change in the Yaque River valley, Dominican Republic Holocene 28:1818-1835 doi:10.1177/0959683618788732

Hutschenreuther A, Watzke J, Schmidt S, Budel T, Henry AG (2017) Archaeological implications of the digestion of starches by soil bacteria: Interaction among starches leads to differential preservation Journal of Archaeological Science-Reports 15:95-108 doi:10.1016/j.jasrep.2017.07.006

Isendahl C (2011) The Domestication and Early Spread of Manioc (Manihot Esculenta Crantz): A Brief Synthesis Lat Am Antiq 22:452-468 doi:Doi 10.7183/1045-6635.22.4.452

Jean JS (2019) La biographie d’un paysage. Etude sur les transformations de longue durée du paysage culturel de la région de Fort-Liberté, Haïti. PhD, Leiden University

Johnson ES, Marston JM (2020) The experimental identification of nixtamalized maize through starch spherulites J Archaeol Sci 113:105056 doi:10.1016/j.jas.2019.105056

Keegan WF (1997) Bahamian Archaeology: Life in the Bahamas and Turks and Caicos before Columbus. Media Publishing, Nassau

Laffoon JE, Hoogland MLP, Davies GR, Hofman CL (2016) Human dietary assessment in the Pre-colonial Lesser Antilles: New stable isotope evidence from Lavoutte, Saint Lucia Journal of Archaeological Science-Reports 5:168-180 doi:10.1016/j.jasrep.2015.11.020

Lammers-Keijsers Y (2007) Tracing Traces from Present to Past : A Functional Analysis of Pre-Columbian Shell and Stone Artefacts from Anse à la Gourde and Morel, Guadeloupe, FWI. PhD diss., Leiden University Press, Leiden. doi:10.5117/9789087280284

Larbey C (2018) How did Foraging and the Sharing of Foraged Food Become Gendered? In: Lightfoot E, Liu X, Fuller DQ (eds) Far from the Hearth Essays in Honour of Martin K. Jones. McDonald Institute for Archaeological Research, Cambridge, pp 95-108

Las Casas B (1909) Apologetica historia de las Indias. Bailey-Ballière e Hijos Madrid

6

Lathrap DW (1970) The Upper Amazon. Ancient Peoples and Places. Thames and Hudson, London

Li MQ, Yang XY, Wang H, Wang Q, Jia X, Ge QS (2010) Starch grains from dental calculus reveal ancient plant foodstuffs at Chenqimogou site, Gansu Province Sci China Earth Sci 53:694-699 doi:10.1007/s11430-010-0052-9

Li W, Pagán-Jiménez JR, Tsoraki C, Yao L, Van Gijn A (2020) Influence of grinding on the preservation of starch grains from rice Archaeometry 62:157-171 doi:10.1111/arcm.12510

Liu L, Duncan NA, Chen XC, Liu GX, Zhao H (2015) Plant domestication, cultivation, and foraging by the first farmers in early Neolithic Northeast China: Evidence from microbotanical remains Holocene 25:1965-1978 doi:10.1177/0959683615596830

Louderback LA, Field J, Janetski JC (2015) Curation practices and extraction methods in relation to starch grain yields from ground stone artifacts Journal of Archaeological Science-Reports 4:535-540 doi:10.1016/j.jasrep.2015.10.011

Mann AE et al. (2018) Differential preservation of endogenous human and microbial DNA in dental calculus and dentin Sci Rep 8:9822 doi:10.1038/s41598-018-28091-9

McCafferty GG Ten Years of Nicaraguan Archaeology. In: 76th Annual Meeting of the Society for American Archaeology, Sacremento, California, 2011.

McKey D, Rostain S, Iriarte J, Glaser B, Birk JJ, Holst I, Renard D (2010) Pre-Columbian agricultural landscapes, ecosystem engineers, and self-organized patchiness in Amazonia Proc Natl Acad Sci U S A 107:7823-7828 doi:10.1073/pnas.0908925107

McMichael CH, Piperno DR, Bush MB, Silman MR, Zimmerman AR, Raczka MF, Lobato LC (2012) Sparse pre-Columbian human habitation in western Amazonia Science 336:1429-1431 doi:10.1126/science.1219982

McMichael CH, Piperno DR, Neves EG, Bush MB, Almeida FO, Mongelo G, Eyjolfsdottir MB (2015) Phytolith Assemblages Along a Gradient of Ancient Human Disturbance in Western Amazonia Frontiers in Ecology and Evolution 3:141 doi:10.3389/fevo.2015.00141

Mercader J et al. (2018) Exaggerated expectations in ancient starch research and the need for best practices and authenticity criteria

Mickleburgh HL, Laffoon JE, Pagán-Jiménez JR, Mol AAA, Walters S, Beier ZJM, Hofman CL (2019) Precolonial/early colonial human burials from the site of White Marl, Jamaica: New findings from recent rescue excavations International Journal of Osteoarchaeology 29:155-161 doi:10.1002/oa.2707

Mickleburgh HL, Pagán-Jiménez JR (2012) New insights into the consumption of maize and other food plants in the pre-Columbian Caribbean from starch grains trapped in human dental calculus J Archaeol Sci 39:2468-2478 doi:10.1016/j.jas.2012.02.020

Modi A et al. (2020) Combined methodologies for gaining much information from ancient dental calculus: testing experimental strategies for simultaneously analysing DNA and food residues Archaeological and Anthropological Sciences 12:10 doi:10.1007/s12520-019-00983-5

Morell-Hart S, Joyce RA, Henderson JS, Cane R (2019) Ethnoecology in Pre-Hispanic Central America: Foodways and Human-Plant Interfaces Ancient Mesoamerica 30:535-553 doi:10.1017/s0956536119000014

Newsom LA (2008) Caribbean paleoethnobotany: Present status and new horizons (understanding the evolution of an indigenous ethnobotany). In: Hofman CL, Hoogland MLP, Van Gijn AL (eds) Crossing the Borders: New Methods and Techniques in the Study of Archaeological Materials from the Caribbean, University of Alabama Press, Tuscaloosa. University of Alabama Press, Tuscaloosa, pp 173-194

Newsom LA, Wing ES (2004) On land and sea: Native American uses of biological resources in the West Indies vol 45879. University of Alabama Press, Tuscaloosa

Nieves-Colón MA, Ozga A, Honap TP, Pestle WJ, Warinner C, Stone AC Comparison of aDNA yields from calculus and tooth roots in pre-Columbian skeletal remains. In: 84th Annual Meeting of the American Association of Physical Anthropologists, St. Louis, Missouri, 2015.

Oliver JR (2001) The archaeology of forest foraging and agricultural production in Amazonia. In: McEwan C, Neves EG, Barreto C (eds) The Unknown Amazon: Culture in Nature in Ancient Brazil. British Museum Press, London, pp 50-85

Pagán-Jiménez in Oliver JR (2014) Nuevos aportes a la arqueología del sitio el saladero, bajo Orinoco, Venezuela. In: Rostain S (ed) Actas Del Tercer Encuentro Internacional de Arqueología Amazónica. Instituto Francés de Estudios Andinos, Quito, pp 97-112

Pagán-Jiménez in Ulloa Hung J (2014) Arqueología en la Linea Noroeste de La Española. Paisaje, cerámicas e interacciones. PhD, Leiden University

Pagán-Jiménez JR (2007a) De antiguos pueblos y culturas botánicas en el Puerto Rico indígena: el archipiélago borincano y la llegada de los primeros pobladores agroceramistas, Paris Monographs in American Archaeology Series 18, British Archaeological Reports International Series 1687 vol 1067. Paris Monographs in American Archaeology Series 18. Archaeopress, Oxford

Pagán-Jiménez JR (2007b) Uso de plantas en una comunidad Saladoide tardío del Este de Puerto Rico (Punta Candelero): estudio de residuos vegetales (almidones) en artefactos líticos, cerámicos y de concha. Copies available at the Consejo para la Protección del Patrimonio Arqueológico Terrestre de Puerto Rico, San Juan

Pagán-Jiménez JR (2008) Envisioning Ancient Human Plant Use at the Rio Tanamá Site 2 (AR-39) through Starch Analysis of Lithic and Clay Griddle Implements. In: Carlson LA (ed) A multidisciplinary approach to the data recovery at two village sites on the Río Tanamá. Southeastern Archaeological Research, US Corps of Engineers, Jacksonville, Florida., Copy available at the Puerto Rico State Historic Preservation Office, San Juan., pp 241-257

Pagán-Jiménez JR (2009) Nuevas perspectivas sobre las culturas botánicas precolombinas de Puerto Rico: implicaciones del estudio de almidones en herramientas líticas, cerámicas y de concha Cuba Arqueológica 2:7-23

Pagán-Jiménez JR (2011a) Assessing Ethnobotanical Dynamics at C.E.-11 and C.E.-33 through Analysis of Starch Grains, Plant Processing, and Cooking Artifacts. Copy available at the Puerto Rico State Historic Preservation Office, San Juan

Pagán-Jiménez JR (2011b) Dinámicas fitoculturales de un pueblo precolombino Saladoide tardio (King's Helmet) en Yabucoa, Puerto Rico El Caribe Arqueológico 12:45-59

Pagán-Jiménez JR (2012) Early use of maize and other food crops among Early Ceramic and later Neoindian traditions of northeastern Amazonia revealed by ancient starch grains from ceramic and lithic artifacts of the Chemin Saint-Louis archaeological site, French Guiana Archaeology and Anthropology 17:78-107

Pagán-Jiménez JR (2013) Human–Plant Dynamics in the Precolonial Antilles. In: Keegan WF, Hofman CL, Rodríguez Ramos R (eds) The Oxford Handbook of Caribbean Archaeology. Oxford University Press, New York, pp 391-406

Pagán-Jiménez JR, Ali Z, Santiago-Marrero CG, Hofman CL (2020) Plantscapes of dwelling: Precolonial household mounds, phytocultural dynamics and the ensuing human ecosystems at El Flaco and El Carril (cal. AD 990–1450), northern Dominican Republic Review of Palaeobotany and Palynology 274:28 doi:10.1016/j.revpalbo.2020.104160

Pagán-Jiménez JR, Guachamín-Tello AM, Romero-Bastidas ME, Constantine-Castro AR (2016) Late ninth millennium B.P. use of Zea mays L. at Cubilán area, highland Ecuador, revealed by ancient starches Quatern Int 404:137-155 doi:10.1016/j.quaint.2015.08.025

Pagán-Jiménez JR, Rodríguez López MA, Chanlatte Baik LA, Narganes Storde Y (2005) La temprana introducción y uso de algunas plantas domésticas, silvestres y cultivos en Las Antillas precolombinas: una primera revaloración desde la perspectiva del ‘arcaico’ de Vieques y Puerto Rico Diálogo Antropológico 3(10):7-33

Pagán-Jiménez JR, Rodríguez Ramos R, Hofman CL (2019) On the way to the islands: the role of domestic plants in the initial peopling of the Antilles. In: Hofman CL, Antczak AT (eds) Early Settlers of the Insular Caribbean Dearchaizing the Archaic. Sidestone Press, Leiden, pp 89-106

Pagán-Jiménez JR, Rodríguez Ramos R, Reid BA, van den Bel M, Hofman CL (2015) Early dispersals of maize and other food plants into the Southern Caribbean and Northeastern South America Quaternary Science Reviews 123:231-246 doi:10.1016/j.quascirev.2015.07.005

Pané FR, Arrom JJ, Griswold SC (1999) An Account of the Antiquities of the Indians. Duke University Press, Durham. doi:10.1215/9780822382546

Parducci L et al. (2015) Proxy comparison in ancient peat sediments: pollen, macrofossil and plant DNA Philos Trans R Soc Lond B Biol Sci 370:20130382 doi:10.1098/rstb.2013.0382

Pearsall DM (2002) Maize is still ancient in prehistoric Ecuador: The view from Real Alto, with comments on Staller and Thompson J Archaeol Sci 29:51-55

Pearsall DM (2006) The origins of plant cultivation in South America. In: Cowan CW, Watson PJ, Benco NL (eds) The Origins of Agriculture: An International Perspective. The University of Alabama Press, Tuscaloosa, pp 173-206

Pearsall DM (2015) Paleoethnobotany, Third Edition: A Handbook of Procedures. Left Coast Press Inc., Walnut Creek, California

Pearsall DM (2018) Case Studies in Paleoethnobotany: Understanding Ancient Lifeways Through the Study of Phytoliths, Starch, Macroremains, and Pollen. Routledge,

Pearsall DM, Duncan NA, Jones JG, Friedel DE, Veintimilla CI, Neff H (2016) Human–environment interactions during the early mid-Holocene in coastal Ecuador as revealed by mangrove coring in Santa Elena Province The Holocene 26:1262-1289 doi:10.1177/0959683616638421

Perry L (2002a) Starch analyses reveal multiple functions of quartz "Manioc" grater flakes from the Orinoco Basin, Venezuela Interciencia 27:635-639

Perry L (2002b) Starch Granule Size and the Domestication of Manioc (Manihot Esculenta) and Sweet Potato (Ipomoea Batatas)1 Econ Bot 56:335-349 doi:10.1663/0013-0001(2002)056[0335:Sgsatd]2.0.Co;2

Perry L (2004) Starch analyses reveal the relationship between tool type and function: an example from the Orinoco valley of Venezuela J Archaeol Sci 31:1069-1081 doi:10.1016/j.jas.2004.01.002

Perry L (2005) Reassessing the traditional interpretation of "Manioc" artifacts in the Orinoco Valley of Venezuela Lat Am Antiq 16:409-426 doi:Doi 10.2307/30042507

Pestle WJ, Laffoon JE (2018) Quantitative paleodietary reconstruction with complex foodwebs: An isotopic case study from the Caribbean Journal of Archaeological Science-Reports 17:393-403 doi:10.1016/j.jasrep.2017.11.032

Piperno DR (1998a) The origins of agriculture in the lowland Neotropics. Origins of agriculture in the Neotropics. Academic Press, San Diego, CA

Piperno DR (1998b) Paleoethnobotany in the Neotropics from microfossils: New insights into ancient plant use and agricultural origins in the tropical forest Journal of World Prehistory 12:393-449 doi:Doi 10.1023/A:1022812132194

Piperno DR (2009) Identifying crop plants with phytoliths (and starch grains) in Central and South America: a review and an update of the evidence Quatern Int 193:146-159

Piperno DR, Dillehay TD (2008) Starch grains on human teeth reveal early broad crop diet in northern Peru Proc Natl Acad Sci U S A 105:19622-19627 doi:10.1073/pnas.0808752105

Piperno DR, Holst I (1998) The presence of starch grains on prehistoric stone tools from the humid neotropics: Indications of early tuber use and agriculture in Panama J Archaeol Sci 25:765-776 doi:DOI 10.1006/jasc.1997.0258

Piperno DR, Ranere AJ, Holst I, Iriarte J, Dickau R (2009) Starch grain and phytolith evidence for early ninth millennium B.P. maize from the Central Balsas River Valley, Mexico Proc Natl Acad Sci U S A 106:5019-5024 doi:10.1073/pnas.0812525106

Power RC et al. (2018) Dental calculus indicates widespread plant use within the stable Neanderthal dietary niche J Hum Evol 119:27-41 doi:10.1016/j.jhevol.2018.02.009

Power RC, Salazar-García DC, Straus LG, González Morales MR, Henry AG (2015) Microremains from El Mirón Cave human dental calculus suggest a mixed plant–animal subsistence economy during the Magdalenian in Northern Iberia J Archaeol Sci 60:39-46 doi:10.1016/j.jas.2015.04.003

Roberts P et al. (2018) Historical Tropical Forest Reliance amongst the Wanniyalaeto (Vedda) of Sri Lanka: an Isotopic Perspective Hum Ecol Interdiscip J 46:435-444 doi:10.1007/s10745-018-9997-7

Rodríguez Ramos R (2005) The function of the edge-ground cobble put to the test: an initial assessment Journal of Caribbean Archaeology 6:1-22

Rodríguez Ramos R (2010) What is the Caribbean? An archaeological perspective Journal of Caribbean Archaeology 3:19-51

Rodríguez Ramos R, Pagán-Jiménez JR, Santiago-Blay J, Lambert JB, Craig PR (2013) Some indigenous uses of plants in pre-Columbian Puerto Rico Life Excit Biol 1:83-90

Rodríguez Suárez R, Pagán-Jiménez JR (2008) The Burén in precolonial Cuban archaeology: New information regarding the use of plants and ceramic griddles during the Late Ceramic Age of Eastern Cuba gathered through starch analysis. In: Hofman CL, Hoogland MLP, Van Gijn AL (eds) Crossing the Borders, New Methods and Techniques in the Study of Archaeological Materials from the Caribbean. The University of Alabama Press, Tuscaloosa, pp 159–169

Roosevelt AC (1980) Parmana: prehistoric maize and manioc subsistence along the Amazon and Orinoco. Academic Press, New York

Rouse I (1992) The Tainos, Rise and decline of the people who greeted Columbus. Yale University Press, New Haven

Santiago-Rodriguez TM et al. (2013) Microbial communities in pre-columbian coprolites Plos One 8:e65191 doi:10.1371/journal.pone.0065191

Siegel PE et al. (2015) Paleoenvironmental evidence for first human colonization of the eastern Caribbean Quaternary Science Reviews 129:275-295 doi:10.1016/j.quascirev.2015.10.014

Smith BD (2015) A Comparison of Niche Construction Theory and Diet Breadth Models as Explanatory Frameworks for the Initial Domestication of Plants and Animals Journal of Archaeological Research 23:215-262 doi:10.1007/s10814-015-9081-4

Sturtevant WC (1969) History and ethnography of some West Indian starches. In: Ucko PJ, Dimbleby GW (eds) The Domestication and Exploitation of Plants and Animals. Gerald Duckworth & Co. Ltd., London, pp 177-199

Tao DW, Zhang J, Zheng WQ, Cao YP, Sun K, Jin SA (2015) Starch grain analysis of human dental calculus to investigate Neolithic consumption of plants in the middle Yellow River Valley, China: A case study on Gouwan site Journal of Archaeological Science-Reports 2:485-491 doi:10.1016/j.jasrep.2015.05.003

Valamoti SM, Samuel D, Bayram M, Marinova E (2008) Prehistoric cereal foods from Greece and Bulgaria: investigation of starch microstructure in experimental and archaeological charred remains Vegetation History and Archaeobotany 17:S265-S276 doi:10.1007/s00334-008-0190-6

Walker JB (1980) Analysis and replication of the lithic artifacts from the Sugar Factory Pier site, St. Kitts, West Indies. Unpublished M.A. thesis, Master's thesis, Washington State University, Pullman.

Watson EB, Pasternack GB, Gray AB, Goni M, Woolfolk AM (2013) Particle size characterization of historic sediment deposition from a closed estuarine lagoon, Central California Estuar Coast Shelf S 126:23-33 doi:10.1016/j.ecss.2013.04.006

Wesolowski V, de Souza SMFM, Reinhard KJ, Ceccantini G (2010) Evaluating microfossil content of dental calculus from Brazilian sambaquis J Archaeol Sci 37:1326-1338 doi:10.1016/j.jas.2009.12.037

Wilson SM (2007) The Archaeology of the Caribbean. Cambridge University Press, Cambridge

Zavareze ED, Dias ARG (2011) Impact of heat-moisture treatment and annealing in starches A review Carbohydrate Polymers 83:317-328 doi:10.1016/j.carbpol.2010.08.064

Ziesemer KA et al. (2015) Intrinsic challenges in ancient microbiome reconstruction using 16S rRNA gene amplification Sci Rep 5:16498 doi:10.1038/srep16498