9-2009

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ABSTRACT

This report presents results of a study examining the ancient use of plants at four Late Classic (CE 600-900) Maya rural farmsteads in northwestern Belize. Our research specifically targeted residential middens for macrobotanical recovery. Samples yielded the remains of more than a dozen plant families, representing some genera that do not currently grow in the area. These plants were used in the Late Classic, countering the idea that ancient botanical remains do not survive in Neotropical archaeological contexts. We also evaluated two macrobotanical sample processing methods vis-à-vis one another: flotation and dry screening. Our results indicate that flotation recovered 58% more seeds than dry screening, while dry screening yielded almost twice as much charcoal and other wood as flotation. The divergent quantities in the types of material recovered suggest a comprehensive macrobotanical recovery program should include the use of both processing methods.

KEYWORDS: Paleoethnobotany, Maya, Belize, flotation, dry screening.

Ancient macrobotanical remains illuminate various aspects of the past, from diet to household economic activities to social inequality to paleoenvironment. Three techniques are commonly used to recover these materials from archaeological deposits: flotation, water assisted screening, and dry screening (Pearsall 2001:11-99; Smart and Hoffman 1988; Wagner 1988; Wright 2005). Experimental studies in temperate contexts reveal that each of these methods tends to recover different types of macrobotanical remains depending on the types of deposits (Pearsall 2001:11-99, Wagner 1988). Flotation tends to recover higher amounts of seeds, wet screening is best suited to recovery in waterlogged environments, and dry screening tends to recover higher amounts of wood and fruit parts (Pearsall 2001, Wagner 1988). An understanding of the impact of these macrobotanical recovery methods is currently lacking for the lowland Neotropics.

Few archaeologists routinely collect macrobotanical samples from excavations in the tropical rainforest, largely due to a prevailing understanding that plant remains do not survive the annual wet-dry cycle and exposure to microorganisms (most recently restated in Baleé and Erickson 2007; but see Pohl 1990; Turner and Harrison 1978; Turner and Sanders 1992). Turner and Miksicek (1984) and Lentz (2000) have observed the few instances where macrobotanical remains were recovered and presented as "the most convincing evidence for the identification of species used by the Classic Maya" (Turner and Miksicek 1984:182). Some work, however, has demonstrated the presence of fossil pollen and some plant remains from several contexts in the Maya area (Lentz 2000; Turner and Miksicek 1984). While microremains are used mainly in paleoenvironmental reconstruction (e.g., Dunning et al. 2003), little information on excavated Lowland Maya macrobotanical remains has been published. Most evidence comes from wetland agriculture sites where flotation recovery was used (Turner and Miksicek 1984), or from the site of Copan (Lentz 2000). It is certain, however, that archaeobotanical materials are present in a broad variety of neotropical microclimates, including cave sites (Prufer and Hurst 2007), lowland coastal sites (Perry 2004; Roosevelt 1980) and rainforest surface sites (Archila 2005; Crane 1996; Dunham 1996; Heckenberger et al. 1999; Leyden 1987; Turner and Miksicek 1984).

Recent work by Lentz (2000), building on earlier foundational work by Turner and Miksicek (1984), demonstrates that neotropical contexts can and do yield more than chance find botanical macroremains when systematic recovery and consistent methodologies are employed. While the quantity of recovered materials may not be overwhelming, these remains do exist and are important to our understanding of the ancient Maya. This need is especially critical when set against the backdrop of nearly 80 years of debate and publication regarding the sustainability and nature of ancient tropical agricultural systems (Baleé and Erickson 2007, Cowgill 1962; Fedick 1996; Harrison 1990; Meggers 1954, 1987; Reina and Hill 1980; Roosevelt 1980; Turner and Miksicek 1984). Within this literature some investigators have gone the extra mile to incorporate and report their macrophyte findings (Crane 1986, 1996; Lentz 1991, 1999, 2000;

McKillop 1996; Miksicek 1990; Prufer and Hurst 2007; Robin 2002; Turner and Miksicek 1984:183-4).

Taxonomically determinable plant remains from archaeological contexts are an ideal point of departure for reconstructing ancient Maya subsistence practices. A growing body of literature suggests that ancient macrobotanical remains DO survive hundreds of years after their deposition in what some consider to be 'harsh' tropical climates; high amounts of seasonally variable, annual rainfall coupled with intense insolation (Beaubien 1993; Crane 1986, 1996; Heckenberger et al. 1999; Lentz 1991, 1999, 2000; McKillop 1996; Miksicek 1983, 1990; Newsom and Wing 2004; Turner and Miksicek 1984:183-4).

In furthering these avenues of research, our work in northwestern Belize demonstrates that macrobotanical remains, including fruits, stems, and seeds, survive from the Late Classic Maya era (CE 600-900) in numbers sufficient to support inference and interpretation. This dataset has important implications for our understanding of the ancient Maya diet as it permits us to characterize the kinds of plants used, their associated ecologies, the contexts in which specific plants were used, and to reconstruct food preferences beyond the standard models that focus on corn (*Zea mays*), beans (*Phaseolus* spp.) and squash (*Cucurbita* spp.) (Lentz 2000). This dataset also provides detailed evidence currently lacking in many paleodietary studies of the Maya, as well as bridges ethnohistoric evidence for plant consumption.

CLASSIC MAYA PLANT CONSUMPTION

Archaeologists have reconstructed some of the roles and ranges of plants used by the ancient Maya using a variety of methods. Our knowledge of past diet, economic activities, social inequality, and paleoenvironment is relatively impoverished in the absence of macrobotanical evidence. Many reconstructions of the role of plants in the ancient Maya diet, for example, are based on analyses of human bone chemistry (e.g., Whittington and Reed 1997; Wright and White 1996; Wright 1999), linguistic/ethnographic evidence (e.g., Bricker 1986; de Landa 1566 (1937); McNeil 2006; Pohl 1981; Redfield and Villa Rojas 1962) , floristic survey (e.g., Atran 1993; Gomez-Pompa 1990) , and, as noted above, a few instances where plant macrophytes were systematically recovered (Lentz 2000, Turner and Miksicek 1984).

Bone chemistry and isotope studies, however, can thus far only permit diet reconstruction in general terms. Whittington and Reed (1997:160) note that, while isotopic studies of Late Classic inhabitants of Copan had a diet rich in maize, it is only with the paleoethnobotanical study by Lentz (1991) that indicates Copan elites consumed a substantially wider range of plant foods than commoners. Isotopic methods are not yet sufficiently sensitive to identify the breadth and complexity of diets heavily dependent on a diverse set of plant foods, and the development of ancient plant data can potentially illustrate these kinds of distinctions in the archaeological record.

Linguistic, iconographic and ethnographic datasets additionally aid in the identification of plants by the modern, historic, and ancient Maya (e.g., Bricker 1986; Chen 1987; de Landa 1566(1937); Farriss 1984; Gómez-Pompa 1990; Marcus 1982; Pohl

1981; Redfield and Villa Rojas 1962; Reina 1967; Roys 1972; Villa Rojas 1945). While no comprehensive written record of Late Classic Maya food systems exists, dietary information can be found in historic Spanish documents and ethnography. Additionally, Prehispanic codices (Bricker 1986), and murals (Saturno 2006), demonstrate that some forms of written evidence remain to be tapped (McNeill et al. 2006; Pohl 1981). Another fruitful avenue of research is the search for relict groves of cultivated taxa now living within the confines of the Neotropical rainforest (e.g., Atran 1993; Chen 1987; Dunham 1996; Folan et al. 1979; Gómez-Pompa 1990; Graham 1987; McKillop 1996; Puleston 1978). Taken together, the isotopic, linguistic, and modern floristic approaches can vastly enhance our understanding of ancient Maya plant use. Without an improved focus on recovering a record of archaeological plant remains, we continue to miss the vital linkage between past and present that archaeologists require for lifeway reconstruction.

The use of plant microremains continues to play an important and established role in Neotropical archaeological and environmental reconstruction (Binford 1987; Brenner et al. 1990; Crane 1986, 1996; Hansen 1990, Islebe et al. 1996; Kepecs and Boucher 1996; Leyden et al. 1996; McNeil 2006; Miksicek 1983, 1990; Piperno 2005; Whitmore et al. 1996; Wiseman 1983; Zeder et al. 2006). Additionally, the combination of classes of recovered microremains, e.g. phytoliths with starch grains, has enhanced our understanding of exploited and domesticated plants in the archaeological record of the lowland Neotropics (Bozarth and Guderjan 2004; Hutson et al. 2007; Perry 2004). To date, microremains provide important evidence for interdisciplinary studies on cultigen development (either domesticated, e.g. *Zea mays* [Staller et al. 2006; Zeder et al. 2006] or locating specific comestibles, e.g. *Theobroma cacao* [McNeil et al. 2006]). Even with these advances, however, the level of determination afforded by some microremains, in the case of several important economic plant families, e.g. Poaceae (grains), Solanaceae (peppers), and Fabaceae (beans and tropical trees), yields only general taxonomic information that is more holistically interpreted when corroborated with seed, fruit, flower, or wood remains (Pearsall 2001; Pearsall et al. 2004; Pearsall and Piperno 1993).

The past 20 years of research into the daily life of the Prehispanic Maya has included only a few examples of systematic recovery and analysis of archaeobotanical finds (e.g., Lentz 1991, 1999; Pohl 1990; Turner and Miksicek 1984:183-4). Possibly contributing to this situation is the scant publication record of applied field methods of macroremain recovery for the Maya lowlands, with few demonstrating the application of consistent field methodologies and a commitment to the substantive analysis and interpretation of ancient macrophytes (e.g., Lentz 1991; Miksicek 1983; Pohl 1990). Fortunately, we have some idea of what we should be looking for.

Ethnographic and ethnohistoric studies indicate that the traditional lowland Maya diet was based on maize (*Zea mays*), beans (*Phaseolus* sp.), squash (*Cucurbita* sp.), chilies (*Capsicum* sp.), and cacao (*Theobroma cacao*)(Farriss 1984; Lentz 1999; Miksicek 1990; Redfield and Villa Rojas 1962; Villa Rojas 1945). Root crops may have also included manioc (*Manihot esculenta*) and jicama (*Pachyrhizus tuberosus*), introductions from lowland South America (Roys 1972). Tree crops such as avocado, (*Persea* *americana*) and guava (*Psidium guajava*) are also known to comprise a part of the modern and colonial period Maya diet (Redfield and Villa Rojas 1962; Roys 1972). *Balche*, a beer made with the bark of the *Lonchocarpus* tree, was often consumed at feasts. Aside from the bulk of the ethnographic record indicating that specific foods were used in specific instances, we know that plant materials played a role in food preparation and serving technologies. For instance, ethnographic studies describe the use of special organic objects, such as baskets and gourd bowls (*Lagenaria* spp. and *Cresentia* spp.), in Maya residences (Bricker 1986; Pohl 1981; Villa Rojas 1945). These materials, together with food remains, when deployed in specific preparation and serving contexts would lead to necessarily specific garbage deposition patterns, that were as complexly diverse in instance as well as practice.

These deposits should leave distinct macroremain signatures in the archaeological record in the form of fruits, flowers, wood, and seeds, and, as indicated in the literature, have not been adequately addressed for Maya archaeology (Lentz 1999; Piperno and Pearsall 1998). The degree to which these and other modern plant consumption practices can be verified among ancient populations should be assessed through the recovery of plant macroremains from ancient residential garbage deposits, which is the focus of our investigation.

STUDY AREA AND SAMPLE COLLECTION

The research area lies within the boundaries of the modern Programme for Belize conservation territory in Northwestern Belize (Figure 1). Houk et al. (1993) and Hageman (2004a) have located a series of non-elite residential compounds in rural areas some distance from the large centers of La Milpa and Dos Hombres. We consider these sites to be representative of farmsteads on the La Lucha Escarpment of northwestern Belize. Here, residences typically consist of two to eight mounds surrounding a central courtyard. Most mounds are less than two meters tall. The residences themselves are associated with adjacent or closely situated areas of agricultural production in the form of terraces (Beach et al. 2002; Hageman 2004a).

One focus of our study is Guijarral, located adjacent to a shallow drainage in a range of low, karstic hills, which are studded with over 140 agricultural terraces (Operation 45; Figure 2). The site center is a two-courtyard plaza group with 10 structures (two of which are shrines) located just west of the edge of the Rio Bravo Escarpment. Previous work suggests the site was initially occupied during the Early Classic (CE 250-600), when the smaller of the two shrines was constructed. The site was abandoned for a time, then reoccupied during the Late/Terminal Classic (CE 700-850), when the entire A-1 courtyard and its associated buildings were constructed (Hughbanks 2006; Sullivan et al. 2008).

Additional residences lie within a 300 m radius of Guijarral. We chose to excavate at Chispas (Operation 46; Figure 3) located atop a hill some 150 m west-southwest of Guijarral. Chispas is a two-structure courtyard group, with a 1.5 m-tall Lshaped building on the north and west, and a low, 0.5 m high platform on the south. This group, with some modicum of forest clearance for agricultural production in antiquity, was intervisible with Guijarral. Excavations here indicate Late/Terminal Classic construction (Hageman 2004a).

The second focus of our study is an area located 20 km south of Guijarral, near the edge of the same escarpment. One courtyard group, the Barba Group (Operation 5; Figure 4) is located on a hill above two drainages, and features residential buildings on the north and west sides of the courtyard and a shrine on the east side of the plaza. The shrine is about 2.5 m tall, while the other mounds are about 1.5 m in height. The drainage to the north contains 22 check dams and footslope terraces, while the drainage to the south has two additional check dams. Previous work (Hageman 2004a, 2004b) indicates the group was constructed in the Late/Terminal Classic.

As with Guijarral, we compare the Barba residence with the nearby Bronco Group (Operation 11; Figure 5), one of the larger residential groups in the vicinity. This residence is located about 200 m north of Barba, and consists of three mounds no greater than 0.5 m in height atop a small hill. As with Barba, excavations indicate Bronco was built in the Late/Terminal Classic period (Hageman 2004a, 2004b)

Of the four residential groups, Guijarral and Barba contain shrines that likely played a likely role in local ancestor veneration (Hageman 2004b). In addition, ceramics recovered from middens associated with these shrines contain a 2:1 preponderance of food preparation and serving vessels to food storage vessels (Hageman 2004a, 2004b).

This is consistent with similar proportions at sites where ancient feasting has been identified (Fox 1996; LeCount 2001). Part of our work is to explore the degree to which specific plant species may have been associated with feasting versus day-to-day consumption.

METHODS

At each site we excavated eight square meters of midden. These middens were identified through the recovery of ceramics in shovel tests in non-mound, non-platform locations at each residential group. Excavation units were laid out in 1 x 1 m squares, adjacent to one another where possible. Vertical control was maintained using 10 cm levels. Excavators sampled about 4 liters of matrix from each 10 cm level within each 1 x 1 m unit. This standard sample volume allows us to control for sample volume throughout the stratigraphic sequence, and allows us to evaluate the effects of potentially poor preservation by comparison between levels. Samples were collected by trowel and transported in spunbound synthetic fabric, e.g., Tyvek, sample bags. Alternating levels and excavation quadrants received alternating recovery treatment, flotation or dry sieving. Thus the process of separating the botanical remains from the soil matrix alternated by excavated level and by meter square excavation area. The result was a mosaic of coverage where each level of the midden was half dry sieved and half floated, while still maintaining a degree of horizontal control. In addition to generating our own reference materials from the research area for comparative purposes, we relied upon reference checklists for local flora and ethnobotany in the area (Brokaw et al. 1990; Carnegie Institution of Washington 1936; Carnegie Institution of Washington, 1940; Lentz and Dickau 2005; Roys 1931; Schipp 1933; Smith et al. 2004).

Dry-Sieving

Pearsall (2001) is clear that techniques used for archaeobotanical recovery should largely be dependent on the soil conditions present at the site. For that reason, dry-sieving makes good sense in desert or other xeric environmental zones, and water-sieving may generate more desirable results in areas where matrices are clayey, damp, or waterlogged. In the case of the PFB territory, the soils have highly variable clay contents, are dry for at least six months of the year (and are generally dry during our excavation seasons), the use of dry-sieving is appropriate.

Our dry-sieving system uses a standard series of geological sieves, as developed by Dr. Lee Newsom at the University of Florida Museum of Natural History (Newsom personal communication 2008). In the case of macrobotanical sampling we used 18-inch diameter screens. The series grades between 4 mm to 0.425mm openings, decreasing by half with each step down in size, using four screens total (4.0, 2.0, 1.0, and 0.425 mm). The smallest screen size was based on the smallest seed likely to be recovered based on the regional environment. In our area it would be either *Argemone* sp. (Papaveraceae) or *Nicotiana* spp. (Solanacaeae), with an average size diameter of 0.5 mm (Colorado State

University 2008). Only the 4 liters of sample went through the standard series, while the remaining excavation matrix was passed through ¼-inch screen.

Samples were processed in the field lab at the R.E.W. Adams Research Station, in the Programme for Belize lands, located in Orange Walk District, Belize. Soils were added to the screens a small portion at a time, and brushes, not agitation, were used to gently pass the soil matrix through the different screens. Five separate fractions were recovered from each sample. Normally, screening reduced the overall 4 liter sample by two-thirds, leaving us with 4 standard fractions and about 150 ml of soil that passed through the 0.425 mm screen. A fifth sample, a 200 g portion of the original sample, was reserved for later microremain analysis, including phytolith, pollen, and starch grain recovery. Often dry screening is perceived as being overly time consuming when compared with flotation or wet sieving recovery methods. We found that while more time may have been spent actually passing matrix through the screens, that two people could still process up to 40 liters of matrix per day, roughly 10 samples. Additionally, in contrast to the wet recovery techniques, dry processing produced scope-ready samples. Wet processing still required that the samples take time to gently air dry on a line, and then required sieving once dry to make them analysis ready, requiring additional processing time.

The four macroremain fractions were reviewed in the field using incident light stereomicroscopes with magnification up to 50x. Here 100% of the 4 mm and 2 mm fractions were scanned. The 1 mm and 0.425 mm fractions were scanned for seeds only beginning with 10% of the fraction volume; if we did not encounter any seeds, the sample was returned to storage. If seeds were encountered during the 10% scan then an additional 20% of the sample fraction was scanned. In all, 10%-30% of the smallest two sieve fractions were examined for seeds. We found, as mentioned above, that dry sieving produced scope-ready samples with the least amount of sample handling, especially when the stereoscopes and reference materials were present in the field to enhance analysis efficiency.

Flotation

Flotation continues to be one of the most important methodological developments in archaeobotanical research worldwide (Ford 1988; Wagner 1988; Wright 2005). During the 1980s and 1990s many excavations in the Neotropics began to use flotation with limited results. No comparison of flotation to other macroremain recovery methods for the Neotropics is known to the authors, and what we highlight here is that flotation, based on criteria for soil processing methodologies outlined by Pearsall (2001), has been applied to the exclusion of other potential sorting methods, such as wet screening (used extensively by faunal specialists in the region, see Emery 2004) and dry screening.

Pearsall (2001) argues that, in soils of variable humidity and high clay content (and where overall conditions permit and require that large (> 10 L) samples are taken) flotation is not only more practical but is necessary to accommodate the sample size. As described above, our soils have highly variable clay content depending on factors including slope and elevation (Brokaw et al. 1990). Additionally, the soil's variable and sometimes relatively high carbonate load, due to the eroding limestone substrate in some areas, makes dry fine sieving difficult. Hence, we saw direct benefits to using flotation in addition to dry sieving. As a result, we opted to float our materials as well as use dry screens.

Flotation was conducted in the lab using a “Flote-Tech A” flotation machine (Hunter and Gassner 1998; Rossen 1999). The primary advantage to using this machine in the lowland tropical rainforest is that it recycles water. At our field campsite, water is pumped from a well some 300 feet deep and transported some 300 m via a pipe to storage tanks. Water is the scarcest resource that we manage, as it may well have been for the Ancient Maya (e.g., Lucero and Fash 2006; Scarborough 2003), so having a recycling water system as a part of our flotation operation is one of our primary processing requirements. Of the flotation systems rated by Pearsall (2001) and Hunter and Gassner (1998) the “Flote-Tech A” is the top rated flotation system in the literature for ease of use, efficiency of personnel and daily sample volume that recycles water.

The second important advantage of this device is that variables such as water flow can be regulated and standardized across multiple samples. This helped to ensure consistency in sample processing and enhances comparability between samples (Hunter and Gassner 1998). The Flote-Tech A handled the neotropical soils without difficulty. Two people working the machine were able to process some 50-75 L of soil per day, roughly 10-20 samples. Though some of our samples contained a relatively heavy and dense clay load, we did not run into the same problems with these soils noted by Rossen

(1999). This may be due to the fact that our samples were half the size of those used in Rossen's (1999) study.

The third benefit of the Flote-Tech A system was that we were able to use the same small-screen size, 0.425 mm, as that of our smallest dry screen. This is critical for comparative work, where comparable results are difficult to achieve if mesh size is not standardized across methods, and is largely missing from the literature where investigators compare sieving techniques with flotation. For example, Wagner's (1988) study compares dry sieves with openings of 6.0 mm, to wet sieves with openings of 1.6 mm, to flotation that use screens and gauze sizes of between 0.25 and 0.4 mm. In that case, one cannot accurately evaluate the efficacy of recovery between these systems as the screen sizes are not capable of capturing materials that are the same size. In our case, we are confident that we can compare recovery results between the dry sieving and flotation as we are using the same size.

As with the dry screened material, we recorded the weight and volume of the samples. Once the light and heavy fractions were captured they were set to line dry in a covered area. After drying, the samples were passed through a standard series of screens, described above, for preparation for stereoscope analysis. Both heavy and light fractions were examined in the field using the same incident light stereoscopes (5-50x). Light fractions were 100% analyzed, and the heavy fractions were analyzed according to the above protocol where 100% of the 2.0 mm and 4.0 mm fractions were reviewed, and up to 30% of the 1.0 mm and 0.5 mm materials were reviewed. A further benefit of the use of flotation, is the potential to export the light fraction materials for sample review. As a result, we did export some unexamined light fractions to the United States for examination at the NEIU Anthropology Lab.

RESULTS

In this discussion we present data recovered from samples taken from midden levels 21 cm below the ground surface. These excavation levels indicated the best Late Classic archaeological contexts (layers of ceramic sherds and lithic debitage associated with relative dates from the local chronology), the lowest visible levels of bioturbation (fewer invertebrate remains, insect and land snail), and overall better preservation (more seeds and charcoal). Excavations at Barba and Guijarral are up to one meter below the surface; the residential units of Bronco and Chispas presented slightly shallower deposits.

Our data are reported in two forms. First, all organic materials apart from charcoal materials are strictly reported as counts. Density calculations for cross-context comparisons are reported as counts divided by the total volume of the soil sample taken from the excavated context prior to processing. In the case of charcoal, these data are reported as weight in grams. Stem materials appear as both count and weight data in our tables.

Overall we recovered 8963 identifiable items from the midden contexts at the four sites. Table 1 reports all materials recovered from all fractions, using both flotation and dry sieving, from all four sites. The majority of recovered material consists of small land snail shells (n=5322). The second and third largest categories, by count, are ceramic (n=1656) and seed remains (n=1240). A variety of other plant materials were also recovered including flower parts (n=60), fruit parts (mostly peduncles, n=84), and charcoal remains (n=176). Most of these materials consisted of seeds and other reproductive organs, and were recovered as carbonized or partially carbonized. The flower parts were mostly made up of the basal portions of the calyx and/or pedicels with adhering sepal or petal attachments. Here we report the lithic debitage (n = 418) and ceramic sherd counts recovered from the samples that were larger than 2.0 mm. The data in Table 1 demonstrate that through the use of both flotation and dry screening techniques, we were able to recover large numbers of several classes of small organic materials from all of the sites.

Since half of each excavated context was processed differently, yet using the same smallest screen size of 0.425 mm, we expected one of two patterns in our data. First, proportionately similar recovery rates among the same class of organic material between flotation and dry screening would indicate the techniques are roughly equivalent. Alternatively, completely disproportionate counts or weights among seeds, stems, flowers, and/or fruits would indicate different potential qualities for organic material recovery between the two methods. Our results indicate different items have a distinct incidence of recovery depending on the method used.

Table 2 presents the count data for the recovered organic materials. Seed materials appear to be recovered more often using flotation rather than dry sieving. This apparent advantage, however, is not the same in every site where we worked; this is demonstrated by the nearly 25% increase in seeds recovered by dry screening at the Guijarral site. Additionally, flotation seems to enhance the recovered quantity of a range of plant materials including fruit and flower parts. In contrast, 50% more charcoal was recovered under the dry screening regime than in the samples recovered by flotation. This contradiction is noted by both Pearsall (2001) and Wagner (1988).

Some continuities exist between the recovered quantities of organic remains. For instance, at Chispas there was no marked distinction between flotation and dry screen charcoal recovery by count (Table 3). At Guijarral and Barba, dry screen and flotation were differentially effective. Ultimately, however, across the three sites, dry screening methodologies recovered twice as much charcoal. Table 2 shows no clear pattern of enhanced recovery when all four sites are compared. Internal variation between sites by recovery method can be significant when broken down first by site, and then by category, as seen for charcoal recovery in Table 3.

Table 2 does show that either of the recovery techniques can have a demonstrated advantage over another at a given site. Yet from our point of view as investigators, there is no real way to see if one or the other technique will be effective in enhancing the recovery of organic materials. In examining at Table 4, where we only report the seed remain counts recovered from all four sites, we see that using the recovery techniques in tandem was helpful in yielding a potentially broader range of taxa across all the sites. In some cases flotation was more effective in recovering one taxon than dry screening ,e.g. *Orbignya* sp., and vice versa, e.g. *Acoelorrhaphe* sp. In the end we believe that this difference indicates the importance of building both types of recovery into archaeological practice in the Neotropical rainforest setting. Without both recovery methods present, we may have misrepresented or ignored a potential taxon and the interpretation of its potential role in cultural and ecological terms.

Discussion

The recovery of macrobotanical data in archaeological sites in the lowland Neotropics is not only possible, but when employed systematically can generate a potentially highly informative dataset. What we have aimed to demonstrate is the great utility in using both flotation and dry screening recovery methodologies in tandem at sites like those encountered in the lowland tropical rainforests of northern Belize.

Table 4 demonstrates the distribution and differential recovery of seeds from the four Late Classic Maya sites in our study, and highlights two main points regarding recovery methodology and arguments about Late Classic Maya plant use. First, we can clearly see that the variety of recovered plant materials, both in terms of diversity and plant parts recovered, is measurable and unique. We managed to recover many individual plant remains, as well as some never recorded in ancient Maya sites, e.g., *Asclepias* sp. and *Oenothera* sp. The recovery of a variety of plant species gets us closer to understanding what species were important to the ancient Maya and also common to their local environment. In the case of previously unencountered or recovered species, we can develop, in concert with a very rich ethnographic and ethnohistoric database for the region, a much more holistic idea of what the ancient Maya were doing with plants in antiquity. Our use of dual recovery methods highlights the need for this kind of holism in the paleoethnobotany of the ancient Maya. For instance, of the taxa recovered by dry screening, some are very important economically, such as *Z. mays* (cupules), *Celtis* sp. and *Crescentia* sp. These happen to be from plants with particularly durable fruits and seeds, respectively, demonstrating perhaps the preferential recovery of more woody carbonized plant remains via dry screening methods. However, the carbonized palm seed fragments from *Orbignya* sp., likewise woody and dense, appear to be preferentially recovered through flotation.

These observations about the use of dual recovery methods bring us to the second point we take from our data set. Most archaeological research tends to depend on a single recovery methodology for macrobotanical recovery, dry or wet screening, or flotation. We found that, in our Neotropical rainforest contexts, flotation (Table 2; n=804) recovered nearly twice as many seeds as dry screening. Yet Table 4 indicates that dry sieving and flotation together recovered 17 taxa common to both methods, while 5 taxa were unique to flotation and 11 taxa to dry screening. While in some cases this appears to be due to density of seed coats or relative buoyancy associated with a certain type of plant remain, the reasons for this pattern are not clear at this time, as discussed above in the case of *Orbignya* sp. Our aim here is to argue that both methods have their advantages in recovering different parts of the spectrum of plant diversity at these sites. In the case of this study where we excavated in middens and were interested in maximizing the recovery of plant diversity, this kind of dual recovery strategy was helpful. We acknowledge that in primary deposition contexts, e.g. floors and features in architecture, it may not be feasible to employ such a strategy. We do recommend, on the basis of this study, that a range of botanical remain recovery methods be considered and that a recovery strategy evolve during excavation in concert with both specialist and primary investigator concerns to maximize recovery in the Neotropical rainforest setting.

The reality of this benefit and the combined methodological approach highlights two major themes within our developing research. The first is that the Maya of this period were clearly provisioning using fallow secondary forests, as exemplified by the presence of several palm genera (e.g., Arecaceae) and weedy herbs that are not presently a part of the flora around the site today (e.g., Amaranthaceae, Asclepidaceae, Onagraceae, Solanaceae). This follows models for both ecological niche construction through human disturbance (Smith 2007) and premises akin to the use of Neotropical forest systems in maintaining and developing provisioning resources (Ewel 1986). The second theme is that local food choices are apparently divided based on the types of food production activities taking place in association with feasting. Based on the ceramic and architectural evidence for feasting sites, we believe that Barba and Guijarral were both loci for ancestral feasting during the Late Classic period. Alternately, Chispas and Bronco are examples of non-elite households within 300 m of each feasting locus. In several instances certain species only occur at feasting sites, and the same is true for seeds only being present at non-elite households. In the case of the former, some seeds represent species noted as being present in ethnographic feasts (e.g., Villa Rojas 1945) and thus are linked to rituals that reaffirmed social inequality in the past. Additionally, we see the presence of some seeds in both contexts. While our data are limited, and many of our unknowns stand to be identified, we believe the contexts demonstrate the need to use a dual methodology approach for locating macrobotanical and other cultural remains from the Neotropical archaeological record.

CONCLUSION

Though conventional wisdom speaks against the likelihood of recovering ancient botanical remains from Maya archaeological sites, our results indicate otherwise. Our analysis has shown that a variety of plants were used by the Late Classic Maya, including successional forest species. This is in line with emerging understandings of Neotropical subsistence patterns in other parts of the Americas (Baleé and Erickson 2007; Heckenberger et al. 1999). The range of plants recovered allows us to consider Maya subsistence practices as incorporating many plants outside the traditional realm of domesticated and semi-domesticated species. In addition, the contents of middens associated with ceramic and architectural evidence of feasting further allow us to consider the association of some plant species with festal events, others with everyday consumption, and still others common to both contexts.

Our results were made possible by the parallel implementation of two macrobotanical recovery techniques. Though flotation recovered a much larger quantity of seeds, dry screening efforts yielded a larger diversity of seeds and greater quantities of wood. These methods, applied to midden materials, have helped demonstrate that substantial amounts of macrobotanical remains can be recovered in Neotropical contexts—remains that have the potential to significantly inform questions of subsistence, local ecology, diet, and social inequality.

Acknowledgements. We would like to express our gratitude and appreciation to Dr. Fred Valdez, Jr., of the University of Texas at Austin and director of the Programme for Belize Archaeological Project (PFBAP), who permitted us to conduct this work at the R.E.W. Adams Research Station. Figures 1-5 are used here by permission of the PFBAP. We would also like to thank Dr. Jaime Awe of the Belize Institute of Archaeology, who issued the permit for the work described above. Dr. Richard E.W. Adams donated the Flote-Tech Model A to the PFBAP. Students enrolled in the summer archaeological field school at Northeastern Illinois University (NEIU) undertook excavation, processing, and some analysis. Dr. Mary Kimble of NEIU Biology loaned us microscopes to use in the field, while Dr. Lesa Davis of NEIU Anthropology helped overcome administrative hurdles. An earlier version of this paper was presented in the Fryxell Symposium at the

71st Annual Meeting of the Society for American Archaeology. We thank Dr. Lee Newsom and Dr. Heather Lapham for their invitation to participate. We also thank two anonymous reviewers for their comments on a previous draft of this paper. Any errors that remain, however, are strictly our own.

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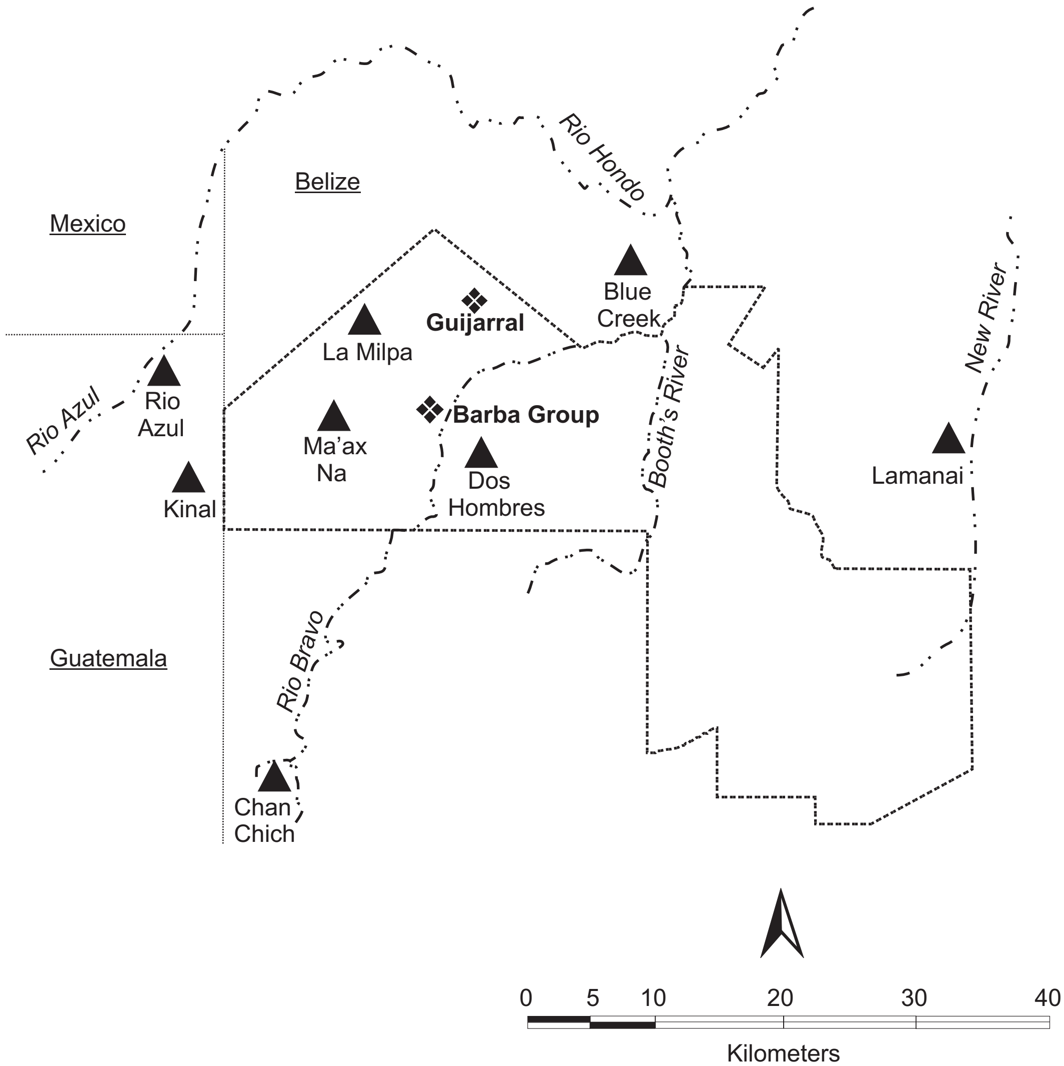

Mexico
Belize
Guatemala
Rio Hondo
Rio Azul
Rio Bravo
Booth's River
New River
Blue Creek
Guijarral
La Milpa
Barba Group
Rio Azul
Ma'ax Na
Dos Hombres
Kinal
Lamanai
Chan Chich
0
5
10
20
30
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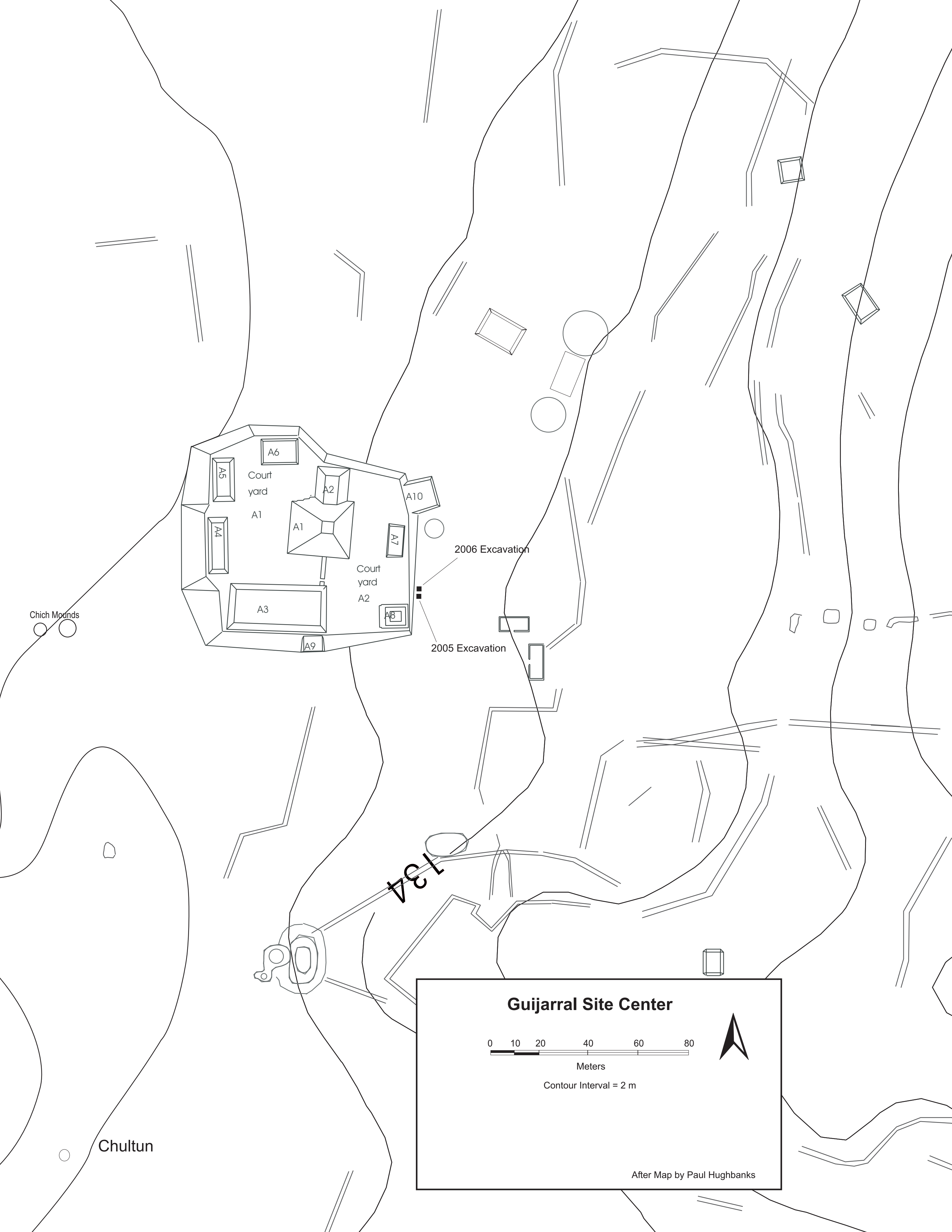
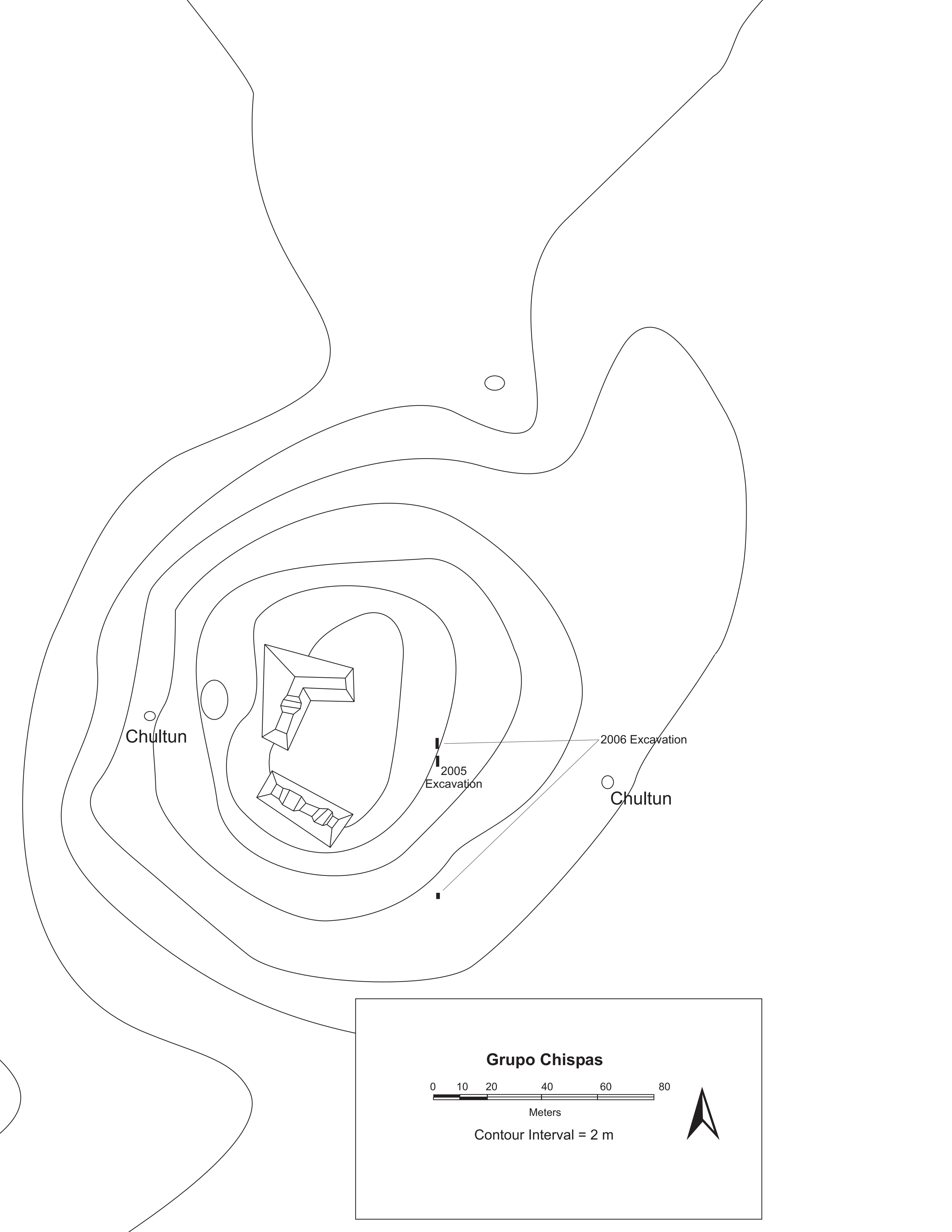
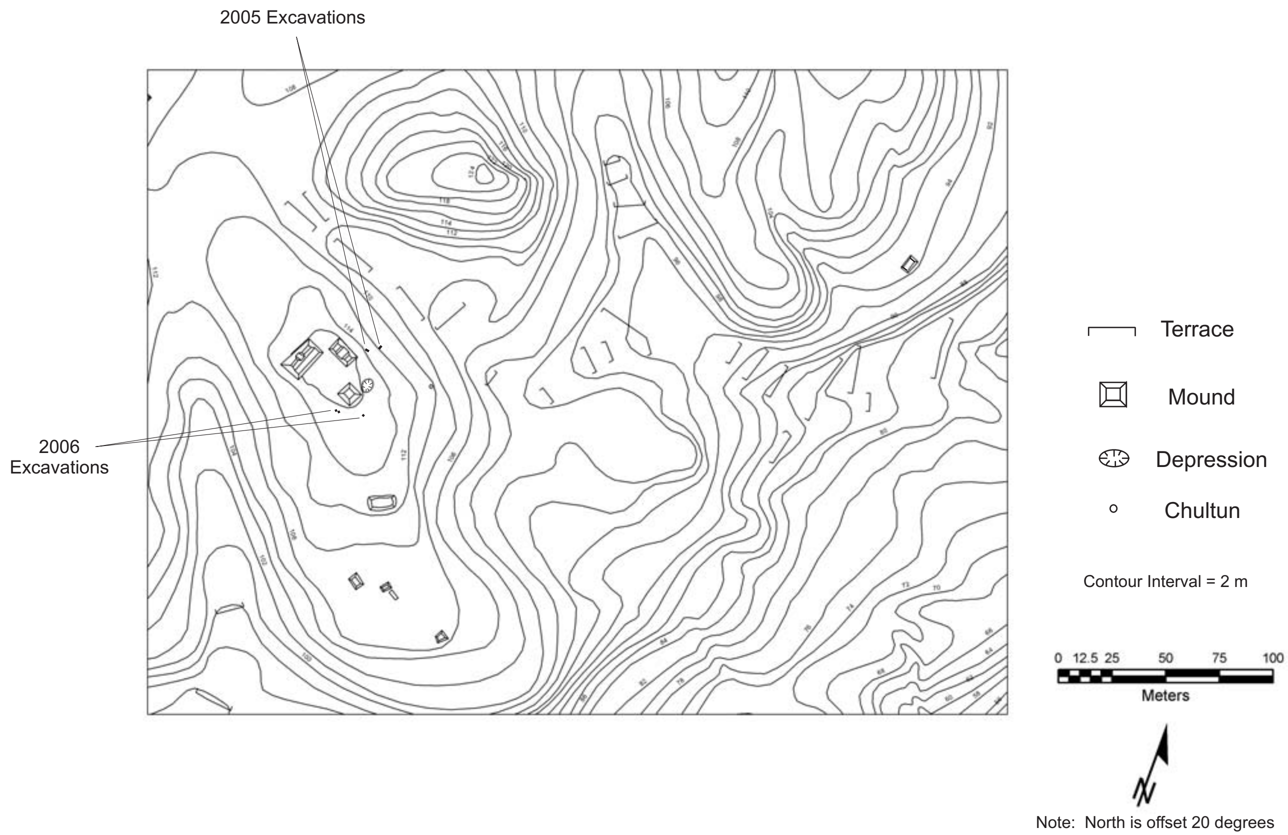
Kilometers



Guijarral Site Center
0
10
20
40
60
80
Meters
Contour Interval = 2 m
After Map by Paul Hughbanks
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
Court
yard
A1
Court
yard
A2
2006 Excavation
2005 Excavation
Chich Mounds
Chultun
134


Chultun
2006 Excavation
2005
Excavation
Chultun
Grupo Chispas
0 10 20 40 60 80
Meters
Contour Interval = 2 m


2005 Excavations
2006
Excavations
Terrace
Mound
Depression
Chultun
Contour Interval = 2 m
0 12.5 25 50 75 100
Meters
Note: North is offset 20 degrees

Material	**Class**	**Site**				**Total**
		Barba	**Bronco**	**Guijarral**	**Chispas**	
Faunal	Shell	1033	2251	1145	893	5322
Artifact	Ceramic	73	168	1158	257	1656
	Lithic	91	15	232	80	418
Botanical	Flower	0	3	47	10	60
	Fruit	6	14	31	33	84
	Seed	239	214	450	337	1240
	Spore	0	0	0	7	7
	Charcoal Count	29	0	112	35	176
	Charcoal Weight (g)	8.94	0.00	29.73	7.94	46.61
Total Count		1471	2665	3175	1652	8963

Count of Recovered Materials			Site				Grand Total
Recovery Method	**Material**	**Class**	**Barba**	**Bronco**	**Guijarral**	**Chispas**	
Dry Screen	Artifact	Ceramic	27	105	697	118	947
		Lithic	11	15	197	80	303
	Botanical	Flower	0	1	21	3	25
		Fruit	1	2	4	16	23
		Seed	16	49	263	108	436
		Spore	0	0	0	2	2
		Stem	4	0	88	20	112
Dry Screen Total			59	172	1270	347	1848
Flotation	Artifact	Ceramic	46	63	461	139	709
		Lithic	80	0*	35	0*	115
	Botanical	Flower	0	2	26	7	35
		Fruit	5	12	27	17	61
		Seed	223	165	187	229	804
		Spore	0	0	0	5	5
		Stem	25	0	24	15	64
Flotation Total			379	242	760	412	1793
Grand Total			438	414	2030	759	3641

Recovery Method	Charcoal Data	Site			Total
		Barba	Guijarral	Chispas	
Dry Screen	Count	4	88	20	112
	Weight(g)	1.73	23.75	5.89	31.37
Flotation	Count	25	24	15	64
	Weight(g)	7.21	5.98	2.05	15.24
Total Count		29	112	35	176
Total Weight(g)		8.94	29.73	7.94	46.61

Family	Determination	Recovery Method	Site				Total
			Barba	Bronco	Guijarral	Chispas	
Alismataceae	*Potamogeton* sp.	Dry Screen				3	3
Amaranthaceae	*Amaranthus* sp.	Flotation		2	3		5
Arecaceae	*Acoelorraphe* sp.	Dry Screen	4		10	11	25
		Flotation		3		2	5
	Acrocomia sp.	Dry Screen				1	1
	Orbignya sp.	Dry Screen			1	4	5
		Flotation	1	13	10	47	71
	Reinhardtia sp.	Flotation		1			1
	cf. Arecaceae	Dry Screen			9		9
Asclepidaceae	*Asclepias* sp.	Dry Screen			122		122
		Flotation		1	69		70
Asteraceae	cf. Asteraceae	Dry Screen			2		2
		Flotation			1	1	2
	Zinnia sp.	Flotation		1			1
Bignoniaceae	*Crescentia* sp.	Dry Screen		2			2
	UKN #78- FS39	Flotation		3			3
Burseraceae	*Bursera* sp.	Dry Screen		4	2		6
Cecropiaceae	*Cecropia* sp.	Dry Screen	1	1	1		3
		Flotation				1	1
Cucrbitaceae	*Momordica* sp.	Dry Screen		1			1
		Flotation		1			1
Fabaceae	*Cassia* sp.	Dry Screen	4	2			6
	cf. Fabaceae	Dry Screen			2		2
		Flotation		1		2	3
	UKN #200-FS37	Flotation	3				3
	UKN #6-FS1	Dry Screen				27	27
Flacourtiaceae	*Zuelania* sp.	Dry Screen			16	8	24
		Flotation		1	1	14	16
Malphigiaceae	*Byrsonima* sp.	Dry Screen		4		3	7
		Flotation	2	8	1	2	13
Malvaceae	Malva sp.	Dry Screen			1		1
Myrtaceae	*Psidium* sp.	Dry Screen		1			1
		Flotation			1	2	3
Onagraceae	*Oenothera* sp.	Dry Screen		9	13	20	42
		Flotation	27	86	11	34	158
Poaceae	cf. Poaceae	Dry Screen			3	1	4
		Flotation			2		2
	Chusquea sp.	Dry Screen				1	1
		Flotation		1	4		5
	UKN #37-FS19	Dry Screen			3	2	5
		Flotation	1		6	4	11

	Zea mays	Dry Screen				2	2
Polemoniaceae	*Collomia* sp.	Dry Screen		4			4
Rubiaceae	*Hamelia* sp.	Dry Screen			1	4	5
		Flotation				1	1
Solanaceae	UKN #4-FS1	Dry Screen			1	2	3
		Flotation		1			1
Sterculiaceae	*Guazuma* sp.	Dry Screen			4		4
		Flotation			2		2
Ulmaceae	*Celtis* sp.	Dry Screen	1	3			4
Undetermined		Dry Screen	3	12	42	10	67
		Flotation	184	29	21	92	326
Unidentifiable		Dry Screen	3	6	30	9	48
		Flotation	5	13	55	27	100
Total			239	214	450	337	1240

Table 1. Overall materials recovered (charcoal materials reported by weight, all other plant parts reported by count), all Operations and all levels 21 cm below surface (n = 37 samples; approx. 122.5L)

Table 2. Comparison of Count Data Recovered from four sites in the PFB Territory, dry screening and flotation compared, minimum screen size for both techniques 0.425 mm. (*not all lithics for these heavy fractions reported)

Table 3. Comparison of Plant Charcoal Materials Recovered from three sites in the PFB Territory, dry screening and flotation compared, minimum screen size for both techniques 0.425 mm.

Table 4. Determined charred seed remains recovered from 21cm and below at four Late Classic Period Maya sites in the PFB territory. Determinations are listed by family and recovery method. Undetermined Taxa comprise 31 distinct determinations across all examined contexts.