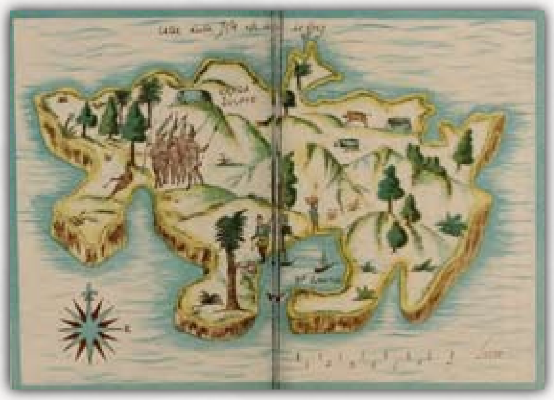

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Essays in archaeology, ethnohistory & ethnography of the Amerindian circum-Caribbean

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Corinne L. Hofman &
Anne van Duijvenbode

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Foreground image: Coral artefact with human face in relief found at the site of Anse à la Gourde, Guadeloupe, AD 1000-1400 (Photo by J. Pauptit).

Background image: Detail of feature layer with postholes cut into the bedrock at the site of El Cabo, Dominican Republic, AD 1000-1500 (Photo by A.V.M. Samson).

Back cover, left to right: Artistic, life-sized interpretation of the archaeological site El Chorro de Maíta, Cuba , AD 1200-1600 (Photo by A. van Duijvenbode). / Wooden stool or duho recovered from the island of Dominica, dated between AD 1315-1427. Catalogue number ECB40669, Economic Botany Collection, Royal Botanic Gardens, Kew, UK (Photo by J. Ostapkowicz). / Clay Figurine found at the Lavoutte site, St. Lucia, AD 1200-1500 (photo by M.L.P. Hoogland).

Front cover, left to right: Map of Guadeloupe published by Champlain in 1859 (Photo by A.J. Bright). / The Trio-Okomoyana village of Amotopo in the midwest of Suriname in 2007 (Photo by J.L.J.A. Mans). / Frontal view of the upper incisors and canines of individual 72B from the site of El Chorro de Maíta, Cuba, AD 1200-1600, showing intentional dental modification (Photo by H.L. Mickleburgh).

Contents

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EPILOGUE

Early phytocultural processes in the pre-Colonial Antilles

A pan-Caribbean survey for an ongoing starch grain research

Jaime R. Pagán-Jiménez

This work examines the available archaeobotanical information of the circum-Caribbean with the aim of re-evaluating the botanical cultures of the region. My intention is to demonstrate that the period of the earliest population movements to the islands (ca. 5600 BC) was mediated by complex interregional processes in which crop plants were important items within exchange networks of goods and ideas. The article demonstrates that crop plant dispersions along with other cultural practices intrinsically linked with them were a reality since the dawn of human arrival to the islands. Details on the magnitude of these processes are unknown and further research will deal with these issues. This work is intended to be a basic framework for the largest archaeological starch grain study which – to date - has been formulated in the hemisphere.

Este trabajo explora información arqueobotánica del circum-Caribe con el objetivo de revalorar el ámbito de las culturas botánicas de la región. Mi interés es demostrar que el periodo de los primeros movimientos humanos hacia las islas (ca. 5600 BC) estuvo mediado por complejos procesos interregionales y las plantas económicas formaron parte esencial de las redes de intercambio de bienes e ideas. Enfatizamos que la dispersión de plantas y otras prácticas intrínsecamente relacionadas con ellas fueron una realidad desde los albores del poblamiento humano de las islas. Desconocemos la magnitud de todos los procesos señalados y deseamos detallarla en futuros trabajos. Este escrito es un marco de referencia básico para el más abarcador estudio de almidones arqueológicos que se haya formulado - hasta ahora - en el hemisferio.

Ce travail examine les données archéobotaniques actuellement disponibles pour la région circum-Caraïbe en vue de procéder à une réévaluation des cultures botaniques de la région. Mon intention est de démontrer que les premiers mouvements démographiques insulaires (ca. 5600 BC) se sont produits par le biais de processus interrégionaux complexes dans lesquels les plantes alimentaires représentaient des articles importants dans les réseaux d'échange de biens et d'idées. L'article démontre que la dispersion de plantes alimentaires, tout comme d'autres pratiques culturelles intrinsèquement liées à ces dernières, ont été une réalité dès l'arrivée de l'homme dans le monde insulaire. Les détails sur l'ampleur de ces processus sont toujours inconnus à ce jour et de nouvelles recherches se chargeront de traiter ces questions. Ce travail vise à être un cadre de référence de base pour l'étude archéologique la plus élargie de graines d'amidons formulée jusqu'à ce jour dans l'hémisphère.

Introduction

Experts in Antillean archaeology have so far argued that two different pre-Arawak or 'Archaic' traditions made the pioneering entry into the islands from separate regions: the Yucatán Peninsula and the Orinoco delta, located near both ends of the Antillean arc of isles (Cuba and Trinidad/Tobago). Archaeological narratives tell that, once on the islands (ca. 5500 BC), pre-Arawak people maintained their movement from Cuba and Trinidad/Tobago to the northeast of the island arc, converging in Puerto Rico. Supposedly equipped with subsistence strategies based on hunting, fishing and gathering, the pre-Arawak people lived for at least 5000 years on the islands until the arrival of the Saladoid: a new and 'more advanced' culture which allegedly displaced or assimilated them (see Rodríguez Ramos 2010 for discussion). Arguments and assumptions about the 'true origin' of the pre-Arawak people have been built on comparative (i.e. morphological) elemental studies of lithics (see Coe 1957; Wilson *et al.* 1998) and cartographic analyses of marine currents of the Caribbean Sea (see Callaghan 2003; Rouse 1992), in conjunction with a Western rationalization which sees the Yucatán and Orinoco regions as obvious jump stations to the Antillean arc.

Starting in 2004, the author began to collect archaeobotanical data which strongly suggest a much more complex phenomenon. Today, some of those early groups traditionally characterized as non-agricultural and nomadic, are considered carriers and producers of domestic plants and crops of continental origin. These plant assemblages were extremely important for many Neotropical cultures since at least 7000 BC and through all the periods defined to this date in the circum-Caribbean region. The archaeobotanical data also suggest other possible continental points of origin and/or intense multi-vectorial interactions for the early human and crop dispersals into the Antilles. These interactions seem to have been initially configured by pre-Arawak people and reinforced by subsequent cultures through time. In this paper I will make a synthetic regional survey on the phytogeography of some important circum-Caribbean economic plants based primarily on the recovered microbotanical remains, particularly starch grains, pollen and phytoliths. The main objective here is to set up wide empirical foundations for the further formulation of feasible phytocultural scenarios around some of the most significant human interactions and movements of plants in the pre-Colonial Antilles and the Greater Caribbean as a whole.

Continental circum-Caribbean and beyond: its early phytocultural spectrum

Central America

Maize (*Zea mays*) has been underestimated in Antillean archaeology. It has been regarded by many researchers (e.g. Rouse 1992; Newsom 2006) as a minor economic plant resource for the pre-Colonial cultures of the archipelagic and southern areas of the circum-Caribbean region, at least until a few centuries before the European irruption to the Americas. Macrobotanical remains of this plant have been recovered in archaeological contexts of extraordinary organic preservation along the northern regions of Central America. Some of those findings, along the periphery of the ascribed centre of maize domestication in Mesoamerica (the Balsas River Valley in south-western Mexico), were dated close to 4000 BC in Mexico (Piperno and Flannery 2001). Pollen grain is also frequently used to

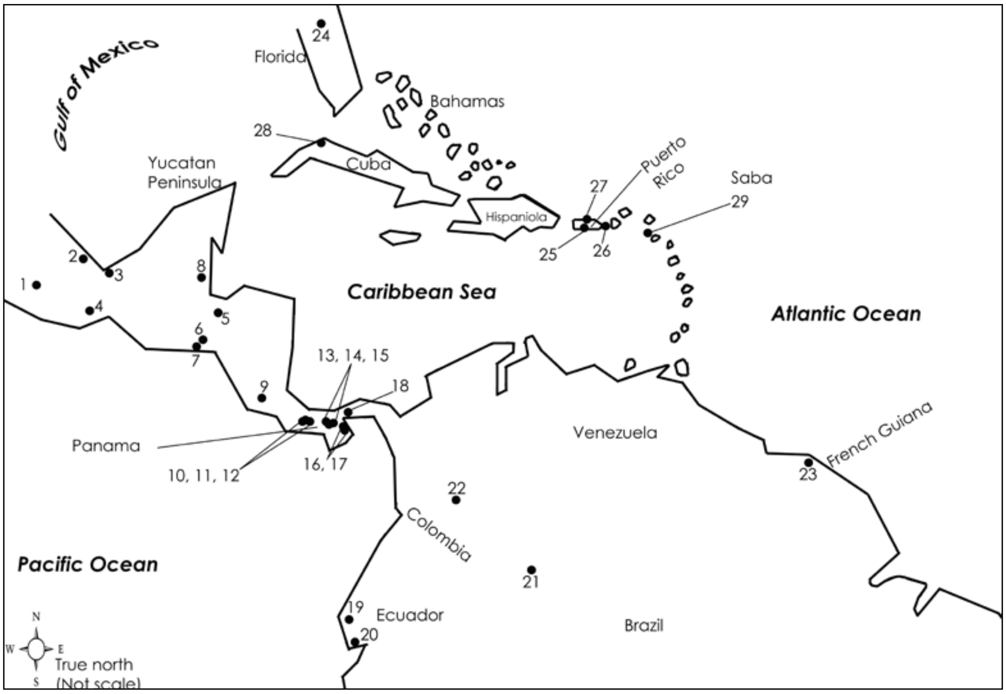

Figure 1 Selected early archaeological sites and/or natural places in the circum-Caribbean (and beyond) mentioned in the text in which microbotanical remains have been studied.

establish the presence and variable stages of domestication of maize in the Neotropics. The oldest dates of domestic maize pollen lie between ca. 5500 BC in the area of Xihuatoxtla, Guerrero (Piperno *et al.* 2009) and 5200 BC (Pohl *et al.* 2007; Pope *et al.* 2001) at San Andrés, Tabasco, this last one accompanied by the presence of domestic manioc (*Manihot esculenta*) pollen (Figure 1).

Older pollen dates from its wild *Zea* correlate (*Z. mays* ssp. parviglumis and other "teosintles") dated back to ca. 7000 BC in the region of initial domestication of maize along the deciduous forests of Guerrero, Mexico (Piperno *et al.* 2009). So far the oldest microbotanical remains of domestic maize and other important economic plants (e.g. squash or *Cucurbita* sp.) were recently published by Piperno *et al.* (2009) showing secure identifications of starch grains and phytoliths recovered from stone grinding tools and sediments of the Xihuatoxtla rock shelter (Balsas River Valley region, Guerrero). These microbotanical remains were reliably associated to fine dated contexts starting at 7000 BC, i.e. between 1500 and 2500 years earlier than estimated with pollen grains or macrobotanical remains hitherto studied in that broad region. In fact, these new dates, directly linked with the initial domestication of maize, match the chronological estimates suggested by genetic studies developed during the last decade (Doebley 2004; Matsuoka *et al.* 2002).

Considering the sample of data and sites present in table 1, it is established here that the region of the Yucatán Peninsula and its immediate continental surroundings – i.e. a region traditionally regarded as one of the areas from which some human groups moved into the far west of the Antilles ca. 4000 BC (*sensu* Rouse 1992)– were an active territory

# in Fig. 1	Country	Site/place name	Main plants identified	Botan. material	Approximate range of dates (calibrated)	Source
1.	Mexico	Xihuatoxtla	Zea mays, Cucurbita sp.,	Starch, phytolith	7000BC and later	Piperno *et al.* 2009
2.	Mexico	Veracruz core	Zea mays	Pollen	2900BC and later	Sluyter and Dominguez 2006
3.	Mexico	San Andrés, Tabasco core	Zea mays, Manihot esculenta	Pollen, phytoliths	5200BC and later	Pope *et al.* 2001
4.	Mexico	Guilá Naquitz	Zea mays, Phaseolus sp.	Macroremains	4300BC and later	Piperno and Flannery 2001
5.	Honduras	Aguada Petapilla core	Zea mays	Pollen	2700BC and later	Webster *et al.* 2005
6.	El Salvador	Laguna Verde core	Zea mays and other Zea species	Pollen	2440BC and later	Dull 2006
7.	El Salvador	El Carmen	Zea mays	Macroremains	1400BC	Dull 2006
8.	Belize	Cob Swamp core	Zea mays	Pollen	2600BC and later	Pohl *et al.* 1996
9	Costa Rica	Laguna Martínez core	Zea mays	Pollen	3550BC	Horn 2006
10.	Panamá	Trapiche	Zea mays, Maranta arundinacea, Dioscorea sp.	Starch	3000-2100BC	Dickau *et al.* 2007
11.	Panamá	Casita de Piedra	a) Maranta arundinacea b) Manihot esculenta, Dioscorea sp., Zamia sp., Fabaceae c) Zea mays, Zamia sp., Dioscorea sp., Calathea sp., Manihot esculenta, Fabaceae	a) Starch b) Starch c) Starch	a) 5400BC b) 4800-4300BC c) 2200-1600BC	Dickau *et al.* 2007
12.	Panamá	Hornito	Zea mays, Zamia sp.	Starch	5600-4500BC	Dickau *et al.* 2007
13.	Panamá	Cueva de los Santanas	Zea mays	Phytolith	5000BC	Piperno and Pearsall 1998
14.	Panamá	La Yeguada core	Zea mays	Pollen and phytolith	5000-4500BC	Piperno and Pearsall 1998
15.	Panamá	Aguadulce	a) Calathea allouia, Maranta arundinacea, Lagenaria sp., and cf. Cucurbita b) Zea mays c) Manihot esculenta, Maranta arundinacea, Fabaceae, Dioscorea trifida and wild Dioscorea d) Zea mays, Marantaceae	a) Phytolith b) Phytolith c) Starch d) Phytolith	a) before 5500BC b) ca.5000BC c) ca.4000BC and later d) ca.4000BC and later	Piperno and Holst 1998
16.	Panamá	La Mula	Zea mays, Dioscorea sp., Calathea sp.	Starch	1300BC	Piperno and Holst 1998
17	Panamá	Monagrillo	Zea mays	Starch	3000BC and later	Piperno and Holst 1998
18.	Panamá	Ladrones	Zea mays, Dioscorea sp.	Starch	5900BC and later	Dickau *et al.* 2007

# in Fig. 1	Country	Site/place name	Main plants identified	Botan. material	Approximate range of dates (calibrated)	Source
19.	Ecuador	Loma Alta	a) Zea mays, Maranta arundinacea b) Capsicum sp., Manihot esculenta, Canavalia sp.	a) Starch b) Starch	a) 4200BC and later b) 3300BC and later	Zarrillo *et al.* 2008
20.	Ecuador	Real Alto	a) Zea mays, Manihot esculenta, Maranta arundinacea, Canna sp. b) Zea mays, Manihot esculenta, Calathea allouia	a) Starch b) Phytolith	a) 2800BC and later for both microbotanical remains	Pearsall *et al.* 2004
21.	Colombia	Peña Roja	Calathea allouia, Cucurbita sp., Arecaceae	Phytolith	7300BC and later	Piperno and Pearsall 1998
22.	Colombia	Jazmin, Guayabito and Campoalegre sites	a) Zea mays, Xanthosoma sp., Dioscorea sp., b) Manihot esculenta	a) Pollen b) Pollen	a) 7000BC and later b) 2000BC	Gnecco and Aceituno 2004
23.	French Guiana	Chemin Saint Louis	Zea mays, Ipomoea batatas, wild and domestic Phaseolus, Maranta cf. arundinacea, cf. Calathea sp., Manihot esculenta, Arecaceae, Capsicum (domestic), cf. Sagittaria sp.	Starch	2460 BC and later	Pagán Jiménez unpub. data
24.	United States	Fort Center	Zea mays	Pollen	500BC	Sears 1982
25.	Puerto Rico	Maruca	Zea mays, Fabaceae, Manihot esculenta, Maranta arundinacea, Canavalia sp., Ipomoea batatas, Xanthosoma sp. Dioscorea (wild), Zamia pumila, Aracaceae	Starch	2800BC and later	Pagán Jiménez 2009
26.	Puerto Rico	Puerto Ferro	Zea mays, Fabaceae, Manihot esculenta, Ipomoea batatas, Canna sp., Zamia portoricencis, Sagittaria sp.	Starch	2100BC and later	Pagán Jiménez 2009
27.	Puerto Rico	Maisabel pond	Zea mays, Canna sp., Ipomoea sp.	Phytolith and Pollen	790 BC and after	Newsom and Pearsall 2003
28.	Cuba	Canímar Abajo	Zea mays, Fabaceae (wild and domest), Ipomoea batatas, Zamia (various sp.)	Starch	3000BC and later	Rodríguez Suárez (in Paz 2006)
29.	Saba	Plum Piece	Prestoea montana, cf. Maranta arundinacea	Starch, raphide	1870BC and later	Nieuwenhuis 2008

Table 1 Some early sites and selected economic plants identified by its microbotanical remains in the circum-Caribbean and adjacent inland continental areas.

of circulation for major economic plants such as maize, squash, manioc, and possibly other high-yield plants like the common bean (*Phaseolus* sp.), from at least 7000 BC (Table 1).

On the southern part of Central America different lines of archaeobotanical evidence, mainly rooted on starch grains and phytolith data, but also on pollen grains, have grown for the last two decades in Costa Rica (e.g., Horn 2006) and Panama (e.g., Dickau *et al.* 2007). Early and secure maize pollen has been found and dated for Laguna Martínez in Costa Rica at around 3550 BC (Horn 2006). Similarly, maize pollen and phytoliths have been identified in La Yeguada (Panama), in contexts dated between 5000 and 4500 BC, together with the constant discovery of starch grains and phytoliths of maize, arrowroot (*Maranta arundinacea*), manioc, lerén/calatea (*Calthea* sp.), cultivated and wild yams (*Dioscorea* sp., *D. trifida*), marunguey or guáyiga (*Zamia* sp.) and beans (Fabaceae, *Phaseolus* sp.), among others plants. Similar plant assemblages have also been reported for a large number of ancient archaeological and natural contexts dated between 5900 to 1300 BC (Dickau *et al.* 2007; Piperno and Holst 1998). Microbotanical data confidently demonstrate that groups inhabiting the Central American region participated in the processes of domestication and early dispersals of the plants identified, long before the accepted estimations. According to Dickau *et al.* (2007), the processes of crop dispersal in this region occurred in the context of diffusion and/or plant exchange of germplasm and not by the movement of agricultural populations (migration) from other culture areas. It should be stressed here that diffusion can not be understood in the classic sense (e.g. *sensu* Steward 1963), but as a set of multi-vectorial processes based on social interactions and probably non-hierarchical exchanges of goods, ideas and technologies (see Rodríguez Ramos and Pagán Jiménez 2006). In this scenario, it has been argued that the Isthmus of Panama served as a land bridge between North and South America for the early dispersion of many domestic resources (Dickau *et al.* 2007:3651), and also for technologies such as metallurgy, and possibly the early development of ceramics, which certainly irradiated to all directions including the Antilles.

The archaeobotanical and palaeoecological information revealed for different chrono-cultural contexts all over Central America clearly encapsulates the whole region in a phyto-cultural setting in which the initial domestication of some of the most important economic plants of the Americas (e.g. maize, beans, chilli pepper, and squash) occurred. Even though this broad region developed extremely diverse societies and cultures which evolved at different rhythms, the movement of domestic and other economically important plant resources was a constant process throughout the territory from ca. 7000 BC. All the 'culture areas' and 'sub-areas' encompassed within Central America actively participated in the movement and exchange, not only of plant resources, but also of basic ethnobotanical practices. This exchange permitted their adoption, adaptation and use among the different systems of cultural values of the whole region.

Northern South America

In the South American continent, archaeobotanical and paleoecological research have also revealed a set of important information. Outside the circum-Caribbean geographic mainland –that is, in the high and temperate regions of South America–, findings of desiccated or charred maize, manioc and other economically valuable plants have been frequent for decades. Countless macrobotanical remains of maize have been reported for the Atacama Desert, between Chile and Peru, as well as for Ecuador and Argentina where some of them were directly dated between 1500 and 500 BC (uncalibrated) (Blake 2006). Similarly, macro- and microbotanical remains of seed and tuberous plants of great relevance to the Neotropics like manioc, common bean, achira (*Canna* sp.) and wild yams, were known and used mainly in South America from the fifth millennium BC or even before. In the Casma Valley, Peru, hundreds of desiccated fragments of manioc have been reported in contexts dated to as early as 1800 BC (Ugent *et al.* 1986). This suggests that manioc was being used and manipulated long before that date given that its centre of origin was probably located in the tropical lowlands of north-eastern South America and/or southern Brazil (Olsen and Schaal 2006; Piperno 2006). Macrobotanical remains of sweet potato, recovered in Tres Ventanas Cave at the Chilca Canyon (Engel 1973), and in the Casma Valley (Ugent *et al.* 1981), have been registered in association with pre-Ceramic contexts dated between 8000 and 6000 BC and between 2250 and 1775 BC, respectively.

In Ecuador, the early (4600 BC onwards) and consistent presence of microbotanical remains (starches and phytoliths) at Real Alto and Loma Alta attest that the early processes of dispersion and use of important economic plants such as maize, arrowroot, jack bean (*Canavalia* sp.), manioc, squash, common bean, palm (Aracaceae) and chilli pepper (*Capsicum* sp.) were highly complex, regionally extensive and chronologically deep (Pearsall *et al.* 2004; Zarrillo *et al.* 2008).

For the immediate periphery of the South American circum-Caribbean, specifically the inland region of Colombia, Castillo and Aceituno (2000; see also Gnecco and Aceituno 2004) have proposed a coherent model of human occupations for the early and middle Holocene in the Porce River Valley, an hydrologic feature located in the central mountain range of the Colombian Andes. Although the human presence in this area could have begun around 7000 BC or earlier, paleofloristic data (mainly pollen) indicates little diversity of the forests and absence of colonizing plant organisms. This suggests minimum alterations due to foraging, which could go unnoticed in palynological columns. Later, between 5550 and 4000 BC, remarkable changes in the flora of some of the studied sites were documented in association with a set of cultural manifestations (e.g. changes in subsistence patterns and rituals) that reflect deeper knowledge regarding the natural elements of this region and deliberate management of the forests. Plants of the *Araceae* and *Melastomataceae* families, regarded as colonizing organisms of disturbed forests, are recurrent in this phase which is also characterized by the emergence of lithic artefacts such as edge-ground cobbles. In later pre-Ceramic phases of the same region (ca. 4550-3000 BC), Castillo and Aceituno (2000) documented for the first time in the palynological record the presence of domesticated plants such as maize and manioc, as well as other potential crops of the *Cucurbita*, *Smilax* and *Amaranthus* genus. Given the absence of these plants in the older zones of the palynological profiles, the researchers suggested that those plants constitute a complex of exotic domesticated species which were integrated into the previously established cultivation systems. Moreover, analyses of phytoliths, starch grains and parenchymatous tissues carried out on stone axes and milling stone bases of this phase, revealed the processing and use of plants from the *Aracaceae*, *Gramineae* families and of the genus *Scheelea* and *Manihot*.

Research in the Araracuara region of the Colombian Amazon have provided interesting accounts of the cultivation of some crops and useful plants (Oliver 2001). Between 7300 and 6150 BC, the people who inhabited the pre-Ceramic site Peña Roja exploited palm seeds of the *Onoecarpus, Mauritia*, *Maximiliana* and *Astrocaryum* genus and other edible fruits. These remains were recovered along with flaked and ground stone tools. Phytolith studies carried out by Dolores Piperno on this site (Piperno and Pearsall 1998) also revealed the processing of important plants species such as lerén (*Calathea allouia*), güiro (*Lagenaria* sp.) and squash (Oliver 2001). Slash and burn practices have also been identified in the same region earlier than 2750 BC. A sediment core extracted from a locality associated to the Abejas archaeological site provided palynological data showing the presence and cultivation of maize and manioc spatially and temporarily linked to the Tubaboniba pre-Ceramic tradition (Piperno and Pearsall 1998). It should be noted that the earliest evidence of maize within the sediment core was recovered 35 cm below the level dated at 2750 BC, thus indicating that the antiquity of this plant was older than that documented for the area. In this context and according to the pollen record showing anthropogenic forest disturbances, agricultural production based on slash and burn techniques was intense.

In the Cauca Valley of western Colombia various sediment core sequences have been studied. One of them, known as Hacienda Lusitania (Monsalve 1985), identified the presence of maize pollen 15 cm below one of the sections of the core that was dated to 3200 BC. Once maize pollen appeared in these sediments, its occurrence increased, as did other specimens of the *Compositae* family, while tree abundance decreased. Another study of core sediments carried out in the same river valley (Bray *et al.* 1987), confirmed the early presence of maize pollen in a soil layer dated to 4730 BC.

The only early archaeological site located in the Caribbean region of Colombia and where archaeobotanical information has been released is San Jacinto 1 (Oyuela and Bonzani 2005). This site, apparently used for special purpose activities, was intermittently inhabited by hunter-gatherers between 5000 and 3900 BC and provided macro and microbotanical remains (seeds, charred wood, phytoliths) of the genus *Cyperus* (junquillo), other grasses, legumes, arrowroot and fruits ascribed to the dry season of the area. The presence of maize or other economic plants such as manioc was not documented although inferences on their potential use at the site have been proposed considering the great quantity of *metates* and other ground stone tools recovered.

Surprisingly, only sparse archaeobotanical data directly associated to the early management and use of economic plants has been acquired in the north-eastern region of South America. As already mentioned, this territory has been interpreted by many researchers (see e.g., Rouse 1992; Wilson 2007) as the main epicentre for the large human migrations who settled the Antilles from its earliest periods (ca. 5500 BC) and during the so-called Early Ceramic Age (ca. 500 BC and later). Studies in the Parmana region of Venezuela have shown detailed cultural sequences where changes in the demographic and settlement patterns arose by ca. 2100 BC (Roosevelt 1980). Between that date and 1600 BC, the inhabitants of the La Gruta phase seem to have maintained a low and stable population density, which Roosevelt (1980) linked to the cultivation of manioc combined with a gathering-based subsistence system. Subsequently, according to Roosevelt, near 800 BC the population increased rapidly in the region. However, this growth process stabilized when the maximum level of population density was reached. During the next Corozal phase, which began around 800 BC and extended until AD 100, maize was apparently introduced and established as the main plant item of an intensive agricultural production system. Maize macrobotanical remains associated to earlier occupations of the Corozal phase (i.e., Corozal I) were scarce, but still occurred in the Corozal and Parmana sites. In addition, the production, use and consumption of maize is suggested by the presence of *metates* in archaeological sites ascribed to the Corozal II occupations (ca. 400 BC-AD 100). Conversely, the chronology and some of the interpretations formulated by Roosevelt (1980) concerning these issues were questioned by Sanoja and Vargas (1983), who suggested that the cultural development of the Corozal II occupations at Parmana, Corozal and Ronquín sites took place later, at a point close to AD 360. These researchers proposed that the presence of maize in the Corozal II sites was part of a process in which a new mixed subsistence system combined the production of seed (maize) and tuberous (manioc) plants to take advantage of both sandy soils of low productivity as well as high-yield clayey soils.

Other later archaeological contexts from the Pozo Azul Norte-1 site (ca. AD 300-900), were recently studied by Linda Perry (2002, 2004) in the middle Orinoco river valley of Venezuela. Among the interesting results of her starch grain research program, Perry documented plants such as maize, yam, arrowroot, guapo (*Myrosoma* sp.), ginger (*Zingibeaceae*) and the complete absence of manioc in the many studied grater board microflakes which have been consistently ascribed to the preparation of cassava (manioc) bread in circum-Caribbean archaeology (see Rodríguez Ramos 2010).

Moving out to north-eastern Venezuela, a sequence of early human activities that began ca. 4750 BC has been proposed along the coastline of Paria. According to Sanoja (1997), cultural manifestations associated by him with hunter-gatherer-fisher groups arose in the area from those times. The first indirect evidence correlated to plant production is the presence of axes, hoes and conical pestles in domestic contexts of semi-permanent villages (Guayana and Remigio sites; Sanoja 1997) dated between 3600 and 2650 BC. Later archaeological sites with ceramic technology (e.g., Las Varas: ca. 2650 BC) have been used to propose the early management and use of plants based on morphological and use-wear patterns observed in certain lithic artefacts. Unfortunately, there are no published archaeobotanical data for this region and its various early human occupations. This situation has only left possible the proposal of conjectures on the development of plant production systems (see Sanoja 1997:163).

In the Guianese area, other pre-Ceramic and Early Ceramic sequences such as Barambina Mound (Alaka phase: 3510 BC), Hossororo Creek (1600 BC) and the Mabaruma phase (1600 BC) have revealed indirect information about the use of economic plants (Sanoja 1997:164). In some cases only lithic tools have been associated to plant processing while others artefacts, such as some ceramic bowls, have been interpreted as cooking pots possibly used for the confection of food plant recipes.

This year (2010) the author was contracted by Inrap (Institut National de Recherches Archéologiques Préventives) to conduct a microbotanical study (starch grains) on grinding stone tools, and ceramic pot and clay griddle fragments from the Chemin Saint-Louis archaeological site in French Guiana. This microbotanical study is the first of its type developed on an early site near the north-eastern coast of the South American continent, on the northern border of Amazonia. The site is characterized mainly as an Early Ceramic site with a minor and earlier Archaic component. A set of twenty ^{14}C dates place the overall contexts between 3300 BC and AD 1200. The preliminary results of the analysis of fourteen artefacts distributed along contexts which ranges ca. 2460 BC to AD 410 revealed the processing of plant organs from palm, beans, maize, arrowroot, cocoyam, sweet potato, and possibly manioc and chilli pepper, among other unidentified species (Pagán Jiménez, unpub. data). An additional wild plant was tentatively identified as arrowhead (also known as swamp-potato) or *Sagittaria* sp.: a tuberous plant used in many regions of the American continents for medicine and for food.

The information outlined above was not intended to be exhaustive. The idea has been to provide a descriptive overview on the phytogeography of some economic plants which were important for the circum-Caribbean mainland, i.e., the geo-cultural entity that surround(ed) the Antillean arc of islands to the south and west. Having sketched this overview, a whole different span of interpretive possibilities can emerge regarding the early movement of people and plants to the Antilles from the continental masses surveyed above. These different possibilities must depart from the rigid visions still reflected in the recent literature (Wilson 2007), which persistently ascribe a single socio-cultural character (i.e., hunter-gatherer-fishers) to the humans who began to settle the Antilles circa 5500 BC (see also Rivera-Collazo, this volume).

'Insular' circum-Caribbean: early introduction and dispersals of economic plants and their phytocultural implications

Of all the archaeobotanical or paleoecological research carried out in the Antilles, only the pollen, phytoliths and starch grains have yielded illuminating results on the early introduction and use of domestic, wild plants and other crops (Newsom and Pearsall 2003; Pagán Jiménez *et al.* 2005; Siegel *et al.* 2005) that provided some of the main sources of carbohydrates and vegetable protein for all pre-Colonial periods. Among these microbotanical remains, starch grains have been so far the only secure plant residue recovered directly from firmly dated pre-Arawak ("Archaic") grinding/pounding lithic tools (Nieuwenhuis 2008; Pagán Jiménez 2009). Pollen and phytoliths, though still very limited, are important when integrated into the overall scenario exposed below.

Starch grain research has not been performed in the earliest pre-Arawak contexts of the Antilles so far. The most extensive study corresponds to analysis of lithic tools from two early pre-Arawak occupations in Puerto Rico, dating between ca. 2890 to 390 BC (Maruca and Puerto Ferro sites, Pagán Jiménez *et al.* 2005; Pagán Jiménez 2009). Following the prevailing explanation models (Rouse 1992), these sites can be easily framed within the same socio-cultural characterizations formulated for some of the earliest sites of the Antilles (e.g., Banwari Trace, St. John and Ortoire in Trinidad, or Canímar Abajo in Cuba), which date back to around 5500 BC. The archaeobotanical findings from Puerto Rico, located just in the middle of the Antillean arch, shakes considerably our preconceptions about the pre-Arawak cultures of the archipelago. Without disregarding the evident cultural diversity of the Antillean arc since the earliest human occupations, local and regional developments during the pre-Arawak occurred within an intra- and pan-Caribbean setting of dynamic interactions.

Recent archaeobotanical data gathered in Maruca and Puerto Ferro demonstrates that some of those people called "Archaic" managed and used exogenous domestic plants and crops and exploited native Antillean wild plants. This information, raised by the study of starch grains recovered from grinding/pounding lithic tools, identified domestic plants, such as maize and manioc, beans and other crops, including sweet potato and cocoyam. Wild plants were also processed with the studied tools: the underground stem of marunguey (*Zamia portorricensis*), rhizomes of achira (*Canna* sp.), tuberous root of a wild yam (*Dioscorea/Rajania* sp.) and the seeds of the corozo palm (*Acrocomia media*). The initial study was limited to only 6 lithic tools (Pagán Jiménez *et al.* 2005). Recently (Pagán Jiménez 2009), a substantial expansion of stone tool samples from each site (10 from Puerto Ferro and 16 from Maruca) confirmed our previously published information, extended the presence of the identified plants to the earlier chronological contexts of both sites and broadened the geographical spectrum of some of those plants. This is the case, for example, for the presence and intentional processing at both sites of the subterranean stems of marunguey (and now also *Zamia pumila*), of rhizomes of other wild plants in Puerto Ferro which had not been previously documented (arrowhead or *Sagittaria lancifolia*) and the identification of an important plant for the economic botany of the Neotropics: arrowroot.

The results generated so far establish for the first time in the Antilles, and with a great level of resolution, that the human groups who inhabited Maruca and Puerto Ferro, at least from ca. 2890 BC, had to be using one or more plant cultivation systems (e.g. home gardens and open plots) in addition to fishing, hunting of small mammals and harvesting wild plants and invertebrate fauna (Narganes Storde 1991, 2004). It is suggested, therefore, that in terms of plants, their subsistence system was mixed at both sites, in which the planting and harvesting of endogenous root and tuberous plants was interspersed with the planting and harvesting of exogenous fruit, seed and tuberous plants. The identification of exogenous domestic plants (maize, manioc and some types of bean), as well as other crops (sweet potato, cocoyam, yam, achira, etc.), suggests that the development of semi-sedentary life, which includes here the creation of home gardens and/or "small" agricultural plots, were in operation on or before ca. 2890 BC in Puerto Rico (for a deeper discussion see Pagán Jiménez *et al.* 2005). Microbotanical data, along with some macrobotanical remains recovered in Maruca (i.e. possibly corozo, tortugo [*Sideroxylon* sp.], sapodilla [*Manilkara* sp.], *Malvaceae* and unidentified tuber fragments; see Newsom and Pearsall 2003) offer additional support to the new socio-cultural scenario proposed elsewhere.

Interestingly, paleoecological studies carried out on the northern coast of Puerto Rico (Burney *et al.* 1994) indicated that between 3500 and 1800 BC a significant increase in paleo-fires (determined by charcoal particles) began near of the Laguna Tortuguero. The authors adjudicated those events to possible anthropogenic activities. Today, we know that the human groups who occupied for several periods the Angostura site in Barceloneta, Puerto Rico, were possibly exploiting resources in the area from around ca. 4900 BC, and settling Angostura with some redundancy between ca. 2400 and 1800 BC (see Rivera-Collazo, this volume). These and/or other related people could be the true architects of the changes observed in the paleo-fires sequences of the area due to the possible development of slash and burn agricultural systems (Rodríguez Ramos and Pagán Jiménez 2006). A similar situation has been documented and interpreted for the north of Vieques island (Sara *et al.* 2003), when charcoal particles increased drastically by around 840 BC. Also, the recovery of macrobotanical remains belonging to arboreal taxa (fruits and vegetables) and some grasses (colonizing organisms such as *Portulaca* sp.) in other previously studied pre-Arawak sites of the Antilles (see Newsom and Wing 2004), suggests that the development of arboriculture/home gardens, or the creation of agricultural fields, could be possible with the preparation (slash and burn) of the field which probably stimulated the appearance of colonizing plants (Newsom 1993; Newsom and Pearsall 2003; Pagán Jiménez 2002, 2007). The archaeobotanical data obtained from Maruca and Puerto Ferro also underpins some indirect results previously provided by other researchers which identified maize pollen and phytoliths in contexts dated to ca. 790 and 1450 BC in northern Puerto Rico and the Dominican Republic, respectively (Newsom and Pearsall 2003; Sanoja 1989; Siegel *et al.* 2005).

The overall data summarized above suggests the structural complexity characterising the pre-Arawak people in view of the large amount of information that they had to build, organize and maintain for processing and securing the production of different plants (e.g., knowledge of soils and water for each species, time for planting and harvesting of crops, type of treatment for the elimination of toxic elements); for collecting molluscs, crustaceans and wild plants that were accessible in different seasonal periods; and for developing fishing practices to procure broad-spectrum species in marine and riparian environments. This level of expertise probably could be obtained, accumulated and managed if, among other things, a cosmological order *ad hoc* with the Antillean physical and natural world existed and was, perhaps, attended by a valued (special) individual or a group of them.

Based on the information compiled herein, the inhabitants of Maruca and Puerto Ferro, rather than representing a new and exogenous human mobilization to the Antilles, were descendants of immigrants who arrived centuries or perhaps thousands of years before, who mastered the production of manioc, maize, sweet potato and beans and combined it with other consumption practices rooted in the Antillean tradition of procurement, maintenance and consumption of marunguey. The vast accumulation of knowledge that the inhabitants of Maruca and Puerto Ferro handled regarding their natural environments allowed them to operate a broad-spectrum economy which permitted the configuration of a varied and highly nutritive menu consisting in faunal items extracted from nature, combined with an important set of local and exogenous food plants. There is not a clear hierarchical distinction between the produced food plants and those gathered from the nature. However, it should be noted here the remarkable correlation of plants such as maize, manioc, bean, sweet potato and marunguey in the studied sites (see Pagán Jiménez *et al.* 2005) having been plants that we know were truly relevant for later Antillean agricultural pre-Colonial economies.

Although the archaeobotanical data collected up to now is certainly not extensive enough to imply that plant derivates were the food staple of the inhabitants of Puerto Ferro and Maruca[1], it is reasonable to conclude that the systematic production of some of them (with different intensities through time) was a fact from ca. 2890 BC and perhaps earlier. Previous interpretations could apply to Puerto Rico and beyond if a particular combination of artefacts is recovered in other pre-Arawak sites, including (but not restricted to) edge-ground cobbles, conical pestles, irregular *manos* and milling stone/coral bases. In fact, and reinforcing those previous propositions, recent starch grain analyses on lithic *manos* and edge-ground cobbles from Canímar Abajo (Cuba) –one of the earliest Antillean sites dating to ca. 5650 BC– identified maize, sweet potato, beans (wild and domestic) and several species of marunguey (*Zamia* sp.), and other useful plants on contexts dated between 1266-816 BC and earlier (see Martínez-López *et al.* 2009; Paz 2006).

As already mentioned, the archaeobotanical information gathered on some pre-Arawak sites of the Greater Antilles questions the traditional explanatory models from our region. These models place all the cultural manifestations prior to the agro-ceramic Saladoid expansion in an extremely simple and passive level of socio-cultural development (see e.g., Fitzpatrick and Keegan 2008; Wilson 2007). Several lines of reasoning shape these models. The first one emerges from the idea that the pre-Arawak human groups were usually organized into non-agricultural and family-based nomadic bands, which had a social structure

1 Bone chemistry-isotope studies should be performed to determine these aspects (see Laffoon and de Vos, this volume).

similar to that described for continental Archaic people (see Rouse 1992; Veloz Maggiolo and Pantel 1988; Veloz Maggiolo and Vega 1987). An examination of the current state of knowledge concerning the so-called Paleoindian, especially during the late Pleistocene and the early and middle Holocene (see Dillehay 2008; Scott Raymond 2008), reveals that the argument is built on an assumption of family-based bands organized around the exploitation of different seasonally available resources. Therefore, the establishment of the various types of early human settlements in continental America was seen as evidence of a certain degree of rational/logistic mobility based on the availability of different resources. A good example of this is the case of San Jacinto 1, an archaeological site where sufficient and different sources of data supported this type of explanatory models (Oyuela and Bonzani 2005). For the Antillean pre-Arawak horizon, it had been easy to consider that settlements would also respond to this kind of rational/logistic mobility (Newsom and Wing 2004; Rouse 1992; Veloz Maggiolo 1991, 1992), although more dependance on the availability of coastal resources.

Another line of reasoning in support of the prevailing explanatory models of the Antillean archaeology is rooted in the archaeological research of some of the "Archaic" and *protoagrícola* sites of the region. These research programs initially built and then reinforced in the academic community the well-grounded perception that pre-Arawak groups correspond to a development level called the 'gatherer way of life' (or "modo de vida recolector" *sensu* Veloz Maggiolo 1992; Veloz Maggiolo and Pantel 1988; Veloz Maggiolo and Vega 1982, 1987), 'appropriator' (e.g., Guarch Delmonte 1990) or simply hunter-gatherer-fisher (Callaghan 2003; Curet 2003; Goodwin 1979; Rouse 1992; Tabío and Rey 1985). Thus, the factual evidence recovered in many Antillean "Archaic" sites, including stone, shell and bone tools together with faunal food remains, have been seen as data supporting such a level of socio-cultural development. This panorama, combined with the 'complete absence' of visible macrobotanical (domestic) plant remains and a perceived lack of ceramic technology (Rodríguez Ramos *et al.* 2008), has been decisive to place these human groups at the lowest and "primitive" position in the pre-Colonial scale of socio-cultural evolution (see Rivera-Collazo, this volume; Rodríguez Ramos 2008).

Therefore, the information produced for Maruca and Puerto Ferro, together with other recent archaeobotanical data recovered over the last 8 years in Puerto Rico and other Antillean islands have become serious indicators that should encourage new thinking about the pre-Colonial cultures. In synthesis, at least some pre-Arawak societies interpreted for more than 80 years as hunter-gatherer-fishers and who supposedly maintained a nomadic way of life, are now interpreted as societies with notable sedentism that were producing domestic food plants and other crops (possibly in a "low-level food production" fashion, *sensu* Smith 2001), and managing wild plant resources for food. Indeed, some of the exogenous domestic plants and food crops (maize, manioc, sweet potato) that were thought to be brought to the Antilles by the first strictly agro-ceramic settlers of continental origin (i.e., the Saladoids and Huecoids, ca. 500 BC, Rouse 1992), are now chronologically situated nearly two millennia prior to the traditional conception widely accepted. It should be highlighted that an important plant assemblage associated with some culinary traditions of the Isthmo-Colombian region (or ICr), has been also identified in Puerto Rico and Vieques and directly related to artefact-types (e.g., edge ground-cobbles and milling stone bases) that are common to both geographical regions (Rodríguez Ramos 2005, 2010). Accordingly, pan-Caribbean interactions have been revealed between the Antilles and the

ICr, implying the movement of people and/or plants through the chain of isles in earlier dates than that known for Maruca and Puerto Ferro. Conversely, as has been suggested by these and other data (Rodríguez Ramos 2010), the movement of people and plants between those two areas (i.e., the ICr and Puerto Rico) could have occurred through direct marine voyages across the open sea (Rodríguez Ramos and Pagán Jiménez 2006).

Later phytocultural dynamics in the Antilles: a surface view from Puerto Rico and its pan-Caribbean implications

After more than 5000 years of pre-Arawak occupations in the Antilles, various new cultural manifestations which brought typically continental ceramic traditions and culinary practices entered the island region from various areas of north and north-western South America. In this context, the starch grain analysis approach applied to culturally exogenous and endogenous agro-ceramic artefact assemblages –like those of the Huecoid, Saladoid and Ostionoid people from Puerto Rico and Cuba– has begun to demystify some rigid pre-understandings regarding tool function and the plants which were supposedly processed or cooked with them (table 2). This is the case of the *burén* or clay griddle that for more than 70 years has been associated with the cooking or handling of manioc (cassava) bread. Now, this artefact is also directly related with a broader spectrum of plants (e.g., maize, bean, arrowroot, sweet potato and marunguey, among others) where manioc has not yet been identified (see Pagán Jiménez 2009). Similar data began to emerge from a small sample of studied microflakes, which were interpreted as grater board teeth and have been historically considered part of the toolkit to process the manioc tuberous roots. Now these tiny artefacts have revealed that many of the plants identified in the *burenes* (maize, arrowroot, marunguey) were also processed with them (Pagán Jiménez 2006), but not manioc as has also been shown for pre-Colonial Bahamas (Berman and Pearsall 2000, 2008) and Venezuela (Perry 2002, 2004).

Starch grain analyses have also contributed to interpretations of the cultural biography of some economically important plants such as maize. This versatile plant has been consistently interpreted (Newsom 2006; Newsom and Wing 2004) as a high status food resource consumed exclusively by the late Ostionoid indigenous elite of Hispaniola and also as a plant of minor importance for the overall pre-Colonial diet of the islands in any period. I have established elsewhere (Pagán Jiménez 2007, 2009, 2010) that the ways of processing and consumption of its seeds go beyond the allegedly restrictive and sometimes simple uses that still continue to be attributed to this botanical resource (see e.g. Newsom 2006, 2008). According to Newsom, the kernels of this plant were consumed green or boiled by the indigenous elite. However, recent starch grain research in the Bahamas (Berman and Pearsall 2008), Cuba (Rodríguez Suárez and Pagán Jiménez 2008) and Puerto Rico (see e.g., Pagán Jiménez 2009), has firmly demonstrated the presence of maize starches in grinding/pounding/grating stone tools and clay griddles of fourteen archaeological sites and contexts, ranging from domestic/communal to ritual/magic-religious spaces and artefacts of all the periods defined for the northern Antilles, which contrast heavily with those previous restrictive assumptions assigned to this plant (see also Pagán Jiménez 2007). Maybe maize was never a

*Next page: Table 2 Antillean archaeological sites where starch grain studies has been formally performed or published. * Calibrations were made using Calib Radiocarbon Calibration Program (Rev 5.0.1). Calibration data sets: intcal04.14c (Reimer et al. 2004) and marine04.14c (Hughen et al. 2004).*

Site name	Region/Country	Chronological ranges with 2σ calibrations BC-AD* (number of samples considered in parenthesis)	Cultural ascription	Physiographic elements and distance to shore line (in meters)	No. of artefacts studied (artefacts with starch content in parenthesis)	Reference
1. Maruca	Ponce, Puerto Rico	2870 – 630BC (9)	Archaic	Coastal plain ~1,500 m	20 (20)	Pagán Jiménez 2009; Pagán Jiménez *et al.* 2005
2. Puerto Ferro	Vieques, Puerto Rico	2260 – 340BC (10)	Archaic	Coastal slope ~1,200 m	12 (12)	Pagán Jiménez 2009; Pagán Jiménez *et al.* 2005
3. Plum Piece	Saba Island (Lesser Antilles)	1870 – 1520BC (3)	Archaic	Upland (mountain) ~772 m	11 (5)	Nieuwenhuis 2008
4. Punta Candelero	Humacao, Puerto Rico	340BC – AD220 (2)	Huecoid	Coastal plain ~120 m	18 (15)	Pagán Jiménez 2007
5.Sorcé/La Hueca (depósito Z)	Vieques, Puerto Rico	160BC – AD540 (11)	Huecoid	Alluvial plain ~330 m	40 (33)	Pagán Jiménez 2007
6. Río Tanamá 2 (AR-39)	Arecibo, Puerto Rico	AD350 – 890 (6)	Late Saladoid (Cuevas)-Early Ostiones (Santa Elena)	Alluvial plain ~5,950 m	6 (4)	Pagán Jiménez 2008a
7. Three Dog	San Salvador, Bahamas	AD600-1160 (12)	Ostionoid (Early Lucayan)	Plain over sand dune ~30 m	28 (14)	Berman and Pearsall 2000, 2008
8. Punta Guayanés (King's Helmet area)	Yabucoa, Puerto Rico	AD640-880 (2)	Late Saladoid (Cuevas)	Promontory over coastal hill ~50-100 m	5 (4)	Pagán Jiménez 2008b
9. Punta Candelero	Humacao, Puerto Rico	AD660 – 1020 (2)	Late Saladoid (Cuevas)	Coastal plain ~120 m	13 (12)	Pagán Jiménez 2006
10. Cueva de los Muertos (SR-1)	Utuado, Puerto Rico	AD680 – 1190 (2)	Ostionoid (modified Ostiones or proto-taíno)	Karst hill ~17,400 m	3 (3)	Pagán Jiménez and Oliver 2008
11. Macambo II	Guantánamo, Cuba	AD1150 – 1490 (1)	Ostionoid (late Taíno)	Coastal plain > 100 m	1 (1)	Rodríguez Suárez and Pagán Jiménez 2008
12. Ceiba 11	Ceiba, Puerto Rico	AD1150-1270 (2)	Early and late Ostiones (Santa Elena and Esperanza)	Coastal hill (top) ~750 m	5 (5)	Pagán Jiménez 2010
13. Vega Nelo Vargas (Utu-27)	Utuado, Puerto Rico	AD1280 – 1430 (4)	Ostionoid (late Ostiones or Capá- taíno)	Karst piedmont/small valley ~19,390 m	4 (4)	Pagán Jiménez and Oliver 2008
14. Laguna de Limones	Guantánamo, Cuba	AD1200 – 1600 (only relative chronology)	Ostionoid (late Taíno)	Coastal plain/terrace ~7,200 m	4 (4)	Rodríguez Suárez and Pagán Jiménez 2008
15. Ceiba 33	Ceiba, Puerto Rico	AD1410-1470 (1)	Ostionoid (late Ostiones or Esperanza)	Terrace on a Coastal hill ~1250m	3 (3)	Pagán Jiménez 2010

food staple in the region at any point in time, although its variable uses defined up to now (Pagán Jiménez 2010) were more generalized than those interpreted before.

Conversely, another exotic plant has been targeted as the most important source of carbohydrates for many pre-Colonial societies in the Antilles: manioc. This food plant, to date, has been poorly documented in the archaeological contexts studied. According to some chroniclers (Colón 1992; Las Casas 1909; Fernández de Oviedo 1851), during the initial Indigenous-European contact period, manioc was the staple crop of those indigenous societies in some of the islands like Puerto Rico, Cuba, Hispaniola, Jamaica and Bahamas. However, there is also clear information regarding the importance of other plants such as marunguey (or guáyiga) which for chroniclers like Las Casas (1909) were even more important than manioc or sweet potato in the region of Higüey of eastern Hispaniola (see Pagán Jiménez 2007; Pagán Jiménez and Oliver 2008; Veloz Maggiolo 1992).

Considering this scenario it would be expected –at least for those later archaeological sites of the Greater Antilles (e.g., early and late Ostionoid sites of Puerto Rico and Cuba) in which 18 lithic and ceramic artefacts have been studied for starch content– that manioc were ubiquitously present if this plant was so important for the cultural spectrum generically encapsulated under the Taíno. On the contrary, starch grain studies conducted so far evidence a different picture; namely that the knowledge and use of many of the plants previously documented remained important and possibly more so than manioc (see Pagán Jiménez and Oliver 2008; Rodríguez Suárez and Pagán Jiménez 2008). Archaeobotanical studies conducted in these late archaeological sites registered the use of plants such as an-

Vernacular name (*taxa*)	Period I[a]	Period II[b]	Period II[c]	Period II[d]	Period III[e]	Period IV[f]	Ubiquity of plants through periods (%)	Remains recovered (referentes)
Tubers (and rhizomes, roots and tuberous stems)								
⊗ Batata or Sweet potato (*Ipomoea batatas*)	X	X		X	X	X	83.3	Starch[1]; charred fragments[3]
⊗ Yuca or Manioc (*Manihot esculenta* Cranz)	X	X			X	X	66.6	Starch[1]; charred fragments[3]
♦ Ñame silvestre(*Dioscorea/Rajania*)	X	X			X	X	66.6	Starch[1]
♦ Ñame mapuey (*Dioscorea trifida*)		X					16.6	Starch[1]
♦ Ñame dunguey (*Dioscorea altissima*)		X					16.6	Starch[1]
⊗ Achira or Gruya (*Canna indica*)	X			X		X	50	Starch[1]
⊗ Yautía Blanca (*Xanthosoma sagittifolium*)	X	X			X	X	66.6	Starch[1]
⊗ Yautía de palma (*Xanthosoma undipes*)					X	X	33.3	Starch[1]
♦ Marunguey (*Zamia portoricensis*)	X	X					33.3	Starch[1]
♦ Marunguey (*Zamia amblyphyllidia*)				X	X	X	50	Starch[1]
♦ Marunguey, Guáyiga (*Zamia pumila*)	X	X		X			50	Starch[1, 2]; desiccated leaves[5]
♦ Yuquilla, Arrowroot (*Maranta arundinacea*)	X	X		X	X	X	83.3	Starch[1]
⊗ Lerén (*Calathea allouia*)		X			X	X	50	Starch[1]
♦ Flecha de agua (*Sagittaria lancifolia*)	X						16.6	Starch[2]
♦ Calatea (*Calathea* cf. *veitchiana*)		X				X	33.3	Starch[1]
❂ Suelda consuelda (*Anredera vesicaria*)		X					16.6	Starch[1]
❂ Bejuco de membrillo (*Smilax dominguensis*)		X					16.6	Starch[1]

Vernacular name (*taxa*)	Period I[a]	Period II[b]	Period II[c]	Period II[d]	Period III[e]	Period IV[f]	Ubiquity of plants through periods (%)	Remains recovered (referentes)
Seed plants								
♦ Frijol silvestre (*Fabaceae*)		X		X	X	X	66.6	Starch[1]; Seed[3]
⊗ Frijol domesticado (*Phaseolus vulgaris*)	X	X		X	X		66.6	Starch[1]
♦ Maíz (*Zea mays*)	X	X		X	X	X	83.3	Starch[1]; Seed and kernel fragments[3]; charred fragments[3]; pollen[6]
⊗ Haba (*Canavalia*)	X	X			X	X	66.6	Starch[1]
-- *Poaceae*		X			X	X	50	Starch[1]; Seed[3]
Ω Achiote (*Bixa orellana*)					X	X	33.3	Starch[1]; Seed[3]
♦ Verdolaga (*Portulaca* sp.)					X	X	33.3	Seed[3]
⚙ Yerba coquí (*Hypoxis* sp.)					X	X	33.3	Seed[3]
√ Cohoba (*Anadenanthera* sp.)					X		16.6	Starch[7] Seed/Wood[3]
Fruits								
⊗ Aguacate (*Persea americana*)	X						16.6	Seed[4]
⊗ Zapote amarillo (*Pouteria campechianum*)	X		X	X	X	X	83.3	Wood/Seed[3]
⊗ Palma corozo (*Acrocomia media*)	X				X	X	50	Starch[1]; Seed[3]
⊗ Papaya-Lechosa (*Carica papaya*)				X			16.6	Seed[3]
⊗ Guayaba (*Psidium guajava*)					X	X	33.3	Seed/Wood[3]
⊗ Guanábana/coyur/anón (*Annona* sp.)					X	X	33.3	Wood/Seed[3]
⊗ Palma (*Aracaceae*)	X					X	33.3	Seed[3]
Ω Higüera (*Crescentia cujete*)					X	X	33.3	Seed/Wood[3]
⊗ Guácima (*Guazuma ulmifolia*)					X	X	33.3	Wood[3]
⊗ Jagua (*Genipa americana*)					X		16.6	Wood[3]
⊗ Uva de playa (*Coccoloba uvifera*)	X				X	X	50	Seed/Wood[3]
⊗ Caimito (*Chrysophyllim cainito*)					X		16.6	Seed/Wood[3]

Table 3 Selected economic plants identified by previous paleoethnobotanical studies in Puerto Rico. **Periods (approximate ^{14}C date ranges, see Rodríguez Ramos 2010):** ***a***, *"Archaic Period" (5500BC-AD100);* ***b***, *"Agro-ceramic Period", La Hueca Culture (350BC-AD400);* ***c***, *"Agro-ceramic Period", Early Saladoid Culture (400BC-AD400);* ***d***, *"Agro-ceramic Period", Late Saladoid Culture (AD300-900);* ***e***, *"Agro-ceramic Period", Ostionoid "Early Taino" Culture (AD400-1100);* ***f***, *"Agro-ceramic Period", Ostionoid "Late Taino" Culture (AD900-1550);* **Symbols:** ⊗ *= food plants (their seeds, tubers and/or fruits);* ♦ *= food and/or medicinal plants (their seeds, tubers, fruits and more);* **Ω** *= industrial plants (used for dye, condiment, fuel, construction, raw material for artefacts elaboration, etc.);* ⚙ *= medicinal (their seeds, leaves, tubers, etc.);* **√** *= hallucinogen (their seeds, exudates, etc.);* **--** *= unknown use;* **Notes:** ***1***, *Source data: Pagán Jiménez (2007);* **2**, *Source data: Pagán Jiménez (2009);* **3**, *Source data: Newsom and Wing (2004). Clarification for this source: Macro-botanical remains of plants like maize, achiote, batata, yuca and frijol (Fabaceae) have been found in no more than 2 of the approximately 36 sites studied for botanical macro-remains content in the region;* **4**, *Source data: Rouse and Alegría (1990);* **5**, *Source data: Veloz Maggiolo (1992);* **6**, *Source data: Lane et al. (2008);* **7**, *Source data: Pagán Jiménez (unpublished data).*

natto for the first time (see Newsom and Wing 2004; Pagán Jiménez 2007), while marunguey, arrowroot, maize, bean and sweet potato, placed within the total number of samples studied, are the most ubiquitous plants to be found (see some identified taxa per period in table 3). Undoubtedly, manioc starches have been recovered in early and late Ostionoid contexts from Puerto Rico, although its occurrence within the total assemblage of studied artefacts is almost imperceptible. These Ostionoid artefacts with manioc starch include a stone mortar from Vega de Nelo Vargas site (Utu-27: AD 1280-1430), two milling stone bases and one edge-ground cobble from Cueva de los Muertos (AD 680-1190), both sites located in Utuado, Puerto Rico. Another artefact where a single manioc starch grain was recovered is a ceramic pot fragment from Ceiba 11 site (AD 1150-1270). This artefact contained charred crust, presumably food remains, attached to the inside of the utensil (Pagán Jiménez 2010). Two other late Ostionoid sites from Cuba (Laguna de Limones and Macambo II)[2] did not reveal the use and preparation of any manioc recipe (e.g., cassava bread) even when 5 different *burenes* subjected to starch analysis documented grains of marunguey, bean, maize, sweet potato, cocoyam and arrowroot in a similar fashion than those documented in 5 other *burenes* in Puerto Rico associated to two late Saladoid sites and one late Ostionoid site (Pagán Jiménez 2008a, 2008b; Rodríguez Suárez and Pagán Jiménez 2008).

At least for pre-Colonial Puerto Rico, the observed tendency is quite clear: a broad-spectrum economy was important for all the cultural periods studied until now. Each site, its respective ecosystems and the varied ways of exploiting them should have its own specificities and dynamics. Among them, we interpreted intra- and inter-site particularities regarding the use of and access to certain plants through time (e.g., Pagán Jiménez 2007). In other words, the phytocultural dynamics that existed within the studied sites show that some plants which were apparently highly esteemed at a given time subsequently decreased significantly or simply disappeared from the archaeobotanical record, resulting inversely in the increase of other plants. These are the specificities that can help us to define the nature of the economic and botanical cultures of our ancestors at the local, regional and pan-Caribbean levels.

Concluding remarks

This brief overview has made clear that the time of the earliest incursions into the Antilles (ca. 5500 BC) was characterized by processes of intense human mobility occurring along the entire surrounding continental area since long before. This time also marks true attempts at plant domestication and dispersion while diverse and strong, local or regional identities started to take shape and were later accentuated. Therefore, more than answers, this essay has intended to generate further questions regarding the circum-Caribbean phytocultural circumstances, particularly during the earliest migration and settlement episodes on the Antilles. The recent multidisciplinary evidence from the continent and the islands supports the call for the reconsideration of the "appropriator" or hunter-gatherer-fisher character of the first Antillean inhabitants, as we have argued elsewhere (Pagán Jiménez *et al.* 2005; Rodríguez Ramos 2008; Rodríguez Ramos and Pagán Jiménez 2006; see also Rivera-Collazo this volume).

2 Laguna de Limones (AD 1150-1490) and Macambo II (AD 1200-1600, relative chronology), both sites in Guantánamo Province.

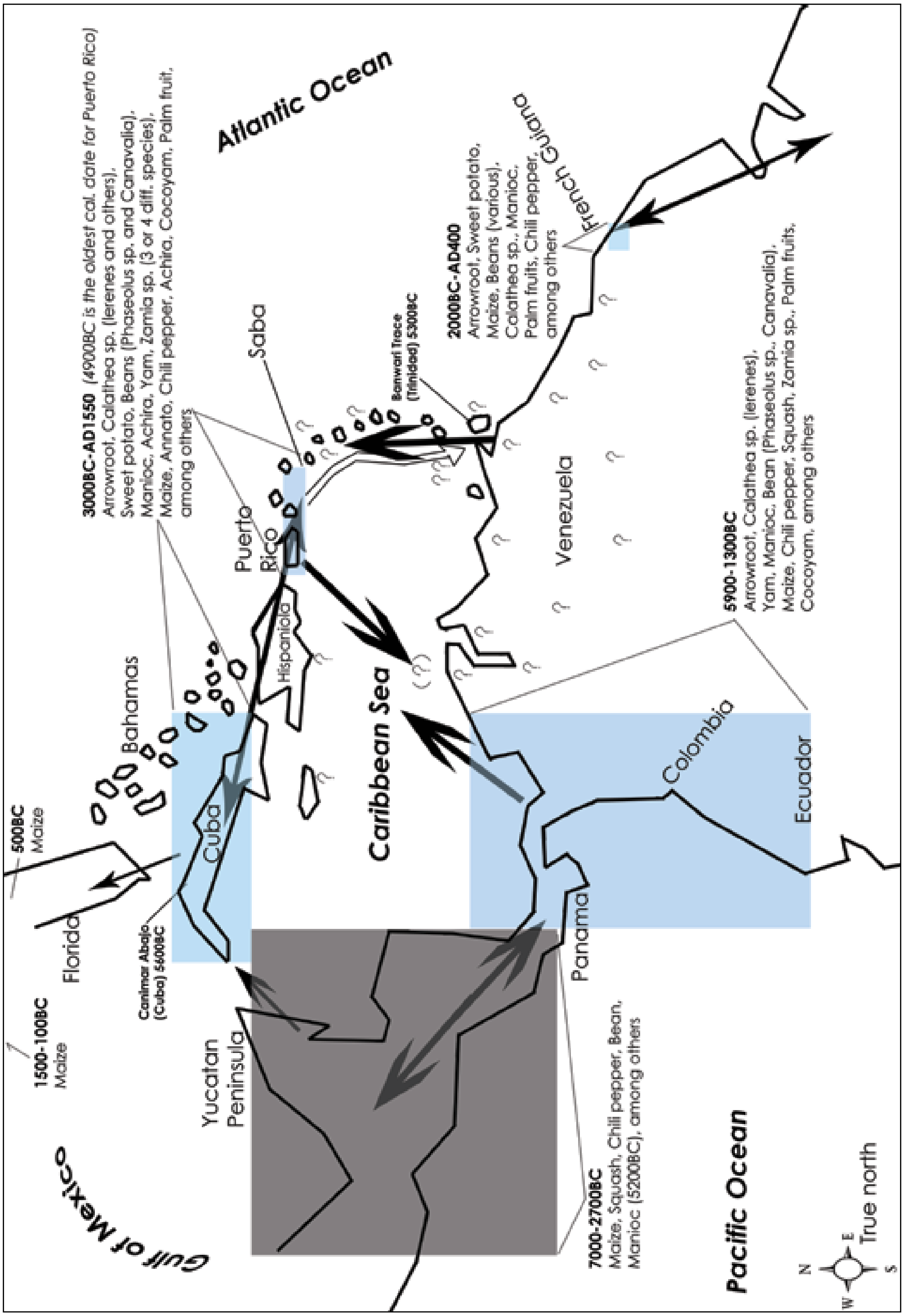

Figure 2: Interrelated (arrows) plants among assemblages through the archipelagic and continental areas of the circum-Caribbean, early human occupations. The "question" symbol represents void spaces for archaeobotanical data during the same early periods.

Using the archaeobotanical information summarized above for Puerto Rico and the surrounding region, several strong statements can be confidently made. The interaction vectors initially developed by the Antillean pre-Arawak societies were consistently reinforced over thousands of years. At least between Puerto Rico and the ICr (figure 2), there was a constant flow of botanic resources, technology, ideas and values among pre-Arawak groups and among later agro-ceramist groups as well (e.g., Huecoids, see Pagán Jiménez 2007; Rodríguez Ramos 2010; Rodríguez Ramos *et al.* 2008; Rodríguez Ramos and Pagán Jiménez 2006).

Other traditionally accepted interaction vectors, such as those between the Orinoco region and the Antilles, or between the Florida peninsula and the Antilles, can also be recognized during the earliest migrations towards the islands. This has important implications regarding the flow of economic plants from the Antilles towards the southeast United States (Rodríguez Ramos and Pagán Jiménez 2006). The Antilles was previously discarded as an open vector for the dispersal of important botanical resources like maize from South America to the southeast United States before the Christian era, as Sears (1982) proposed, due to the absence of direct archaeobotanical data within the islands and to the attributed hunting-gathering-fishing nature of their "Archaic" inhabitants (see e.g., Keegan 1987). This view of the Antillean region can now be transcended, notwithstanding the fact that the new direct paleoethnobotanical evidence for the presence and use of maize and other economic plants (e.g., *marunguey* sp.) before the Christian era is still regionally limited to Puerto Rico and Cuba (Pagán Jiménez *et al.* 2005; Pagán Jiménez 2009; Siegel *et al.* 2005). Further research on ancient starch grain on additional Antillean islands and from different time periods should provide further evidence to reformulate this important geo-cultural connection. Promising research lines include the exchange of economic botanic resources (e.g. maize, marunguey or *Zamia*) and other socio-cultural practices associated with them, such as the processing and consumption of marunguey. Certainly, with the formulation of archaeobotanical projects like the one we are initiating here, we can provide from the Antilles new and unexpected data about some of the important paleoethnobotanical information gaps that still exist in such continental region (see Brown 1994; Kelly *et al.* 2006; Lusteck 2006).

The attempt to understand the role of botanic cultures within the context of pre-Colonial cultural development and evolution in other areas of the Antilles and its continental surrounding, clashes with the fact that there is no comparable information neither quantitative nor qualitative, excluding Panama and Colombia. The paleoethnobotanical (i.e., macrobotanical) studies done for almost 30 years in the Antilles, even though significant (see e.g., Newsom and Wing 2004; Newsom 2008) have not provided fundamental data about the economic and nutritious plants that supplied the bulk of carbohydrates and vegetable protein in the indigenous diet of any period. It is definitely necessary to develop multidisciplinary synchronic and diachronic studies regarding the phytocultural characteristics of the Antillean pre-Colonial cultures. This can be achieved, for example, through the integrative research of macro and microbotanical remains, chemistry of human remains and chemistry of food crusts attached to artefacts. However, the study of starch grains has been the most precise approach in these regards as it can establish a direct link between root and seed resources to the tools humans used to satisfy diverse biocultural needs. Integrating this approach to the research program of the Leiden University Caribbean Research Group will begin to address some of the large information voids, not only on the Antillean islands themselves, but also in some continental areas, such as French Guiana and surrounding territories.

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Communities in contact

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