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Archaeological Evidence of a Prehistoric Farming Technique on Guam

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Abstract—On Guam, few archaeological sites with possible agricultural features have been described and little is known about prehistoric cultivation practices. New information about possible upland planting techniques during the Latte Phase (c. A.D. 1000–1521) of Guam's Prehistoric Period, which began c. 3,500 years ago, is presented here. Site M201, located in the Manenggon Hills area of Guam's interior, contained three pit features, two that yielded large pieces of coconut shell, bits of introduced calcareous rock, and several large thorns from the roots of yam *(Dioscorea)* plants. A sample of the coconut shell recovered from one of the pits yielded a calibrated (2 sigma) radiocarbon date with a range of A.D. 986–1210, indicating that the pits were dug during the early Latte Phase. Archaeological evidence and historic literature relating to planting, harvesting, and cooking of roots and tubers on Guam suggest that some of the planting methods used in historic to recent times had been used at Site M201 near the beginning of the Latte Phase, about 1000 years ago. I argue that Site M201 was situated within an inland root/tuber agricultural zone.

Introduction

The completion of numerous archaeological projects on Guam in recent years has greatly increased our knowledge of the number and types of prehistoric sites, yet few of these can be considered agricultural. Descriptions of agricultural terraces, planting pits, irrigation canals, or other agricultural earth works are generally absent from archaeological site reports, although it has been proposed that some of the piled rock alignments in northern Guam could be field boundaries (Liston 1996). Information contained in early historic accounts, evidence provided by various artifacts, such as stone and shell scrapers, and the results of microscopic analyses of charred residue on pottery sherds (Crowther et al. 2003, Loy 2001a, Loy 2001b, Loy & Crowther 2002), charred wood fragments from archaeological features (Murakami 2000) and archaeological soils and sediment cores (Collins & Pearsall 2001a, Pearsall & Collins 2000, Ward 2000), suggest that Guam's soils were worked, various food plants (including roots and tubers) were harvested, peeled, grated, and cooked, and a variety of plants were present.

While it is increasingly clear that prehistoric agriculture on Guam did not involve construction of major earth works of the types found elsewhere in Micronesia, such as the terraces and elaborate systems of ditches, mounds and taro patches of Palau and Yap (Hunter-Anderson 1991), little attention has been paid to archaeological features that could relate to prehistoric cultivation practices on Guam.

This paper presents new information about possible planting techniques used during the early part of the Latte Phase of Guam's Prehistoric Period. The Latte Phase (c. A.D. 1000–1521) is named for the latte sets (stone foundations consisting of two parallel rows of pillars and capstones) that frequently mark the archaeological sites dating to this temporal interval (Spoehr 1957). While little is known about Latte Phase cultivation practices, the subsistence system probably incorporated horticulture, reef and ocean fishing, and wild resource collecting.

This paper begins with descriptions of Site M201's archaeological and environmental setting in the Manenggon Hills project area and its archaeological features (two pits interpreted as planting holes). A brief review of Guam's archaeological literature concerning the cultivation and processing of plants, particularly roots and tubers, follows. Section three reviews the historic literature concerning traditional Chamoru practices with respect to planting and processing roots and tubers. A discussion of Site M201 as a possible prehistoric dry land agricultural plot concludes the paper.

Description of Site M201, Manenggon Hills, Guam

Inventory survey and the subsequent monitoring of vegetation clearing in the 1350-acre resort complex in Guam's southern interior, called here the Manenggon Hills project area, identified 86 archaeological sites including Site M201 (Hunter-Anderson 1994a, Moore et al. 1989) (Figs. 1 & 2). The sites were documented and many were hand excavated prior to their destruction. Charcoal samples recovered from 50 of the sites yielded 74 radiocarbon dates that range (calibrated at 2 sigma) from A.D. 29–390 to modern times (Hunter-Anderson et al. 1994a). The dates indicate that area-usage intensified during the Latte Phase, peaking in the 1400s (Hunter-Anderson & Moore 1994a, Hunter-Anderson et al. 1994a:1.14). However, dates from two of these sites indicate people were in this area hundreds of years earlier (Table 2). A sample of charcoal from Site NP7, located near the edge of a small, intermittently moist area, yielded a radiocarbon date with a calibrated (2 sigma) range of A.D. 29–390. Another sample of charcoal recovered from Site M210's ridge-top hearth or small earth-oven yielded a radiocarbon date with a calibrated (2 sigma) range of A.D. 255–542 (Hunter-Anderson et al. 1994a:1.9–1.12).

The Manenggon Hills project area encompassed three different physiographic zones: limestone substrate, volcanic area downcut by streams, and volcanic plateau (Hunter-Anderson et al. 1994b:1.23). Site M201 was situated in the volcanic area downcut by streams and narrow wetlands.

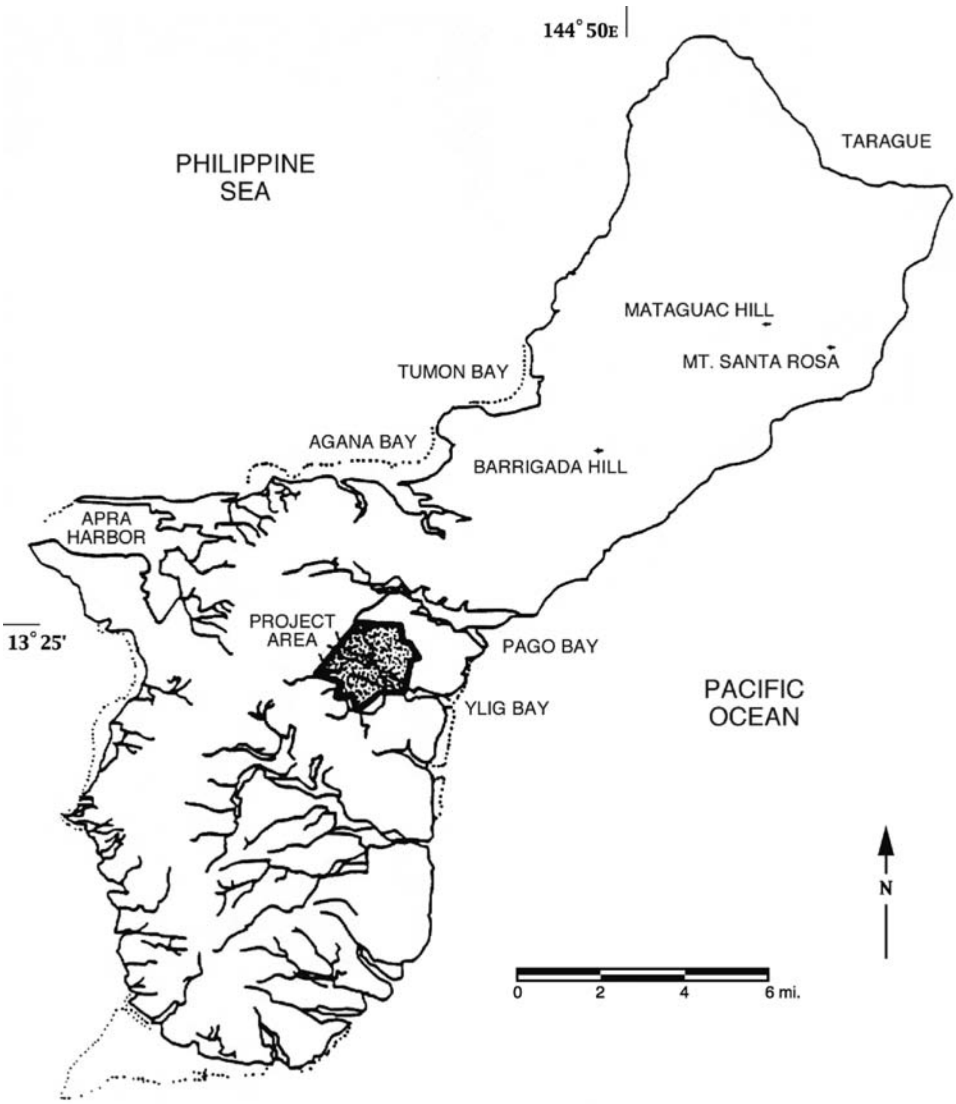

Figure 1. Map of Guam showing the location of the Manenggon Hills project area.

The soil in the vicinity of Site M201 is classified as Akina-Atate silty clays derived from tuff and tuff breccia (Young 1988:25). This soil type is acidic, has low fertility, and lacks water during the dry season (December to May) making it moderately suited for subsistence farming; its productivity can be improved through applications of fertilizer and lime (Young 1988:25). Typically, the surface layer of this soil unit consists of about 13 cm of dark reddish brown silty clay. The subsoil is dark red or yellowish red clay about 135 cm thick (Young 1988:25).

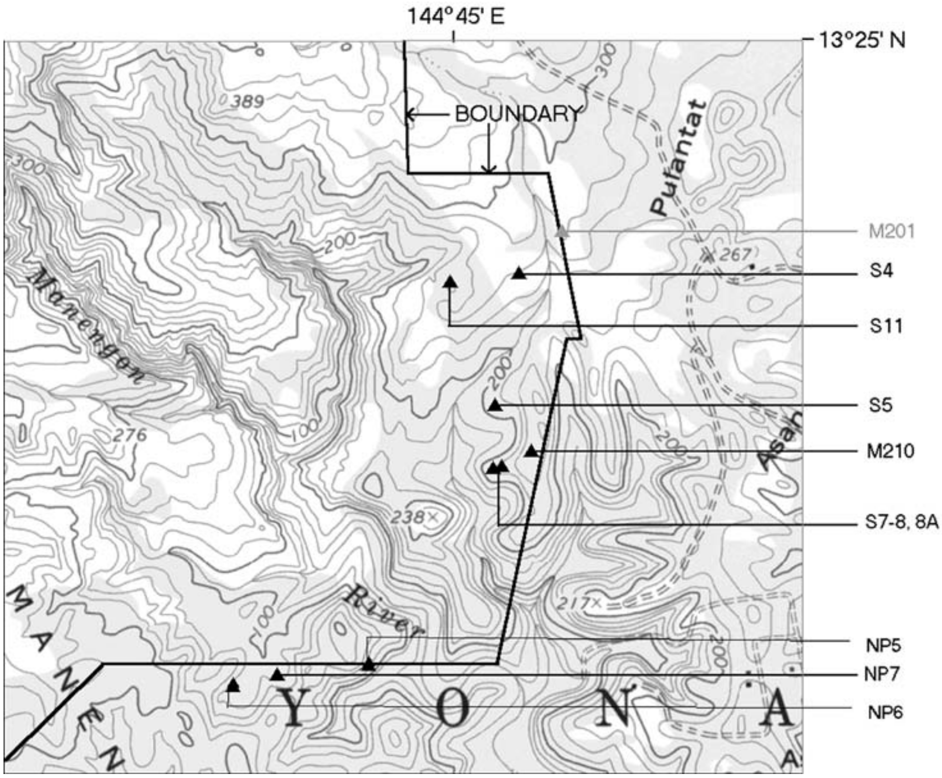

Figure 2. Part of the Manenggon Hills project area showing the eastern boundary line and the location of several prehistoric sites including the probable farming site, M201.

Prior to mechanical clearing and earth grading in the project area, the Akina-Atate clays that formed the rise on which M201 was situated, supported grasses and low bushes. With the exception of bamboo *(pi'ao,* whose young shoots are edible [Moore & McMakin 1979:86]), no cultivated or wild food plants (such as arrowroot, bananas, taro, yams, coconut palms) were identified on the site. A bamboo grove (probably *Bambusa vulgaris)* grew about 65 m (200 ft) west of the rise along the banks of a small, unnamed tributary of the Manenggon River. Downstream, the Manenggon River joins the Ylig River and eventually debouches on Guam's east coast.

Pillars and capstones from two disturbed latte sets (Sites S4 and S11) were found on the west side of the unnamed tributary, about 165 m (500 ft) southwest of Site M201. Remains of three more latte sets (Sites S5, S7 and S8) were located on the east side of the stream about 500 and 670 m (1,500 and 2,000 ft) southwest of Site M201. These surface features and the emplaced boulder-mortars, stone and shell tools, pottery, and marine shell midden deposits at some of these sites, as well as the human skeletal remains at Site S8A, provide evidence that people lived in the vicinity of M201 during the Latte Phase.

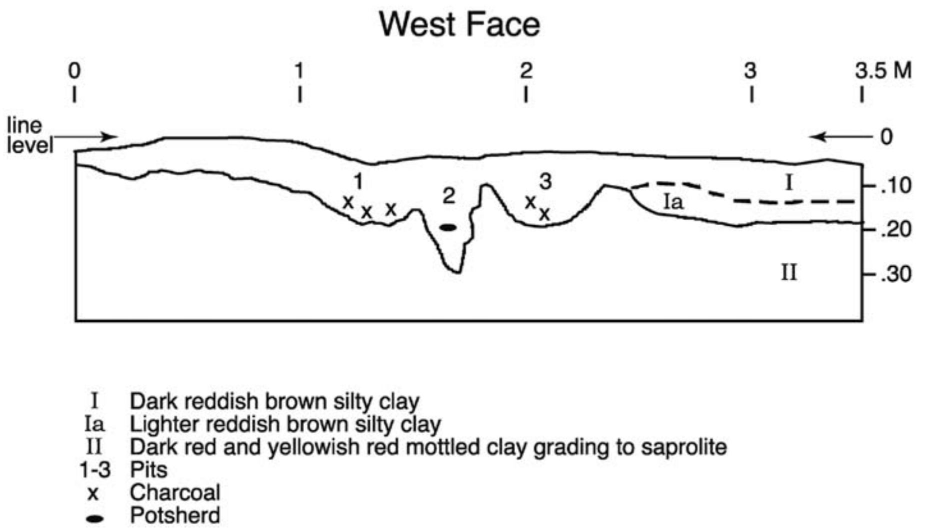

Figure 3. West face of the road cut at Site M201, showing Pits 1–3.

The surface dimensions of M201's pottery scatter were about 5 m wide by 10 m long (Moore & Hunter-Anderson 1994:1.102). The three adjoining pits of Site M201 were exposed in the west face of a new road cut through a low rise (Moore & Hunter-Anderson 1994:1.101–1.102). In profile, the pits extended downward from the dark reddish brown clayey soil of Layer I into the culturally sterile, yellowish red clay (Layer II), in an exposure that was about 2.5 m long (Fig. 3). The southernmost pit (Pit 1) was about 44 cm wide (N/S) and extended below ground surface about 28 cm. The middle pit (Pit 2) was about 24 cm wide (N/S) and extended below ground surface about 52 cm. The northernmost pit (Pit 3) was about 40 cm wide (N/S) and extended below ground surface about 32 cm. As Fig. 3 shows, the cross section of Pits 1 and 3 was basin shaped and Pit 2 had a distinct "V" shape.

While M201's pits were not completely excavated, Pits 1 and 3 were probed to determine how far they extended to the west. Each continued west from the face of the road cut about 25 cm, but their overall east/west dimensions are unknown because of the truncation caused by the road construction. North/south along the exposure, the centers of Pits 1 and 3 were separated by a distance of about 80 cm. Possibly other pits were present at the site, but M201 was not hand excavated, and only Pits 1–3 were observed.

Figure 3 also shows that the soils north of Pit 3 probably had been disturbed previously, to a depth of about 20 cmbs, causing a slight color differentiation within Layer I. In contrast, Layer I south of Pit 1 was shallow (10 cm thick) and appeared to be undisturbed (see Fig. 3).

A thickened rim sherd, typical of pottery made during the Latte Period, was recovered from Pit 2. Fairly large pieces of coconut shell (some measuring 3 cm along one axis) were observed in the fill of Pits 1 and 3, but none was seen in Pit

2. A sample of coconut shell recovered from Pit 1 (Fig. 4) was sent to Beta Analytic Inc., Florida, for processing. The sample (Beta 34896) yielded an early Latte Phase radiocarbon date with a calibrated (2 sigma) age range of A.D. 986–1210 (Table 2) (Hunter-Anderson et al. 1994a:1.10).

Robust thorns from the roots of a yam *(Dioscorea)* plant were found in Pits 1 and 3. It is unclear whether these derived from the wild spiny yam, *gaddo' (D. esculenta* var. *tiliaefolia)* (Fosberg et al. 1987, Moore & McMakin 1979:146, and see Driver 1989), or from one of the less spiny varieties *(D. esculenta* var. *esculenta)* (Fosberg et al. 1987, Moore & McMakin 1979:144–145, and see Stone 1970:126–128) (Table 1). The defensive structures on the *gaddo'* plants can include prickles on the stems of the above ground vines, spiny growths on the tubers, and robust thorns that grow from the dense and thorny roots (Moore & McMakin 1979:146; Berrie et al. 1987). It is not known if this spiny yam was cultivated in prehistoric times, but it likely was. In the mid-1800s it was not planted but it grew abundantly in rocky places, and its tubers were harvested in December (de la Corte 1970:121). The *esculenta* variety, *(nika)* which may or may not be prickly, is cultivated in gardens today and is also found naturalized (Moore & McMakin 1979:145).

Prior to mechanical clearing of the vegetation in the project area, vines of wild yam plants were commonly observed. Some plants were seen west of M201 in the vicinity of S11 and others were seen south of M201 in the limestone sub-

Figure 4. Sample of *Cocos* nut shell recovered from Pit 1.

strate area. The robust thorns of the yam roots can be fairly long (Fig 5) and they are sharp enough to penetrate a shoe. Accidentally stepping or sitting on one can be a painful experience. In prehistoric times, the thorns may have been used for a variety of purposes; however, currently there is no evidence to suggest they were utilized.

In addition to the thorns, a few small pieces of intrusive coralline rock were observed in the volcanically derived clay near the base of Pit 1. The absence of abundant fire-altered rock fragments in the fill of these three pits suggests that they were not remnants of earth-ovens, fire-pits or hearths (subsurface features commonly found at other sites within the project area).

In the synthesis of the project area findings, it was proposed that the thorns recovered from the pit fill indicated that the pits were dug during planting and/or harvesting yams (Hunter-Anderson & Moore 1994b:2.5). No explanation was provided for the calcareous rock or the pieces of coconut shell observed in pits 1 and 3. If the pits formed as a result of yam cultivation, the authors (Hunter-Anderson & Moore 1994b:2.5) noted they "would be the earliest agricultural features known from the project area and from the interior hills of Guam."

Figure 5. A wild yam plant (probably *D. esculenta* var. *esculenta)* growing in the Manenggon Hills project area. Note the dark thorns on the ground in two areas at the bottom of the photo (circled).

Archaeological Evidence for Roots and Tubers

The Latte Phase artifact assemblage relating to food processing includes emplaced-boulder and bedrock mortars, stone and shell tools, and clay pot fragments. Archaeologists propose that the mortars *(lusong)* were used to grind, pulverize, and de-husk plant products, such as rice, cycads, and arrowroot *(gapgap, Tacca leontopetaloides)* tubers. Mortars are found at many Latte Phase sites, both those with and those without latte sets (see for example, Hunter-Anderson & Moore 2002). Their wide distribution across Guam's landscape (north and south) is an indication of their importance. While they definitely form part of the Latte Phase artifact assemblage, few have been securely dated and it isn't known with certainty when mortars were first used in the interior. In part, this is due to the fact that archaeologists seldom recover materials suitable for dating directly associated with these artifacts. A radiocarbon date with a calibrated range (2 sigma) of A.D. 240–641 has been reported for a ridge top site with a basalt mortar in Guam's southern interior (Henry et al. 1999:C-103). While the date from this site suggests that some interior mortars may have been utilized prior to the beginning of the Latte Phase, additional early dates from other interior mortar sites are needed to support this idea since most date to the Latte Phase (post A.D. 1000).

The stone and shell scrapers, knives, and blades, commonly recovered from archaeological deposits are thought by archaeologists to indicate that soil was dug, roots and tubers were scraped or peeled and cut into pieces, and plant stalks were cut. In the future, examination of residues on the utilized edges of such tools could help indicate on what plants they had been used. Studies of this nature, completed on ancient tools from other Oceanic sites, have identified starch grains and calcium oxalate raphide structures from *Colocasia* and *Alocasia* taros (see Spriggs 2002:79).

Recently, residues on 35 pottery sherds recovered from various sites on Guam have been analyzed at the University of Queensland (Loy 2001a, 2001b, Loy & Crowther 2002, Crowther et al. 2003) and they provide information about the kinds of plant foods that had been cooked in the clay pots represented by these sherds. Characteristics of 32 of these sherds place them within the Latte Phase; three appear to be earlier (Pre-Latte Phase). Microscopic analysis of charred residue on the interior surfaces of these sherds indicates that taro, *Cordyline*, and other (unidentified) starches were cooked in some of the pots (Loy 2001a, 2001b, Loy & Crowther 2002). The analyzed residue on some of the exterior surfaces of these sherds also suggests that broken pot fragments and plant parts were discarded in the same place (Crowther et al. 2003).

Taro *(Colocasia)* starch, and in some cases raphides of *Colocasia* and *Cyrtosperma,* were confirmed on more than half (n=18) of the 35 analyzed sherds, including two of the Pre-Latte specimens. While the two early sherds are not directly associated with radiocarbon dates, based on their characteristics and dates from other parts of the sites they came from (Hunter-Anderson et al. 2001:137), it could be inferred that taro *(Colocasia)* was cooked in clay pots by 2000 years B.P., if not earlier. Starch from *Cordyline,* identified on the other early sherd, suggests that this sugary plant also was cooked prior to the beginning of the Latte Phase.

Microscopic analyses of soil samples taken from archaeological sites and sediment cores have identified phytoliths from palms, breadfruit, arrowroot, canna, Job's tears, rice and bananas (Collins & Pearsall 2001a, Collins and Pearsall 2001b, Pearsall & Collins 2000, Hunter-Anderson 1994b). Analyses of pollen in sediment cores taken from archaeological sites, and marsh and riverine localities have identified cultivable plants including *Ipomoea* (not necessarily sweet potato as other species of this genus are present on Guam [Fosberg et al. 1979]), coconut, breadfruit, aroids *(Alocasia, Colocasia* and *Cyrtosperma),* betel palm, pandanus and *Cordyline* (Athens & Ward 1995, 1999, 2004, Cummings 2002:E-4, Cummings & Puseman 1998:L-7, L-13, Dixon et al. 1999:151, Ward 2000). Taro *(C. esculenta)* pollen has been associated with radiocarbon dates that indicate these plants were present just prior to and during the Latte Phase (A.D. 850 [Athens & Ward 1999:151] and A.D. 1430–1656 [Cummings & Puseman 1998:L-7]). Among the food trees represented in the charred wood samples recovered from archaeological sites are breadfruit, coconut, and pandanus (Murakami 2000).

With the exception of the thorns from M201, archaeological evidence of yam *(Dioscorea)* has yet to be identified in the soils or in the charred residues on pottery sherds from Guam. Currently, M201's yam thorns, associated with the radiocarbon date with a calibrated range (2 sigma) of A.D. 986–1210, provide the only archaeological evidence of prehistoric yam on Guam. However, a single yam pollen grain, associated with a calibrated radiocarbon date of A.D. 670–880, recently was identified in a soil sample from an archaeological site on Tinian (Hunter-Anderson 2005).

It is clear from the archaeological review of artifact types, residues on pottery sherds, and fossil plant evidence from soils and sediments that people on Guam in prehistoric times had access to a fairly wide range of plant foods, including those derived from root plants, had various tools with which to process them, and cooked some of them in clay pots. The data indicate that plants, such as unidentified species of the breadfruit genus *(Artocarpus),* coconut *(Cocos nucifera),* and betel palm *(Areca catechu),* were present prior to human arrival (Athens & Ward 1995, 1999). While precise dates for the advent of the other food plants (including yams, taro, bananas, sugar cane, sweet potatoes) remain unknown, it is clear that that several types of taros and yams were present on Guam by the beginning of the Latte Phase, when Site M201 formed.

Historical Information about Root/Tuber Cultivation

Historical accounts describe the Chamoru diet at European contact (Magellan's visit in A.D. 1521) as consisting of fish, rice, roots, breadfruit, coconut, ginger, bananas, and sugar cane (Lévesque 1992[2]:94, 1995[5]:481). Later, the Jesuit missionaries (Higgens 1985:43, and see Russell 1998:177) noted that for "four months of the year [they live] on products of the ground, coconuts, which are abundant, bananas, sugar cane, and fish. The remainder of the year they supplement the lack of fruits with certain roots." Although this food list (c. 1668) lacks specific information about the kind(s) of root products consumed, taro, yam and other plants, such as arrowroot *(gapgap)* probably can be considered as forming part of the traditional, pre-European Contact diet (see Table 1).

While most of the plants thought to be traditional Chamoru foods require human intervention to propagate and flourish (Barrau 1961, Yen 1991), the earliest historic accounts contain few descriptions of gardens and gardening practices in the Marianas. Fields of rice were observed on Guam in 1565 (Abella 1965), and rice was among the provisions taken on by some of the ships stopping at the islands in the 16th century (Lévesque 1992[2]:158, 617, 647 and see Hunter-Anderson et al. 1995), but detailed descriptions of the methods for growing rice

Table 1. Scientific, common and Chamoru names for some of the edible root plants on Guam.

Family Name	Genus and Species*	Common Name	Chamoru Name
Araceae	*Alocasia macrorrhiza*	wild taro	piga'
	*Colocasia esculenta***	taro	suni, sune, zuni, sunen agaga'
	Cyrtosperma chamissonis	swamp taro	baba'
	*Xanthosoma sagittifolium**** (New World introduction)	white taro	sunen Honolulu
Convolvulaceae	*Ipomea batatas****	sweet potato	kamuti, camote
Dioscoreaceae	*Dioscorea alata*	yam, winged yam	dågu, dago****
	Dioscorea esculenta var. *esculenta*	yam	nika, nica
	Dioscorea esculenta var. *tiliaefolia*	thorny yam	gaddo', gado, gadu
Euphorbiaceae	*Manihot esculenta****	cassava, tapioca, arrowroot	Mendioka
Liliaceae	*Cordyline fruticosa******	ti plant	Chamoru unknown, Baston de San Jose (Spanish)
Taccaceae	*Tacca leontopetaloides*	arrowroot	gapgap, gabgab
Zingerberaceae	*Curcuma longa*	turmeric	mangngo' hålom tåno

*Fosberg et al. (1979, 1987)

**The number of taro cultivars now on Guam is unknown, estimates range from 10 to 23 different varieties of *Colocasia* (Manner 1993:41).

***Introduced early in the Historic Period.

****Artero et al. (1993) list four other Chamoru names for yam varieties not readily keyed to scientific names *(dågon å'paka', dågon agaga', dågon lulok,* and *dågun håya).* Other sources for the Chamoru names listed here include Arceo (pers. comm.), Moore and McMakin (1979), Stone (1970), Topping et al. (1975).

*****There is pre-contact evidence for the plant, but it is known by its Spanish name.

(paddy or dry) or the other food plants listed above were not found in the review of the historic accounts written prior to A.D. 1600.

The lack of gardening descriptions in the early reports is partly due to the conditions under which much of the inter-cultural contact took place. When European sailing vessels approached the island, Chamorus in their canoes, drew near to the ships and offered fresh produce in exchange for pieces of iron. When Europeans went ashore, usually it was for a brief, often hostile, call and the recorded encounters do not include details about Chamoru planting techniques.

The most detailed report of the early Historic Period comes from Juan Pobre, a lay brother of the Franciscan order of Discalced Friars who jumped ship and lived on Rota for seven months in 1602 (Driver 1989:9, 12, 15). His observations were made prior to the establishment of a Spanish settlement in 1668, but well after the beginning, in 1565, of Spain's Manila Galleon trade between Manila and Acapulco which involved annual stops at Guam (Schurz 1939). While on Rota, Pobre noted that a variety of roots and tubers was planted in plots located in the hills some distance away from the coastal villages, and people living on the coast traded or exchanged fish for the agricultural products grown by people living in

Table 2. Ten radiocarbon dates from the Manenggon Hills project with calibrated (2 sigma) ranges that fall within the time span A.D. 29–1296 (adapted from Hunter-Anderson et al. 1994a:1.10–1.12).

Site Number	Beta Number	Site Type	Feature Dated	Dated Material	Age Range (A.D.)	Est. Date (A.D.)
NP7	56090	Open, moist area	Pit	Charcoal	29–390	180*
Wet16	52952	Wetland	Core, 161-181 cmbs	Bulk soil	129–576	
M210	44104	Open, ridge	Earth-oven	Coconut Shell	255–542	410
M237	48410	Open, ridge	Earth-oven	Coconut Shell	775–1153	980
S11	38893	Dist. latte set(s), mortar fragment	Charcoal lens	Charcoal (unident.)	874–1152	1000
NP6	56088	Open/mortar/ moist area	Earth-oven (disturbed)	Coconut Shell	888–1207	1000*
M201	34896	Open	Pit	Coconut shell	986–1210	1031*
M220A	46991	Open/mortar	Fire pit	Charcoal	1002–1277	1160
M213	46985	Open/mortar	Earth-oven	Coconut Shell	1031–1281	1210
M236	48409	Rock shelter	Deposit	Charcoal	1021–1296	1210

*Calibrated date has multiple intercepts; earliest is shown the interior (Driver 1989:21). Pobre described four types of commonly grown tubers including two kinds of taro, known in Chamoru as *piga' (Alocasia)* and *suni (Colocasia),* and two types of yams, known in Chamoru as *dågu (Dioscorea alata)* and *nika (D. esculenta)* (Driver 1989:16, Dr. C. L. Raulerson, biologist, University of Guam, provided the scientific names used in Driver's translation). They also grew rice and *kamuti* (a type of sweet potato, *Ipomea batatas,* Driver 1989:30, Lévesque 1993[3]:172). The sweet potato is thought to have been introduced to Guam fairly early in the Historic Period (Barrau 1961:54, Lévesque 1992[2]:94, 136, 157, 324, 522, Stone 1970:488).

According to Pobre, the Chamorus worked the soil with wooden sticks (Driver 1989:17). The end of the stick was shaped like a knife that projected "to one side or to the other" and was "three fingers wide and two hands long" (Driver 1989:17). During his time on Rota, Pobre planted corn among the tubers belonging to his host, and ears of corn were harvested and consumed by the Chamorus (Driver 1989:12). Although Pobre apparently participated in gardening activities, his account does not provide descriptions of his own or Chamoru planting techniques.

Spain formally established the Catholic mission in the Marianas in 1668; its headquarters were based in Hagåtña, Guam (Carano & Sanchez 1964). After this time, providing local food supplies for the missionaries and soldiers was among the challenges faced by the Spanish officials. In 1678, the governor of the Marianas received instructions to improve the land rights of the cooperative Chamorus by allocating more land to them and to allow the missionaries and their assistants to lawfully obtain food from the local people (Lévesque 1996[7]:90–91). Probably in an effort to increase food production, the Spanish administrators in 1680 were instructed to annually expand the size of lands under cultivation by the Chamorus (Lévesque 1996[7]:292). And, when the Spanish first began to move the Chamorus into a few large settlements in 1680, it was with the understanding that the local people would retain access to their trees and gardens (Lévesque 1996[7]:313).

It is not clear to what extent the forced re-settlement (or *reducción)* disrupted traditional agricultural practices, but it is probably at least partly responsible for the land use pattern that was in effect until WWII. Generally, families had a village residence (where they attended church) and a ranch *(låncho)* located some distance away (Spoehr 1954:147–156). The ranches had simple structures that provided shelter from the sun and rain, and a place for cooking, but most people did not reside there full-time (Bowers 2001:139–154). During WWII, the land use pattern changed as many Guam Chamorus moved to their ranches where they stayed throughout most of the Japanese Occupation (1941–1944). When Guam was retaken in 1945, the U.S. acquired much of the island, including some of the former farming areas, for military installations.

By the early 1700s the Spanish colonial administration had established church and government plantations to furnish meat and produce for the clergy, the governor, the military garrison assigned to maintain peace, and to provision the galleons during their stops (Lévesque 1998[12]:513–516). Chamorus were required to work in these plantations, often receiving no pay or food for their services and leaving them little time for their own gardens (Lévesque 1997[9]:259, 1998[12]:513, Rogers 1995:83). The crops raised in these plantations included taro, yams, corn, and sweet potatoes (Lévesque 1998[12]:668). While these accounts emphasize the importance of the garden products to the Spaniards, they contain no descriptions of the planting methods used.

Though at times Chamorus may have had little time or energy to tend their gardens, they continued to plant food crops for their own use. The French explorer, Crozet, noted in 1772 that every family had property that was "divided into gardens, orchards, and ploughed or spade-worked fields" (Rogers 1995:84, and see Lévesque 1999[14]:608). Twenty years later, Naturalist Antonio de Pineda visited the island with the Malaspina Expedition (1792) and described many plants, including four types of yam *(nika, dågu, nika simarrona* [simarrón or cimarrón is the Spanish word for wild], *dågu simarrona)* and several varieties of taro *(suni,* three or four varieties of *piga', baba',* and two that were unnamed) (Lévesque 2000[16], Mallada 1990:12–14, 82–83). *Baba'* is the Chamoru name for swamp taro *(Cyrtosperma chamissonis* [Fosberg et al. 1987]), that Stone (1970:120, and see Topping et al. 1975) found to be uncommon on Guam. While prehistoric archaeological evidence for *Cyrtosperma* was described earlier in this article, it is unclear as to what extent it was cultivated then or later. One of the places it might have been grown in the past is a moist area within the Fena watershed of southern Guam. Local people refer to a spot there, where the plant occurs abundantly, as "the place of *baba*" (Ronck 1973:54).

Pineda (Mallada 1990:12–14) described how the yams and taro were cooked at the end of the 18th century. Some yam *(nika* and wild *nika)* tubers and taro *(piga', baba',* and *suni)* roots were roasted in earth-ovens *(chåhan)* while other yams *(dågu* and wild *dågu)* were added to soups. The *suni (Colocasia)* taro was not peeled before roasting, but the *piga' (Alocasia)* was peeled and then cut into chunks. The leaves and hearts of the *suni* plants were also cooked and eaten (Barratt 2003:241). In addition, some *suni* leaves were dried and sent to Manila (Barratt 2003:241).

In 1802, Haswell, the American first officer of the *Lydia,* an American ship chartered to bring supplies to Guam (Rogers 1995:88), observed that each house had a large piece of land planted with tobacco, that rice was grown in the lowlands, and that yams were plentiful.

Members of the Freycinet expedition, which visited Guam in 1819, described Guam's plants, including those that were under cultivation (including corn, yams, wet and dry taro, wet and dry rice), compiled a general planting and harvesting schedule, listed the general agricultural tasks, and noted where productive areas were located on the island (Lévesque 2002[19]:268–277, 396–399, 403). They observed that yams were planted in dry areas with deep soil but, due to the abundance of wild yams, farmers planted more taro than yams (Levesque 2002[19]:398).

By 1819, many new plants (in addition to corn and sweet potatoes) had been introduced along with new animals, food processing tools, gardening implements, and planting techniques (Lévesque 1998[11]:122). The new plants came from the New and Old Worlds and apparently included additional varieties of taro, yams, and sweet potatoes.

For example, the Freycinet reports list 11 varieties of yam (seven *dågu* and four *nika),* 12 varieties of taro (six *suni,* three *piga',* two *papao,* one *baba'*), and three varieties of sweet potatoes (Barratt 2003:240). Of all these roots, the six *suni (Colocasia)* varieties were most valued and they were the main types of taro grown (Barratt 2003:241). Apparently the *piga' (Alocasia)* varieties were not cultivated at that time and the *baba' (Cyrtosperma)* was wild and required no care (Barratt 2003:151, and see Stone 1970), although the roots of these two plants could be consumed when food was scarce. The term *papao* on the list above may refer to the plant parts (mainly leaves of the *sunen agaga'*) that are used to prepare a local dish called *gollai hågon suni* (Arceo pers. comm.).

The *suni* varieties of taro were grown in dry land plots and in swampy areas. In Chamoru (Arceo pers. comm.), the dry land *suni* is now called *sunen ånglo' tåno'* (reported as *suni hinanong* in Lévesque 2002[19]:397) and the moist area suni is called *sunen sisonyan* (reported as *suni fetchi* in Barratt 2003:241). The moist plots produced more tubers per year than the dry land plots, and they continued to be productive year after year while the dry land plots generally produced one harvest (Barratt 2003:151). Tubers planted in January (the beginning of the dry season) were placed in holes that were 9 to 12 inches deep, while those planted in April (near the end of the dry season) could be placed in holes that were only four inches deep. The soil, whether in a dry or moist plot, was dug just prior to planting (Barratt 2003:151). Later, Bowers (2001:148) noted that when Chamorus planted some varieties of taro *(suni bisaba,* Philippine taro) in moist soils, they selected places where the marsh grass *karisu (Phragmites karka)* grew.

The gardening tools used in the planting/harvesting of *suni* at the time of Freycinet's visit, were the *tanum* and *cubo* (Barratt 2003:150–151). The wooden *tanum* had a cylindrical shaft and a sharpened point that was used to dig the planting holes (and to break coconuts), while the *cubo,* less than two feet long and fitted with an iron tip, was used to dig the starchy roots which generally were harvested in December (Barratt 2003:147–148, 155).

The Freycinet reports (Barratt 2003:155) indicated that in earlier times, prior to their visit, Chamorus had a method for storing the harvest of starchy roots. This process apparently involved piling the roots (probably yams and sweet potatoes as taro corms do not store well in the tropics once they are harvested) in a field, surrounding the pile with a stake fence, and covering it with coconut leaves. Stored in this way, it was said, the roots could be kept for as long as a year. If this is true, the stone mounds or platforms found at some archaeological sites on Guam (i.e., Liston 1996) may have served as foundations for these storage piles. The loosely stacked stones that form these features would have raised the harvested tubers above the ground and provided air circulation which would have helped to inhibit the accumulation of moisture at the base of the tuber pile.

Throughout the 1800s, many of the historic accounts referred to the food plants and foods commonly consumed on the island (de la Corte 1970, Ibanez 1992; Olive 1984, Plaza 1979) but little additional information about gardening practices was found.

Villalobos inspected the island in 1833, reported the number of people living in each of the 11 villages occupied at that time, noted cultivated fields in various places, and apparently counted or estimated the number of root plants present in the gardens (Plaza 1979:2). He reported nearly 400,000 yam, taro and sweet potato plants. How many of these were in government plantations is unclear. Most likely, different varieties as well as different stages of maturity would have been represented among the root plants he observed.

De la Corte (1970:120–122) noted that wetland varieties of taro could be produced on the same land for many years if small sprouts or shoots were left in the ground when the large roots were pulled out. Olive (1984:21), who served as Governor from 1884–1887, listed the common edible root foods as including sweet potato, several cultivated varieties of yam, several cultivated varieties of taro, tapioca, and the wild spiny yam and wild arrowroot plants. In 1887, the islanders were described as devoted to agriculture and the most common food made from plants was tortillas *(titiyas,* prepared from ground corn) (Ibanez 1992:97). Other plant foods listed were fruits, roots, rice, breadfruit, seeded breadfruit, sweet potato, and wild or cultivated yams (Ibanez 1992:97).

In 1898 the United States gained control over Guam and in 1899, Lt. Wm. Safford, who served as an aide to the first American Governor Leary, arrived on the island (Rogers 1995:108–109). Safford (1910:48, 72) noted that every family (including soldiers, teachers, and government officials) had its field of corn, tobacco patch, and plots of taro and yams. In the tobacco patch, he saw newly planted seedlings shaded by half a coconut husk (Safford 1910:221), an observation that perhaps indicates the usefulness of this readily available resource for gardening. Like others before him, Safford (1905:141,144) observed taro being cultivated in swamps and other moist areas and in newly cleared patches of dry ground.

Safford (1905:257) noted that many yam varieties were grown, and he observed that the uncultivated wild spiny yams could be confused with the cultivated prickly yams (Safford 1910:88). He described yam cultivation, a process he thought more difficult than growing taro (Safford 1905:145, 259–260). Yams were usually planted in small hillocks arranged in a large circle, sometimes with a tree or high pole in the center. The yam vine climbed a slender pole thrust into each hillock and inclined toward the center pole or tree, thus forming a sort of tepee (Safford 1905:259). The ground was kept free of weeds and loosely mounded around the base of the vine. In about eight or nine months the yams were ready to harvest. Once the vine turned yellow and died, the yam was left in the ground for a short while. When yams were harvested, the top (or crown) of the tuber was cut off with the vine attached, and re-buried in the ground. Loose soil was piled around the base of the old vine. After several weeks another yam, with buds, was produced. This yam was removed, cut into pieces, and each bud section was planted to produce a new vine. Safford did not mention coconut husks or plant fertilizer being used in this planting scheme, but his description of the planting/harvesting process illustrates how easily the yam thorns could be incorporated into the soil of a yam plot.

While yam production on Guam apparently never attained the importance that it did on some of the other Micronesian islands, such as Pohnpei and Yap (Barrau 1961, Hunter-Anderson 1991), Sproat (1968:41) indicated that post-war yam gardens in the Marianas were sometimes fenced. No description of these fences was provided and it is not clear whether they were built to keep feral or free ranging domesticated pigs from digging up the yam tubers, or for some other reason. If the fences served as pig barriers, then their construction may date only to historic times as there is no compelling evidence for prehistoric pigs in the Marianas. Alternatively, the post-war construction of the fences may have been a continuation of an earlier practice whereby some agricultural plots were marked. While stone or other prehistoric field markers were not noted near M201 or elsewhere in the project area, piled stone alignments and mounds have been described at archaeological sites in the northern part of Guam (see Liston 1996).

Fritz (2001:58–62) described in detail some of the agricultural features and practices in the Marianas at the beginning of the 1900s, including Rota's rice and taro terraces (perhaps also prehistoric), but he made no mention of coconut husks or other plant remains being used in the planting processes.

Post-WW II descriptions of the basic techniques for growing the staple food plants in Micronesia state that composting and mulching the soils could increase production (Barrau 1961). The plants or plant parts commonly used as "fertilizer" in Micronesia include parts of the coconut palm (Sproat 1968:63). For example, old coconut leaves, coconut husks, detritus from decayed coconut trunks, as well as other decaying vegetable matter frequently are added to wet taro pits (Fosberg 1960:20, Luomala 1974:25, Manner & Clarke 1993, McCutcheon 1985, Pollock 1992). On Guam, Carolinian and Palauan women currently bury grasses and other unidentified plant materials, possibly including various parts of the coconut palm, in the moist soils of their taro plots located on the edges of Hagåtña Swamp (Hunter-Anderson et al. 1989:40).

While the practice of adding vegetable matter to enrich the soils of wet taro pits has been well documented, generally dry fields didn't require similar treatment because they gained nutrients from the felled (and sometimes burned) vegetation left on the ground when the dry field was cleared for planting. However, in recent times on Guam, parts of the coconut palm have been used in the planting of dry fields. In the 1920s, applications of coconut husk ash, or copra meal, were added to the soils of various garden plots at the Guam Agricultural Experiment Station (Briggs 1921; Guerrero 1926). Some Chamoru farmers, raising dry land taro on Guam, put coconut husks in their planting holes (Manner

1990). Manner (1990:41), who interviewed the Chamoru farmers, described their traditional dry land taro planting process as follows.

> "Taro was planted in holes enlarged by a digging stick (metal crowbars are in use today) approximately 8" deep and 6–16" in diameter. Some farmers, [sic] placed a section of coconut husk in the hole in order to keep the hole large, and as the husk rotted, it provided both nutrients and organic matter. Planting was done during the full moon. If the taro was being grown mainly for its leaves, close planting was employed. Otherwise the corms were planted at a spacing of 3' x 3'. A close planting scheme was believed to provide additional weed control through the heavier ground shade…After the development of 5–7 leaves, the plants were mounded with soil to cover the corm. Hoes are used for this purpose today"

While Manner's (1990) information concerning the intentional placement of coconut husks in taro planting holes does not indicate when this practice occurred, how widespread it was, how long it continued, or if it was associated only with taro, it indicates that within modern memory, Guam farmers utilized coconut husks in the cultivation of dry land taro.

This review indicates that the traditional root/tuber food plants were retained rather than dropped from the subsistence system once new plants (particularly corn and sweet potatoes) were introduced to the island (see Pollock 1986). In fact, the greater number of taro and yam varieties reported in the 1800s, suggests that farmers added new types of root plants to their gardens as they were introduced to the island, or they made varietal distinctions as mutations developed locally over time. The number of taro cultivars presently on the island is unknown, but estimates range from 10 to 23 (Manner 1993:41). The complex reasons for the apparent reliance on root foods through time have to do, in part, with how well these plants were adapted to Guam's environment and how their food products were incorporated into the Chamoru social system (see Luomala 1974).

It is not known how planting practices associated with root/tubers changed when the new gardening implements were introduced, but based on the similarity of the dimensions of the proposed prehistoric planting holes (Pits 1 and 3) at M201 and the traditional taro planting holes described by Manner (1990:41) for Guam, it appears that the techniques were not greatly modified. The c. 40–44 cm-north/south diameters (16–18 inches) of the remaining visible portions of Pits 1 and 3 at M201 are comparable to the width of 16 inches reported for traditional taro planting holes (Manner 1990:41). The c. 28–32 cm depth (11–13 inches) below present ground surface for Pits 1 and 3 are comparable to the depth of 9–12 inches reported for traditional dry field taro planting holes dug in January (Lévesque 2002[19]:398). The north/south distance of about 80 cm (31 inches) that separates the midpoints of Pits 1 and 3 is only a little less than the average planting distance (3 feet) said to have been employed by the traditional taro farmers (Manner 1990:41).

Manner's (1990) description of traditional dry field taro planting methods provides an explanation for the previously unexplained pieces of coconut endocarp found in Pits 1 and 3. There are at least two reasons why coconut husks (with the attached coconut shell) would be useful in the planting process. The first is that the husks created space for tubers to grow and the second is that as they decayed they added elements to the soil that improved productivity (Manner 1990).

Apparently the practice of placing sections of coconut husks (and their attached nut shells) into planting holes has had a long history on Guam. Possibly this planting practice has been continuous, passed down from generation to generation since prehistoric times. Alternatively, it was known, lost and re-invented in more recent times.

Discussion

Some aspects of Site M201, when compared with historic descriptions of traditional Chamoru gardens and planting methods (Barratt 2003, Driver 1989, Lévesque 2002[19], Manner 1990), and the fossil evidence of plants present on Guam in prehistoric times, support the interpretation of M201 as a prehistoric dry land garden plot. The crop or crops grown at M201 remain open to conjecture, but archaeological evidence indicates that both taros and yams were present on Guam by the beginning of the Latte Phase when the site was formed. Descriptions of gardens located in Guam's interior during early historic times, combined with the archaeological evidence of land use during prehistoric times, makes M201's location seem a reasonable place to find a prehistoric farm plot.

The yam thorns in Pits 1 and 3 seem to indicate that yams grew here. If so, then it appears that the size of yam planting/harvesting holes was similar to those for taro. If M201 was a yam plot, the deeper pit (Pit 2) between the two planting holes may have held a stake or pole against which smaller poles rested. Other planting holes, not seen by the archaeological monitor, may have existed. Alternatively, the circular pattern of planting yams, described by Safford (1905), was a late development or one of a number of different yam planting patterns.

On the other hand, Pit 2 could represent a trench or furrow that separated the two plantings (taro or yams). It is unlikely that it served as an irrigation canal. The top of the rise, where the M201 pits were located, was elevated above the nearby stream and it would not have been possible to easily direct stream water into a ditch or canal as was done in the rice fields in Merizo just prior to WW II (Thompson 1947:App. A). However, water from the stream (carried in clay pots or sections of bamboo) could have been used to keep the plants at M201 moist during times of inadequate rainfall. How much "hand-watering" of gardens occurred in prehistoric times is unknown, but during historic times ranchers transported water in bamboo lengths to gardens situated on waterless parts of the northern plateau (Olive 1984:19), and in 1819 tobacco fields in Hagåtña were hand-watered using bamboo containers (Lévesque 2002[19]:107).

Young's (1988:25) assessment of the productivity of the soils in the vicinity of Site M201 pointed out that the addition of compost could improve its fertility and the addition of crushed coral limestone could provide calcium and reduce the soil's acidity. Generally, all soils on Guam, including the Akina-Atate clays of Site M201, are low in phosphorous (Young 1988:67). Bowers (2001:186–187, and see Barrau 1961) noted that coconut husks add salts, potash, lime and phosphoric acid to the soil. Burying the ashes of burned coconut husks quickly adds these elements, but burying the unburned husks adds humus and prevents loss of materials by burning (Bowers 2001:187). Based on the archaeological evidence from M201, it appears that the prehistoric farmers practiced soil enhancement by adding both sections of coconut husks (with the attached nut shell) and small calcareous rocks to planting holes for the calcium and other beneficial properties these materials contributed to their gardens.

The limited range and quantity of artifacts present (only pottery fragments weighing 147 g) at M201, the large pieces of coconut shell recovered from two of the pits, and the undisturbed profiles of the three intact pits suggest that the pit zone was used for a short time before being abandoned. If M201 was a garden plot, it probably was part of an agricultural system that depended upon shifting cultivation, a common gardening pattern in the Pacific (Barrau 1961; Bellwood 1979). Under this system, garden plots usually are left fallow for longer periods of time than they are cropped (Ruthenberg 1980:15–16). Generally, a dry plot yields one harvest, although proper crop rotation (root crops followed by non-root crops) significantly extends the length of time a single plot can be used (Hunter-Anderson 1991; Pollock 1992). Perhaps M201's pit zone yielded a single crop. Whether the absence of visible pit profiles in the area immediately north of Pit 3 (see Fig. 3) is due to a planting technique that differed from the one used in the pit zone, or because later re-planting in this section destroyed the boundaries of the original planting holes, or some other factor(s) is unknown.

The radiocarbon date (A.D. 986–1210) from M201 suggests that by the early Latte Phase, if not before, people cultivated dry land crops in this interior part of Guam. While none of the other Manenggon Hills archaeological sites was identified as a garden plot, it is likely that traditional crops, including yams, taro, bananas, sugar cane and rice were grown elsewhere in the project area. An example of another possible farming locality is Site NP5, an undated, prehistoric artifact scatter (lithics and pottery) situated along the crest of a limestone ridge in the southeast portion of the project area. Archaeological excavations in Units 4 and 5 at NP5 exposed yam thorns in pockets of soil that had developed in the limestone bedrock (Moore and Hunter-Anderson 1994:1.374).

While Site M201 may be the earliest recognized farming site on Guam, it was probably not the first attempt to cultivate this part of the island. The apparent soil modification techniques employed by M201's farmers suggest that they already had gained experience with planting in similar soils and were acting appropriately by adding elements to their plantings to ensure success.

Dating the beginning of cultivation in the island's interior is not possible with the project area data, but the suite of radiocarbon dates from the project provides some information about the frequency of human visitation. Only two (M210 and NP 7) of the 50 dated sites have calibrated radiocarbon ages with ranges that fall within the first 775 years of the first millennium (A.D. 1–775) (Table 2). Because of the apparently infrequent number of visits during this time, it seems likely that people participated in few, if any, gardening activities here prior to A.D. 700. However, pollen from *Cocos nucifera* and *Artocarpus* sp. identified in a sediment core taken from a wetland in the project area indicates that these two food trees were present by A.D. 129–576 (Table 2) (Ward 1994:9, Hunter-Anderson et al. 1994a:1.12). Whether these trees were intentionally planted, or migrated to the area through natural processes is uncertain, but it could be argued that some human modification of the vegetation had taken place in the project area prior to A.D. 700.

Seven of the project area sites (including M201) yielded dates with ranges that fall within a 521 year-long temporal interval beginning about A.D. 775 and ending about A.D. 1296 (Table 2). The greater number of sites with age ranges falling within this later time period indicate that the area had begun to be used more often. The site types include, in addition to M201's proposed agricultural area, a latte site (S11), an open site with an earth-oven (M237), three open sites with bedrock or emplaced stone mortars and earth-ovens (M213, M220-A, and NP6) and a rockshelter (M236). These sites suggest that activities included planting and harvesting, food processing, cooking in earth-ovens, probably building temporary shelters, and utilizing rockshelters, perhaps for shelter or storage.

Possibly there was a connection between the earth-oven sites and former gardening spots at Manenggon Hills. In the early 1900s it was noted that earth-ovens were seldom used on Guam except at the ranch (Safford 1905:127). From this it could be inferred that earth-oven cooking was, and had been in the prehistoric past, part of the ranching experience. Earth-oven cooking has the advantage to farmers in that once the oven is prepared it takes several hours for the food to cook, thus allowing time for people to complete other tasks, such as working in their fields (see Kirch [1994:114] for a description of the farmers in Futuna [an island group situated north east of Fiji] cooking in earth-ovens while they tended their crops). If earth-ovens do mark former gardening spots, then four (M213, M220-A, M237, NP6) of the earth-oven sites listed on Table 2 could have been other agricultural areas. If the estimated radiocarbon dates given for the sites are correct, two of these (M237 and NP6) could have been utilized several decades earlier than M201.

Although people apparently performed a fairly wide range of tasks in the project area after A.D. 1000, a note of caution about the timing of mortar use is necessary. The dates shown on Table 2 were obtained on charcoal recovered from the earth-ovens, not from the mortars directly. A late Latte Phase date (A.D. 1400–1600) for mortar use has been suggested for another interior region of southern Guam (Hunter-Anderson & Moore 2002:75). The earliest Manenggon

Hills mortar site (NP6) listed on Table 2 contained bedrock mortars made from recalcified limestone boulders that were a natural geological component of the site. The radiocarbon date from NP6 has a range (calibrated at 2 sigma) of A.D. 888–1207 (Table 2), near the beginning of the Latte Phase.

Site NP6 was located near an intermittently moist area that may have been a good place to raise food plants. A soil sample taken from a small pit thought to be a possible agricultural feature at site NP7, another site located near this moist area, was submitted to Linda Cummings at the Paleo Research Institute, Colorado, to see whether any fossil plant remains of food plants could be identified. Among the kinds of vegetation identified were grasses, ferns, shrubs, unknown trees, and coconut palm; no edible root plants were recognized (Cummings 2004).

Current project data provide little evidence for increased utilization of the Manenggon Hills area prior to A.D. 1000. Why the major expansion to this interior region occurred after that time remains open to discussion. Climatic factors, such as wetter or dryer times, could have prompted utilization of the interior soils. For example, increased rainfall could have made the interior soils more productive. On the other hand, increased periods of droughts may have meant that new fields in less productive areas had to be planted in order to produce enough food. Perhaps new food plants, such as dry land rice, were introduced then, or became important ceremonial foods within the traditional subsistence system (see Hunter-Anderson et al. 1995), drawing people inland to plant rice along with crops that had been previously grown. Another possibility is that the size of Guam's population had increased and/or depleted soils in coastal gardens caused land shortages that pressured people to move inland to farm, and eventually live, in the area. Further consideration of these, and other, explanations are important to advance our understanding of Guam's prehistory, but are beyond the scope of this paper.

Clearly, archaeologists could pay more attention to prehistoric sites on Guam, with the goal of identifying agricultural features. Submitting soils from these features, as well as artifacts from archaeological sites, for microscopic analyses to identify starch grains, plant raphides, pollen, and phytoliths could provide additional information about which plants were grown, and/or processed and cooked. Data such as these, paired with radiocarbon dates, can contribute to a better understanding of Guam's prehistoric farming practices and how they may have changed over time.

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References

Note: Most of the archaeology in Guam has been done in the last 25 years. Much of the work is not published, but is contained in contract reports prepared for the clients. Copies are deposited at the Historic Resources Division of the Department of Parks and Recreation, the Micronesian Area Research Center at the University of Guam, and the Nieves M. Flores Memorial Library, Hagåtña.

Artero, V. T., J. J. Cruz & V. M. Santos. 1993. Chamorro and Scientific Names of Fruits and Vegetables. Guam Cooperative Extension, College of Agriculture and Life Sciences, University of Guam.

Abella, D. 1965. Legazpi claims Marianas for Spanish throne. Pacific Profile 3(1): 18–36.

Athens, S. J. & J. V. Ward. 1995. Paleoenvironment of the Orote Peninsula, Guam. Micronesica 28: 51–76.

Athens, S. J. & J. V. Ward. 1999. Paleoclimate, vegetation, and landscape change on Guam: The Laguas Core. *In* B. Dixon, J. S. Athens, J. V. Ward, T. Mangieri & T. Rieth, Archaeological Inventory Survey of the Sasa Valley and Tenjo Vista Fuel Tank Farms, Piti District, Territory of Guam, Mariana Islands, pp. 121–151. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Athens, S. J. & J. V. Ward. 2004. Holocene vegetation, savanna origins and human settlement of Guam. Records of the Australian Museum, Supplement 29: 15–30.

Barratt, G. (Tr.). 2003. An Account of the Corvette L'Uranie's Sojourn at the Mariana Islands, 1819, by Louis Claude de Freycinet. Occasional Historical Papers No. 13. CNMI Division of Historic Preservation, Saipan.

Barrau, J. 1961. Subsistence Agriculture in Polynesia and Micronesia. B.P. Bishop Museum Bulletin 223. Honolulu.

Bellwood, P. 1979. Man's Conquest of the Pacific. Oxford University Press, New York.

Berrie, G. K., A. Berrie & J. M. O. Eze. 1987. Tropical Plant Science. Longman Group (FE) Ltd., Hong Kong.

Bowers, N. M. 2001. Problems of Resettlement on Saipan, Tinian and Rota, Mariana Islands. Occasional Historical Papers Series No. 7. CNMI Division of Historic Preservation, Saipan.

Briggs, G. 1921. Report of the agronomist and horticulture. *In* Report of the Guam Agricultural Experiment Station, 1920, pp. 45. Government Printing Office, Washington, D.C.

Carano, P. & P. C. Sanchez. 1964. A Complete History of Guam. Charles E. Tuttle Co., Rutland, Vermont.

Collins, S. K. & D. M. Pearsall. 2001a. phytolith analysis. *In* R. L. Hunter-Anderson, B. Dixon & Tina Mangieri, Cultural Resources Survey of Five Navy Surplus Guam Land Use Plan Parcels, Territory of Guam, Mariana Islands, pp. E-1-E-14. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu

Collins, S. K. & D. M. Pearsall. 2001b. Report of phytolith analysis. *In* R. L. Hunter-Anderson, Archaeological Investigations at Ngachang, Ordot-Chalan Pago Municipality, Guam, pp. 60–68. Micronesian Archaeological Research Services, Guam.

Crowther, A., M. Haslam & T. H. Loy. 2003. Residue analysis of ten potsherds from Guam. Report Number: MARS 390. University of Queensland, St. Lucia, Australia.

Cummings, L. S. 2002. Pollen analysis, Guam Ordnance Annex. *In* J. Allen, B. Dixon, K. Aronson, D. Gosser, L. Gilda, T. Moorman, C. O'Hare, M. Riford & J. Toenjes, Final Report, Archaeological Survey and Excavations at Naval Ordnance Annex, Territory of Guam, pp. E-1-E-9. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Ogden Environmental and Energy Services Co., Inc., Honolulu.

Cummings, L. S. 2004. Pollen, phytolith, and starch analysis of a Pre-Latte Phase pit, Guam. Paleo Research Institute Technical Report 04–95. Paleo Research Institute, Golden, Colorado.

Cummings, L. S. & K. Puseman. 1998. Pollen, phytolith, and macrofloral analysis at sites in the NAVACTS Ordnance Annex. *In* J. D. Henry, A. E. Haun, M. A. Kirkendall & D. G. DeFant, Vol II: Appendices, Final Report Phase I Archaeological Survey and Subsurface Testing, U.S. Naval Activities Ordnance Annex, Guam, pp. L-1-L-37. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Paul H. Rosendahl, Ph.D., Inc., Hilo, Hawaii.

de la Corte, F. 1970. Descriptive and Historical Report on the Mariana Islands, 1875. Madrid National Press. Translated by MARC. Manuscript on file, Micronesian Area Research Center, University of Guam, Mangilao.

Dixon, B., J. S. Athens, J. F. Ward, T. Mangieri & T. Rieth. 1999. Archaeological inventory survey of the Sasa valley and Tenjo Vista fuel tank farms, Piti District, Territory of Guam, Mariana Islands. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Driver, M. G. 1989. The Account of Fray Juan Pobre's Residence in the Marianas 1602. Micronesian Area Research Center, University of Guam, Mangilao.

Fosberg, F. R. 1960. The Vegetation of Micronesia. Bulletin of the American Museum of Natural History. Volume 119:Article 1. New York, New York.

Fosberg, F. R., M.-H. Sachet & R. Oliver. 1979. A geographical checklist of the Micronesian Dicotyledonae. Micronesica 15: 41–295.

Fosberg, F. R., M.-H. Sachet & R. Oliver. 1987. A geographical checklist of the Micronesian Monocotyledonae. Micronesica 20: 19–129.

Fritz, G. 2001. The Chamorro, A History and Ethnography of the Mariana Islands. Translated by E. Craddock, Edited by S. Russell. Occasional Historical Papers Series, 1. CNMI Division of Historic Preservation, Saipan.

Guerrero, J. 1926. Report of the Assistant in Agronomy and Horticulture. *In* Report of the Guam Agricultural Experiment Station, 1925, pp. 15–16. Government Printing Office, Washington D.C.

Henry, J. D., A. E. Haun & M. A. Kirkendall. 1999. Phase I archaeological survey and subsurface testing, U.S. Naval Activities Ordnance Annex, Guam. Commander, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Paul H. Rosendahl, Ph.D., Inc., Hilo, Hawaii.

Higgens, M. 1985. The Life and Martyrdom of the Venerable Father Diego Luis de Sanvitores by Franciso Garcia (1683). Nieves M. Flores Memorial Library, Hagåtña, Guam.

Hunter-Anderson, R. L. 1991. A review of traditional Micronesian high island horticulture in Belau, Yap, Chuuk, Pohnpei, and Kosrae. Micronesica 24: 1–56.

Hunter-Anderson, R. L. (Ed.) 1994a. Archaeology in Manenggon Hills, Yona, Guam. Volumes I–IV. MDI Guam Corporation, Yona, Guam. Micronesian Archaeological Research Services, Guam.

Hunter-Anderson, R. L. 1994b. A paleoenvironmental investigation of the effects of prehistoric Chamorro farming practices on the native vegetation in southern Guam. Prepared for The Guam Historic Preservation Trust, Guam.

Hunter-Anderson, R. L. 2005. Archaeological monitoring and data recovery at TN-1-0857 (S4) and Vicinity for the IBB Low Band Antenna Project, Northwest Tinian Island, Commonwealth of the Northern Mariana Islands. International Broadcasting Bureau (IBB), Saipan. Micronesian Archaeological Research Services, Guam.

Hunter-Anderson, R. L., B. Dixon & T. Mangieri. 2001. Cultural resources survey of five Navy surplus Guam land use plan parcels, Territory of Guam. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Hunter-Anderson, R. L. & D. R. Moore 1994a. Retreat or expansion: Tracking prehistoric settlement in Guam's interior. Paper presented at the Australian Archaeological Assoc. Annual conference, Nov. 24–26, 1994. La Trobe Univ., Bundoora, Victoria.

Hunter-Anderson, R. L. & D. R. Moore 1994b. Research questions revisited. *In* R. L. Hunter-Anderson (ed.), Volume IV, Synthesis of Interpretive Findings, Implications for Future Research, pp. 2.1–2.38. MDI Guam Corporation, Yona, Guam. Micronesian Archaeological Research Services, Guam.

Hunter-Anderson, R. L. & D. R. Moore. 2002. Phase I and Phase II archaeological survey at Waterfront Annex and Ordnance Annex, Territory of Guam. Department of the Navy, Pacific Division, Pearl Harbor, Hawaii. Micronesian Archaeological Research Services, Guam.

Hunter-Anderson, R. L., D. R. Moore & J. R. Amesbury. 1989. Archaeological investigations in Hagåtña Swamp. Jones and Guerrero, Inc., Hagåtña, Guam. Micronesian Archaeological Research Services, Guam.

Hunter-Anderson, R. L., D. R. Moore & J. R. Amesbury. 1994a. Summary and synthesis. *In* R. L. Hunter-Anderson (ed.), Volume IV, Synthesis of Interpretive Findings, Implications for Future Research, pp. 1.1–1.66. MDI Guam Corporation, Yona, Guam. Micronesian Archaeological Research Services, Guam.

Hunter-Anderson, R. L., D. R. Moore & J. R. Amesbury. 1994b. The Manenggon Hills Archaeological Project. *In* R. L. Hunter-Anderson (ed.), Volume I, Project History, Research Design, Methods of Site Discovery, Data Recovery, and Analysis, pp. 1.1–1.100. MDI Guam Corporation, Yona, Guam. Micronesian Archaeological Research Services, Mangilao, Guam.

Hunter-Anderson, R. L., G. B. Thompson & D. R. Moore. 1995. Rice as a prehistoric valuable in the Mariana Islands, Micronesia. Asian Perspectives 34[1]: 69–89.

Ibanez, Luis y Garcia. 1992. The History of the Marianas with Navigational Data, and of the Caroline, and Palau Islands from the Time of their Discovery by Magellan in 1521 to the Present [1887]. Micronesian Area Research Center, University of Guam, Mangilao.

Kirch, P. V. 1994. The Wet and The Dry, Irrigation and Agricultural Intensification in Polynesia. The University of Chicago Press, Chicago.

Lévesque, R. L. 1992. Volume 2, Prelude to Conquest, 1561–1595. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1993. Volume 3, First Real Contact, 1596–1637. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1995. Volume 5, Focus on the Mariana Mission, 1670–1673. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1996. Volume 7, More Turmoil in the Marianas 1679–1683. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1997. Volume 9, Conquest of the Gani Islands, 1687–1696. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1998. Volume 11, French Ships in the Pacific, 1708–1717. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1998. Volume 12, Carolinians Drift to Guam, 1715–1728. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 1999. Volume 14, Full Census of the Marianas, 1746–1773. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 2000. Volume 16, The Malaspina Expedition, 1773–1795. Lévesque Publications, Quebec, Canada.

Lévesque, R. L. 2002. Volume 19, The Freycinet Expedition, 1818–1819. Lévesque Publications, Quebec, Canada.

Liston, J. 1996. The legacy of Tarague Embayment and its inhabitants, Andersen AFB, Guam. Vol. I: Archaeology. 36 CES/CEV, Unit 14007, Environmental Flight, Andersen Air Force Base, Guam. International Archaeology, Inc., Honolulu.

Loy, T. H. 2001a. Cooking residues on four potsherds, Nimitz Hill, Guam. *In* D. R. Moore & R. L. Hunter-Anderson, Phase II Archaeological Survey: Detailed Recording of Sites on the Lands to be Retained by the Navy, Nimitz Hill, Territory of Guam, Mariana Islands, pp. B-1-B-30. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Loy, T. H. 2001b. Analysis of six pottery sherds from the west coast of Guam. *In* R. L. Hunter-Anderson, B. Dixon & T. Mangieri, Cultural Resources Survey of Five Navy Surplus Guam Land Use Plan Parcels, Territory of Guam, Mariana Islands, pp. F-1-F-21. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Loy, T. H. & A. Crowther. 2002. Analysis of pottery sherds from two archaeological sites: Guam. *In* D. R. Moore, Guam's Prehistoric Pottery and its Chronological Sequence, pp. 125–157. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Luomala, K. 1974. The *Cyrtosperma* systemic pattern: aspects of production in the Gilbert Islands. Journal of the Polynesian Society. 83(1):15–34.

Mallada, V. F. 1990. The Guam Diary of Naturalist Antonio de Pineda y Ramirez February 1792. Micronesian Area Research Center, University of Guam, Mangilao.

Manner, H. 1990. Report of the rapid rural assessment of taro production systems in Guam. *In* A. Vargo & L. Ferentinos (comp.), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa, pp. 39–55. Pacific Agriculture Development Office, Tropical Energy House, University of Hawaii, Honolulu.

Manner, H. 1993. Guam. *In* L. Ferentinos & A. Vargo (eds.), Taro Production Systems in Micronesia, Hawaii and American Samoa, pp. 37–46. Research Extension Series 139, College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu.

Manner, H. & W. C. Clarke. 1993. Traditional agroforestry in the high islands of Micronesia. *In* W. C. Clarke & R. R. Thaman (eds.), Agroforestry in the Pacific Islands: Systems for Sustainability, pp. 122–144. United Nations University Press, Tokyo.

McCutcheon, M. 1985. Reading the taro cards: explaining agricultural change in Palau. *In* D. Cattle & R. Schwerin (eds.), Food Energy in Tropical Ecosystems, pp. 167–188. Gordon and Breach, New York.

Moore, D. R., J. R. Amesbury & D. A. Sheldon. 1989. Archaeological investigations of Miyama Hills, Guam. Prepared for Juan Tenorio and Associates. Micronesian Archaeological Research Services, Guam.

Moore, D. R. & R. L. Hunter-Anderson. 1994. Site descriptions. *In* R. L. Hunter-Anderson (ed.), Volume II, Archaeology in Manenggon Hills, Yona, Guam, pp. 1.1–1.399. MDI Guam Corporation, Yona, Guam. Micronesian Archaeological Research Services, Guam.

Moore, P. H. & P. D. McMakin. 1979. Plants of Guam. College of Agriculture and Life Sciences, University of Guam, Mangilao.

Murakami, G. 2000. Charcoal taxa identification, Navy GLUP Project, Guam. *In* R.L. Hunter-Anderson, B. Dixon & T. Mangieri, Cultural Resources Survey of Five Navy Surplus Guam Land Use Plan Parcels, Territory of Guam, Mariana Islands, pp. C-1-C-8. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Olive, F. O. 1984. The Mariana Islands 1884–1887. Random Notes of Governor Francisco Olive y Garcia, M. G. Driver (Tr.). Micronesian Area Research Center, University of Guam, Mangilao.

Pearsall, D. M. & S. K. Collins. 2000. Report of phytolith analysis of samples from Nimitz Hill, Guam. *In* R. L. Hunter-Anderson & D. R. Moore, Phase I Archaeological Survey and Specialized Studies in Undeveloped Portions of Nimitz Hill, Territory of Guam, Mariana Islands, pp. F-1-F-18. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Plaza, F. 1979. Geographic, Military and Political Description of the Island of Guam by Francisco Ramon Villalobos 1833. MARC Working Paper 8. Micronesian Area Research Center, University of Guam, Mangilao.

Pollock, N. J. 1986. Food habits in Guam over 500 years. Pacific Viewpoint 272: 120–143.

Pollock, N. J. 1992. These Roots Remain: Food Habits in Islands of the Central and Eastern Pacific since Western Contact. The Institute for Polynesian Studies, Laie, Hawaii.

Ronck, R. 1973. The Place of Baba–Fena Valley. Pacific Daily News, June 15, 1973, pp. 54. Hagåtña, Guam.

Rogers, R. F. 1995. Destiny's Landfall, A History of Guam. University of Hawaii Press, Hawaii.

Russell, S. 1998. *Tiempon I Manmofo'na.* Ancient Chamorro Culture and History of the Northern Mariana Islands. Micronesian Archaeological Survey Report No. 32. CNMI Division of Historic Preservation, Saipan.

Ruthenberg, H. 1980. Farming Systems in the Tropics. Clarendon Press, Oxford.

Safford, W. E. 1905. The Useful Plants of the Island of Guam. Bulletin of the United States National Herbarium, Vol. 9. Government Printing Office, Washington, D.C.

Safford, W. E. 1910. A Year on the Island of Guam. H.L. McQueen, Washington, D.C.

Schurz, W. L. 1939. The Manila Galleon. E.P. Dutton & Co., Inc., New York.

Spoehr, A. 1954. Saipan, The Ethnology of a War-Devastated Island. Fieldiana: Anthropology, Volume 41. Chicago Natural History Museum.

Spoehr, A. 1957. Marianas Prehistory; Archaeological Survey and Excavations on Saipan, Tinian and Rota. Fieldiana: Anthropology, Volume 48. Chicago Natural History Museum.

Spriggs, M. 2002. Taro cropping systems in the Southeast Asian-Pacific Region. *In* S. Yoshida & P. J. Matthews (eds.), Vegeculture in Eastern Asia and Oceania, pp. 77–94. JCAS Symposium Series 16, Osaka.

Sproat, M. N. 1968. A Guide to Subsistence Agriculture in Micronesia. Agricultural Extension Bulletin No. 9. Publications Office, Saipan.

Stone, B. C. 1970. The Flora of Guam. Micronesica Vol. 6. University of Guam, Mangilao.

Topping, D. M., P. M. Ogo & B. C. Dungca. 1975. Chamorro-English Dictionary. University of Hawaii Press, Honolulu.

Thompson, L. 1947. Guam and Its People. Greenwood Press, New York.

Ward, J. V. 1994. Pollen analysis of wetland sites from Manenggon Hills, Guam: A6 Bridge, Wetland Sites 15 and 16, Pumphouse Wash and M221. *In* R. L. Hunter-Anderson (ed.), Vol. III, Results of Analyses, pp. 9.35–9.52. MDI Guam Corporation, Yona, Guam. Micronesian Archaeological Research Services, Guam.

Ward, J. V. 2000. Holocene pollen record from Nimitz Hill, Guam, Mariana Islands. *In* R. L. Hunter-Anderson & D. R. Moore, Phase I Archaeological Survey and Specialized Studies in Undeveloped Portions of Nimitz Hill, Territory of Guam, Mariana Islands, pp. C-1-C-11. Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. International Archaeological Research Institute, Inc., Honolulu.

Yen, D. E. 1991. Polynesian cultigens and cultivars: the questions of origin. *In* P. A. Cox & S. A. Banack (eds.), Islands, Plants, and Polynesians, pp. 67–95. Dioscorides Press, Hong Kong.

Young, F. J. 1988. Soil Survey of Territory of Guam. Soil Conservation Service, Guam. Department of Commerce and University of Guam, Guam.

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