UNIVERSITY OF CALIFORNIA

Santa Barbara

Holocene hunter-gatherer plant use and foraging choice: a test from Minas Gerais, Brazil

A Dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Anthropology

by

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September 2010

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by

Myrtle Pearl Shock

ACKNOWLEDGEMENTS

In the involved undertaking that is a dissertation, spanning between two continents, there are innumerable individuals who have been influential. However, this project would never have come to fruition without Mike Jochim, Renato Kipnis, Lucas Bueno, Eduardo Neves, and my family, Candace, Clint, Cedric, Byron, and Susan Shock.

I wish to thank those who have listened to me for countless hours and have assisted in the formulation of my ideas. In Santa Barbara I have returned home to the continual friendship and academic support of my fellow graduate students and professors. Many others have provided invaluable hospitality and assistance in my travels. It is through these travels that I have had the opportunity to meet many Brazilians who have become new colleagues and close friends. My thanks and appreciation are due to those who assisted in the identification of archaeological plant remains: knowledgeable residents of the cerrado, herbarium staffers, and botanists in both Brazil and the United States. Additionally, my samples were analyzed in a timely manner due to the countless hours invested by Francini Medeiros in the laboratory.

From my years in graduate school I most value my friends, within and beyond archaeology, in town and out of town, from young to old. Just in case you didn't remember today, you have been and will continue to be very important to me.

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ABSTRACT

Holocene hunter-gatherer plant use and foraging choice: a test from Minas Gerais, Brazil

by

Myrtle Pearl Shock

Archaeological remains of plant materials collected in dry caves from the cerrado region of Brazil were analyzed in light of prehistoric human diet. Focus was on the subsistence in the later half of the Holocene. At two sites, Lapa dos Bichos and Lapa Pintada, in the northern portion of the state of Minas Gerais domesticated plant foods occur in the archaeological deposits. At the site of Lapa dos Bichos, maize (*Zea mays*) and manioc (cassava, *Manihot esculenta*) are first found in the archaeological strata dating between 2000 and 750 years BP. In the deposits dated between 750 and 150 years BP squash and beans are also found. Alongside the remains of domesticated edible foods are native foods and many other plants. In total the research cataloged 822 morphological types of seed and fruit remains collected in two millimeter or larger screen sizes. Of these, 98 types have been identified. Notable native plant foods include palm nuts (*Syagrus oleracea*), passion

fruit (*Passiflora* sp.), jatobá (*Hymenaea* sp.), umbu (*Spondias tuberosa*), and pequi (*Caryocar brasiliensis*).

Analysis of the plant remains from Lapa dos Bichos and Lapa Pintada addressed various questions. Within the archaeological sites, features presented excellent preservation of numerous plant seeds and fruits. Consideration of the possible functions of these features in relation to their form and composition led to the conclusion that they were likely accumulations of garbage. The archaeological record indicated that the introduction of domesticated species did not occur at one time; rather there were temporal variations for when these species were first utilized. Alongside the results of other projects, this observation indicates that the spread of domesticated plants was not driven by large scale population migration, but rather by a process of technological diffusion. The predictions of foraging theory models for changes in subsistence choices associated with the introduction of domesticated plant foods are not substantiated in the archaeological record of these two sites. The diversity of edible native plant foods increased with increases in the number of domesticated species utilized.

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Chapter 1. Introduction: archaeology, botany, and Brazil

This research is framed in terms of the known cultural history for inhabitants of the Brazilian savanna region (cerrado). The archaeological data, which are discussed in greater depth in Chapter 4, suggest changes in hunter-gatherer life-ways and mobility during the Holocene. Specifically, the Holocene is characterized by evidence for increasing sedentism. Changes in mobility suggest that there should have been changes in human diet allowing for, or accommodating, this behavioral change. The prior parallel research into faunal contribution to the diet, however, is not consistent with this hypothesis. Faunal diet was fairly consistent throughout the Holocene as a broad range of species, both large and small, were consumed. The other component of diet, plant contributions, had not been analyzed in a systematic and diachronic manner. This thesis is a systematic and diachronic analysis of plant diet, specifically honed to the latter half of the Holocene.

Considerations of human diet fall within the theoretical domain of foraging theory. As populations become more sedentary and domesticated plant foods are introduced, there is a variety of changes that might be observed in subsistence practices. Three foraging strategies are discussed in Chapter 2 as models to better interpret how these changes could be reflected in archaeological data. The discussion of subsistence is informed by discussions of plant cultivation and domestication as well as the historical

trajectories of cultural theory from the Neotropics. Expectations are framed in Chapter 4 for how the foraging strategies might be manifest within the archaeological remains of plant foods.

Through the in-depth exploration of plant remains this work complements previous research and influences the consideration of the history of human habitation in light of this aspect of the archaeological record. Two specific sites in northern Minas Gerais, Brazil, Lapa dos Bichos and Lapa Pintada, provided the context for this research (Figure 1.1).



Figure 1.1 The location of the Lapa dos Bichos and Lapa Pintada archaeological sites in relation to the modern Brazilian states.

Analysis of plant remains from the archaeological sites of Lapa dos Bichos and Lapa Pintada was based on stratigraphic and spatial components of their recovery and the plant typology. Samples collected from general excavation contexts were compared with those from features rich in plant remains (Chapter 7). Assuming potential functions of features as ritual, storage, or garbage deposits, predictions for feature form and the plant types

found therein were compared to the observed feature data. The features appear to have contained refuse.

At both archaeological sites considered by this study, plant remains are found throughout the archaeological assemblage. Poorer plant preservation in older contexts is one element that contributes to the assemblage; however, it does not overshadow patterns related to changes in the plant assemblage that were based in human behavior. Within later contexts at Lapa dos Bichos and Lapa Pintada domesticated plant species are clearly represented (Chapter 8). Comparison of the archaeological plant assemblages with associated cultural remains indicates that the introduction of domesticated plant species to northern Minas Gerais was not marked by abrupt changes in technological or settlement organization. This circumstance, as well as the temporal lag between the introduction of different domesticated plant species, supports the hypothesis that domesticated plant technology was acquired from surrounding peoples or through trade rather than by way of population migration.

This pattern of subsistence can be outlined from the remains and chronology at Lapa dos Bichos. The utilization of native plant foods prior to 4250 BP is poorly documented due to the low densities of plant remains in these stratigraphic contexts, yet native, oil-rich palms clearly contributed to diet. After 2000 BP plant cultivation is documented from the maintenance of domesticated plants within the local diet; however, intensive agriculture was

unlikely (Chapter 8). Alongside the domesticated plant foods represented archaeologically there is an increase in the edible native species included in the diet. Domesticated plant species, such as beans and squash, were incorporated into the diet after 750 BP; alongside this increase in the number of cultivated species, a greater variety of native foods were found. Data from Lapa Pintada support this pattern. The increase in diet breadth of native food plants in association with cultivation is not a pattern predicted by straightforward optimal foraging models and poses questions about human subsistence choices.

This research was framed in relation to the local geography of Brazil, a country nearly equivalent in size to the continental United States. As is common in such a large geographic area there is considerable diversity in plant communities, topography, and climate. Within this large landmass, the savanna occupies a considerable region. The climate, geology and soils of the land area covered by savanna and the associated vegetation regimes are described in Chapter 3.

The native inhabitants of Brazil were diverse and cultural practices varied; however, those remaining groups who live on the savanna, such as the Kayapo from along the northern edge, provide the best analogous group for our understanding of native groups in this environment. The Kayapo use of fire in managing the savanna environment discussed in Chapter 3 exhibits a potentially important aspect of human relationships with the land and with

plant foods. Additionally, ethnobotanical research with a variety of native Brazilian groups allowed for the compilation of an extensive list of edible plants (Appendix A). Knowledge that a species is edible is necessary for its inclusion in an analysis of subsistence.

This exploration of prehistoric human diet involved a substantial botanical element, as the discussion of plant cultivation and origins is dependent upon the work of botanists. It is through their studies that we understand the manner in which plants can be propagated, what is necessary for the maintenance of a domesticated plant, and the ranges of wild plants ancestral to those that are cultivated. Furthermore, botanical classification systems provide the framework within which we, as archaeologists, can both identify and appropriately discuss excavated plant remains. We would be at a loss without botanists' collections, some of which better frame the nature of archaeological identifications of plant remains.

Botanists have a specific way in which they classify plants in relationship to particular plant characteristics, such as leaves and flowers (or reproductive system). Classified plants are assigned to a genus and species and examples of the leaves and flowers are pressed and stored in herbariums. Scholars build upon the work of those before them by making further collections and refining the classification system. Always at hand for consultation are the herbarium collections made by prior scholars. As the Linnaean classification system was built upon the collection of leaves and

flowers, plant fruits and seeds were often overlooked. As a result few herbariums have comparative fruit and seed collections.

Botanists rarely seek to classify a plant on the basis of only one leaf or one seed. That domain falls to the paleobotanists who work with plant evolution from the fossil record. Paleobotanists have a specific manner in which they work with seeds, or other organs, that are similar: the organ genus. An organ genus is a way to classify plant parts, such as seeds, on the basis of typological similarities. In some cases organ genera are shown to be genera in the Linnaean sense. Regardless, this serves as an organizational tool for the study of similar organs. Links in the fossil record are made from occurrence of seed organs in connection with leaves, stems or flowers, indicating the plant(s) to which the seeds belong. As a paleobotanist is confronted with a task of relating organ genera to descendent plant species, so the archaeologist attempts to relate types of seeds with modern plants. A major difference is that while archaeologists frequently find seeds and fruits, these elements are almost never found in connection with leaves, stems, or flowers.

The first stage in the analysis of archaeological plant remains is classifying the material found into a typology on the basis of visible morphological characteristics of the remains. From the typology relatable modern plant identifications, ideally plant genera or species, are sought by comparing types with known edible plants and collections of seeds and fruits.

The typology created for paleoethnobotanical specimens from Lapa dos Bichos and Lapa Pintada resulted in alphabetic designators of morphologically distinct items. All types have been photographed such that subsequent specimens can be compared to the known items. A selection of the type photographs are presented in Appendix B where the types have been identified or where good evidence points toward identification. The specific information pertaining to identification is discussed in Appendix C, including the botanists who assisted in the classification, the reference specimens consulted in making the classification, and potential directions for better identification. To supplement information from herbariums, a reference collection was initiated in conjunction with the present work including many species that are grown commercially or sold in regional markets (Appendix D).

The relationship of the plant remains to anthropological questions rests on the context of excavation including stratigraphy and spatial organization. Excavation methodologies and materials collected at Lapa dos Bichos and Lapa Pintada are discussed to differentiate between the multiple contexts from which plant remains were recovered (Chapter 5). Multiple research problems are being addressed by these excavations, and the analysis of subsistence from plant remains contributes to them. Furthermore, the conclusions drawn by this project about human subsistence practices are dependent on the results of broader research projects.

Brazilian colleagues and funded research have contributed substantially to the success of this project. My involvement with the Brazilian archaeological community included participation in excavations at Lapa dos Bichos and Lapa Pintada and work in affiliation with the Museu de Arqueologia e Etnologia, Universidade de São Paulo. Observation of modern cultural practices associated with the consumption of native species has informed my understanding of how native species could have been incorporated into past subsistence systems. The cultural experiences of fieldwork and analysis remain interesting topics for another venue.

Chapter 2. Plant domestication and optimal foraging theory

Archaeological analysis of subsistence data is framed in the context of general theoretical trends in the first half of this chapter. The second half of the chapter discusses the history of domestication and subsistence change in the lowland Neotropics. The historical trajectories for models of domestication, cultural development, and technology transmission have informed contemporary interpretations of subsistence data. Consideration of the contribution of plants to human diet also has been informed by advances in plant geography and plant physiology. This first half of the chapter is structured around three themes: models of plant domestication and cultivation, the geographical origins of domesticated plants, and the application of optimal foraging theory to describe subsistence change. Imperative to an examination of literature on plant domestication and cultivation are clear definitions of terminology. The examination of plant domestication and cultivation within the archaeological record depends upon concepts from plant physiology.

The domesticated plant and agriculture

It is not necessary, or indeed likely, for scholars of human subsistence to agree on standard terminology. However, it helps when clear definitions are presented for each study. Where domesticated plants and agriculture are concerned, the terminological differences between Archaeologists and

botanists are based in their different research perspectives. The archaeologists seek to understand the nature of humans' interactions with plants; botanists are preoccupied with modifications in plant physiology and differentiations between species. Within the context of this research the realms of plant physiology, human behavior, and human economics are differentiated. After presenting definitions, theories for the potential paths proposed for plant domestication are reviewed.

What is a domesticated plant?

Domesticated plants are those which have undergone physiological changes making them distinct from their wild relatives. In some, but not all cases, these changes have led to the plant becoming genetically distinct. For many researchers the domestication of a plant is marked by its inability to survive without human aid (Clement 1999a; Harlan 1992).

The major morphological changes associated with domestication are in size and predator/prey relationships. "Enlarged seeds and fruits are widespread among [domesticated] cereal, pulse and fruit crops" (Jones and Brown 2007:37). For plants, many types of changes are related to predator/prey relationships and remove some of the plants' natural mechanism for defending against predation. These changes may include reduced toxicity, reduced quantity of spines, and most strikingly, reduced natural reproductive or spontaneous seeding capabilities (Jones and Brown

2007). For example, many domesticated plants have low seed shatter, which favors seed collection but decreases spontaneous survival as a wild plant.

As domestication is a process, there is considerable ambiguity in defining and discussing plants that have undergone one of the changes that marks domestication. Determining the point at which a plant was fully domesticated is complicated by the existence of domesticated plants that do not possess every attribute. Furthermore, as plant characteristics and survival have varied over time, archaeologists have trouble applying the definition of a domesticated plant as that which cannot survive without human aid. There is almost no way to test plant survival in the past. The characteristics that can be documented archaeologically are generally limited to phenotypic in fruit or cereal size and changes in seeding mechanisms. I suggest that the questions about evolutionary changes in plant physiology do not necessarily track human interactions with plants. Characterization of plants by changes in plant physiology, thereby distinguishing a domesticated plant from a semi-domesticated plant, may be immaterial. Plants for which a change to fruit size or predator/prey relationships occurred were almost certainly manipulated by humans.

Agriculture as an economic system

Archaeologists have long characterized human societies on the basis of human-plant interaction. These labels include foragers, horticulturalists, and agriculturalists. One of the assumptions behind these differentiations is

that humans have a limited amount of labor to invest in subsistence, and thus one behavior will come to dominate the economic system. Agriculture can be characterized as an economic system in which a majority of labor invested in acquiring plant foods comes from cultivation of domesticated plants (Bronson 1977). The result of labor investment in cultivation is the substantial dietary contribution of domesticated plants. Furthermore, investment of labor in cultivation is often seen as related to markers for intensification of production such as the construction of canals or the preparation of special fields. These additional cultural artifacts have assisted archaeologists in the characterization of agricultural economic systems. As the term agriculture has long been associated with a general, cultural economic system, I believe its best use is within this context.

Botanists may use the term agriculture in reference to the specific human behaviors necessary to maintain a domesticated plant species or set of species (e.g. Hawkes 1989). As this characterization of agriculture is at odds with the traditional archaeological usage, I prefer to use the term cultivation.

Cultivation, the human practice

Cultivation can be described as a set of human behaviors that promote the growth, reproduction, and/or productivity of plants. Practices of cultivation that mimic naturally occurring environmental conditions include slashing woody vegetation, burning, breaking ground, weeding, watering,

planting, transplanting cuttings, and gathering seed. These behaviors are not a ranked set of activities dependent upon each other, but rather a set of potential options. Understanding cultivation as variable sets of techniques may make it possible to track different historical trajectories in the use of plant foods where human interactions with plants varied. Taken in this manner, the practice of plant cultivation could occur without domesticated plants or agriculture. However, neither the domesticated plants nor an agricultural economy could be sustained without some of the practices of cultivation.

Given that cultivation was the precursor to or an essential complement to plant domestication, a consideration of human behavior highlighting the shift in activities that led to cultivation would be very useful. Alternate descriptions of cultivation are found within models of plant domestication rather than as independent models.

Potential paths to plant domestication

There is no question that changes in plant physiology occurred in prehistory, changes that set domesticated plant varieties or species apart from their wild ancestors. Evolution is accepted as the framework within which the plants changed. The essential question has been whether the process could be categorized as natural or artificial selection. Thus plant domestication has been framed by its relationship to the humans who utilized the plants. On one hand, a seemingly inevitable process of interaction

between plants and humans, including some cultivation and mediated by the environment, led to domestication. By contrast, models based on artificial selection assume that domestication was a product of humans' conscious choice of actions and their critical evaluation of the world about them. Both models have underlying assumptions about cultivation. Only within a model of artificial selection for plant attributes would cultivation be seen as a behavioral choice.

An accepted model of plant domestication has been that it paralleled cultural development. The academic position that domesticated plants and the adoption of agriculture were perceived as a necessary change along the path to human civilization is advocated in literature both within and beyond archaeology. For example, Hill (1952:289), writing in a text on economic botany, commented that due to domesticated plants, "of necessity he had to forsake his nomadic life and remain in one place at least long enough to harvest his crop. In so doing he took the first step toward becoming civilized, for agriculture is the only mode of existence that has enabled men to live together in communities and accumulate the necessities of life." While models of plant domestication by artificial selection have, at times, been entangled with concepts of civilization or cultural evolution, neither is necessary.

The coevolutionary model

From a historical perspective it seems that coevolution, a model of natural selection, was proposed to counter models where plant domestication paralleled cultural development. From his review of archaeological literature, Rindos (1984:5) rejected the argument that, "If agriculture is the basis of civilization and civilization is characterized by conscious control and production, then agriculture must have originated in the same consciousness and control." Instead he proposed a model for plant domestication that was dependent upon evolutionary theory and the unconscious interactions of humans with plants. This proposal clearly suggests that plant domestication will be best understood in isolation from human cultural goals. As Rindos (1984:6) stated:

> I am not going to dispute the paradigm of consciousness in its most general form; I am only interested in trying to point out that it is not required for the creation of a model for the origin of agriculture. Moreover, at least in this case, it is not only unnecessary, but is also a source of confusion: it distracts us from the fundamental processes underlying the origin of cultivated plants.

For purposes of his model, Rindos (1984) defined the difference between conscious and unconscious plant selection according to intention: selection for a predetermined standard or long term goal versus selection for the preservation of immediately valued individuals. The unconscious plant selection engaged in by humans was described as leading toward increased plant fitness. And thus, unconscious selection could be described and

modeled just as natural selection that favored fit individuals (Rindos 1984).

For Rindos (1984:99), the fundamental process underlying the origin of cultivated plants was coevolution; "*coevolution* is an evolutionary process in which the establishment of a symbiotic relationship between organisms, increasing the fitness of all involved, brings about changes in the traits of the organisms." In the model of coevolution, human populations did not actively seek plant changes, but rather used plants that provided immediate gains. In return, humans evolved from better fitness that was imparted to those who gained more from their interactions with the evolving plants.

This process of plant domestication through coevolution began as an outgrowth of how humans incidentally dispersed and protected plant species, and the process was independent of the practiced subsistence strategies. A second stage of the process occurrs when, "humans become sufficiently dependent upon certain plants so that their survival, at new densities, is dependent on the survival of the plants" (Rindos 1984:159). This stage is clearly dependent upon incidental dispersal leading to resource concentrations and an increase in human population. As a result of this second stage, humans engage in greater environmental disturbance to maintain survival of the plants. This disturbance favors plant performance:

> Plant adaptations that occur under specialized domestication are thus responses to human effects on the general ecology and especially on the local environment. The greatest benefit to plants from people as obligate dispersal agents is the human

> ability to alter consistently local environments in such a way as to place the coevolved plant at a distinct advantage. (Rindos 1984:159)

Additional aspects of this second stage could also have included planting, plant protection, weeding, and storing. In Rindos's (1984:164) third stage, "agricultural domestication is the culmination of these processes: the evolution of domesticated plants now proceeds exclusively within the agroecology." In this stepwise process of plant domestication the immediate force that acted upon plant evolution changed from human-plant interactions to selective processes mediated by agroecological systems.

An additional facet of the coevolutionary model, or any other model based upon principles of natural selection without human choice, is that plant domestication must be driven by outside factors. As human populations did not actively seek changes in plants, the evolution of these plants must have been propelled by other factors. Climatic change and population growth are two of the factors that have been cited as assisting the evolutionary process (Rindos 1984). An integral external factor in many models of plant domestication is the landscape disturbance caused by human populations, especially around settlements.

The key external element of Hawkes' (1989) perspective is the nutrient rich soils caused by human settlements. The plants in such soils are able to grow better. As Rindos might phrase it, plants that could take

advantage of these nutrients had increased fitness. Hawkes' (1989:481) description of the process that roots and tubers underwent to reach domesticated status was also based upon principles of natural selection:

> We know very little of the processes of domestication for roots and tubers, but we assume that they may have followed the generalized pattern for seed crops. Wild species with weedy tendencies, it is assumed, began to colonize the open areas round dwellings, and were gathered as part of the normal plant-food procurement activities of hunter-gatherers. As the plants established themselves they grew better than in the wild because of the higher nitrogen levels round the caves or huts. This first stage led on naturally to the second stage where regular harvesting of roots and tubers took place at the end of the wet season and the onset of the dry season. Finally, and after perhaps a long time-lapse, the third phase of *planting* as well as harvesting took place, and fixed-plot or perhaps even swidden agriculture began to develop.

The combination of disturbed environments with nutrient rich soils and natural selection has been used to explain the situation under which many plant types were domesticated.

Numerous archaeologists have explained crop domestication and the transition toward agricultural practices on the basis of portions of the coevolution model advocated by Rindos, especially the first two stages he proposed, and many more cite unconscious selection as integral to the process of domestication (Barker 2006; Pearsall 1995; Purugganan and Fuller 2009).

Models of human decisions

Where models of plant domestication by coevolution make cultivation an outgrowth of plant needs (e.g., humans as obligate dispersers), in models of artificial selection the selective pressures for plant domestication arise within a system where humans were already engaged in cultivation. Models of plant domestication that are based on conscious human decisions suggest that these decisions led to artificial selection of plant populations. Most of these models do not depend upon long-term human intentionality, but rather a perception of advantages in shorter temporal increments (years or human lifetimes). The artificial selective pressures were driven by conscious perceptions of the advantages in the use of specific plants.

C. Sauer (1963:488-9) placed human populations squarely at the front of domestication processes:

> Cultivated plants may be classed under four groups, though the knowledge is inadequate at present thus to allocate many, if not most, of the plants under cultivation: (1) The unmodified wild species which is planted for convenience of harvesting or for increase of producing units, or which may be allowed to increase by protecting a wild stand. The number of such plants is almost indefinitely large, especially among woody species. Here man serves only to enlarge the local population of the given species or to extend its range by carrying it to settlements and clearings where it did not grow originally. (2) Domestication takes place when, in addition to the care and planting of the wild species, local improved races are created, These may replace the unmodified wild form in certain areas, but not in others. Here man definitely appears as an agent of selection. (3) Full domestication is achieved when the wild form, though still existent, is discarded for purposes of cultivation, and only improved mutants or hybrids are grown.

> (4) Finally, there are the cultigens of which the wild ancestors are lost, and which in most cases depend on the care of man for their continued existence. In numerous cases these have lost the capacity to produce seeds or are otherwise unable to maintain themselves.

Human populations, according to C. Sauer, made the conscious choice to further their manipulation and involvement with given species. The underlying assumption is that involvement with plants was based upon advantages for the human populations. As such, the trajectories of plant domestication could be different depending upon the plant and the specific human choices regarding the propagation and spread of the species. For some species, repetitive intentional selection resulted in the development of new varieties or even new species from wild ancestors.

The driving force behind artificial selection is generally framed as greater yields, greater reliability of harvest, and/or greater resource abundance. Piperno and Pearsall (1998) suggested plant domestication was directly linked to the cycle of planting and harvesting as cultivation was accepted as a resource procurement strategy for the perceived proximal products. Specifically they framed the advantages within the concepts of resource abundance and patch choice from optimal foraging theory. Harlan (1992:133) indicated that greater productivity of domesticated plants was a driving force in artificial selection as "the parts of the plant that show the greatest morphological alterations are the parts most valued by man." Lathrap (1977:723) supported domestication arising from resource

concentration, and specifically he suggested that a goal of human behaviors was to "increase the supply of plants that are actually or potentially rare." From all of these perspectives, domestication of plants went hand-in-hand with advantages for the people who cultivated the plants.

Vavilov (1992:435) indicated that humans had an important role in altering the physiological characteristics of plants through their utilization of the plants:

> When selecting plants from the wild flora that corresponded best to the needs, as far as fruits, grains or roots are concerned, and taking them into cultivation, the primitive farmer was by necessity also in part a plant breeder, who altered the initial population, in essence creating new strains according to his needs.

The role of humans as cultivators was paralleled by natural selection, specifically as it pertained to a plant adapting to the environment. Vavilov (1992) cited the change in the length of growing season between varieties from temperate and tropical areas as an example because the prevalence of pests in a tropical environment would naturally favor plants that reached maturity in a shorter amount of time. My perspective is that even without intent, cultivating plants at a different latitude will select among plants for day length adaption, and growing plants on prepared (disturbed) sites will select for response to greater nutrient availability. The attributes of cultivated sites will favor individuals with natural variation best adapted to the new site. The ability of seeds to respond to additional resources of light, nutrients, or

moisture is usually not an adaptive advantage because these opportunities rarely occur outside of cultivation. Within a cultivated area, selective advantages are different.

The inclusion of human conscious decisions in the selective process suggests that species would follow diverse trajectories based upon differing human behaviors, economic goals, and food preferences. Furthermore, models of conscious practices in plant domestication accept cultivation as a chosen human behavior. Bronson (1977:28) proposed that, "the beginning of cultivation - that is, of the habit of deliberately growing useful plants - was neither a unique nor a revolutionary event. It probably happened repeatedly in different places, starting at a very early date." Cultivation began with minor activities, deliberate planting with the intention of subsequently using the plant (Bronson 1977).

Plant geography and plant physiology

Archaeologists who study plant subsistence depend upon the research produced by plant geographers and plant physiologists. The increased sophistication of models within these disciplines can substantially affect archaeological models. Plant geographers have developed increasingly precise methods to locate the origins of plant crops. The historical trajectory in plant geography has been a shift from investigating the origin of a suite of domesticated plants to determining the specific histories of individual domesticated species. Plant physiologists contribute information

on the reproductive characteristics of plant species, information important to the specific cultivation practices necessary to maintaining a crop.

Plant physiology and the weedy species

For Hawkes (1989) and Rindos (1984) the disturbed environment offers evolutionary advantages to plants that result in better growth, and by so doing has increased plant fitness. The natural, and even inevitable path to domestication of crops in disturbed environments seems at odds with known elements of plant reproduction. Given a model where plants become productive within human refuse, the plant population would need to meet two criteria: spatial separation from the population from which it was collected and a high plant concentration. The likelihood that desirable traits, assumed to be in a volunteer plant population near human settlements, would be better expressed in subsequent generations would depend upon the distance of the garbage midden from the wild stand. If human settlement occurred close to the wild plant stand, cross-pollination between the wild stand and plants in a garbage midden would be predicted. Through cross-pollination, subsequent generations of volunteers might not maintain the desirable traits concentrated by original selective pressures. Furthermore, the collection of fruit from volunteer plants would depend on the occurrence of sufficient fruit or grain to make harvesting worthwhile. While it is unlikely that these volunteer plants would replace harvest of wild populations due to the limited spatial extent of midden soils, an argument from the perspective of selective

pressures can also be framed. Obtaining a sufficient volunteer stand would tend to suggest that more than one generation of volunteers grew. During the time-lapse to reach a productive plant population the likelihood that various generations would cross with wild populations would be increased. Also the harvesting of volunteer fruit from this hypothetical, new, self-sustaining stand would remove the original selective pressure, and would remove the desirable seed from reproductive population, in the same way human harvesting removed the best seeds from the wild population. Natural and predictable processes suggest some of the possible holes in models of unconscious selection leading to domesticated plant populations. Due to these factors the plants which would prosper in nutrient-rich environments would be those in which the edible portion was already of desirable size and that had a weedy growth habit and thus were able to take advantage of the increased nutrient availability. However neither of these factors would necessarily lead to enhancements in fruit size or plant evolution to a state of increased fitness. Plants in human garbage would be subject to the same processes of plant reproduction as others of the same species within the environment.

Locating domestication centers from modern plant populations

Plant geography examines the geographical dispersal of plant species and their phenotypic and genotypic traits. This includes investigating the origins of species in a systematic manner. A basic assumption of plant

geography is that the modern range of the closest wild relative of a domesticated species can serve as an indicator for the range within which domestication occurred. This principle has been utilized since the 19th century by the notable pioneer De Candolle (Hill 1952; Vavilov 1992). Determining the closest wild relative of domesticated plants has been facilitated by genetic studies and experiments that attempt to cross domesticated species with their wild relatives. The variability across a domesticated plant's range can also point to its origin of domestication. However, distinct botanical factors may make this method tricky to use:

> There may be occasions when the present racial variation is the result of the similarity of different species and their hybridization with each other. In the case of cross-pollinating plants, where under natural conditions mainly dominant characteristics are present, perhaps an opportunity for isolation and exposure to external variation can arise far from the center of origin, or due to artificial breeding, e.g. inbreeding of recessive forms (Vavilov 1992:33).

Utilization of methods from plant geography has made it possible to determine the location or locations from which many species originated.

Initial studies in plant geography identified 'hearths', or centers, of plant domestication, an objective in keeping with diffusionistic cultural models. The hearths of domestication proposed by C. Sauer (1952) were centralized locations where suites of plants were found. The diffusion of agriculture from a hearth resulted in derivative centers where additional crop species were domesticated using the knowledge provided by the initial

innovation of agriculture (Carter 1977; C. Sauer 1952). The proposals also coincided with archaeological proposals for the unique invention of traits in civilizations:

> Conceptual models of domestication and spread that appeared plausible in the 1950s now appear simplistic and, at best, partial truths. In the 1950s, plant domestication was commonly visualized as simply a discovery or invention, the result of human intelligence at a particular time and place. Agriculture spread from a few original centers simply because it gave greater yields than than gathered wild foods. Archaeologists were still hoping to find "the first farming village" in their regions (J. Sauer 1993:1).

Research into the origins of domesticated plants carried out by Vavilov placed additional weight on the involvement of human civilizations in plant domestication, thus the suggestion in seeking centers was that they not only contain wild relatives, but that they were centers of human civilization. "As can be seen, the main geographical centers of original introduction into cultivation of the majority of the plants grown are associated not only with floristic areas, distinguished by rich flora, but also with ancient civilizations. Actually, the seven large centers distinguished correspond to the sites of ancient agricultural civilizations" (Vavilov 1992:434). Vavilov additionally made distinctions within the hearths in relation to specific species. "A valuable conclusion in Vavilov's work is that many of our cultivated species of first rank, the primary crops as he calls them, had a diversified rather than a single origin" (Hill 1952:288). Vavilov distinguished between the geographic ranges within which similar domesticates, like hard and soft wheat, arose

from the wild species.

The model of hearths for plant domestication has been supplanted in archaeological and botanical literature. The abandonment of the concept of civilization arising from discrete locales helped to undermine the concept of hearths as the two concepts often went hand in hand. "The concept of 'center of origin' in which innovations occur in a limited geographical area and out of which they are diffused is logical and intellectually satisfying, but does not always fit the evidence. Sometimes there are centers and sometimes not" (Harlan 1986:22). To counter diffusionist arguments, Harlan (1986) cites ethnographic cases where prolonged contact between agricultural and non-agricultural societies did not result in diffusion of the agricultural practices. While these ethnographic cases may be interpreted in a variety of ways, the firm rejection of hearths of plant domestication can be made from botanical data. Cultivated plants had diffuse origins and domestication was not culturally restricted. "It now appears that crop domestication has often been a process, diffuse in space and time, rather than an event. Even within a species, wide-ranging wild progenitors have been repeatedly domesticated at different times and in different regions" (J. Sauer 1993).

From their diffuse geographical origins, plants were adopted into subsistence systems. The nature of plant origins added new dynamics to the archaeological study of plant cultivation and subsistence. Questions at the

forefront of studies on domestication now include what it took to get a number of plants, that originated in different regions, into one system of cultivation and how longitudinal changes in the availability of plant species affect subsistence choices. In eastern North America, one of the best studied regions in regard to plant cultivation and domestication, scholars have tracked the timing when distinct plant species were introduced and associated changes in subsistence systems (e.g., Fritz 1993; Hart 2008; Scarry 2008; Yarnell 1993). Not all local plants were brought into cultivation at the same time, and the introduction of plants from distant locales of origin were temporally disparate. A near 1000 year temporal gap between maize and bean introduction to eastern North America has been documented (e.g., Hart and Scarry 1999; Yarnell 1993). Within Central and South America it appears similar chronological differentiations occurred in the adoption of domesticated plants. An example for South America of chronological differentiation is the early introduction of the bottle gourd and a distinct introduction of maize to established systems of cultivation (Erickson et al. 2006; Heiser 1989; Lathrap 1977).

For archaeologists, data compiled by plant geographers provide promising leads for locating the original locales of plant cultivation. However, the distribution and composition of plant populations has been influenced by humans. Due to these dynamic relationships, care must be taken in distinguishing between the origins of cultivation and of domestication.

"Domestication can begin within, adjacent to, or distant from the native range of the wild progenitors. The archaeological record is not detailed enough to distinguish between domestications beginning *in situ* and those starting with introduction to adjacent regions" (J. Sauer 1993:270). Thus the origin of plant cultivation for a specific species could have been situated in one geographic and cultural area, yet its domestication would not have had to occur in that area. This caution does not negate the useful information on plant origins provided by plant geography.

Physiological differences between perennial and annual plants that affect domestication

Perennial and annual plants frequently differ, not only in growth habit, but in the population involved in reproduction. In nature, fruit trees often reproduce through cross-pollination meaning that offspring are heterozygous and the fruit tree population is genetically diverse. Due to the long lifespan of most fruit trees, the natural processes of cross-pollination make short-term selection for individuals with improved phenotypes in their offspring very difficult. Selecting offspring with desirable characteristics is delayed until they reach maturity, and throughout, the desirable plants cross with individuals from the remainder of the wild population. Even in a diverse population, the cultivation of fruit trees could have been desirable due to the production of resource concentrations, and thus could have preceded cultivation of annual plants. Major advantages in cultivating trees have resulted from naturally productive species or, more commonly, the ability to control the

morphological and genetic characteristics of offspring. The majority of practices that maintained desirable traits within fruit tree populations are unsustainable without human activity, and thus the plants are considered to have been domesticated. Most fruit tree domestication has involved vegetative reproduction (Spiegel-Roy 1986). Vegetative reproduction maintains the desired genetic and morphological characteristics through clones that are identical to their parent. The method of reproduction involved in the propagation of fruit trees could determine the rate at which selection for desirable traits could occur, the time elapsed to domestication, and a directly advantageous characteristic, an increase in fruiting productivity of the plants.

Notable domesticated tree species are propagated vegetatively, yet the domestication may be almost invisible archaeologically. The domesticated olive can not be distinguished from wild olives on the basis of grains, stones, or wood remains (Lipschitz et al. 1991). In describing how domesticated and wild plants can be so similar, Lipschitz and colleagues (1991:441) departed from the natural reproductive habits of plants:

> Cultivation of fruit trees [instead of cereals] means a change from sexual to vegetative reproduction. All wild forms reproduce from seeds, while under cultivation the maintenance of preferred genotypes is possible only by vegetative propagation. Spontaneous populations show wide variability and maintain a high level of heterozygosity. Cultivated varieties of fruit trees can therefore be maintained only by vegetative reproduction, i.e. by cuttings, roots of twigs [sic], suckers or by grafting. Selection could have operated only during a relatively limited

> number of generations, and the cultivars would not then have diverged markedly from their progenitors. This is in sharp contrast to grain plants, in which selection could have operated continuously during thousands of generations.

Thus the domestication of the olive by vegetative reproduction occurred rapidly, did not diverge from the wild ancestors, and created a plant population that was only sustainable through human engagement in propagation.

There were other factors that influenced the domestication of different fruit trees. These included the development of parthenocarpic individuals (e.g., fig), polyembryony (e.g., orange), and grafting (e.g., apple) (Kislev et al. 2006, Lipschitz et al. 1991, Spiegel-Roy 1986). In parthenocarpic trees no fertilization occurs, so no seeds can be set, but the plant produces "virgin" fruit. Figs that exhibited this characteristic produced more desirable fruit, however due to the lack of seed they would not reproduce independently requiring vegetative reproduction. Parthenocarpic figs have been found at archaeological sites in Jordan (Kislev et al. 2006). The maintenance of this food was likely based on human propagation by vegetative means. Domesticated citrus trees can be grown from seed for more consistent offspring as the cultivated varieties exhibit a mutation for polyembryony in which a second embryo forms in the seed from the maternal tissue (Spiegel-Roy 1986). Growth of the embryo from maternal tissue produces a clone of the mother and thus a copy of the desirable characteristics. The modern

method for maintaining standard characteristics in fruit trees is grafting. The process of grafting allows for the implanting of genetic material, normally a limb or bud, onto another plant with an existing root system. A graft is a clone that will possess the same attributes as its parent. Within China and Europe, the evidence for grafting comes from written texts rather than archaeological evidence (Spiegel-Roy 1986). All of these methods of fruit tree reproduction can bypass the selection of trees from seedlings over multiple generations. For this reason, domestication could have been a rapid and reoccurring process following the discovery of a tree with desirable characteristics such as larger fruit or more fruit production. The same type of wild fruit could have been domesticated multiple times or selected multiple times from wild plants as attested to by the multiple varieties of many fruits. The rapid nature of domestication is supported by an observation that in many fruit trees the genetic changes are governed by a single allele (Spiegel-Roy 1986).

Fruit trees, of course, could have been domesticated from seed, however the difficulty was that most seedlings would be unwanted types. Long-term selection of natural seedlings is the potential route by which current avocado cultivars were developed, yet avocado is not clearly a domesticate (Spiegel-Roy 1986). In other species, such as almond, the desirable traits are dominant so thinning of the less than 25% of offspring with undesirable characteristics is economically feasible and leads to more of the future offspring expressing the dominant characteristics. Furthermore,

not all fruit trees cultivated today were domesticated. The cultivation or collection of fruit was common from wild pecan, cashew, *Ribes* (e.g., currant), *Rubus* (e.g., blackberry), *Grossularia* (e.g., gooseberry), *Vaccinium* (e.g., blueberry and cranberry), and numerous tropical trees (Clement 1999b, Spiegel-Roy 1986). Modern breeding and selection programs have, since the 1950s, domesticated some of these and efforts are ongoing to domesticate additional fruit tree species (Leakey and Akinnifesi 2008). However, some species, such as cashew, are indistinguishable from the wild forms (J. Sauer 1993).

The majority of perennial fruit trees mentioned above come from the Old World, due to historical trends in research. Knowledge of the reproductive habits of many neotropical fruit trees is needed to better examine how heterozygous natural offspring are and what modifications to the plants may have occurred due to human cultivation and propagation.

The spread of cultivation technology and domesticated plants

Models for the spread of domesticated plants have often been linked to arguments for the spread of agriculture. Domesticated plants are suggested to have spread due to their increased productivity, ability to adapt to climatic change, potential to support expanding populations, or use in amassing wealth (Barker 2006; Boserup 1965; Bronson 1977; Rindos 1984). Behind many of these models is an assumption that a society with domesticated plants could out-compete its neighbors and expand to take

over or displace its neighbors. Considering the spread of cultivated and domesticated plants in isolation from agricultural expansion, the reasons given are still frequently related to productivity and processes of diffusion or human migration.

Not all domesticated or cultivated plants were spread beyond the locations where they were brought under cultivation. For Vavilov (1992:434-435) a factor differentiating between plants that were spread and those that were not was productivity:

> As the investigations have shown, the majority of the species of cultivated plants typical of the geographical centers in question, and associated with ancient agricultural civilizations, did not disperse beyond the borders of the initial areas of type-formation because of their remarkably low agricultural value, geographical isolation or other causes. The majority of the species are still mainly used by the people who took them into cultivation. Out of the number of cultivated plants, determined at present to be ca. 1500 species (not including decorative ones), not more than one fourth have dispersed far from their initial centers of origin or where they were originally brought into cultivation. (Vavilov 1992:434)

Models from foraging theory would support a similar deduction that those plants with greater nutritional values and requiring a lower labor investment in processing would have been more likely to have spread.

The spread of agriculture has long been seen as operating by one of two diffusionary mechanisms, inheritance or horizontal transmission. Models of inheritance are based on knowledge transmission in a vertical fashion, be it through parent/child relationships or those between masters and

apprentices. The horizontal transmission of knowledge is seen as working between peer groups and between cultures through mechanisms such as trade. A common archaeological example illustrating both modes of knowledge transmission would be the ceramicists who copy designs from their neighbors, but continue to make pots the way they always have. In this example, ceramic iconography is spread horizontally while vertical inheritance conserves preexisting ceramic construction techniques. The mechanisms involved in the spread of a particular technology may have influenced the manner in which those technologies were used. As such, examining the mechanisms by which cultivated or domesticated plants spread in a given region could influence the conclusions that are made concerning the cultural elements of that spread.

Two specific examples for the knowledge transmission underlying the spread of domesticated plants come from Europe and eastern North America. In Europe the spread of domesticated plants has been discussed in terms of population migration whereby technology would have been transmitted vertically (Bellwood 2005; Mannion 1999; cf. Tringham 2000). On the other hand, in eastern North America, the introductions of domesticated plants, specifically maize and beans, were temporally distinctd and the probable horizontal transmission did not introduce new, non-local cultural elements to the societies that subsequently grew maize and beans (Scarry 2008; B. Smith 1989).

A final consideration in regard to the spread of plants is the directionality. Many of the models for technological spread due to migration imply that knowledge transmission occurred in a single direction. Demonstrating unidirectional spread of plant technology is dependent upon a single origin for the cultivated species or a single culture concentrating species into an economic suite. With both the demonstrated geographic dispersion and differing chronological sequences for cultivated plants' origins, it is likely that the spread of cultivated plants was multidirectional such that plants from various locations came to be cultivated in any given locale.

The primacy of cultivation in the process of domestication

Within archaeological research directed toward understanding domesticated plants, the plant origins and physiological changes have been emphasized over understanding of the human behaviors related to plant cultivation. This is both a historical trend that arose from the discussion of hearths of human civilization and due to the fact that documenting any physiological change in plants appears to be concrete evidence of domestication. A problem arises however when researchers utilize plants with domesticated characteristics in the search for the 'earliest' human behaviors associated with cultivation, as cultivation does not require that the plant manipulated be different from the wild species. Logically the set of behaviors involved in plant cultivation should occur prior to domestication. As

humans grew and managed plant species, their actions often initiated artificial selection and provided conditions within which natural selection might occur. However, long term cultivation of plant species did not necessitate morphological changes to the plant that could be termed domestication. To this day there are cultivated plants that cannot be differentiated from their wild ancestors, especially some tree crops.

Documenting the initiation of cultivation is harder archaeologically than indicating the presence of a plant species that has been modified from its wild form. Archaeological documentation of cultivation may often require multiple lines of evidence. For example, cultivation might be demonstrated by changes in settlement characteristics, landscape modification, clearing of vegetation, and plant utilization, or a combination thereof. In fact, researchers whose primary focus is on changes in human behavior, Piperno and Pearsall (1998) for example, have expressed greater concern for cultivation as a change in human behavior than for specific morphological changes in to the plant species, as they utilized pollen records to document disturbed vegetation related to practices of cultivation.

Another reason that the cultivation of a plant should have preceded domestication is based in botany. Plant variation may arise at random, but some mechanism must have acted for these random changes to become widespread or genetically fixed. Human interference was especially vital to the maintenance of recessive characteristics or those whose spread was

dependent upon vegetative reproduction. Human behaviors could multiply and move plant populations with desirable traits in an efficient manner. In cross-pollinating plants, human seed selection would change the genetic makeup of the breeding population. Continual selective pressures might fix desirable characteristics, even extremely recessive ones, in a plant population.

Cultivation opens opportunities for a different suite of plant attributes to be expressed. As areas of land are opened for planting, the availability of light and nutrients increases. These areas are inherently advantageous to weedy plants, including tomatoes and squashes, but do not inherently assist plants that can not take advantage of the additional nutrients. Many wild plants are successful due to their ability to utilize small amounts of nutrients and survive in less than optimal light conditions. Within areas of cultivation, non-weedy plant species should, through selection, come to exhibit physiological adaptations to increased nutrients and light, adaptations that should lead to greater seed or fruit productivity.

It has been desirable to study domesticated plants because they should have been associated with human behaviors necessary to their propagation; however, the domesticated plants do not necessarily mark the change in human behaviors. Cultivation is a human behavior and the concept can be applied to the study of archaeologically represented plants, including those that were never domesticated. Changes in subsistence

elements of human behavior, such as the adoption of cultivation, can be analyzed in the context of foraging theory.

Utilization of optimal foraging theory to frame interpretations of subsistence change

Cultivation, as a series of behavioral changes, is intrinsically tied to changes in food supply and usage. The use of predictive models, based on expectations for cultivation, link the archaeological remains of food consumption to behavioral changes in the use of plants. As plants that exhibited no characteristics of domesticated species could have been cultivated, modeling from the species known currently as domesticates might not faithfully represent human subsistence behaviors. Optimal foraging theory provides a robust set of models to examine human subsistence behaviors and changes in resource use.

Foraging theory is closely tied to evolutionary theory, employing the assumption that the decisions made in obtaining food can provide adaptive benefits to the people who engage in certain sets of practices (Boone 2002; E. Smith 1983). The discussion of adaptive benefits, be they somatic or reproductive, is outside the scope of this project. Instead the specific benefits of each foraging strategy will be examined in terms of their observable consequences on human behavior. The assumption in testing decision making is that the individuals and groups under consideration observed the outcomes of their actions and then chose either maximizing or

satisficing behaviors (Simon 1959). Three foraging strategies and their links to human choices are discussed below.

Diet breadth models assume that humans will choose foods on the basis of the greatest gains for the least effort expended. The models calculate efficiency in terms of the number of hours invested in finding and acquiring resources and the calories returned, allowing resources to be ranked. Subsistence changes are reflected in diet breadth. High-ranked resources will always be part of the diet while inclusion of lower-ranked resources, those requiring more effort to acquire or process, will fluctuate (Hawkes and O'Connell 1992).

Risk aversion models of subsistence assume a predictability of resources, where those resources that provide reliable returns are chosen whether or not they are calorically optimal (Caraco et al 1980; Stephens 1981; Stephens and Charnov 1982). The logic behind humans choosing reliable resources is that using this strategy they are unlikely to starve. Within the reliable resources, ranking is based upon efficiency as in the optimality model.

Patch choice models provide an alternative view of foraging strategies as they approach the problem spatially (Winterhalder 2001). Whereas the first two models described assume a homogeneous environment, patch choice models consider homogeneity to be an unrealistic assumption. The

fundamental idea is that people exploit one area intensively before moving onto the next. The model is based on optimality, but it gauges whether the optimal returns can be obtained by continued exploitation of the current patch or from a yet unexploited patch, taking into consideration the effort to get there (Smith 1983). Therefore, the resources chosen are based on their proximity to each other within the environment as well as caloric efficiency.

The logic of these foraging strategies provides a context within which plant cultivation can be compared with other subsistence behaviors, specifically foraging. Additionally, the structure of the models necessitates the inclusion of archaeological data on specific species, closing the gap between data and theory.

Histories of domestication and subsistence change for the South American Neotropics

The Neotropics extend across the lowlands of Central and South America. Archaeological inquiries into this region have included consideration of subsistence practices. Within the lowland regions of South America, expectations for subsistence behavior of prehistoric populations were based in the trajectories of broader theoretical debates. Historically, general models discussed subsistence trends in the Neotropics; often more recent studies concentrate on local subsistence specificities. Within the context of South American subsistence, the origins and spread of specific plants have become important, not only to understanding subsistence, but

also to questions of cultural contact and spread. There is little subsistence documentation or conjecture for the neotropical savannas, but models have been developed for the Amazonian lowlands bordering upon the savannas.

Staple crops?

The research on subsistence and plant domestication in the Old World implied that agricultural economies relied upon a limited set of staple crops, including wheat, barley, rye and pulses. Furthermore, a strong emphasis has been placed upon the role of cereal grains for growing populations, and thus agricultural economies (Reed 1977). While subsequent research has demonstrated the problems with models based on staple crops or cereal grains, they were intellectually pleasing. The search for a set of staple crops in the New World was fulfilled in northeastern North America by the maize, beans, and squash triumvirate (Hart 2008). In the tropics the dominant plant species were harder to pin down. Researchers settled on maize and manioc as the potential, and competing, staple crops for the lowlands. A detailed exposition on the division between maize and manioc cultivation was presented by C. Sauer (1952) where he differentiated between plants propagated by seed and those propagated vegetatively. The search for tropical staple crops as well as the origins of civilization in the tropics drove a generation of archaeological theory.

While Tello, from his work in the Andes, had proposed a hearth of plant domestication in the Amazon Basin, C. Sauer re-framed the general

discussion by dismissing Brazil on the basis of a 'primitive' population by indicating the secondary importance of the plants that came from there, and by questioning these plants' actual origin in Brazil. C. Sauer (1952:42) identified northwestern South America as the "likeliest spot in the New World for agricultural origins." In this region he sought support for early domesticated plants propagated by cuttings. When discussing Caribbean populations he stated, "this tropical culture is based strongly on the idea of vegetative reproduction" (C. Sauer 1952:40). The mainland Caribbean river valleys were proposed as the location for subsistence intensification due to the geographical proximity of multiple environments and the location at the juncture between South American and Central American plant species. However, he differentiated between agriculture and crop origins, suggesting that the origins of vegetative cultigens, "are to be sought not in tropical rain forests, but in areas of alternate rainy and dry seasons" (C. Sauer 1952:40).

C. Sauer (1952) placed the domestication of plants propagated by seed, and generally annual in nature, in a separate hearth near the border of Mexico with Central America. Furthermore, some of the annuals were seen as arising from weed species after cultivation was underway. "The ancestors of most New World seed plants appear to have been attractive weeds. . . . They were gentle, well-behaved weeds that liked the sunshine, loose earth, and plant food of the tilled spaces, and had no great root system. Such volunteers, usable by man, were first tolerated, then protected, and finally

planted" (C. Sauer 1952:71). Despite their lowly origins as weeds, the seed crops were projected to have risen to dominance after a climatic shift to which they were better adapted than the root plants. While the division he made into agriculture by cuttings or by seeding was reductionist, it attempted to establish categories of staple crops from an abundance of cultivated plant species.

Carl Sauer's work in cultural geography laid foundations for research on the origins of domesticated plants in Central and South America. His conviction that root crops were the foundation of subsistence economies has been echoed in many works that highlight manioc's role in societies (Carneiro 1983). Many of his other suggestions have also informed subsequent hypotheses. Steward (1963) proposed a model of agricultural spread across the lowlands with the Caribbean as the point of origin. Piperno and Pearsall (1998) emphasized a similar geographic origin in their thesis of agricultural origins in the lowland Neotropics. The theme of plant cultivation by vegetative reproduction was picked up by Lathrap (1970) as he coined a subsistence system of 'vegeculture' (Iriarte 2007). The modern search for wild manioc has been carried out in the edges of the rainforest with the savanna (Allem 2000; Olsen and Schall 1991, 2001) and manioc's physiology is referenced by archaeologists who discuss its spread; plants, like manioc, with large underground storage organs are thought to have developed these organs as an adaptation to assist in surviving the dry

season (Harlan 1992; Pearsall 2008). Furthermore, the dichotomy between subsistence based on root crops and that based on seed crops was highlighted in the theories of Roosevelt (1980).

Subsistence models based on environmental factors

Subsistence studies in the Neotropics have been anchored on the perception of limited agricultural productivity due to the tropical environment and the interpretation of manioc as the primary and staple crop. Both discussions of subsistence and sociopolitical complexity were influenced by the limits perceived in lowland environments. Speaking of manioc Houge (1929:305) commented:

> It appears that root crops . . . do not furnish a reliable basis for a populous or permanent civilization. It is true that we find in the West Indies and a vast area in South America what may be termed the cassava culture based on the root of the *Manihot utilissima* [a synonym for *Manihot esculenta*], but even in localities where maize is an adjunct there has been produced no civilization of importance in the progressive nature of man.

The framing of subsistence models in the lowland Neotropics in reference to the environment can be demonstrated from ethnographic and archaeological literature.

Carl Sauer's indication that manioc was the staple crop for the lowland Neotropics was supported by ethnographic studies. Lowie (1963a, 1963c) summarized subsistence practices in the lowland Neotropics for both the "Tropical Forest" and "Marginal" culture groups. One of the diagnostic features of the "tropical forest" cultures was the "cultivation of tropical root

crops, especially bitter manioc" (1963c:1). However, this statement was presented with the caveats that not all groups in the Tropical Forest culture region cultivated manioc and that many species of lesser importance were utilized. The cultivated species of lesser importance that Lowie (1963c) mentioned are included in Table 2.1. Of the many useful wild species he noted, those that are edible have been incorporated into Appendix A. For the Marginal cultures, "what remains true is that as a rule agriculture is less intensive than in the Tropical Forests; that manioc and maize, when raised, tend to be less important than sweet potatoes and yams; that correlatively other food-getting activities loom larger" (Lowie 1963a:382). While the ethnographically documented Marginal tribes were not reported as intensive agriculturalists, some of the Northwestern and Central Ge were documented to have engaged in seasonally intensive cultivation and expressed territoriality when they fought over wild resources (Lowie 1963a,1963b). The *Timbira* followed a round of gathering during the dry season and planted crops and were settled during the wet season. Wild plants were used in subsistence, "gathering is very important for the simpler tribes. . . . Even incipient farmers, like the *Northern Ge*, relied largely on the babassú [*Attalea speciosa*] and other wild-palm fruits and fought for the possession of stands of these trees" (Lowie 1963a:382).

Table 2.1. Lowland domesticated plant species used as food. (* Identified as a semi-domesticated plant)

Taxon	Family	Source
Annacardium occidentale L. *	Anacardiaceae	Clement 1999a; Clement et al. 2008; Lowie 1963c
Spondias mombim L. *	Anacardiaceae	Clement 1999a; Clement et al. 2008
Annona montana Macf. *	Annonaceae	Clement 1999a; Clement et al. 2008
Annona muricata L.	Annonaceae	Clement 1999a; Clement et al. 2008
Annona reticulata L. *	Annonaceae	Clement 1999a; Clement et al. 2008
Rollinia mucosa (Jacq.) Baillón	Annonaceae	Clement 1999a; Clement et al. 2008
Arracacia xanthorrhiza Bancr.	Apiaceae	Lowie 1963c
Hancornia speciosa Gomes	Apocynaceae	Lowie 1963c
Macoubea witotorum Schultes *	Apocynaceae	Clement 1999a; Clement et al. 2008
Colocasia esculenta (L.) Schott	Araceae	Lowie 1963c
Xanthosoma brasiliense Engler	Araceae	Clement 1999a
Xanthosoma sagittifolium Schott	Araceae	Clement 1999a; Lowie 1963c
Acrocomia sp.	Arecaceae	Lowie 1963c
Astrocaryum aculeatum Meyer *	Arecaceae	Clement 1999a; Clement et al. 2008
Bactris gasipaes Kunth	Arecaceae	Clement 1999a; Clement et al. 2008; Lowie 1963c
Quararibea cordata Vischer *	Bombacaceae	Clement 1999a; Clement et al. 2008
Ananas comosus (L.) Merrill	Bromeliaceae	Clement 1999a; Clement et al. 2008
Canna edulis Ker.	Cannaceae	Clement 1999a
Carica papaya L.	Caricaceae	Clement 1999a; Clement et al. 2008; Lowie 1963c
Coupeia subcordata Benth. *	Chrysobalanaceae	Clement 1999a; Clement et al. 2008
Ipomoea batatas (L.) Lam.	Convolvulaceae	Clement 1999a; Lowie 1963c
Cucurbita maxima Duch.	Cucurbitaceae	Clement 1999a; Lowie 1963c
Cucurbita moshata Duch. ex Poir.	Cucurbitaceae	Clement 1999a; Lowie 1963c
Cyclanthera pedata Schrad.	Cucurbitaceae	Clement 1999a
Sicana odorifera (Vell.) Naud.	Cucurbitaceae	Clement 1999a; Lowie 1963c
Dioscorea dodecaneura Steud. *	Dioscoreaceae	Clement 1999a
Dioscorea trifida L. f.	Dioscoreaceae	Clement 1999a; Lowie 1963c
Manihot esculenta Crantz	Euphorbiaceae	Clement 1999a; Lowie 1963c
Arachis hypogaea L.	Fabaceae	Clement 1999a; Lowie 1963c
Canavalia ensiformis (L.) DC.	Fabaceae	Clement 1999a; Lowie 1963c
Canavalia plagiosperma Piper	Fabaceae	Clement 1999a
Cassia leiandra Benth. *	Fabaceae	Clement 1999a; Clement et al. 2008
Inga cinnamomea Benth. *	Fabaceae	Clement 1999a; Clement et al. 2008
Inga edulis Mart. *	Fabaceae	Clement 1999a; Clement et al. 2008
Inga feuillei DC *	Fabaceae	Clement 1999a; Clement et al. 2008
Inga macrophylla H.B.K. *	Fabaceae	Clement 1999a; Clement et al. 2008
Pachyrhizus tuberosus Spreng.	Fabaceae	Clement 1999a

Continued on next page

Table 2.1 - continued from previous page.

Taxon	Family	Source
Phaseolus lunatus L.	Fabaceae	Clement 1999a; Low ie 1963c
Phaseolus vulgaris L.	Fabaceae	Clement 1999a; Low ie 1963c
Mammea americana L. *	Guttiferae	Clement 1999a; Clement et al. 2008
Platonia insignis Mart. *	Guttiferae	Clement 1999a; Clement et al. 2008
Heliconia hirsuta L. f. *	Heliconiaceae	Clement 1999a
Poraqueiba paraensis Ducke	Icacinaceae	Clement 1999a; Clement et al. 2008
Poraqueiba sericea Tul.	Icacinaceae	Clement 1999a; Clement et al. 2008
Persea americana Mill.	Lauraceae	Clement 1999a; Clement et al. 2008; Low ie 1963c
Bunchosia armeniaca DC *	Malpighiaceae	Clement 1999a; Clement et al. 2008
Byrsonima crassifolia H.B.K. *	Malpighiaceae	Clement 1999a; Clement et al. 2008
Calathea allouia (Aubl.) Lindl.	Marantaceae	Clement 1999a
Maranta arundinacea L.	Marantaceae	Clement 1999a; Low ie 1963c
Maranta ruiziana Korn. *	Marantaceae	Clement 1999a
Pourouma cecropiifolia Mart. *	Moraceae	Clement 1999a; Clement et al. 2008
Eugenia stipitata McVaugh *	Myrtaceae	Clement 1999a; Clement et al. 2008
Eugenia unifora L.	Myrtaceae	Low ie 1963c
Myrciaria cauliflora McVaugh *	Myrtaceae	Clement 1999a; Clement et al. 2008
Psidium guajava L. *	Myrtaceae	Clement 1999a; Clement et al. 2008; Low ie 1963c
Passiflora edulis Sims	Passifloraceae	Clement 1999a; Clement et al. 2008
Passiflora quadrangularis L.	Passifloraceae	Clement 1999a; Clement et al. 2008
Zea mays L.	Poaceae	Clement 1999a; Low ie 1963c
Talinum triangulare Willd. *	Portulacaceae	Clement 1999a; Clement et al. 2008
Borojoa sorbilis Cuatr. *	Rubiaceae	Clement 1999a; Clement et al. 2008
Chrysophyllum cainito L.	Sapotaceae	Low ie 1963c
Pouteria caimito Radlk.	Sapotaceae	Clement 1999a; Clement et al. 2008
Pouteria lucuma (Ruiz & Pav.) Kuntze	Sapotaceae	Low ie 1963c
Pouteria macrocarpa Baehni *	Sapotaceae	Clement 1999a; Clement et al. 2008
Pouteria marcrophylla (Lam.) Eyma *	Sapotaceae	Clement 1999a; Clement et al. 2008
Pouteria obovata H.B.K. *	Sapotaceae	Clement 1999a; Clement et al. 2008
Capsicum sp.	Solanaceae	Low ie 1963c
Solanum lycocarpum A. St.-Hil.	Solanaceae	Low ie 1963c
Solanum muricatum Aiton	Solanaceae	Low ie 1963c
Solanum sessiliflorum Dunal	Solanaceae	Clement 1999a; Clement et al. 2008
Theobromia bicolor H. & B. *	Sterculiaceae	Clement 1999a; Clement et al. 2008
Theobromia cacao L.	Sterculiaceae	Low ie 1963c
Cissus gongyloides Burch.	Vitaceae	Clement 1999a

Steward (1963:886) simplified the conclusions of Lowie when he stated for the Tropical Forest cultures, "so far as agriculture, hunting, and

gathering are concerned, important local differences have not been indicated. Sweet manioc was general, and bitter manioc became the staple throughout the area of its distribution". Steward's interest in subsistence was within the greater context of cultural ecology for which demonstrating a single subsistence mode was advantageous to defining cultural regions. The societies documented ethnographically as practicing agriculture in lowland regions were not seen as a local development as they did not appear to have the sophistication of their neighbors. From their location and cultural sophistication, Steward interpreted the Tropical Forest cultures as originating on the developed Caribbean coast. "The basic Tropical Forest cultures occur mainly in the areas accessible by water routes, both the coast and the great rivers, whereas simpler or Marginal cultures tend to be distributed in a vast **U** around the periphery of the Amazon Basin" (Steward 1963:883). "A further inference of these distributional data is that the developed Tropical Forest culture spread southward along the Atlantic Coast to the Amazon and along the Amazon tributaries, predominantly upstream" (Steward 1963:885). Due to the perceived flow of cultural characteristics along the waterways, where waters were less navigable the transmission of cultural traits was curtailed and the hinterlands were left at a primitive level, thus also explaining the differences noted by Lowie (1963c) in subsistence.

Meggers (1954) proposed that environment played an important role in determining agricultural potential and thus the possible cultural

development. For the Tropical Forest, she (1954:807) stated, "although it represents an increase in security of food supply, slash-and-burn agriculture is not sufficiently productive or permanent of locale to support large concentrations of population or stable settlements." While agricultural development was a substantial element in Meggers' model, she does not specify the subsistence system. Environmentally based models justified the lack of agriculture in Marginal cultures by the absence of conditions that permitted agriculture development. Meggers (1954) proposed environmental limitations to cultural development, however she saw cultures as evolving in place. This is in opposition to Steward's proposal that Tropical Forest groups arose from the devolution of Circum-Caribbean cultures that had devolved from Andean cultures. In support of this position Meggers (1954) argued, from Rouse's (1953) data, for a Tropical Forest culture which predated the Circum-Caribbean cultures. The cultural development which occurred within the Tropical Forest cultures was, however, influenced by surrounding cultures as two of the four ceramic horizon styles had exotic origins (Meggers 1997; Meggers and Evans 1961). To explain cultural complexity outside of the norm for Tropical Forest populations Meggers (1954) proposed that when a culture of greater organization attempted to settle the Tropical Forest area they were not successful or they experienced cultural reversion. She found evidence for this in archaeological work on the Rio Napo and with

the Marajoara culture at the mouth of the Amazon (Evans and Meggers 1968; Meggers 1954; Meggers and Evans 1957).

The perception of the Amazonian tropical forest as a single environmental zone with a consistent level of agricultural sophistication was undermined by Carneiro's (1970) hypotheses on the origin of the state. To explain differences in the social organization of groups historically observed along the Amazon river and those living away from major rivers, Carneiro (1970) discussed resource concentration. He denoted the *várzea* (seasonally flooded river margins) as productive agricultural land that would have allowed for a concentration of resources. This landscape distinction has influenced theories of agricultural intensification, plant usage, and cultural affiliation.

Based on the environmental division made by Carneiro, Roosevelt (1980) differentiated between the agricultural productivity of two environmental zones, the forest and *várzea*. She indicated that, while environmental factors limited subsistence intensification in the forests, the floodplain had great potential for maize agriculture. The close association of subsistence models to those of sociopolitical development, seen in prior research, was maintained by Roosevelt (1980) who proposed that while a tropical forest subsistence system had been developed on the basis of manioc, the later introduction of maize allowed for cultural development. Roosevelt supported the model of change from manioc to maize subsistence

with the archaeological record of the Parmana region. Here griddles, markers of manioc cultivation, were associated with a long period of low population density. "During the next period of occupation, maize and maize-processing tools appear in the refuse for the first time, and concomitantly there is a large increase in regional population density" (Roosevelt 1980:253). By linking subsistence intensification to maize agriculture, changes to Amazonian cultural systems continued to be tied to external influences from either Central America or the Andes.

Others have defended manioc as a productive plant that could have sustained cultures of greater sociopolitical complexity. Carneiro's (1983) ethnographic study of the Kuikuru of the Upper Xingú found that manioc production was quite successful. Yield was higher than needed from a simple caloric viewpoint and thus inevitable losses to animals and disease would not endanger subsistence. The overproduction was on the order of three times the necessary caloric amount. "Manioc cultivation, then, provides the Kuikuru with a broad and stable subsistence base. On this base they have developed a culture that is relatively rich by Tropical Forest standards" (Carneiro 1983:108). The majority of Kuikuru diet was based on manioc together with the uses of some other cultigens.

Models where cultural sophistication was linked to external societies did not leave room for models of subsistence development or significant achievements in plant domestication within the lowland netropics of the

Amazon. Furthermore, the good conditions of plant preservation in Mexican and Andean rock shelters dissuaded investigation into poorly preserved lowland subsistence systems and practices (Iriarte 2007). Models of cultural development within the lowlands, such as those advocated by Lathrap, provided the archaeological context for considering independent plant developments.

Lathrap described the classification system of South American cultures used by Steward as flawed from its geographic assumptions. "Once such a theory of extreme environmental determinism was formulated, it was an easy further step to conclude that any group in the Amazon Basin which exhibited any of the diagnostic features of the Circum/Caribbean level must of necessity have migrated there from outside or have been strongly influenced by adjacent areas of high civilization" (Lathrap 1970:46). While Lathrap rejected Steward's proposed trajectory of development and sought cultural developments locally within the lowland Neotropics, he did not discard the geographical grouping. Lathrap (1970:47) justified grouping based upon subsistence, "Tropical Forest Culture must be defined in terms of shared cultural elements rather than as a uniform level of cultural achievement. The most crucial part of this shared cultural content lies in the sphere of economics. Tropical Forest Culture is a way of life supported by intensive root-crop agriculture." To further elaborate this model of shared

culture and its spread, Lathrap sought to locate the origins of domesticated plants and agriculture:

> The distributional evidence suggests that there was no single point of origin for the Tropical Forest system of agriculture. Manioc and sweet potato were most likely first domesticated north of the Amazon while the peanut was clearly first domesticated south of it. So it is better to postulate a series of widely dispersed populations, each experimenting with the food potential of a range of the local flora and each ultimately contributing one cultigen or more to the pool of crops which ultimately became the Tropical Forest agricultural system. (Lathrap 1970:60)

Notably Lathrap (1970) indicated a chronological gap between plant domestication and the cohesion of an agricultural system. Within the Amazon Basin he did not find manioc remains, much less date them, so he based his calculations for spread on the dated evidence for manioc in coastal Peru. To better understand economic dynamics, Lathrap (1970) proposed that ceramic griddles were an indirect indicator for the spread of manioc. From the geographic dispersion of the origins of domesticated plant crops across the Amazon Basin, Lathrap proposed that the cultural system spread from the central Amazon. The model presumed internal population growth leading to successive waves of migration following the river courses that would have displaced hunter-gatherer populations away from the floodplains.

The environmental focus on subsistence has suggested that variability in Neotropical ecosystems was related to subsistence productivity. In the Amazon, differentiation has been based on the environmental position of

settlements on the *várzea* or in the forest and the respective role of manioc or maize as the staple crop. These early models for lowland subsistence systems were based on scant archaeological remains of plants. Rather, interpretations of subsistence were formed from ethnographic analogy and presented as justifications for the acceptance of other models. One of the general questions that these researchers were trying to understand was the path by which agricultural populations spread into the lowland Neotropics of South America. The focus on manioc and maize as staple crops discouraged discussion of other plants and their role in subsistence. A legacy of Lathrap and Roosevelt's work can be perceived in informal correlations made between ceramic griddle fragments and manioc consumption.

The use of the Amazon as a principal region for the investigation of lowland subsistence was logical given the breadth of ethnographic research in the region and prevailing theoretical trends. The indigenous Amazonian populations that have survived in greater numbers and populations on the savanna margins were interpreted as technologically inferior and thus the subsistence of savanna groups was a lesser version of that practiced in the Amazon (Lowie 1963a, 1963b).

Subsistence as documented in archaeological remains

A dramatic shift in subsistence studies in the lowland Neotropics can be linked to the direct study of the plant remains. The interpretations of subsistence demonstrated, to date, from preserved macrobotanical remains,

phytoliths, starch grains, pollen, and genetic material, suggest some of the potential new directions that will shape these studies. The utilization of these techniques in archaeological research has led to the documentation of cultivated crop assemblages and subsistence practices, examination of assemblage change through time, distinction of domesticated species from their wild ancestors, and identification of genetic markers in domesticated species that indicate the directionality of plant spread.

The archaeological remains of plants from the Marajó Island, at the mouth of the Amazon River in Brazil, point to a significant dietary contribution of wild plants to the Marajoara culture (A.D. 400-1300). Roosevelt (1991) found charred remains of tree fruit crops, wild grass seeds and possible maize kernels in garbage deposits. Among the native tree fruits, açai is the only one suggested as a major dietary nutrient. Roosevelt (1991) concludes that the region would be suitable for the production of wild grains based on the local environmental conditions. These practices might be supported in the archaeological record by the larger size of charred archaeological grain seeds and by human dentition. The dental remains point to heavy abrasion and rare decay, signs which indicate consumption of gritty food and not soft starchy food. Roosevelt's (1991) summary of plant contribution to subsistence portrayed a system where tree crops were used extensively, seed crops were the staple, and root crops were supplementary.

To examine the validity of the widespread assumptions that archaeological assemblages with microlithic flakes (for graters) and ceramic griddle fragments were associated with manioc based subsistence, Perry (2002, 2004, 2005) examined starch grains from sites in the Middle Orinoco Basin. Perry (2002, 2005) recovered 164 starch grains from five flakes at the Pozo Azul Norte-1 site. None of the starch grains were from manioc. The plant foods represented were a palm (*Attalea*), yam (*Dioscorea* sp.), arrowroot (*Maranta* sp.), *guapo* (*Myrosma* sp.), a member of the ginger family (Zingiberaceae), and maize (*Zea mays*) with a predominance of maize starch. These results were substantiated by research at the site of Los Mangos del Parguaza where starch from yam, arrowroot, a plant from the ginger family, and maize were found (Perry 2004). These starch grains were recovered from ground stone, microlithics, and flake artifacts. Perry's research clearly suggests that great caution should be placed on describing subsistence practices from indirect evidence.

While cultivated plant remains have long been documented on Peru's dry north coast, the investment into phytolith analysis has substantially expanded the geographical range of research. The expanded number and geographical distribution of sites with data on plant subsistence allows for chronological comparisons as well as different behavioral sequences in the adoption of cultivation. Along the Ecuadorian coast, sites from Manabi and Esmeraldas Provinces have records with maize occurring substantially later

than at the Real Alto and Las Vegas sites in Guayas and Santa Elena Provinces (Pearsall 1994). In addition, the introduction of maize occurred in synchrony with an assemblage of plants including root crops and palms. "It appears that a well-developed agricultural system was introduced into the region and maintained" (Pearsall 1994:133). The cultural implications of this data set are different from a data set where plants were introduced over a longer period of time (e.g., the data presented in Pearsall 1992 for the introduction of major lowland South American crops to coastal Peru). The regional diversity in subsistence behaviors is highlighted by distinct histories for the adoption of plant species.

Studies involving phytolith analysis have also propelled the search for early archaeological occurrences of specific plant species which became or might have become domesticated. Piperno and Pearsall (1998) correlated the occurrence of these species with practices of plant husbandry. From the Las Vegas site, remains of *Cucurbita*, maize, and *Calathea allouia* (leren) have been recovered. The occurrence of *Cucurbita* was dated in samples from 9740 and 7170 BP, while maize occurred in those dated to 7170 and 5780 BP. Similarly early evidence comes from the Colombian Amazon where, "a carbonized seed of the palm *Oenocarpus* yielded a radiocarbon determination of 9250 ± 140 B.P. The phytolith assemblage from the uppermost stratigraphic level containing *Cucurbita*, leren and bottle gourd . . . yielded a direct determination of 8090 ± 60 BP" (Piperno and Pearsall

1998:204). While the paleoethnobotanical data for early plant use are accumulating, it is not always demonstrated that these species were utilized within systems of plant husbandry.

Domesticated plants have also been documented from studies of pollen. One lake core record came from the lowlands of the eastern Ecuadorian Andes. "At 5300 BP, pollen and phytoliths from maize appear together in the record. This first evidence for maize appears at the same point as mature forest indicators decline and disturbance indicators rise" (Pearsall 1994:122). Pollen records have the potential both to tag the temporal introduction of specific species and to document changes in local vegetation regimes.

As plant genetics can be used to determine affinity, some of the domesticated plants that spread over long distances may be tracked genetically. Freitas and colleagues (2003) have demonstrated three general genetic groups of maize. The geographical distribution of these genetic groups in South America along side archaeological chronologies has provided a model for the spread of maize. It appears that the earliest route followed the Andes and Pacific Coast of South America. A second geographically and genetically distinct group of maize spread across the lowlands of South America. Meanwhile, the third genetic group could have spread in any direction due to its occurrence across the continent, but the dates for it from archaeological contexts are more recent (Freitas et al.

2003). Genetic studies have also begun with beans and manioc that may reveal directionality of these plants' spread (Freitas 2006; Schaal and Olsen 2000).

The plant remains found at archaeological sites have brought into question the interpretation of a subsistence system for the lowland tropics that is based upon a limited set of staple carbohydrate sources. Additionally, Perry effectively questions the role and geographic extension of manioc as the most important starch. Neotropical subsistence research has documented very early cultivation practices in the Andes. This highlights both our lack of knowledge on how species originating in the eastern lowlands reached the Andes and the need to frame hypotheses for early cultivation in the lowlands. Meanwhile, genetic studies are beginning to illuminate the routes along which domesticates were dispersed. On a cautionary note, while documenting subsistence systems with domesticated plants can be straightforward, demonstrating that they represent agricultural systems should include additional rigor required to understand the broader subsistence context. One of the greatest achievements of the research described above has been to shift the discussion of human subsistence from a few to numerous plant species.

The origin of neotropical domesticated plants

Domesticated and cultivated plant species of Central and South America did not originate in a single location, however the original models

worked from this premise. C. Sauer (1952) proposed a hearth of plant domestication in northeastern South America on the basis of environmental suitability. Vavilov (1992:128) included the involvement of human civilization in suggesting a hearth along the Pacific, "as far as it is possible to judge from the data available, it is possible to distinguish a focus of primary agriculture in the New World and a center of type-formation in *Mexico and Peru* and the mountain areas adjacent to them." This model from 1927 (republished in a 1992 translation) was superseded by Vavilov's 1940 revision of New World domesticates into two centers, the Central American geographical center and the Andean center, each with three locational foci. While promoting centers, he did not disregard plant geography. Vavilov (1992:433) indicated species domesticated outside of these centers, "Manioc, pineapple and groundnuts . . . were taken into cultivation within the interior areas of tropical South America." By contrast, Brücher (1989) did not support any focal origin for cultivated neotropical plants. The lack of unified origins for cultivated plants makes generalizations difficult. However the more refined recognition of plant geography has influenced archaeology with attempts to distance discussion from the traditional hearths or centers of domestication. Pearsall (1992) differentiated domesticated plants into 'complexes' based on geographic areas. Clement (1999b) sought to abandon the models for centers of crop domestication by enumerating areas (centers, minor centers, and regions) of varying plant genetic diversity in the lowland Neotropics.

Clement's model reflects Harlan's argument for regions as centers and non-centers of plant domestication.

Botanists continue to work to determine the origins of economically useful species. Researchers have worked to expand the list of plants cultivated and domesticated in the Neotropics (Clement 1999a; C. Sauer 1963). Discussions of crop origins for multiple species can be found in a succession of publications (Brücher 1989; Clement 1999a, 1999b; Hawkes 1989; J. Sauer 1992). Extensive research has also focused on the origins of specific crops such as peach palm (*Bactris gasipaes* Kunth) and manioc (*Maihot esculenta* Crantz) (Allem 2000; Mora-Urpí et al. 1997; Olsen and Schaal 1999, 2001). In this work great caution has been applied as simple genetic diversity in the current, cultivated plant can actually conflate the relationship between humans and plants rather than locales of origin. Ladizinsky (1998) demonstrated various ways by which human cultivation and manipulation of plants increased their genetic diversity.

The traditional archaeological focus on plants perceived to have been the staple crops of a subsistence system, such as manioc and maize, relegated numerous other species to categories such as "lesser". As this stigma has broken down, the divide between botany and archaeology has been closing. The plants that botanists and geographers have long noted as cultivated or domesticated within the Neotropics are being added to archaeological models of cultivation and agroforestry.

Archaeologists have learned from plant remains and plant geography that cultivated plants originated across the Neotropics. Some of the plants that were cultivated and domesticated in the lowlands of South America spread into adjacent regions and contributed to various subsistence systems. Other cultivated and domesticated plants of the Neotropics were utilized on a localized basis. Archaeologists can be certain that early on, the adoption of cultivated plants, due to their geographically dispersed nature, did not involve a specific suite. Therefore it can be expected that various human populations with knowledge of cultivation utilizing a variety of cultigens existed across the Neotropics prior to the spread of cultural groups traditionally viewed as agriculturalists. Archaeological data have confirmed this in northwestern South America and along the Pacific Coast.

Chapter 3. Environment, geography, and human geography of central Brazil

Central Brazil is covered by tropical savannas and seasonally dry tropical forests. This area receives seasonal, rather than year round precipitation (Figure 3.1). The standard designations for variation within central Brazil are cerrado, caatinga, pantanal, and semi-deciduous forest. The cerrado is a vegetation regime typically appearing to suffer from stress and ranging from grasslands to scrub and forest. A drier region in northeast Brazil with desert characteristics is the caatinga (Figure 3.2). The pantanal is a seasonally inundated grassland floodplain of the Paraguay River that is dotted by islands of forest. The semi-deciduous forests are transitional formations with generally denser vegetation where trees lose their leaves during the dry season. They generally border upon the Amazon to the north and the Atlantic rain forests to the south.

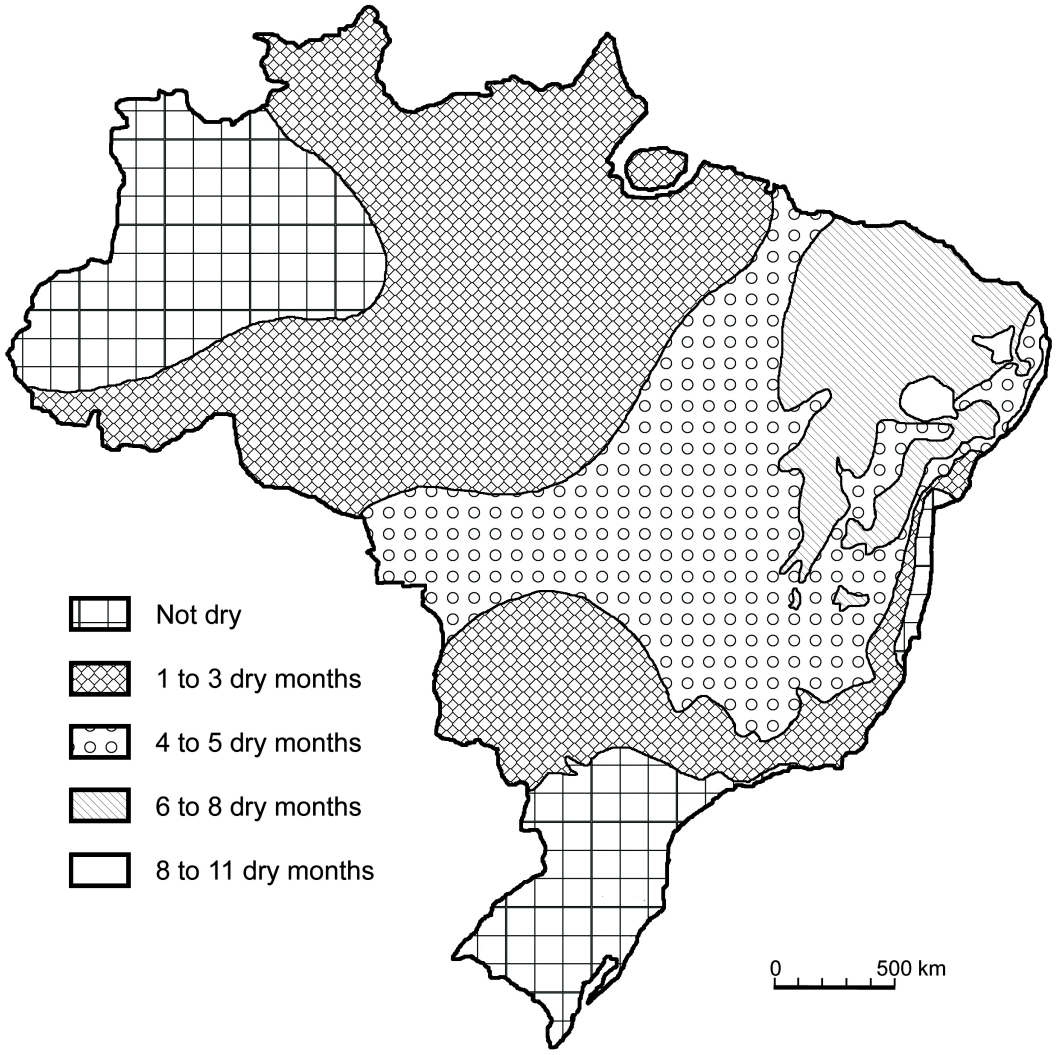


Figure 3.1. Rainfall variation across Brazil is extreme with some areas experiencing no dry months and others recording up to 11 dry months a year. The majority of central Brazil is dry for four or more months of the year (IBGE n.d.).

The pantanal and semi-deciduous forest will not be discussed here as neither are directly associated with the region of archaeological sites in question. Originally the terms cerrado and caatinga were used to describe vegetation types, however both terms are now used more broadly in reference to the ecosystems that are structured around these vegetation

types. A variety of factors distinguish these zones, but climate is pivotal; caatinga is more desert-like and dominates an area with less rainfall.

The image that jumps to mind with the word savanna is that of grassy vegetation stretching across a broad flat plain, reminiscent of Africa. In the Americas, historically “savanna” has been broadly applied to tropical grassy areas, both with and without trees. In Brazil “savanna” included vegetation of the pantanal, cerrado, and caatinga (Cole 1960). More recent names applied to this broad category of vegetation are tropical savannas and seasonally dry tropical forests. Both terms better describe the true nature of dry tropical vegetation, if savanna only brings to mind grasslands. This broader class also includes Brazil's semi-deciduous forests. This research focused on sites located in the cerrado (tropical savanna) and caatinga (seasonally dry tropical forest or SDTF).

The distinction between the tropical savanna and seasonally dry tropical forest formations has been made on the basis of appearance and moisture regime. “Seasonally dry tropical forest occurs where the rainfall is less than 1600 mm/yr, with a period of at least 5-6 months receiving less than 100 mm” (Pennington et al. 2006:3). The caatinga is a seasonally dry tropical forest. Meanwhile, “savannas are defined by their grass-rich ground layer. They are found under similar or slightly wetter climatic conditions to SDTF but tend to be on poorer soils” (Pennington et al. 2006:6).

In a general sense, the Brazilian tropical savannas and seasonally dry forests occupy a strip running north-east to south-west between the Amazon rain forest in the north and the Atlantic rain forest in the south; on the west is the Paraguayan border and in the east the Atlantic ocean (Figure 3.2). The tropical savannas and seasonally dry tropical forests are distributed across the high interior plateaus where elevation varies between near sea level and 1300 meters (Furley and Ratter 1988). These interior plateaus drain into all of the major Brazilian river systems: the São Francisco River, the Amazon River, the Tocantins River, the Paraguay River, and the Paraná River (Figure 3.3). While broken tropical savanna patches are found in northern Brazil and within the Amazon where soil fertility is very low or where human activity has changed the vegetation, the greatest extent of tropical savanna vegetation is fairly continuous (Pennington et al. 2006). Forest formations wind their way into the savanna, but are limited to dendritic networks along waterways. At many edges the tropical savannas grade into semi-deciduous forests. Seasonally dry tropical forest formations are fairly continuous on the eastern side of the tropical savannas; Brazilians call this region the northeast.



Figure 3.2. The central Brazilian biomes are the cerrado, caatinga and pantanal (IBGE 2004a, 2004b).



Figure 3.3. Brazil is split into seven major river basins and five basin areas composed of small rivers that run into the Atlantic ocean. The central Brazilian plateau crosses the headwaters of five major Brazilian rivers. The archaeological sites studied in this work are located on tributaries of the São Francisco River (ANA n.d.; FAO-Forestry 2000).

The multitude of classification schemes for variables affecting central Brazilian vegetation and environment are beyond the scope of this research. Some of the salient aspects of climate, soils, geology, and vegetation are

discussed in this chapter as they highlight the diversity and complexity of the region.

Climate

The Brazilian tropical savanna and seasonally dry tropical forests are located in latitudes of the tropics and subtropics. The climate is tropical with wet and dry seasons; however, the moisture regime of the cerrado and caatinga are different.

The cerrado, a tropical savanna, exhibits a, “remarkable variation across the region in both the average annual temperature, ranging from 18° to 28°C, and rainfall from 800 to 2,000 mm, with a very strong dry season during the southern winter (approx. April-September)” (Oliveira-Filho and Rather 2002:93). May to August are cooler months with almost no rainfall (Figure 3.4). The warmth of September and October brings the onset of rains with thunder-storms; this is the fire season when vegetation is dry, making fuel abundant (the intense modern fire season begins in July and August). The cerrado has a “substantial wet season and effective water storage in the rooting zone” (Furley 1999:224), allowing plants to grow for a portion of the dry season. Cerrado is estimated to have covered an area of approximately two million square kilometers, or 23% of Brazil, prior to the development of modern ranches and farming operations (Oliveira-Filho and Ratter 2002; Ratter et al. 1997).

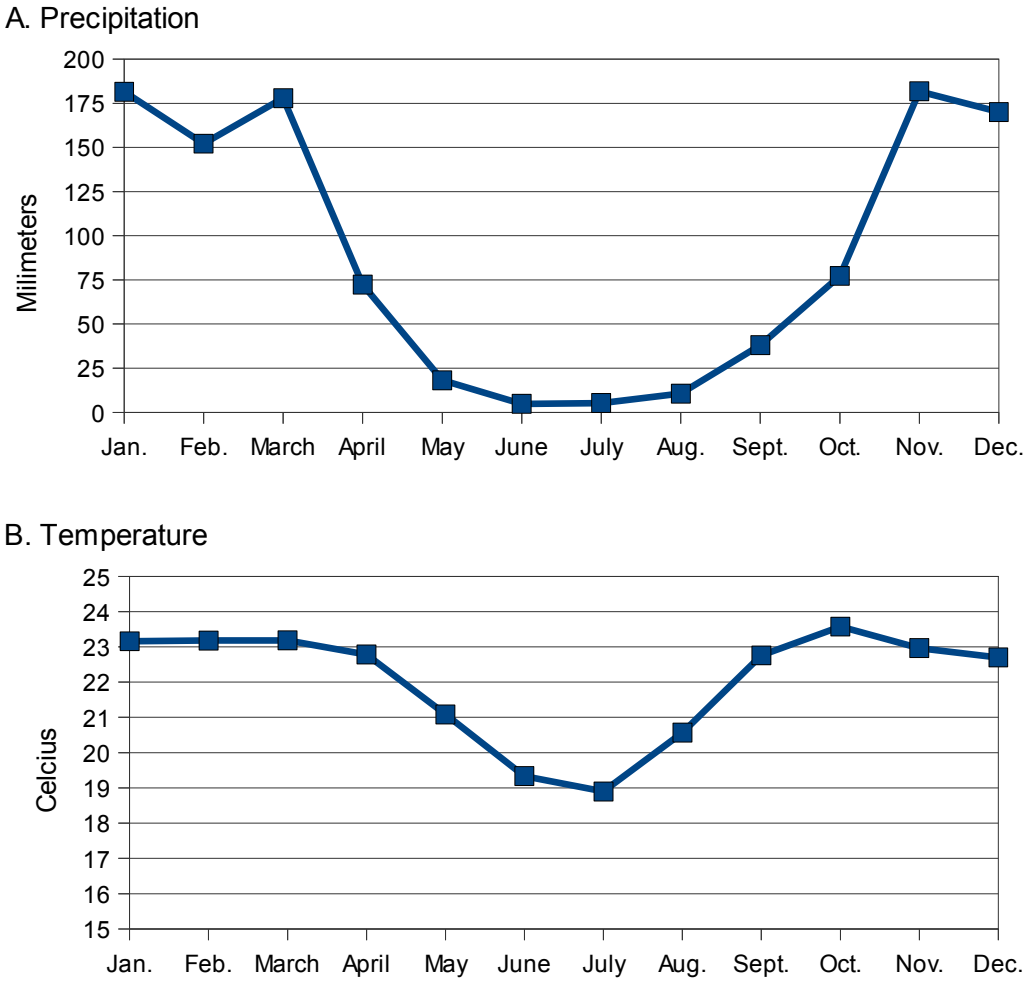


Figure 3.4. In the cerrado average monthly precipitation (A) is greatest during the summer coinciding with high average monthly temperatures (B) and the growing season for plants. Monthly average precipitation (mm) and temperature (°C) from 1987 to 2007 at Brasília, Distrito Federal, Brazil (data from U.S. Climate Prediction Center n. d.).

Caatinga vegetation has a semi-arid moisture regime. For the caatinga, a seasonally dry tropical forest, precipitation of 300 to 1000 mm per year is concentrated in a three to five month period (Figure 3.5) (Eiten 1982; Sampaio 1995; Tabarelli et al. 2003). The tropical climate combined with low rainfall is a difficult growing environment for plants as they have, “high

potential evapotranspiration throughout the year (1500-2000 mm y^{-1})" (Sampaio 1995:35). This high evapotranspiration potential, or need of the plants for moisture, is not overcome by rainfall, generally leaving the soils and plants with a water deficit (Figure 3.6). At Petrolina, Goiás state, an average yearly rainfall of 336 mm has been reported in comparison to average yearly pan evapotranspiration of 1570 mm (U.S. Climate Prediction Center n. d.). Pan evapotranspiration is the calculated evapotranspiration for a uniform grass reference surface based on the amount of water evaporation off of a class A pan (Allen et al. 1998). The growing conditions of the caatinga favor a different set of plants than those of the cerrado. Caatinga is estimated to have covered between 600,000 and 900,000 km^2 prior to ranching activities (Sampaio 1995).

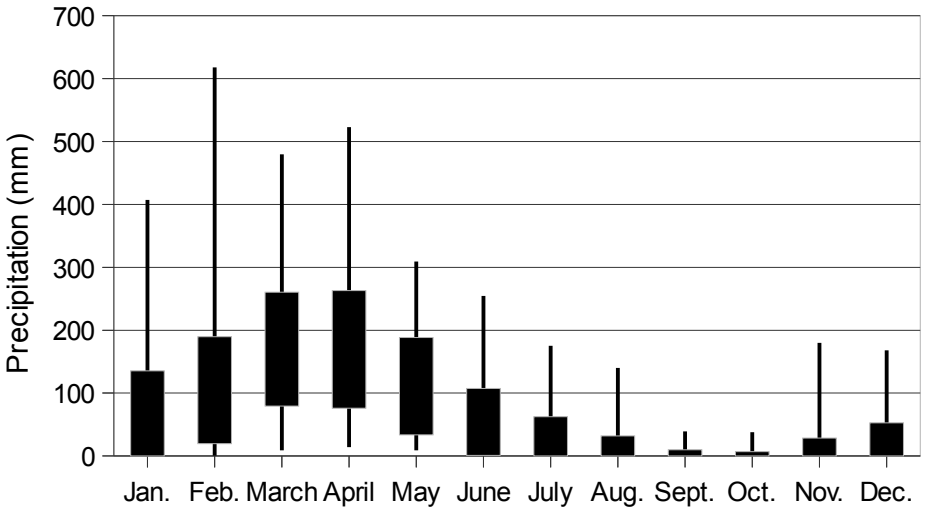


Figure 3.5. Precipitation in the caatinga is very seasonal, as can be seen from the concentration of rainfall between January and May. The lines indicate the range of variation in recorded average monthly precipitation, the boxes indicate one standard deviation from the mean. Precipitation data recorded in Quixeramobim,

Ceará, Brazil between 1896 and 2004. (WMSSC data referenced by Mitchell 2003.)

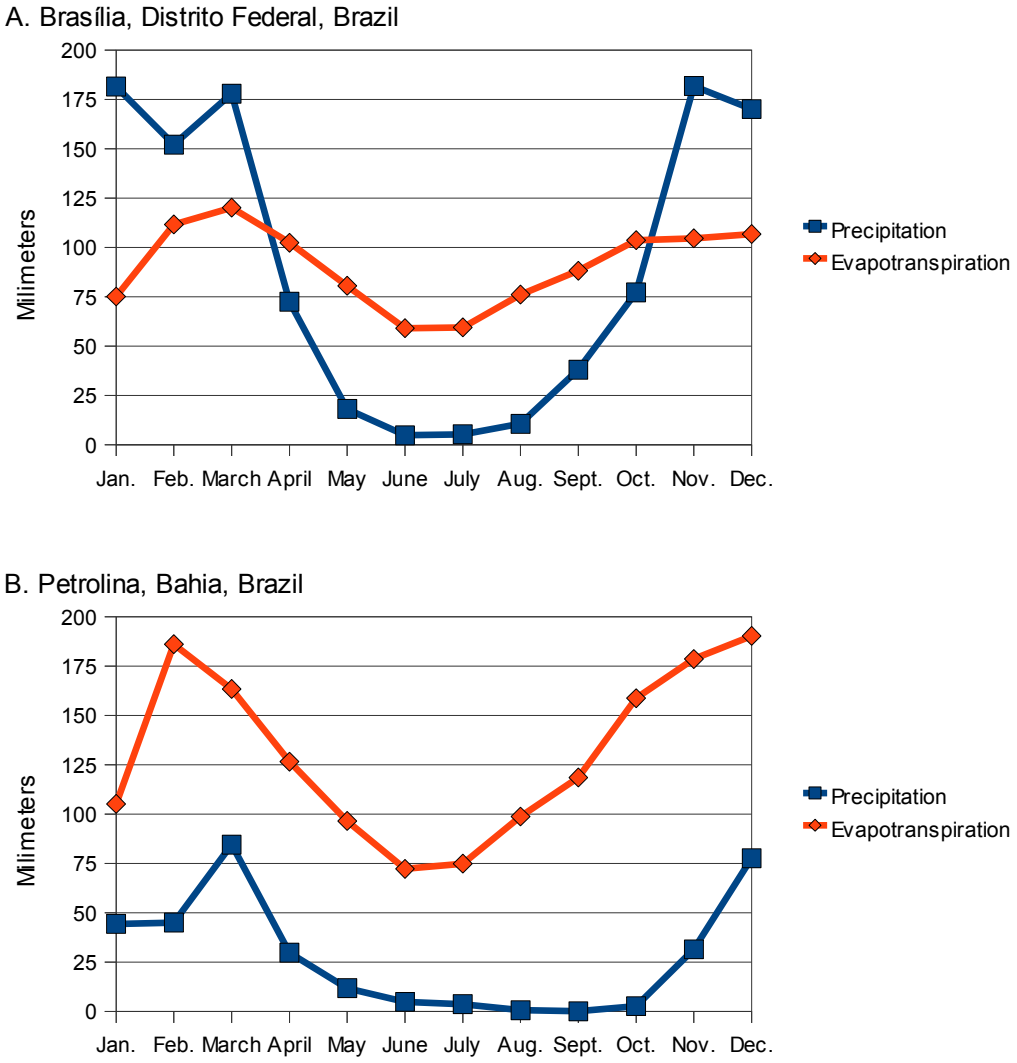


Figure 3.6. Comparison of the average monthly precipitation (mm) and average monthly evapotranspiration (mm) at locales in the cerrado (A) and caatinga (B). The Data acquired from the U.S. Climate Prediction Center (n. d.) for the period from 1987 to 2007.

The inter-annual variation in climate of the Brazilian tropical savannas and seasonally dry tropical forests includes drought cycles. Drought is

classified as a year when rainfall is thirty percent or less of the annual average rainfall (Figure 3.7). In the caatinga, “drought years are common and severe droughts lasting 3-5 years have occurred every 3-4 decades” (Sampaio 1995:35). Drought frequency is unknown for the cerrado.

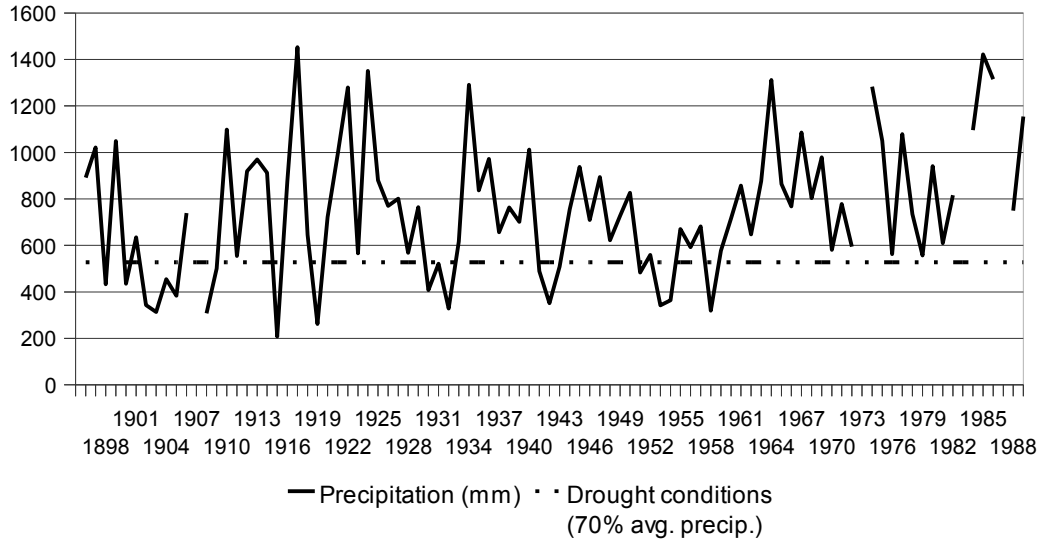


Figure 3.7. Precipitation in Quixeramobim, Ceará, Brazil from 1896 to 1989. This location in the caatinga shows extreme fluctuations in yearly total rainfall, with a record high of 1452 mm in 1917 and a record low of 208mm in 1915. The yearly average precipitation is 753 mm. (WMSSC data referenced by Mitchell 2003.)

Geology

Brazil is old geologically. The central Brazilian plateau sits atop the Brazilian shield. Made of Precambrian crystalline rocks, the Brazilian shield makes up the basement geology of South America. The Precambrian rocks are divided into the Amazonian Craton with northern and southern portions and the São Francisco Craton (Hartman and Medeiros Delgado 2001). Sauer (1950) termed the shield regions the Guiana highlands and Brazilian

highlands due to their higher landscape position. The highlands, composed of very old rocks, are not mountainous and slope slowly into adjoining basins (C. Sauer 1950). Sedimentary basins, overlying lower portions of the shield, are the second major Brazilian geological formations (Figure 3.8). There are three major basins: the Paraíba basin in eastern Brazil, the Paraná basin in southwestern Brazil and the Amazon basin located in northern Brazil. The sedimentary basins have relatively old Silurian to Cretaceous deposits. Geological formations that are old, deeply leached, and have been greatly eroded affect soil composition, available soil nutrients, and landscape relief.



Figure 3.8. Brazil can be divided geologically into crystalline shields and sedimentary basins. The shields rocks are classified as the Precambrian craton and Precambrian orogenic belts, the latter underwent metamorphism. Geologic formations of the sedimentary basins are of Quaternary and Phanerozoic age (IBGE 2006).

Within the major geological units are rocks with different depositional histories. The shield is composed of metamorphic rocks such as amphibolite, granitoids, and schists. Since erosion of these rocks is slow their breakdown does not rapidly release nutrients into the soil. Areas of the shield rocks are

(or were) rich in ores and semi-precious stones (Hartman and Medeiros Delgado 2001). The sedimentary basins contain limestone and dolomite formed during episodes of deposition in shallow oceanic waters. These sedimentary rocks are relatively soluble and quickly erode to clays. Both limestone and dolomite have been subject to the formation of karst topography where erosion occurs by dissolution of calcium carbonate within cracks and layers of a rock formation and leads to the creation of caves and sinkholes (Piló 1989). Most archaeological sites in caves and rock shelters are found in areas with limestone or dolomite formations.

Due to the great antiquity of the geological material underlying modern day Brazil, relief is shallow (C. Sauer 1950). There are no high mountain chains, so plateaus and their escarpments are the prominent features.

> Most of the semiarid area [of the caatinga] is located on the [Proterozoic] crystalline basement which was successively raised and eroded until the Tertiary, forming a large flattened surface of elevations between 300 and 500 m. This surface is divided by higher elevation mountains and plateaus (900-1000 m), respectively representing residual formations of the Proterozoic surface, and the Paleozoic and Mesozoic sedimentary layers [from sedimentary basins]" (Sampaio 1995:38).

The lack of relief has led to fairly stable surfaces for soils. The long-term stability of a soil can contribute to its depth and nutrient content.

Soils

Brazilians soils have been mapped by Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) with a focus on agricultural potential.

Most of the soils of the central Brazilian plateau were originally derived from sandstones or or other rocks rich in silica. Plateau soils in Brazil are old and naturally exhausted (Cole 1960). The soils are neither eroded at a great rate nor enriched by newly weathered parent material, and consequently, soil fertility becomes progressively poorer over time. Where the plateau is bisected by watercourses, the ensuing slopes are subject to erosion, which helps to create soil fertility by removing some of the older weathered soils. In some areas of the caatinga there is virtually no soil and the surface of the ground is stony (Cole 1960).

In northeastern Brazil, caatinga soils are characterized by their low nutrient content. “Soils on the crystalline basement tend to be shallow, clayey and rocky . . . those on sedimentary material tend to be deep and sandy” (Sampaio 1995:38); the first type is more common, but neither is nutrient rich. Caatinga soils are greatly influenced by the local aridity which slows the physical breakdown of the parent material, or underlying rocks. Factors including slope and vegetation cover have produced a great variability in soils from the same parent material, and in combination with the tendency for soil characteristics to change over short distances, it is difficult to make generalizations (Sampaio 1995).

Most cerrado soils are Oxisols, from the technical standpoint of the US Soil Survey classifications. “In Brazilian terminology, the Oxisols are represented by the Latosol group which are characteristically deep (>3 m). well drained, red or yellow, clay-rich, structurally strong but nutrient-poor soils” (Furley and Ratter 1988:101). These physical characteristics are visible on the landscape: road cuts expose great depths of red to yellow soils, and after a rainstorm soils exposed without vegetation will be a clay slick good for taking a car ice skating.

Soil nutrient cations can be taken up by plants' roots from the soil and are held by the negatively charged surfaces of soil particles. The potential of the soil to supply these nutrients is quantified as the cation exchange capacity. “Most cerrado soils are acidic with low cation exchange capacities and high levels of aluminum saturation, which directly affect root systems and indirectly inhibit calcium and phosphorus uptake” (Furley and Ratter 1988:101). Extensive, long term soil weathering and plant uptake remove transportable nutrients, leading to a tendency for soils have high levels of exchangeable aluminum (Ruggiero et al. 2002). This aluminum, a non-nutrient, can be taken up by the plant in its attempts to acquire nutrients. One specific adaptation of cerrado vegetation is tolerance to aluminum toxicity. Tolerant plants store excess aluminum in leaf tissue or occasionally root tissue such that the plant can take up enough calcium and magnesium from the soil to maintain healthy levels of these nutrients (Furley and Ratter 1988).

The low cation exchange capacity of Brazilian soils and their low fertility is a product of long-term weathering of old geological material on a stable land surface.

A basic question of the soil scientists and geomorphologists working in central Brazil has been whether or not soil properties, and specifically soil nutrients, control the phenotype of the cerrado. Soil depth is important as scrub vegetation generally forms where soils are greater than three meters deep. Areas with shallow soils over bedrock tend only to support grasslands with low herbaceous vegetation (Gottsberger and Silberbauer-Gottsberger 2006). While there are no straightforward correlations between soil nutrients and vegetation, there are some important observations. Forest formations are more frequently found on soils with a greater nutrient content and higher pH, with the best correlations occurring in relation to surface soil nutrients (Ruggiero et al. 2002). This correlation with surface soil nutrients can be "explained by the fact that vegetation itself influences soil characteristics at the upper layers, for instance by transferring organic matter through nutrient cycling" (Ruggiero et al. 2002). Thus, while some soil nutrient patterns exist, they may not determine the type of vegetation that is present since they may be products of the overlying vegetation.

Cerrado, a Brazilian tropical savanna

Named for the predominant type of vegetation composed of shrubs and small trees, the cerrado is visibly unmistakeable (Gottsberger and

Silberbauer-Gottsberger 2006, Oliveira and Marquis 2002, Oliveira-Filho and Ratter 2002). "The most characteristic feature of the taller shrubs and trees, and which enables a cerrado to be recognized on sight, is their tortuosity. The trunks are often leaning, and trunks and boughs are almost invariably quite twisted. Most [woody] species have thick corky, ridged bark" (Eiten 1982:31) that provides protection against fire. Within the cerrado there are various physiognomies, or external aspects of the vegetation. Brazilians have characterized the cerrado on the basis of how much herbaceous and woody vegetation is present (Table 3.1). The grassy layer of vegetation is largely overlooked except in opposition to shrubs and trees. Since the classifications are based on phenotypical observations, the quantification of wood vegetation is variable, and the “types” are gradations of one biome across differential soils, slopes, and micro climates.

Table 3.1. Brazilian classification scheme for cerrado vegetation types, derived from Furley 1999, Gottsberger and Silberbauer-Gottsberger 2006, and Oliveira-Filho and Ratter 2002.

Portuguese common name	English translation	Shrub and tree quantities
Campo limpo	Open grassland	None
Campo sujo	Open shrubby grassland	Some shrubs and no trees, <10% canopy coverage
Campo cerrado	Shrubby grassland	Visually dominated by shrubs and low trees, 10-40% canopy coverage
Cerrado sensu stricto	Open canopy woodland	>30-40% canopy coverage, trees generally <8 m in height
Cerradão	Closed canopy woodland	>50-60% canopy coverage

The greatest factor influencing the physiognomy of the cerrado is the soil moisture regime. Deep soils that hold moisture well are the most likely to support woody vegetation (Gottsberger and Silberbauer-Gottsberger 2006). However, predicting cerrado vegetation type on the basis of moisture alone does not work. A list of factors that limit growth of woody vegetation includes: "1) lower soil fertility alone . . . 2) more or longer water-logged soil during the year, or 3) shallower soil alone . . . Other determinants of cerrado structure are geology, soil structure, depth of soil, drainage and topology of soil layers" (Gottsberger and Silberbauer-Gottsberger 2006:61). The effects of soil moisture on plants are also noticed in the botanical realm as various species are known to occur as both shrubs and trees and the form can be linked to available moisture during plant development.

The cerrado is an extremely diverse biome and the number of vascular plant species found within it is still debated. "Mendonça et al. (1998) list 6,429 native species from all communities of the biome. Future investigations will certainly add many species to the list" (Oliveira-Filho and Ratter 2002:105).

Non-cerrado vegetation types

Within the geographic range of the cerrado two distinct vegetation non-savanna forms occur along rivers, gallery forest, and riparian areas. The gallery forests are similar in composition to the tropical forests and thrive along river banks where soil is nutrient rich and the soil water availability is

high year round. During the dry season, gallery forests contain visible, green riparian vegetation in contrast to their dry surroundings. The riparian areas, locally called veredas, are “valley-side marshes where the water table reaches or almost reaches the surface during the rainy season; they are often found in the middle of topographic sequences, between gallery forests and cerrado” (Oliveira-Filho and Ratter 2002:104). Marshes generally form over very shallow bedrock, a common feature in the transition from plateau lands to basin.

Caatinga, a Brazilian seasonally dry tropical forest

The caatinga can be described as “a thorny, deciduous, dry woodland that covers most of the Brazilian Northeast” (Albuquerque, S. 1999:241). Located to the east of the cerrado, it is a continuation of xeric vegetation in a region where rainfall is less and the dry/wet seasonality is more pronounced. A visible characteristic of caatinga vegetation is that trees and shrubs are deciduous, shedding their leaves during the dry season. In addition, while the caatinga is dominated by shrubs, the quantity of cacti and other desert adapted plants is notable (Cole 1960; Albuquerque, S. 1999).

Modern and historical practices of cattle grazing have degraded some areas of caatinga vegetation and heavy grazing often favors the expansion of thorny shrub vegetation into areas formerly covered by grasses (Albuquerque, S. 1999). However, there is much natural variation of caatinga vegetation and high variability of biomass productivity related to rainfall.

> The caatinga vegetation ranges from well-developed stands of dry forest with canopy trees 17 m tall and 2220-28,020 plants ha^{-1} to 5 m-tall scrub types with 619 plants ha^{-1}. Such variation in vegetation structure is conditioned by soil type and topography, human disturbance and, most important, by the amount of annual rainfall . . . In certain regions of caatinga vegetation, the average annual rainfall explained 86% of the variation in the height of woody plants (Tabarelli et al. 2003:198).

From the above description it is apparent that the caatinga vegetation spans a gradient of physical forms, similar to the cerrado; however, the classification of caatinga types is less standardized. Regional differences break the caatinga into “the high thorn forest found in the area known as the Agreste and the low thorny and succulent scrub of the Sertão” (Cole 1960:168). The Agreste is the moister eastern portion near where caatinga meets coastal forests and the Sertão is the drier region on open plains and shallow hill slopes where sometimes there may be a year with no rain (Eiten 1982). Another attempt to classify caatinga vegetation has been based upon soils and topography by the Projeto Radar na Amazônia (RADAM Brasil project):

> RADAMBRASIL divided the caatinga into three types: dense tree steppe, open tree steppe and park steppe. The first type occurs on higher, more humid places, and the second type on the pediplains [joined pediments], where the soils are shallower. The third type occurs in some river valleys . . . (Sampaio 1995:47).

Neither classification system is entirely satisfactory. Two of the major determinants of caatinga vegetation are rainfall and vegetation succession,

as demonstrated in the research of Severino Albuquerque.

Severino Albuquerque's (1999) research was directly concerned with the effect of cattle stocking rates on the caatinga, however his observations concerning precipitation and vegetation progression have great explanatory power. Sixteen of the 29 herbaceous species from a grazing test area emerged and grew in greater quantities when there was greater rainfall, exhibiting a linear relationship between plant frequency and precipitation. Extreme drought caused high rates of shrub mortality. Another variable considered was the effect of excluding cattle. Lack of grazing resulted in less low vegetation, both herbaceous and woody, as taller shrubs came to dominate. "The woody canopy of Caatinga in rest tends to become closed, curtailing the space suitable for the herbaceous stratum" (Albuquerque, S. 1999:244). In the absence of fires or grazing the caatinga vegetation trends toward a closed woodland. (Vegetation succession tending toward woodland is also known for the cerrado based on exclusion experiments (Gottsberger and Silberbauer-Gottsberger 2006)). In this sense the caatinga vegetation varies on the order of tens of years, confounding fixed classification schemes.

Species diversity is another aspect that often distinguishes vegetation regimes through consideration of endemic species, those unique to a particular geographic region:

> In the caatinga, richest woody plant families are Leguminosae, Euphorbiaceae, Compositae, Solanaceae, Boraginaceae and Cactaceae. At present, 322 woody plant species have been recorded for the caatinga vegetation. Among them, at least 57 species are widely distributed among the neotropical dry forests (Tabarelli et al. 2003:199).

While species diversity of caatinga vegetation is somewhat lower than that of the cerrado, these data suggest that a variety of woody species are endemic to the caatinga. The diversity and distribution of herbaceous species within the caatinga is not well documented, leaving us with a very general definition of the caatinga vegetation as it “consists essentially of thorny trees and shrubs which lose their leaves during the dry season, of spiny succulents and of low-growing herbs which come up after rain. It occupies the hot, arid, north-east of Brazil where its distribution is governed mainly by the duration and intensity of drought.” (Cole 1960:172)

Fires and their effects on plant communities

"Fire is a common feature of the cerrados, as it is for most savanna ecosystems. Fires set by man or lightning are common and have been for thousands of years" (Miranda et al. 2002:51). A discussion of the modern use of fire and its effects on cerrado vegetation is the first step toward an understanding of fire's role in the past. “The indigenous people of the cerrado region used fire for hunting, stimulation of fruit production, control of undesirable species and tribal war” (Miranda et al. 2002:51). Modern occupations have changed the frequency and timing of burning, or the fire

regime of the savanna. “Nowadays the principal cause of fire in the cerrado is agricultural, its purpose either to transform cerrado into crop fields or to manage natural (more open cerrado forms) or planted pasture” (Miranda et al. 2002:51).

Seasonality, in part, determines the degree of destruction caused by a fire. Dry season fires are of a higher intensity because of the quantity of dry fuel, low air humidity, and high winds (Mistry 1998). Modern ranching activities promote dry season fires that are highly destructive as herbaceous vegetation is dry and more flammable. The frequency of these fires in prehistory is unknown (Mistry 1998). Comparison of thirty lightning generated fires led Ramos-Neto and Pivello (2000) to conclude that the natural pattern probably did not include dry season fire. The lightening generated fires fell into two categories, small wet season fires and intense transitional season fires. The transitional season fires occurred at the onset of the rainy season with lightning storms setting off abundant dry fuel, but the extent of these burns was controlled by the accompanying rain and natural barriers, areas with almost no fuel because of previous small wet season fires (Ramos-Neto and Pivello 2000). Natural fire frequency for the cerrado has been estimated as being on the order of once every few decades (Gottsberger and Silberbauer-Gottsberger 2006). Wet season fires would have been far more frequent but hard to count because they quickly burn out (Gottsberger and Silberbauer-Gottsberger 2006; Ramos-Neto and Pivello 2000). Lightning has

not been the only cause of fire because human habitation contributed to burning. It has been suggested that fire frequency increased approximately 6000 yr BP and that this may have been a human-driven change (Vernet et al. 1994).

Prescribed burns in the Federal District, Brasilia demonstrate that burning of different cerrado physiognomies removed between 94% and 75% of available fuel, respectively, in campo sujo and cerradão (Miranda et al. 2002). The herbaceous layer is consumed first by fire. Where the maximum flame height was three meters and burning occurred fairly rapidly, some of the woody vegetation could survive, especially if the bark was thick (6 to 8 mm) so that the tree cambium was not killed. Younger, smaller woody plants were more commonly killed [or burnt back] than older, larger individuals (Miranda et al. 2002). These observations are comparable to those made by researchers who found fire consumption of 84% of biomass in campo sujo and 54% of cerrado sensu stricto biomass (Castro and Kauffman 1998). Survival of many woody plants is due in great part to their higher moisture content, (Mistry 1998). However, plant survival also depends on the time since last burning as a greater accumulation of fuel over a longer time interval will lead to potentially hotter fires that could kill larger trees.

Fires appear to have a negative impact on an area; however, many plants survive and prosper in the aftermath of a fire. Many herbaceous plants have subterranean organs that are insulated from fire by the soil and will

send up sprouts within a few days of a fire (Gottsberger and Silberbauer-Gottsberger 2006; Miranda et al. 2002). The insulation of underground plant tissues was supported by measurements of soil temperatures during fires. Coutinho (1982) observed a maximum soil surface temperature of 74°C (165°F), with depths experiencing far less temperature gain, and the return of soils to pre-fire temperatures within an hour. In a seemingly reversed relationship, fire frequently induces flowering in grasses, herbs and orchids (Coutinho 1982; Gottsberger and Silberbauer-Gottsberger 2006; Miranda et al. 2002). Investigation of flowering after fires lead to the observation that many of the same plants will flower after being cut off and that this may be a mechanism for dealing with drought or that these species may in fact be fire dependent (Coutinho 1982). Fire also leads to some seed germination, especially in species with hard seed coatings, and some fruiting as in the Mangaba (*Hancornia* spp.) (Coutinho 1982; Mistry 1998; Mistry et al. 2005)

The frequency of fires contributes to the type of vegetation present in an area. Very frequent burning favors the prevalence of herbaceous vegetation while fire suppression favors the prominence of woody vegetation (Coutinho 1982; Furley and Ratter 1988; Gottsberger and Silberbauer-Gottsberger 2006). Since herbaceous vegetation burns more readily and fires quickly spread over large expanses, the cause and effect between vegetative type and fire frequency is confounded. Fires however do not contribute significantly to soil nutrients. The influx of nutrients due to ash

occurs in the top five centimeters of the soil, is quite temporary, and only benefits herbaceous vegetation with shallow root systems. The net effect of burning is nutrient loss (Coutinho 1982; Mistry 1998). Nitrogen, potassium, sulfur, and carbon are lost during burning. Plant species are sometimes distinct to certain vegetation types. For example, some woody plants characteristic of cerradão are rarely found in open forms of cerrado, suggesting that fire suppression is a key factor to their establishment and health (Furley and Ratter 1988). Increased fire frequency with modern ranching led to changes in plant populations; in particular, a drop in number of species of woody plants has been noted (Hoffmann and Moreira 2002; Mistry 1998). The decrease in species diversity is due in part to the lack of time between burns for woody plant seedlings to get re-established and for mature woody plants to "grow and form a sufficiently thick and fire-resistant bark between fires" (Gottsberger and Silberbauer-Gottsberger 2006:134; Hoffmann and Moreira 2002; Mistry 1998).

The known responses of caatinga vegetation to fire come from experiments with slash-and-burn activities in which the drying time of slashed vegetation was varied. Fires burned more biomass with an increase in the time from slashing to burning. These more severe fires were also harder on the vegetation as fewer of the plants resprouted two months after the fire, an attribute that, in turn, affects the degree of ground cover. Severe fire also

appears to change plant succession as more resilient species recover faster and begin to dominate (Sampaio et al. 1993).

Foods

Foods are directly linked to the environment. What plants can grow in a given area? What animals can survive in a given ecology? For the Brazilian tropical savannas and seasonally dry tropical forests the diversity of plant foods is much higher than the diversity of higher animal species.

Today most of our foods don't look anything like plant parts, but many of them originated as plant seeds, foliage, or fruit. For the human forager, the most basic question is knowing if specific plants are edible. The known edible plants from Brazil are quite varied and numerous. While we have some indications as to which of these occur in the cerrado and caatinga, the current distribution of plant species may be different from the prehistoric distribution. Species ranges expand and contract due to environmental as well as human forces so even if we could accurately portray the plant distribution of 500 BP it would not necessarily be accurate for 1000 BP. As such, species mapping and the distribution of species over time are outside the realms of the current research. Documentation of central Brazilian plant foods focused on two activities, identifying known edible species native to Brazil and compiling the nutritional values for edible species with confirmed occurrence in the cerrado or caatinga. The Brazilian plant species identified as edible are documented in Appendix A. A compilation of nutritional data is

presented in Table 3.2. The number of plants for which nutritional values have been calculated is limited.

Table 3.2. Nutritional value of cerrado plants on the basis of 100 g of edible tissue (data presented by Franco 1992 and Silva, Dijalma et al. 2001).

Plant species	Common name	Plant part	Calories	Sugar (g)	Protein (g)	Fat (g)
Acrocomia aculeata	Palm	kernel	243.0	28.0	4.4	27.9
Anacardium othonianum	Cashew nut	seed	556.0	37.9	17.9	37.0
Anacardium othonianum	Cashew fruit	peduncle	36.5	8.4	0.8	0.2
Ananas ananassoides	Wild pineapple	berries	56	13.5	0.4	0.1
Annona crassiflora	Custard apple	fruit	52.0	10.3	0.4	1.6
Attalea speciosa	Palm	kernel	313.0	13.3	3.9	29.5
Bromelia balansae	Heart of flame	fruit	51.0	13.5	0.6	0.1
Brosimum gaudichaudii	Mamacadela	fruit		5.0	2.0	
Byrsonima verbascifolia		fruit	60.5	11.7	1.4	1.2
Campomanesia cambessedeana		fruit	64	13.9	1.6	1.0
Caryocar brasiliense	Pequi fruit	endocarp		6.8	1.0	10.0
Caryocar brasiliense	Pequi nut	seed	89.0	21.6	1.2	0.9
Dipteryx alata	Barú	mesocarp	616.7	25.5	26.3	
Eugenia calycina	Pitanga	fruit	46.7	6.4	1.0	1.9
Eugenia dysenterica	Cagaita	mesocarp		5.0	0.5	
Eugenia klotzschiana	Cerrado pear	fruit			4.9	
Genipa americana	Jagua	fruit	81.7	18.3	1.2	0.4
Hancornia speciosa	Mangaba	fruit	47.5	10.5	0.7	0.3
Hymenaea stigonocarpa	Jatobá	seed pod pulp	115.0	29.4	1.0	0.7
Inga spp.	Ingá	seed pod pulp	97.7	21.6	2.6	0.1
Mauritia flexuosa	Palm	kernel	114.9	2.2	3.0	10.5
Orbygnia phalerata	Babaçu palm	kernel	334.3	13.3	3.9	19.5
Pradosia brevipes	Armadillo fruit	fruit		81.8	11.8	
Psidium firmum	Brazilian guava	fruit	37.8	8.0	1.0	0.2
Solanum lycocarpum	Lobeira	fruit	345.0	86.0	9.5	
Spondias mombim	Cajá-mirim	fruit				
Syagrus oleracea	Palm	heart			5.6	

Cerrado animal populations have many more small mammals than large mammals and are generally characterized by low population densities. Cerrado mammals are dominated numerically by bats (81 species) and rodents (51 species) (Lacher and Alho 2001; Marinho-Filho et al. 2002). The total number of species is 194 and there are no large herd animals represented. "In general, this fauna is composed of small-sized animals: 85% of the species have body masses no greater than 5 kg, and only five species weigh more than 50 kg" (Marinho-Filho et al. 2002:267,275; Table 3.3). Cerrado mammals are not significantly distinct from those found in other areas, "only 18 species may be considered exclusive to this biome" (Marinho-Filho et al. 2002:277). In terms of food productivity, mammals would not be great resources as the majority are small in size and infrequently encountered and the largest mammals are quite rare (Table 3.3). "The great majority of cerrado mammalian species have wide distributions, and, although the total number of individuals for a given species may be considered high throughout the entire range of the biome, most species tend to be locally rare" (Marinho-Filho et al. 2002:276). Thus, for indigenous populations, the scarcity of animal species would have made hunting a time-consuming endeavor and the majority of species encountered would be very small mammals.

Table 3.3. Mammals of the cerrado that can have weights above 10 kg (22 lbs). Data from Marinho-Filho et al. 2002.

Animal species	Common name	Animal weight range (kg)	Rare or abundant
Myrmecophaga tridactyla	Giant anteater	22-40	rare
Priodontes maximus	Giant armadillo	30-60	rare
Chrysocyon brachyurus	Maned wolf	20-30	rare
Lontra longicaudis	Neotropical otter	5-15	rare
Pteronura brasiliensis	Giant otter	24-34	rare
Leopardus pardalis	Ocelot	8-15	rare
Panthera onca	Jaguar	30-150	rare
Puma concolor	Cougar	30-120	rare
Tapirus terrestris	South American tapir	200-250	rare
Pecari tajacu	Collared peccary	17-30	rare
Tayassu pecari	White-lipped peccary	25-40	rare
Blastocerus dichotomus	Marsh deer	100-150	rare
Mazama americana	Red brocket deer	24-50	rare
Mazama gouazoupira	Brown brocket deer	13-23	abundant
Ozotoceros bezoarticus	Pampas deer	28-35	rare
Hydrochaeris hydrochaeris	Capybara	35-65	abundant (near water)
Agouti paca	Lowland paca	5-13	rare

The caatinga is similar to the cerrado in that the number of mammalian species is limited, bats make up the majority of mammal species, and few species are endemic to the caatinga (Sampaio 1995). One study reported 86 species for the caatinga, but this number may be high because those species living in human created habitats such as agricultural fields were included (Sampaio 1995).

Human geography

Brazil was home to a great diversity of ethnic groups at European contact. One of the best markers of this diversity comes from linguistic evidence. For central Brazil the linguistic data are particularly important as

ethnographic material is patchy at best. Well known ethnographies of indigenous Brazil come from the Amazonian environment.

Linguistic stocks found in Brazil are the macro-Jê, macro-Tupi, Karib, and Arawak, alongside a number of languages from isolated or minor families (Urban 1992). Brazil was a complicated place linguistically, with many families and linguistic stocks territorially interspersed. In a general sense, central Brazil strays from this complexity with almost all languages deriving from the macro-Jê linguistic stock. The northern margin of central Brazil had a linguistic mix, possibly as a result of greater contact with the multitude of Amazonian groups. Within the macro-Jê stock are the families Jê, Karajá, and probably Bororo (Urban 1992). These language families are reflected in the extant indigenous population:

> When the Portuguese colonisers [sic] arrived in Brazil, hundreds of indigenous ethnic groups inhabited the *cerrado* region. These itinerant ethnic groups probably had no contact with Europeans until about the year 1650 (Ribeiro, 2002), when the 'bandeirantes' - Portuguese men and their descendants who penetrated and opened up unknown centers of the country searching for minerals and slaves - arrived. From then on, their populations have been severely reduced (to less than 10 per cent of the initial number) by diseases and conflicts, and nowadays, about 45,000 individuals of 26 ethnic groups live in the *cerrado*, mainly in federal indigenous reserves. Most of them belong to the linguistic families Jê (Xavante, Krahô, Akroá, Kayapó, Kanela, Goyá, Xerente, Gavião), Karajá (Karajá, Javaé, Xambioá), Aruák (Terena, Pareci), Bororo (Bororo, Umutina) and Tupi-Guarani (Apiaká, Avácanoeiro, Guajajára, Kaiabi), as well as several smaller groups (Barbosa and Schmiz, 1998: ISA, 2004). [Pivello 2006:131]

Moving out of the cerrado, the caatinga is a location of linguistic diversity with many isolated languages (Urban 1992; Dantas et al. 1992).

While linguistic heritage does not indicate cultural heritage, these patterns suggest that the populations of the cerrado were related to other groups living in the same environment while those populations from caatinga were potentially more isolated.

Colonial and early Brazilian history determined the fate of many indigenous groups and thus our current knowledge of the indigenous cultures. The Xavante who now live in the Amazon forest of Mato Grosso were inhabitants of the cerrado in Goiás before they began to move, motivated by a desire to avoid contact with the Portuguese (Silva 1992). *Bandeirantes*, explorers from Portuguese settlements on the coast who sought riches and prime farm land, explored the state of Goiás extensively from 1720 to 1730. As the region was subsequently settled and minerals extracted, indigenous groups are mentioned in the documented accounts when they threatened mining or mining cities (Karasch 1992). With the decline of mining around 1780, the interior of Goiás was transformed into an area of agriculture and ranching with labor supplied by indigenous slaves as the African slave trade was in decline (Karasch 1992). While the exact timing of events varied across central Brazil, the history of colonial contact in Goiás followed a common trajectory.

The opening by the Portuguese of the states of Minas Gerais and São Paulo to widespread mineral extraction and plantations, beginning in the late 17th century, led to the displacement, death, or enslavement of indigenous people. Enslavement often occurred in the context of missions and options for the indigenous were bleak (Lopes da Silva 1992; Karasch 1992). "The political ideal of indigenous policy in Goiás at the end of the 18th century, was to liberate the captaincy of the non-assimilated Indians and at the same time bring them under the authority of church and state as 'children'" (Karasch 1992:397, my translation). Brazilian independence changed policies such that indigenous peoples should ideally become agricultural workers (Karasch 1992). Central Brazil´s indigenous population was culturally and demographically impacted by centuries of co-habitation with Portuguese and Brazilians and, as such, the ethnographic record for this region is virtually non-existent.

In the northeast, the caatinga did not yield riches or easily developed agricultural land. Beginning in the early 17th century cowboys began using the expanses of scrub vegetation to raise livestock necessary to feed workers on sugar plantations on the coast. The local, indigenous subsistence was undermined by grazing and some indigenous populations were displaced. At regional missions there were complaints about the native people; their linguistic diversity in combination with the indigenous tendency to nomadic practices made conversion efforts difficult (Dantas et al. 1992).

In modern Brazil the remnant indigenous territories fall under federal jurisdiction and are managed by Fundação Nacional do Índio (FUNAI). This foundation provides information on the modern populations. The majority of modern indigenous communities and territories are located in the Amazon basin. (Figure 3.9).



Figure 3.9. Indigenous populations in Brazil are recognized by the Fundação Nacional do Índio. Indigenous communities and territories both formally and informally recognized are represented here (IBGE 2008).

While ethnographic data do not exist for most of central Brazil, some mid 20th century authors might lead one to think otherwise. In *The Handbook of South American Indians* the majority of central Brazilian indigenous populations were classified as "marginal" (Steward 1949). "The Marginal peoples were distinguished by their lack of farming and their generally simple cultures" (Steward 1949:671). An element of environmental determinism can be seen in this prognosis. "Because the Marginal tribes lived in areas of limited resources and had elementary exploitative devices, the size and composition of their groups and many of their institutions had to be adapted to subsistence needs" (Steward 1949:672). Steward goes into greater detail explaining the environmental limitations that prohibited food storage, necessitated great mobility, and led to farming not being productive. Steward´s reasoning can be critiqued for his theoretical viewpoint. However, the authoritative nature of his descriptions should be juxtaposed with the fact that the few groups remaining for ethnographic scrutiny had seen hundreds of years of contact and extant groups predominantly inhabited the northern edge of central Brazil, farther removed from Portuguese and Brazilian habitations until the 20th century.

Lowie (1946) noted that multiple Jê speaking groups shared subsistence practices, with agriculture occurring less intensively than in groups of the tropical forest. Other food collection activities were more important. Agricultural cultivation included cultivating manioc, maize, sweet

potato, yam and native cotton; clearings were only made in gallery forest (Lowie 1946). Among Kayapó men economic activities included hunting, fishing, and collecting Brazil nut, pequi (*Caryocar brasiliensis*), and babaçu (*Attalea speciosa*, an oil rich palm nut) (Turner 1992).

Indigenous food knowledge

Ethnobotanical accounts provide some information on which edible foods were considered important. The Šere´ente of the Jê linguistic family occupied a region between the São Francisco River and Tocantins River drainages. Curt Nimuendajú (1942) collected ethnographic data in 1930 and 1937 among the Šere´ente and their neighboring tribe the Šava´nte-Akwẽ who are distinguished politically, but not linguistically. They practiced a mixed economy of horticulture, hunting and gathering. The ethnographic data has no ethnobotanical information, except the following on the importance of palm species:

> The two most important wild plants are the burity palm (*Mauritia flexuosa*) and the babassú palm (*Orbignia speciosa* [now *Attalea speciosa*]). The split leaflets of the burity offer so important and so widely usable a material in basketry and for tying that it is hardly possible to picture the ancient Šere´ente without burity. The fruits of this palm, while also important as food, are not indispensable. The reverse holds for the babassú. Most important are its extremely oily seed kernels, next in utility its leaflets employed for matting and decoration. Now, the stands of burity and babassú near the fixed villages were not free for general use, but divided up among the four societies. Trespass formerly precipitated brawls between the associations concerned (Nimuendajú 1942: 62).

Indirect knowledge of indigenous plant usage is a more plentiful source of data. During colonization, Portuguese colonists and slaves of African descent learned plant knowledge from indigenous groups, drawing some of the knowledge into the mainstream culture. For central Brazil the long-term ramifications of contact can be seen in the incorporation of native foods into regional and national cuisine. One of the most prominent examples is the consumption of pequi (*Caryocar brasiliense*), a plant that still grows wild across central Brazil and is highly prized in local recipes. Many modern communities also hold beliefs about medicinal properties of plants that potentially derive from indigenous sources. In a survey of urban women in Goiânia, Goiás, Rizzo et al. (1990) found that a majority of women used medicinal plants and many of these plants were native. In all districts surveyed more than 80% of the population used medicinal plants and they acquired them by either growing them or acquiring them at market (Rizzo et al. 1990, 1999). Other researchers have similarly found that rural populations utilize a great number of plants from the caatinga and, while there are a variety of uses for native plants, medicinal uses are quite numerous (Albuquerque, S. 2006; Albuquerque and Andrade 2002b; Albuquerque, U. et al. 2005). While knowledge of local plant utility likely has indigenous roots, the richness of past indigenous knowledge is likely underrepresented as much was lost in the process of colonization (Clement 1999b).

Indigenous practices of plant and fire management

Fire to manage vegetation in the cerrado is the major ethnographically reported activity. The Krahô used fire in multiple aspects of land management, including to protect crop plots and cerrado from intense fires and encourage tree fruits.

> Protective burning is principally centered around the swidden plots. As soon as fuels begin to cure in the early dry season (mid-April/May), low intensity fires are set around the plots and the adjoining gallery forest so as to create a buffer from high intensity late-season fires. A thicket-forming type of cerrado ... is also protected by early dry season burns as it is rich in fruiting trees as well as many animals (Mistry et al. 2005:371).

> Resource enhancing fires are set to stimulate fruiting and fresh grass. Areas that have a particularly high density of fruiting trees are burned in the early dry season, normally April or May, to promote flowering and the consequent production of fruit. These are a crucial component of Krahô nutrition during the dry season. We observed *Mangaba* (*Hancornia* spp.) trees whose surroundings had been burned in the early dry season and were laden with fruit, and trees of the same species whose surroundings had not been burned and had very little fruit on them (Mistry et al. 2005:372).

Other functions of fires included driving game animals, keeping areas clean of high vegetation so that people would not be bitten by snakes, and smoking out bees to retrieve honey.

While fires to protect vegetation are normally close to the villages, planned by the men, and occur on frequent time intervals, the Krahô also engage in unplanned burning. One informant, Feliciano Tephot, pointed out that areas away from the village are sometimes intentionally burned, "at

times, four or five years pass that no-one goes there, except a hunter, to hunt deer, and at the time he passes there he sets fire, to clean, because if–I think this–if you leave a place, a space for a long time, it can catch fire and kill trees. It kills, it doesn´t clean underneath" (Mistry et al. 2005:375)

It has been suggested that the Krahô practices of differing fire histories create a patchy landscape that may benefit "the maintenance and enrichment of biodiversity through the creation and preservation of a variety of microhabitats that support different species" (Mistry et al. 2005:381).

Ethnographic evidence for landscape management in the tropics indicates that swiddens play an important roll in the establishment of horticultural and agricultural fields. Slash and burn agricultural practices are reported for the Kayapó in their use of the rain forest but not for surrounding regions of dry forest and cerrado (Posey 1985, 2002). The Krahô practice swidden agriculture but only within gallery forests, locations along rivers with vegetation similar to the composition of the rainforest (Mistry et al. 2005). Swiddens appear to be created preferentially in forested areas with good water availability, and the cerrado vegetation regime is an unlikely candidate for this form of plant management.

Posey (1985, 2002) observed that the Kayapó managed the cerrado by creating forest islands. These locations were ethnographically documented as human constructions in 75% of cases. Maintenance included

transporting nutrient rich soil, planting of seeds and seedlings, and felling of trees to let in light (Posey 1985, 2002). Of the plants in forest islands, 85% had been intentionally planted and almost all had recognized uses (Posey 1985). Analysis of identified plants supported the anthropogenic origin of these forest islands as only 25% of species were identified as coming from the cerrado (Gottsberger and Silberbauer-Gottsberger 2006). Further plant management reported by Posey (1985, 2002) included extensive planting of seeds and seedlings along established trails. The sum of these practices would indicate an extremely profound human impact upon the cerrado and rain forest environments as well as a method for modern society to deal with environmental degradation of the same zones, both results widely publicized by Posey.

The validity of Kayapó management practices are convincingly questioned by Parker (1992), especially in regard to the creation of forest islands. Parker (1992) carried out ethnographic work and made botanical collections at the same community where Posey had previously worked. A survey of the species diversity between a "managed" forest island and one that occurred in the savanna away from human habitation found no significant differences in plant diversity or types. The habitat of origin for plants in forest islands was determined to be local on the basis of the collection used by Posey as a reference. "The Museu Goeldi´s own herbarium collection clearly and definitively demonstrates that the species

found by Posey and Anderson in their study area were precisely those *commonly found in such areas*: the disturbed margin of a savanna and forest transition" (Parker 1992:416, emphasis in original). A further doubt was raised when Posey´s key informant identified 47% of the "managed" forest island plants collected by Parker as useless and approximately 10% more to serve only as food for birds (Parker 1992). The Kayapó deny creating the forest islands.

Chapter 4. Archaeologically recorded occupation of central Brazil

Caves have an almost mythical lure to archaeologists. Early exploration of the American west focused on caves due to the magnificent conditions of preservation. Examples include the work of Luther Cressman in Oregon and Jesse Jennings in the Great Basin. The list of caves and rock shelters that have been the foci of excavation is extensive. The seemingly mythical draw of caves to the archaeologist has been a strong guiding force to archaeology on the Brazilian savanna. For Brazilian researchers well preserved strata, rock art (generally pictographs) and human burials were attractive aspects of cave archaeology.

The regions of central Brazil with substantial archaeological projects include Lagoa Santa (Minas Gerais), Serranópolis (Góias), Santa Elina (Mato Grosso), Peruaçu (Minas Gerais), São Raimundo Nonato (Paiuí) and Serra Geral (Bahia) (Figure 4.1) (Martin 2005, Prous, ed. 1992/93, Prous and Malta, eds. 1991; Prous and Rodet, eds. 2009; Schmitz et al. 1986, 1989, 1996, 2004; Vialou, ed. 2005, 2006). In addition to academic projects, Brazilian cultural resource management law has led to extensive projects in association with railroad and dam constructions. The quantity of gray literature on archaeological interventions is growing rapidly. The focus in this chapter will be on some of the major trends in archaeological research as

reflected in major academic projects. The majority of the sites excavated by academic projects are in rock shelters.



Figure 4.1. Regions of central Brazil that have been foci of substantial archaeological investigation.

Driving questions behind research in central Brazil have included constructing cultural history, documenting early Holocene human

settlements, analyzing lithic technology, and documenting rock art traditions. Evidence for indigenous diet is also surveyed as it is directly relevant to this research project.

Cultural chronology

Cultural chronology has been constructed almost exclusively based on technology in central Brazil. Martin (2005:155, my translation) suggested that human behavior and social organization, rather than technological changes in material culture should be used to construct chronology:

> The isolated classification of objects does not lead anywhere and does not serve to reach an understanding of human facts and socioeconomic behavior. The modern tendencies in archaeology and of the new Brazilian archaeologists, who are engaged in opening new paths, propose, aside from inferring human behavior by studying the archaeological register, that also the attempt should be made to define ethnic units.

These new directions would require an in depth analysis of rich archaeological assemblages and theoretical positioning to guide fieldwork. And, as the data do not speak for themselves, hypotheses would need to be formulated and empirically tested (Martin 2005).

Due to the long tradition of data collection related to technological units, the research discussed will focus on cultural chronology produced within projects that utilized the framework of culture history. This framework and the focus on technological assemblages has led to large, regional generalizations. Culture history reconstructions have focused on rock

shelters, which have distinct advantages for establishing regional chronologies. These locations often contain discrete strata that allowed for the temporal organization of cultural remains, even without radiocarbon dates. In central Brazil pivotal studies in cultural chronology came from the work of Schmitz and colleagues. The cultural chronology of central Brazil, based on sites in southern Goiás, especially in the Serranópolis region, documented changes in material culture.

The Serranópolis region has many archaeological sites in sandstone rock shelters where rock art and surface artifacts led to recording, survey, and excavation. Stratigraphic positioning of artifacts from excavation at three sites was the basis for the cultural chronology. Schmitz et al. (2004) described the boundaries between the phases as abrupt; however, as excavation was conducted in artificial levels, topographic changes within the rock shelters mixed the assemblages that were subsequently studied and analyzed in the laboratory. The chronology was composed of three phases, the dates for which are approximate: Paranaíba (11,000 to 8500 BP), Serranópolis (8500 BP to the time of Christ), and Jataí (500 AD to colonization) (Schmitz et al. 2004). This chronology was modified for central Brazil from that proposed by Schmitz (1987) for Brazil as a whole, the later of which was critiqued by Kipnis (1998) as a mimic of North American chronological changes in subsistence strategies: big-game hunters to widespread foraging to agriculturalists.

Lithic technology was an important aspect to describe distinct phases. Projectile points only existed in the Paranaíba phase. Other bifaces and limaces (unifacial, slug-shaped tools) also pertained, almost exclusively, to this early phase. Artifact modification and shaping were common in the Paranaíba phase and probably led to the larger quantity of debitage found in association with these occupations. The lithic industry changed in the Serranópolis phase as tools were less modified, moving away from bifacial pieces. Alongside the move to a less formal tool industry, hammerstones and cobble supports became most numerous in the Serranópolis phase. The majority of the tools were based on irregular flakes with little retouch (Schmitz et al. 1986, 1989, 2004). The Jataí phase lithic industry was similarly informal with many retouched flakes that, by morphology, fit into a specific tool type category. A signature artifact of the Jataí phase were small spindle-shaped groundstone tools. The Jataí phase also contained pottery that served as its identifying characteristic more so than the lithics,.

Analysis of faunal remains from the Serranópolis region sites led to a broad characterization of economy (Schmitz et al. 2004). During the Paranaíba phase subsistence was defined as generalized hunting on the basis of diversity in faunal species. The Serranópolis phase assemblages contained many gastropod remains, indicating a time of crisis when gathering gastropods as well as hunting made up the diet (Rosa 2004;

Schmitz et al. 1989, 2004). The Jataí phase marked the colonization of the region by incipient cultivators who also engaged in food collection.

From lithic technology and faunal remains in the Serranópolis region and site characteristics in the Caipônia region, it has been suggested that the population during the Serranópolis phase was more sedentary than that of the Paranaíba phase. One of the reasons for this suggestion is that rock art, thought to date to the Serranópolis phase, shows regional variation. Rock art is interpreted, in part, as a marker of territoriality, which would not have been necessary in the Paranaiba phase when population density was sparse and the majority of central Brazil was linked by a single lithic tradition (Schmitz et al. 1989, 2004). Greater sedentism reportedly occurred with horticultural occupations across central Brazil. The Jataí phase occupation is generally associated with a type of ceramics known as the Una tradition. In the Serranópolis region the Jataí phase occupations are reported from within rock shelters (Schmitz et al. 2004). In some regions of central Brazil more than one ceramic tradition has been documented, and the later is often associated with additional changes in settlement. Some open air archaeological sites in the Caiapônia region are documented as large horticultural villages, on good land, with ceramics of the Aratu tradition (Schmitz et al. 1986). The cultural chronology elaborated by Schmitz and colleagues documented continuous human habitation of central Brazil. The relatively stable population might have been disrupted at the time when later

ceramic types were introduced if population migration accounted for the large habitations, such as those found in association with the Aratu tradition ceramics (Schmitz et al. 1986, 1989, 2004).

While the cultural chronology was meant to have been used as a model, some artifact types described by Schmitz et al. (1989, 2004) have been used in a manner similar to geological type fossils. The limace is the formal tool generally used as an archaeological type fossil, a tool characteristic of a particular era used to define a specific period or culture. Limaces of the Serranópolis region were *almost all* found in the Paranaíba phase and have thus been used as a marker of early habitations (Schmitz et al. 2004, emphasis mine). A subdivision of the Paranaíba phase, the Itaparica tradition, has been recognized in the Brazilian northeast on the basis of limaces made of chert, silicified sandstone and chalcedony (Martin 2005). Limaces have been found in the regions of Serra Geral, Central Bahia, Sobradinho, Itaparica, and the São Francisco River Valley (Martin 2005). The majority of archaeological strata from these sites that contained limaces have not been directly dated to validate the temporal placement. While limaces are an example of clear morphological patterning (Kipnis 1998, Rodet, M. 2009), their temporal specificity has been questioned. In north-central Minas Gerais, tools in the limace forms are found in Late Holocene contexts (Isnardis 2009).

A continuous occupational history of central Brazil is rejected by researchers in some regions where they have observed hiatuses in site occupation based on radiocarbon dating. The areas of Lagoa Santa and Montes Claros are the primary examples of discontinuous occupation (Araujo et al. 2005, Bueno 2008). The hiatuses have been interpreted as the regional movement of populations due to increasingly dry environmental conditions (Araujo et al. 2005). Other regions with apparently broken chronologies, such as Caiapônia have not been interpreted as representing abandonment as survey does not fully encompass possible site locations (Schmitz et al. 1986).

Early Holocene humans in South America

Brazilian archaeologists' fascination with caves is often traced to Peter William Lund. Generally considered to be the father of Brazilian paleontology, Lund, a Danish native, excavated paleontological remains from the Lagoa Santa region of Minas Gerais between 1834 and 1844 (Hurt 1960, Prous 1991a). In the process of his excavations, Lund also discovered human remains at the sites of Sumidouro, Lapa Vermelha, and four others (Hurt 1960). Lund claimed that human remains from Sumidouro had been deposited in association with megafauna; the human remains were encountered disarticulated. At the neighboring Lapa Vermelha human remains and fossil animals came from separate strata (Hurt 1960). In light of the catastrophic theories of evolution prevalent in Europe at the time, Lund's

discoveries were discredited on the chance that the depositional contexts at Sumidouro were later mixed, and this remains a possibility since water flows through Sumidouro (Hurt 1960, Prous 1991a).

Other researchers were fascinated by Lund's finding of human burials, especially as the prevailing scientific theories changed toward Darwinian evolution. In 1926 and 1929 Padberg Drenkpohl excavated at the site of Confins, another rock shelter in the Lagoa Santa region (Prous 1991a). Confins yielded human burials, but none in association with remains of Pleistocene megafauna. Likewise, Harold V. Walter was drawn to the Lagoa Santa region to gain greater knowledge of the association between extinct mammals and human habitation. His excavations began in 1933 and were in cooperation with Arnaldo Cathoud and Anibal Matos (Prous 1991a). One of the notable discoveries was made in 1935, "near a fragment of a horse skull and three molars and a part of a femur of a young mastodon he encountered a broken skull and other bones of a human skeleton" (Hurt 1960:573). The intact chronological position of these remains and those of the magafauna has been questioned upon the basis that a secondary cave entrance could have washed materials into the back portion of the cave (Hurt 1960). In 1958, H.V. Walter published his conclusions from the excavations of seven archaeological sites, but no dates were forthcoming as, "C14 (active radio carbon) testing, is very costly, and samples of material have to be sent at present to North America for analysis" (Walter 1958:196). Furthermore, these

researchers made no systematic collections, keeping only the the best pieces, making it difficult for their work to be reanalyzed (Prous 1991a).

Hurt (1960) was involved in a 1956 excavation campaign which included 8 rock shelters in Lagoa Santa. Lithic artifacts failed to reveal stratigraphic variation beyond what could be considered as random. Human remains were found, but not in association with megafauna:

> In none of the caves excavated in 1956 was there any evidence whatsoever that man was contemporaneous to the extinct Pleistocene animals such as horse, cave bear, or ground sloth. In the Gruta da Lapa do Chapeu a tooth of a mammal tentatively identified as a camel was found in a bed containing sherds, clearly an example of secondary deposition. In the other caves and rock shelters the fossil bones lay below the strata containing human bones and midden deposits (Hurt 1960:583-584).

The human remains were predominantly found interred in a completely flexed position with the head near the knees.

The area of Lagoa Santa has continued to yield research results. An influential project, with an emphasis on human skeletal morphology, has been conducted by Dr. Walter Neves. Cranial morphology has been used as an indicator of genetic similarities and thus the biological affiliation of Early Holocene human populations of Lagoa Santa. An early study within this project drew together morphological data on human remains from six sites dating between 12,000 and 6000 BP. In comparison to Late Pleistocene/ Early Holocene human populations from other areas of the world, the

remains from Lagoa Santa showed a marked biological similarity with those of early Australians. This result was not interpreted as evidence for a trans-pacific migratory route, but rather that both populations were derived from one from Asia (Neves and Pucciarelli 1991). Morphologically non-Mongoloid human remains found in the Americas would suggest that this early American population migrated prior to the definition of Mongoloid morphology in northeastern Asia (Neves and Pucciarelli 1991; Neves et al. 1999). A collection of eleven early Holocene North and South American crania has also been compared to those found at American archaic period sites. Of the Early Holocene samples, only one cranium probably belonged to the archaic population (Powell and Neves 1999). The genetic distance, as represented morphologically, between the early and late population samples was examined in regards to genetic drift (Neves et al. 1999). As genetic drift did not sufficiently explain the genetic diversity, it was proposed that the Early Holocene remains came from a distinct migration. A fourth wave was added to the existing three wave model for migration and population of the New World (Neves et al. 1999, 2003, 2004; Powell and Neves 1999).

Other publications by Walter Neves and colleagues (1999, 2003, 2004) detail the specific affinities of crania from individual sites. Comparison of cranial morphology was used to explore inter-population biological affinities. A skeleton from Lapa Vermelha IV, found between strata dating to 10,220 and 12,960 BP (uncalibrated, and with a minimum date of 9,330±60

BP) was found to exhibit morphological affinity with African and South Pacific populations (Neves et al. 1999). At Santana do Riacho, six of the forty burials dating between 8000 and 10,000 BP had crania complete enough to be measured (Neves et al. 2003). From the same time period, 8000 to 10,000 BP, the site of Cerca Grande produced nine crania (Neves et al. 2004). Human remains from both sites had their closest morphological affinity with modern populations from Africa and Australia (Neves et al. 2003, 2004)

Prous (ed. 1992/93) proposed that the great similarity in burials from Santa do Riacho, Minas Gerais, was an indicator of endogamy. This position has been countered by Neves and Atui (2004) who suggest that the populations of Lagoa Santa were not homogeneous. Utilizing craniometric variables they suggest extreme inter-population variability, greater than that found in many modern populations. The variability was reported to be due to a migratory and small group lifestyle, as opposed to a sedentary lifestyle. As a similar cranial morphology to that found in Lagoa Santa has been detected across the South American continent, the Lagoa Santa population was not geographically isolated (Neves and Atui 2004). Measurements of cranial morphology from populations outside of Lagoa Santa were not included in the study.

Aside from projects focused on human remains from Early Holocene inhabitants of Brazil, diverse projects have documented sites from the Terminal Pleistocene to Early Holocene transition. Sites in the Brazilian

states of Minas Gerais, Mato Grosso, Rio Grande do Sul, São Pualo, Goiás, Pará, Pernambuco, and Piauí provide significant evidence for widespread human habitation (Kipnis 1998, Prous and Fogaça 1999). These sites have securely dated archaeological strata from 12,000 to 10,000 BP (from uncalibrated radiocarbon dates) with flaked lithic assemblages and hearths, as well as, at some sites, pigments, food remains, bone instruments, and ground stone.

An idea that highly formalized, bifacial technology should have been found at early Holocene habitations of Brazil has overshadowed the actual evidence. While lithic technologies varied across Brazil, "during the Early Holocene, no fluted point or leaf shaped projectile point Horizon is known" (Prous and Fogaça 1999:37):

> In sum, early human occupation of eastern South America is characterized by generalized foragers, very different from the 'big-game' hunters in North America. Plant resources, both as food and as raw material for tool manufacture, were very important. A clearly diverse lithic assemblage is not geared towards hunting activity (Kipnis 1998:590).

Brazil was clearly and widely inhabited in the Early Holocene and there is convincing evidence that the population that lived in the Lagoa Santa region was biologically distinct from Late Holocene, indigenous American populations.

Technology and population

As lithic and ceramic technologies have been major foci of analysis in central Brazil, it is from these artifacts that hypotheses about the populations who inhabited the area have been formed. One major study of lithic technology from the region of Serranópolis has been discussed above as it informed upon the creation of a regional cultural chronology.

Lithic assemblages across central Brazil are similarly informal, or expedient, and as such regional distinctions are difficult to make. The lithic assemblage from Santana do Riacho, a site in the Lagoa Santa region, shows some evidence for the fabrication of bifacial points between 8000 and 5000 BP, but points themselves were not found. The move toward an expedient technology, similar to that which occurred in the Serranópolis region, was also noted, "the quantity of quartz pieces retouched with caution diminished rapidly from around 7000 BP" (Prous, ed. 1992/93:376). In chert flakes there were some discrete indications of retouch and raw materials used for ground stone appear, suggesting the introduction of this technology (Prous, ed. 1992/93). Use wear analysis of tools from Santana do Riacho indicated that a great majority were used in woodworking (Kipnis 1998).

Lithic technology in the Peruaçu region

Maria Rodet (2009) studied the lithic assemblages from sites in the Peruaçu region. The lithic assemblage had few formal tools and the common scraper and flake tools were expedient in nature:

> The [lithic] industries are very simple: in general, the final instrument is not very different from the initial form, except, obviously, in rare occasions, such as projectile points and, in a less evident manner, the unifacial instruments from the initial occupations. The steps of the *chaine operatoire* are marked by little or no technical changes. In general, the pieces do not have many removals and the final products are directly discernible, as they are very close to the initial products (Rodet, M. 2009:433, my translation).

Retouched flakes and scrapers indicated the direct use of debitage. The cores presented the same simplicity, as the form of the core appeared to guide reduction choices (Rodet, M. 2009).

The unifacial, elongated, and flat instruments of the first period of occupation (12,000-10,000 BP) are distinct tools lacking in cortex. But, as these more formal tools were reused, small distinctions in morphology of the unifacial tools do not indicate multiple types:

> Technological analysis of the distinct unifacial instruments permits a reflection about the different morphologies of these objects. The technological analysis shows that they are not always standardized examples of a defined model: incomplete internal face, at times very reduced, without the convex shape that links the central part of the object to the edges; very abrupt edges, numerous accidents over the interior face, etc. In fact the pieces correspond to different technical states of their use and restructuring: they are the expression of different stages in a global strategy of management or utilization of the object (Rodet, M. 2009:433, my translation).

Strategies of artifact reuse and resharpening were most obvious in unifacial instruments, but likely permeated all flaked lithic assemblage components. The bifacial tools are quite variable in size and shape, but were generally

made from larger and thicker flakes (Rodet, M. 2009).

Within the Peruaçu region there were distinctions in lithic assemblage between open air and rock shelter sites. At open air sites the assemblage represents initial reduction while in rock shelters debitage is principally from the finishing stage of tool creation.

As the unifacial instruments of the first period of occupation (12,000-10,000 BP) expressed a standardization in production that was not present in subsequent periods, it appears that a preoccupation with, or specialization in, the production of lithic tools diminished through time (Rodet, M. 2009). Despite this lack of investment in flaked stone tools, quartzite polished stone axes, which appear in the levels of "horticultural ceramicists" (Rodet, M. 2009:424), could be an indicator of preoccupation with stone tool form and production.

Maria Rodet (2009) reported many artifacts with indicators of poor craftsmanship. Throughout the prehistory of the Peruaçu region artifacts with poor placement of percussion, as indicated by scars, and bad breaks indicate engagement of people in the process of learning to produce stone tools. At times the majority of a site's lithic assemblage was made up of these pieces with morphologically irregular forms (Rodet, M. 2009).

As the informal tool technology presents only one temporal distinction, that of the unifacial tools from earliest occupations, analysis of raw material

has been undertaken. A great variety of raw materials are available within the catchment region of the Peruaçu River. Interestingly not all raw materials are used in all periods. The earliest occupations (12,000 to 10,000 BP) showed predominantly fine grained, homogeneous chert for flaking. Limestone was used in supports for cracking nuts. The fine grained chert decreased in subsequent periods. From 9000 to 7000 BP the predominant material was medium grained, heterogeneous chert. The variety and qualities of chert utilized for flaking in the period from 7000 to 4000 BP increased greatly, and limestone continues as a support for cracking nuts. During the period from 4000 BP to the most recent occupation chert of medium grain size continued to be the dominant material. New materials appear in limited quantities, specifically quartz crystals and cryptocrystalline jasper and chalcedony.

Ceramic traditions of central Brazil

The appearance of ceramic technology in central Brazil is generally related to the arrival of horticulturalists in a manner approaching the use of a type fossil. Whether the introduction of ceramics occurred because of population movement, trade, or other social interactions is unknown. Additionally, the direct link drawn between ceramics and a horticultural economy should be critically analyzed. The ceramic vessels of central Brazil have been classified into a number of traditions:

> Horticulturalists with ceramics, regular occupants of rock shelters, are already known from various places in Central Brazil. There is a tendency to unite them in the Una tradition.

> They are: the Jataí phase, in Serranópolis, with 1000 AD as the oldest date; the Palma phase, in the east of Goiás, with dates between 720 and 1210 AD; the Pindorama phase, in north-central Goiás, with dates beginning at 500 BC; the Jaborandi phasse, in the southeast of Bahía, with dates about 1000 AD. material without designation and date in the north of Minas Gerais; the Unaí phase, in the northeast of Minas Gerais, with dates until almost 2000 BC (Schmitz et al. 1986, my translation).

The Una tradition was generally thought to encompass many locally named ceramic types as the types were rarely compared. However the regional similarities between early, simple ceramics does not exclude the possibility of different types. The later ceramic traditions, Tupiguarani and Aratu, were generally distinguished on the basis of larger site size (Prous et al. 1994, Schmitz et al. 1986). Regional research is needed to determine how human behaviors in settlement and subsistence practices, associated with ceramic material culture, varied across central Brazil. Greater sedentism and smaller ranges would likely have led to a diversification of cultural practices and ceramic technologies, whereas large population expansions could have led to similar cultural affiliations across larger regions.

The ceramic, open air sites in the Caipônia area might suggest the later scenario, that of population expansion. Sites of the Aratu tradition were not found in rock shelters which had been inhabited in previous periods:

> Their [Aratu tradition] villages, in circular or elliptical form, were located on flat and fertile land, adjacent to creeks of some importance, or, actually, in proximity to the Bonito River. The reasons for this choice should have been linked to the

> necessity for flat surface to locate their homes and large villages, the fertile soils for fields, the soil humidity sufficient for the full maturation of cultivated plants during the rainy period, and the permanent water to meet the needs of a population of hundreds of people (Schmitz et al. 1986:330, my translation).

From the way these horticultural populations structured space, it was interpreted that features such as fields and settlements would have marked their territories, instead of pictographs in rock shelters, in part explaining the absence of their ceramics from the rock shelters (Schmitz et al. 1986). The economy was interpreted as having included products of hunting, fishing, and gathering as supplements to horticultural produce. It is possible that these populations were ethnically Kayapó (Schmitz et al. 1986).

Ceramic technologies found in the Peruaçu region

The central Brazilian traditions discussed in the Peruaçu region include Una, Tupiguarani, Aratu, and Sapucaí. These traditions were based upon technological and morphological characteristics of ceramic vessels and sherds. Within the Peruaçu region ceramics originally classified as part of the Aratu tradition have already been included in the Sapucaí tradition. Additionally, there are indications that the Una and Sapucaí traditions occurred contemporaneously and shared mixed characteristics, and as such should be collapsed into one classification (Carvalho 2009, Henriques 2006, Prous 1983/84, Prous et al. 1994).Therefore the only distinctions that will be made here are between the Una and Tupiguarani traditions. Distinctions

between the Una and Tupiguarani ceramics have been supported by chemical analyses of paste composition (Sabino and Prous 2009).

Mello (2009) analyzed ceramic material from five rock shelters and twelve open air sites in the Peruaçu region. The ceramic material belonged to the Una and Tupiguarani ceramic traditions, the elements of which are described below:

> Una: vessels of small dimensions, with globular or conical form, without any decoration. The paste is compact and the firing is homogeneous. Color of the walls is variable and at times it is polished. The temper contains charcoal. Tupiguarani: large vessels, with complex and composite forms. Polychrome decoration with linear designs with slipped base; the predominant plastic decoration is corrugation. Temper contains unidentified minerals, frequently mixed with grog. Perforated bases appear sporadically (Mello 2009:458, my translation).

At the rock shelters Mello found sherds of both ceramic traditions. At four of the open air sites Tupiguarani tradition ceramics were found and at an additional four possible sherds were found. The majority of ceramic fragments found are undiagnostic, "they were smooth or eroded body sherds, without decoration or slip, with medium thickness, and unidentified mineral or sand temper" (Mello 2009:458, my translation). Rock shelters from the Montalvânia region, approximately 50 miles north of the Peruaçu region, also analyzed by Mello, have similar assemblages with both Una and Tupiguarani ceramics. In the Montalvânia region no open air site assemblages were analyzed. While in Peruaçu region Una and Tupiguarani

ceramic traditions were found in different distributions, the cultural affiliations and practices of the "horticulturalists" are unknown (Mello 2009).

In addition to the characterization of the ceramic assemblage, some 37 wholly or partially reconstructed vessels from the Peruaçu region have been analyzed (Carvalho 2009). The majority of these vessels were open forms of a small or medium size with simply rounded walls. Vessels, even globular forms, showed signs of use for cooking in the form of residues, scrape marks from stirring, and ash from fires (Carvalho 2009). It was noted that some vessels contained mixed characteristics. One vessel (number 7 from Sítio Virgulina) had elements of both the Tupiguarani and Una traditions; the shape was Tupiguarani while the temper and surface treatment were Una (Carvalho 2009). "Attributing a cultural affiliation to ceramics of the region is an arduous task. The traditions were mixed in both stratigraphic level of occupation and in techniques of construction. In various moments we observed elements of one culture inserted into another" (Carvalho 2009:491, my translation).

Rock art as cultural tradition

Rock art has been located across central Brazil. The majority is pictographs in rock shelters, however some petroglyphs have been found. Rock art has been classified into traditions on the basis of design elements and styles of exectution. These traditions are organized temporally on the basis of superimposition (Prous 1991c). The predominant field method used

has been the separation of designs on a single panel into "moments" (Prous 1991c). Based upon the "moments" of execution, the pictograph traditions have been organized into a relative chronology. Since not all traditions appear in the same order in the "moments" on all rock art panels, some traditions may have been produced by contemporary groups in areas that served as frontiers (Prous 1985). Dating of pictographs in central Brazil has been discussed on the basis of rock art spalls and pigments found within archaeological strata (Prous 1991c; Prous and Fogaça 1999). Analysis of rock art has been carried out in Minas Gerais, Piauí, Goiás, and Mato Grosso.

> Prous (1979/80) was the first to establish chronological sequences for the "Traditions" he recognized in Minas Gerais, comparing superimpositions, patinas, topographic locations and dating of archaeological layers that have buried figures in several sites. In Piauí, Guidon used the dating of archaeological layers to assume that the figures on the walls were of the same period, and other scholars have done the same (Prous 1996:215).

Rock art appears to date to the entire period of human habitation in central Brazil. Two sites, Santana do Riacho and Lapa do Boquete, both in Minas Gerais and occupied from the Early Holocene, had pigments found in the oldest archaeological stratum (Prous 1991b; Prous and Fogaça 1999). Additionally, a boulder with a grooved petroglyph was buried by 7000 BP at Lapa do Boquete (Prous and Fogaça 1999). Aside from buried rock art, it has been suggested that the colors of pigments from exotic sources that have

been found in archaeological strata could be used to date the "moments" of rock art in those colors on the rock shelter walls (Prous 1991c).

In the central portion of the state of Minas Gerais it is believed that figures of the Planalto tradition are the most ancient:

> The Planalto Tradition is characterized by visual (and usually quantitative) dominance of animals: mainly deer, fish and birds, which constitute 90% of zoomorphs in Santana [do Riacho]. Geometric motifs are also numerous: above all short strokes, grid, and dots (Prous 1991c:64).

In central Minas Gerais, the Planalto tradition is followed by a number of regional styles. One of these, with realistic anthropomorphic figures, might have been linked with Nordeste tradition influences (Prous 1996). The date range proposed for the Planalto tradition is between, "8 or 11000 BP and 2000 BP" (Prous 1991c:64).

In northern Minas Gerais the rock art sequence is different, but over time expressed greater variability as observed in central Minas Gerais:

> In the valley of the large rio São Francisco, the more ancient paintings are geometrical, frequently bichrome paintings, with some representation of edible plants, weapons and artefacts. Impressive region and chronological variations exist. This São Francisco tradition extends through a great part of central and western Brazil and in Bahia state. In northern Minas Gerais, other Traditions and stylistic units follow, with natural figures: Peruaçu-Urubu, with animals (that vary from site to site), trees and maize pictures; more recent are Desenhos pecked engravings of deer and birds that intentionally destroyed previous paintings. Finally, very recent, typical Nordeste drawings are superimposed on more ancient traditions (Prous 1996:218).

The rock art sequence described above for northern Minas Gerais is based predominantly on research that was carried out within the Peruaçu region.

The rock art of Mato Grosso also demonstrated temporal changes in design elements on the basis of superimposition. The more ancient of the pictographs are placed in high positions within rock shelters and depict anthropomorphs and large animals. "More recent are some smaller and realistic anthropomorphic figures, with little deer alignments. A third phase is characterized by geometric designs . . . The last representations are pecked animal engravings" (Prous 1996:217).

In Piauí the rock art has been described from the region of São Raimundo Nonato. The major traditions are Nordeste and Agreste:

> The most ancient rock art figures are Nordeste paintings (putatively from late Pleistocene to 4000 BP). There are animals (mainly deer and rheas, the American ostrich) and predominantly anthropomorphic figures showing familial and group actions (for instance, a ritual around a tree). . . . The more recent, Salitre subtradition shows a tend to geometrization, even in figurative paintings (Prous 1996:217).

> The Agreste Tradition appears by 7000 BP and succeeds the Nordeste by 4000 BP. Its paintings are less numerous, big, rough animals and anthropomorphic figures (Prous 1996:217).

Both of the Piauí traditions were defined on the basis of forms of the rock art elements.

Petroglyphs are less numerous than the pictographs and have mainly been described for Goiás. In Caiapônia petroglyphs were found in in the

same rock shelters as pictographs. In the Serranópolis region eight sites with only petroglyphs were located and four sites have both petroglyphs and pictographs (Schmitz 1981/82). Petroglyphs along river paths in Goiás were just beginning to be reported in the 1980's. In the Caiapônia region the execution of petroglyphs found in rock shelters changed from engravings to more recent pecked designs (Schmitz 1981/82). In terms of design elements and style, petroglyphs are less varied than pictographs. In a regional comparison, some forms are found in multiple locations across central Brazil. These designs include feet, female sexual symbols, and geometric forms called "tridáctilos" (Schmitz 1981/82). Petroglyph stylistic forms have been noted to be similar to the São Francisco tradition of pictographs. On a local scale, diversity in petroglyphs at archaeological sites also varies, "the simpler figures are encountered in many rock shelters, however some figures have a limited distribution, like the feet or more complex motifs" (Schmitz 1981/82:415, my translation). In the Serranópolis region, petroglyphs are associated temporally with the Serranópolis and Jataí phases.

Central Brazilian rock art traditions were defined on the basis of simple thematic differences, however each expressed originality (Prous 1985). Prous (1985) observed that site direction and structure could have been significant with certain groups choosing to use certain panels and leaving others. Another intergroup relationship that could be explored is that

between newer groups and their ancestors, on the basis of how and where new elements were added to rock art panels.

Rock art has been seen as one of the best indicators of population movement, interaction, and change in central Brazil. The study of rock art is still crippled by the lack of direct dating to confirm chronological associations between the stylistic traditions and archaeological strata and technologies. Prous (1996:218) suggested that:

> Some "Traditions", such as the São Francisco (Prous) and the Geometric (Guidon), could probably be unified, while other "stylistic units" may be a mixture of figures from different periods. Obviously the possibility of direct linkage between rock art (by AMS dating) and archaeological layers will be of great value in placing graphic representations in their cultural context.

Evidence of diet in the Cerrado

Both faunal and botanical remains have been analyzed to construct the diet of populations from the Brazilian savanna. In both, the predominant methodology has been a listing of the species found in the archaeological assemblages and quantification, as with minimum number of individuals or number of individual specimens. Kipnis (2002a) presented a study of faunal remains within the framework of optimal foraging theory, which is discussed in greater detail in chapter 5 as it pertains to one of the sites studied in this research.

In many areas of central Brazil the occurrence of horticultural practices has been linked to the appearance of artifacts associated with horticulture as well as ethnohistorical documentation:

> The importance of ceramics as an indicator for the existence of agriculture is based on the ease with which it is detected and its conservation, even in the most adverse conditions, where it is found extremely fragmented or eroded. Besides ceramics, it is possible to detect the existence of agriculture from the presence of mortars, pestles, and seeds preserved in rock shelters and caves. Certain types of ground stone axes are also associated with agricultural groups who used them, principally, to dig earth (Martin 2005:182, my translation).

While agriculture was seen as a dominant feature of late Holocene occupations in central Brazil, ethnohistoric documents suggest that native plant foods were an important source of nutrition for indigenous Brazilians (Martin 2005). This leads to the question of how to accurately describe late Holocene subsistence practices.

Aside from faunal and botanical remains found in archaeological contexts, human remains provide some insight into food use. The decay and wear patterns in teeth from the Lagoa Santa skeletal population, dated between 10,000 to 8,000 BP, were probably caused by the consumption of a substantial amount of plant foods (Souza 1992/93). Isotopic analysis of skeletal remains from sites in the areas of Lagoa Santa and the Peruaçu region in Minas Gerais indicated a diet rich in plant remains:

> With the view of the isotopic data encountered, it is possible to conclude that the diet of human groups, was probably, from the

> beginning of the Holocene, based primarily in plant resources. This conclusion is possible given the median values and the low variability of $\delta^{15}N$ found in both the human groups when compared to the analyzed animal samples. This tendency toward a substantial presence of plant resources in the diet is even more evident in the Peruaçu Valley, which presents the lowest values of $\delta^{15}N$ in all of the the sampled human material (Hermenegildo 2009:111, my translation).

The material studied by Hermenegildo (2009) included 67 human samples, of which only 20 had collagen preservation sufficient for analyses. The human remains from the Lagoa Santa region were predominantly from the early Holocene, but temporal distinctions in isotopic values were not explored, even as they might account for the noted regional variability.

Animal remains

The analyses of faunal remains from sites in central Brazil point to the consumption of small mammals, gastropods and fish, indicators of a generalized subsistence strategy (Kipnis 2002a, Martin 2005, Rosa 2004, Schmitz et al. 2004). Kipnis's (2002a) optimal foraging analysis of faunal remains indicates a broader diet than would be predicted with the inclusion of small mammals such as rock cavy, cavy, and mouse opossum for the Early and Middle Holocene. There is no evidence that the inhabitants of central Brazil were big game hunters.

In general the faunal diet in central Brazil was consistent from the earliest occupations up until European contact. In the region of Serranópolis, Goiás state, archaeological collections indicated an increase in gastropod

remains coincident with the beginning of the Serranópolis phase. These initial comparisons were based on weight of faunal remains (Schmitz et al. 1989). And while they might be seen as a dramatic change, Rosa (2004) interprets the faunal remains from the Serranópolis region as an indicator of cultural continuity. Within the sites analyzed, fish are sporadically present, potentially related to sporadic episodes of fishing or poor recovery of small remains during excavation. Remains of reptiles and birds were also found in all archaeological samples from all periods (Rosa 2004). Animal species represented in archaeological remains and their quantities did not indicate a drastically different strategy in any period of human occupation.

Plant remains

The documentation of plant contribution to human diet in central Brazil was primarily as lists of species whose remains were found at archaeological sites, almost all of which are rock shelters. The presence of plant remains from domesticated species is interpreted, across the board, as an indicator for agricultural subsistence practices. For example, the São Raimundo Nonato region practiced agriculture based on the remains of maize, bottle gourd, peanut, and beans; the beans and peanut have been dated between 1600 and 1200 BP (Martin 2005).

At the southern limit of the state of Bahia with Goiás are higher elevation plateaus and rock formations known as the Serra Geral. In these

highlands Rosa (1997) studied biological remains from five rock shelters and one open air site. Botanical remains were found in all five rock shelters:

> The most common floristic species present in the studied material, in general terms, were *Syagrus oleracea* (gueroba) [palm nut husks] and *Spondias tuberosa* (umbú) [plant seed]. Besides these, fragments of seeds and other parts of the fruit of *Caryocar Brasiliense* (pequi), *Humaenea stigonocarpa* (jatobá), and *Talisia esculenta* (pitomba) were identified, just like parts of Gramineae (maize) and Cucurbitaceae (bottle gourd), these last related to the cultivation activities of the most recent occupations (Rosa 1997:112, my translation).

By comparison with the modern vegetation regime, Rosa found that these species fruit between August and May. Rosa (1997) makes further qualitative observations which are valuable for regional comparison with the Peruaçu region. Most of the palm nut husks of *S. oleracea* were heavily fragmented, indicating the extraction of the oily palm kernel. In terms of preservation state, a significant number of the *S. oleracea, S. tuberosa,* and *C. brasiliense* seeds were wholly or partially burnt (Rosa 1997). In tables summarizing the excavation unit contents, some distributional patterns of botanical materials can be recognized. The majority of plant remains are found in the upper stata. Native plant foods occurred in one or two strata below the domesticated plant species, as well as alongside of them. *Syagrus oleracea* is the only species documented in the deeper strata, where it occurs in lower frequencies at three of the five rock shelters. While no dates for the strata are presented, the representation of plant remains stratigraphically hints at changes through time.

Plant remains from the site of Santana do Riacho, in central Minas Gerais have been analyzed. The collection numbered 497 remains from two test excavations. The majority of the remains are noted by the authors to be food (Resende and Prous 1991). Plant remains identified are listed in Table 4.1. The unidentified plant remains were predominantly found in the uppermost stratum, 0. Resende and Prous (1991) interpret the different plant compositions of the levels, such as the lack of jatobá in level 2, as a product of human action. They suggest that differences in species presence would not be due to preservation because they found fragile, burnt remains of pequi preserved from 10,000 years ago and unburnt remains of palm nuts were encountered in levels dating until 8000 years ago.

Table 4.1. Plant remains identified from excavation at Santana do Riacho, central Minas Gerais, Brazil (Resende and Prous 1991). Levels at Santana do Riacho date approximately as follows: level 0, to 2800 BP; level 1, 2800 to 4500 BP; level 2, 5000 to 8000 BP; levels 3 and 4, 8000 to 10,000 BP (Prous et al. 1991). *The occurrence of three grains of maize in level 2 may be from a disturbed context unperceived during excavation that would mean the maize is actually of more recent origin (Resende and Prous 1991).

Plant species	Common name	Levels where encountered
Astrocaryum sp.	coco	0, 1, 2, burials (3&4)
Caryocar brasiliense	pequi	1, burials (3&4)
Hymenaea stilbocarpa	jatobá	0, 1, burials (3&4)
Lagenaria vulgaris	bottle gourd	1
Maclura affinis	tayuba	2, burials (3&4)
Myrtaceae family		0, 1
Oenocarpus bataua	patauá	1
Pterodon pubecens	sucupira do cerrado	1, burials (3&4)
Scleria sp.		1, burials (3&4)
Sterculia chicha	chichá	2
Struthanthus sp.	erva-de-passarinho	0, 1
Syagrus sp.	licuri	1, 2, burials (3&4)
Symplocos sp.		1, burials (3&4)
Vantanea sp.		1
Zea mays	maize	1, 2*

Plant remains from Lapa do Santo, also in the Lagoa Santa region in Minas Gerais, were analyzed by Daniela Gonçalves Rodrigues Silva (2006) for a masters thesis. Analysis included plant remains from the standard screens of 35 excavation units and from the flotation of sediment from one excavation unit. From the 35 excavation units the 281 samples yielded 3261 botanical elements, which were classified by morphology into 62 types. The frequently encountered remains of identified species are included in Table 4.2. Sorting of the botanical remains from the flotation sample added 41 morphological types, but due to their small size these types were not identified. The plant remains appear to be well identified and sorted;

however, the data analysis methodology used makes comparison of this data with that from other sites very difficult. A greater number of botanical types are found in the shallow levels which may be due to surface litter, especially as the non-charred plant remains are predominantly found in level 1 (Silva, Daniela 2006). While there are changes in species diversity with depth, these changes can not be clearly interpreted since the data were organized by arbitrary ten centimeter excavation levels. Lapa do Santo has an uneven floor surface, three distinct cultural and chronological strata, and some units that begin in the third, and oldest, cultural stratum. Comparisons made by excavation unit show that some units had a much greater density of plant remains; however, as the results aggregate all levels in the excavation unit, the abundance of plant materials in near surface levels would lead to higher calculated densities of plant remains in a shallow excavation unit than in a deep excavation unit. The variation in the number of morphological types reported by unit may be due to the variation in excavation unit depth and the strata therein. One comparison that separated plant remains by archaeological strata was made between four contiguous excavation units. Strata 1, 2, and 3 contained 14, 17, and 9 morphological types of plant remains, respectively. The most frequent occurrences of *Caryocar brasiliense* and *Sterculia chicha* were reported for stratum 3 (uncalibrated radiocarbon dates with a one sigma error for stratum 3 are 8700±40, 8870±100, and 8930±40 BP).

Table 4.2. Thirty-nine morphological types of plant remains from Lapa do Santo, Minas Gerais, Brazil, identified to varying degrees of botanical certainty (Silva, Daniela 2006).

Family	Plant specie	Number of morphological types
Annonaceae		2
Aquifoliaceae	*Ilex* sp.	1
Arecaceae		2
Arecaceae	*Syagrus* sp.	1
Arecaceae	*Astrocaryum* sp.	1
Caryocaraceae	*Caryocar brasiliense*	2
Euphorbiaceae	*Sapium* sp.	1
Lauraceae		3
Fabaceae		6
Fabaceae	*Anadenanthera cf falcata*	2
Fabaceae	*Enterolobium cf gummiferum*	1
Fabaceae	*Piptadenia* sp.	1
Fabaceae	*Stryphnodendron* sp.	1
Loranthaceae	*Struthanthus* sp.	1
Meliaceae	*Trichilia* sp.	1
Moraceae	*Brosimum cf gaudichaudii*	1
Moraceae	*Ficus* sp.	2
Myrsinaceae	*Rapanea* sp.	1
Myrtaceae		1
Myrtaceae	*Eugenia* sp.	2
Sapotaceae	*Chrysophyllum gonocarpum*	1
Sterculiaceae	*Sterculia chicha*	2
Styracaceae	*Styrax* sp.	1
Symplocaceae	*Symplocos* sp.	1
Thymeliaceae	*Daphnopsis* sp.	1

In the Peruaçu River Valley previously identified plant remains are predominantly edible. The remains are listed below in Table 4.3 along with the sites in which they have been encountered. At the site of Lapa do Boquete many plant remains came from features that were distinct pits lined with basketry or palm fronds (Resende and Cardoso 1995, 1996).

Table 4.3. Plant species identified from sites in the Peruaçu River Valley, Minas Gerais, Brazil (Resende and Cardoso 2009). Site names are abbreviated: Lapa do Boquete (Boquete), Lapa da Hora (Hora), Lapa dos Bichos (Bichos), Abrigo do Malhador (Malhador), Lapa dos Desenhos (Desenhos), Lapa do Caboclo (Caboclo), Tikão (Tikão), and Terra Brava (Brava).

Plant species	Common name	Plant parts found	Sites where encountered	Edible
Annona sp.	Custard apple	fruit and seed	Boquete, Hora, Bichos, Malhador	yes
Bixa orellana	urucum	seed and fruit	Boquete	
Bromelia	mocambira	leaf	Boquete	
Byrsonima sp.	murici	fruit	Boquete	yes
Caryocar brasiliense	Pequi	fruit	Boquete, Malhador, Caboclo	yes
Cnidoscolus sp.	cansanção	fruit	Boquete, Malhador, Bichos, Hora, Desenhos, Caboclo	
Cocos sp.	mata-fome	fruit	Boquete	
Dasyphyllus sp.		flower	Boquete	
Dioclea sp. or *Mucuna* sp.	olho-de-boi or mucuna	seed	Boquete, Bichos	
Enterolobium sp.	tamburil	seed	Boquete, Malhador	
Eugenia dysenterica	cagaita	seed	Boquete, Malhador, Bichos	yes
Gossypium sp.	cotton	seed and fibers	Boquete, Hora	no
Guazuma ulmifolia	mutamba	fruit	Boquete, Malhador	yes
Hymenaea sp.	jatobá	fruit and seed	Boquete, Malhador, Bichos, Hora, Desenhos, Caboclo	yes
Lagenaria vulgaris	bottle gourd	seed and fruit	Boquete, Hora, Bichos, Malhador	
Manihot heptaphylla	maniçoba-do-São-Francisco	fruit	Boquete, Malhador	yes
Manihot sp.	manioc	root	Boquete, Caboclo	yes
Passiflora sp.	passion fruit	seed	Boquete, Malhador	yes
Phaseolus sp.	feijão	fruit and seed	Boquete	yes
Piptadenia sp.	angico	rind	Boquete	

Continued on next page.

Table 4.3 - continued from previous page.

Plant species	Common name	Plant parts found	Sites where encountered	Edible
Pithecoctenium echinatum	pente-de-macaco	seed	Boquete	
Pouteria sp.	grão-de-galo	fruit	Boquete	
Solanum sp.	jurubeba	seed	Boquete	
Spondias sp.	cajá	fruit	Boquete, Bichos	yes
Spondias tuberosa	umbu	fruit	Boquete, Malhador, Bichos, Hora, Desenhos, Caboclo	yes
Sterculia sp.	chichá	seed	Boquete	
Struthanthus sp.	erva-de-passarinho	fruit	Boquete	
Styrax sp.	estoraque	fruit	Boquete	
Syagrus oleracea	guariroba	fruit and leaf	Boquete, Malhador, Bichos, Hora, Desenhos, Tikão, Caboclo, Brava	yes
Symplocos sp.	símplocos	fruit	Boquete	
Talisia esculenta	pitomba	seed	Boquete	yes
Typha sp.	taboa	stems	Boquete	
Zea mays	maize	cob, seed, husk and stigma	Boquete, Malhador, Hora, Desenhos, Caboclo, Tikão, Bichos	

The present research project adds substantially to the plants registered by Resende and Cardosa (1995, 2009) for the Peruaçu region. Many of the newly identified species have preserved seeds or fragments which are of smaller dimensions than those previously identified.

Morphology and origin of maize from the cerrado

Maize morphology has been studied by Bird et al. (1991) from preserved cobs excavated in northern Minas Gerais. The 28 samples from horizons dated between 1000 and 4000 BP were visually examined and classified into four types. Two types, the oldest of the collection, are not known from other regions. The other two types were known from the southern Amazonian cultural area: "Amazonian Interlocking Flours" and the sub type "Morotí-Camba" of the "Tropical Lowland Flours". Another study of maize morphology focused on the number of rows and seeds per row of the cobs. Freitas and Martins (2003) found a great diversity in the number of rows on maize cobs from two sites in northern Minas Gerais, Lapa do Boquete and Lapa da Hora. The maize, dated to between 1010±80 and 570±60 BP (uncalibrated radiocarbon dates), varied between 6 and 18 rows. This variation was indicative of a large number of land races, a finding supported by the diversity of starch grains. Row number variability was maintained through time, however the number of seeds per row appeared to increase through time, indicative of longer ears (Frietas and Martins 2003). Morphologically maize from northern Minas Gerais is not homogeneous.

Maize has also been used to look at processes of cultural spread. Aside from the assertion that late Holocene ceramic populations were agriculturalists, the route and nature of the adoption of cultivation practices has been debated. The principal hypotheses, discussed in chapter 2, placed either maize or manioc as a staple crop and focused on the Amazon and coastlines for the route by which agriculture was spread. The evidence for the spread of domesticated plants came from ceramic analysis and ethnohistory. In most models, the cerrado and caatinga were viewed as marginal environments which received ceramics and domesticated plants after other regions.

The pathways and directions by which domesticated plants spread to central Brazil have begun to be investigated through genetic analyses. Research has explored maize DNA to distinguish population distributions in South America (Freitas 2009, Freitas and Martins 2003, Freitas et al 2003). Archaeological maize specimens from Brazil, Chile and Peru were compared to land races of maize from indigenous groups in Brazil and Paraguay; the latter used for comparison in an attempt to avoid contamination of results from post-colonial redistribution of maize (Freitas et al. 2003). Archaeological maize samples from the Peruaçu region were included. Maize samples were classified into three genotypic types by allele repeat sequences. It was shown that the three genetic sequences were independently introduced to South America, rather than occurring as the result of diversion from a

founder population (Freitas et al. 2003). The first two genetic types of maize were geographically restricted, with one found in the Andes and the other in lowland South America. The only regions which appeared to express mixing of these types were samples from Paraguay and Chile. The samples indicated that contact and mixing of maize was probable in southern South America. The third genetic type was found across South America. From archaeological samples this type is dated later (Freitas et al. 2003). As the genotypes of Andean and lowland maize were found to be distinct, Freitas (2006, 2009) further explored bean proteins, including faseolina, from archaeological samples of northern Minas Gerais. The proteins found were not closely related to those known from the Andes, rather the association was greater with beans from Central America and northern South America (Freitas 2006, 2009). With these data, plants are suggested to serve as markers for routes of migration and preferred contact. And thus, the population from the Peruaçu region was more closely linked to the north of South America and central America, than to the Andes (Freitas 2006, 2009; Freitas et al. 2003). The mechanisms, such as trade and migration, were not specified.

Research directions at Lapa dos Bichos and Lapa Pintada

The sites of Lapa dos Bichos and Lapa Pintada were chosen for this research project to address the question of cultural connections between local regions in northern Minas Gerais on the basis of plant diet. Early

Holocene occupations appear to have shared a technological tradition, known as the Paranaíba phase, with other central Brazilian regions. Cultural chronologies suggest increased sedentism in the Early to Middle Holocene as well as changes with the introduction of ceramic technology.

During the middle Holocene technological assemblages appear to have become more regionalized. In comparing the Serránopolis region with Caipônica, both in Goiás , Schmitz and colleagues note that the rock art is regionally distinct and tool types are informal (Schmitz et al. 2004). Informal, expedient tools, in great part flakes, are documented in northern Minas Gerais as well (Rodet, M. 2009). The diet of early and middle Holocene habitations in northern and central Minas Gerais was extremely broad with the consumption of many small mammals (Kipnis 1998, 2002a, 2002b).

Lucas Bueno has begun to investigate the possibility of regional links between central and northern Minas Gerais (Bueno 2008, in press). As the area around Lagoa Santa, in central Minas Gerais, appears have been uninhabited in the Middle Holocene, he proposes that the population may have moved northward to the area around Montes Claros, which appears to have been first inhabited in the Middle Holocene. Bueno's investigation will include both technology and an analysis of skeletal remains to determine if characteristics of the Lagoa Santa population are found in burial remains.

The late Holocene cultural traditions of the cerrado were marked by the appearance of ceramic technology in diverse regions. The Una ceramic tradition is documented throughout central Brazil including the Peruaçu region (Carvalho 2009, Mello 2009). The extent of dispersal might represent a large region of populations that were connected culturally or through trade. No technological changes in flaked stone tool production have been noted to occur contemporaneously with the introduction of ceramics (Schmitz et al. 2004; Rodet, M. 2009).

Tupiguarani phase ceramics appear at many open air sites, potentially indicating a greater number of habitation sites outside of rock shelters (Mello 2009). Up until this phase there were no indications of discontinuities in the archaeological record which would substantiate a new population. It has been suggested that the Tupiguarani ceramics and settlement pattern may have represented, in parts of the cerrado, a new population focused on horticultural activities (Schmitz et al. 2004).

Did the ceramic bearing occupations of the cerrado herald the spread of populations with a new set of economic practices? An analysis of diet will hopefully provide insight into the changes which occurred during the late Holocene and begin to address the question of whether economic changes were concurrent with technological changes. The focus here is on one geographic region, northern Minas Gerais, as represented by two sites.

Predictive models of temporal changes in subsistence

Diachronic change allows for an interpretation of shifts in human behaviors. Use of change in the archaeological record as the measure of human behavior avoids some of the problems presented by ideal models. The predominant theoretical perspective applied in this research comes from optimal foraging theory. The construction of a model for change and an associated optimal resource set could include plant remains which did not preserve archaeologically. Here an inductive process of reasoning is utilized to determine the model of temporal change and the optimal strategy that is the best fit for the collection of plant remains.

The predictions for four models are presented to examine plant foods in subsistence and their change through time in north-central Minas Gerais: no change, environmentally caused change, change caused by resource stress, and change caused by the introduction of domesticated plants. Subsequently, distinguishing characteristics between the specific foraging strategies, diet breadth, risk aversion, and patch choice are discussed. The logic of each strategy was described in chapter 2.

If the Holocene were a static period, expectations based on the basic differences between foraging strategies will characterize the archaeological assemblage and all stratigraphic layers will have identical signatures:

a) A diet breadth foraging strategy will be characterized by the presence of calorically rich floral species requiring little processing.

b) A risk aversion foraging strategy will be characterized by the presence of common, reliable species that are frequently found within the environment and can be depended upon to produce seasonal yields.

c) A patch choice foraging strategy will be characterized at a given site by a range of species that are from the canopy forest where the caves are located.

If environmental change were the driving factor behind dietary change, it would be expected that changes in floral procurement coincided with environmental shifts and not with environmentally stable periods. Additionally, the effects would be observed in the remains of species sensitive to shifting temperature and precipitation regimes. The species affected would be those which thrive in either the cerrado, caatinga, or gallery forest environmental zones, but not in multiple zones. The magnitude of climatic fluctuations would determine the quantity of species affected and the likelihood that these effects would be visible archaeologically. The location of the Peruaçu River valley near the modern border between cerrado and the caatinga vegetation types makes species movement more likely to be apparent with changing moisture regimes in this region than at the site of Lapa Pintada, deeper within the cerrado environmental zone.

If major Brazilian Holocene changes in plant diet were based on resource stress or population pressure not coinciding with environmental change, the expectation is an intensification in procurement or an increase in species in the diet. In this, the effects of change will be manifest in all components of the diet. Despite this prediction there is no evidence that change occurred in faunal consumption (Kipnis 2002a). The faunal assemblage of the Early and Middle Holocene was characterized by a great breadth of species such that change in the Late Holocene would have been unlikely; however the remains from these latest strata have not been analyzed. Thus with little ability for the diet to expand in faunal resources, the plant resources should reflect conditions of increased resource stress.

If the change in diet during the Holocene were driven by the introduction of domesticated plant foods then the changes should coincide temporally. The most basic models predict shifts in the set of resources utilized based upon their relative energy rankings. The inclusion of new high ranked resources would lead to the removal of low ranked resources in the diet. As domesticated plant foods have relatively high caloric returns, the effects of change driven by the inclusion of new, highly ranked resources should be manifest as shifts in the set of resources utilized. While there are no data for the relative labor investment to cultivate a given plant resource, an individual's labor can only be invested in one activity at any given time. The degree of energy invested in the acquisition of domesticated plant foods

should relate to the degree of disruption in the native plant resources collected.

While identifying the model for the cause of diet change depends in part on the ability to date when the change occurred, the foraging strategy utilized can be distinguished from which predictions are met by the paleoethnobotanical assemblage. Predictions for foraging strategies are discussed in relation to scenarios of increased sedentism and of predicted impacts of domesticated plant foods on native resources.

With decreased mobility, the model of increasing diet breadth is the most supported by literature on dietary changes around the world (Bettinger 1991; Bettinger and Baumhoff 1982; Kelly 1992; Piperno 2006; Sheehan 2002; Weiss et al. 2004). This foraging strategy can be distinguished by an increase in the number of species included in the diet as a smaller area of land must provide the caloric needs of a group. Instead of focusing solely on plants with high caloric returns, this model predicts the inclusion of plants with longer processing times or low returns for harvesting time. Conversely the introduction of domesticated plant species with high resource rankings should lead to a narrower set of native plant resources included in the diet.

Decreased mobility for a hunter-gatherer group does not equate to settling down permanently. One option with an increasingly sedentary pattern would be the exploitation of various patches as seasonality allows or

as a patch is exhausted. A patch choice foraging strategy will change in two dimensions with increased sedentism: how much is exploited within a patch before moving to another and the use of more patches. The dual dimensions mean that there may be overlap in distinguishing between a patch choice and a diet breadth strategy. In the case of the Peruaçu region, the rock shelters are situated in one of the four microenvironmental zones. As such, if the occupations were seasonal camps, a patch choice strategy predicts that diet would be focused intensively on resources from the surrounding canopy forest and that the number of resources from this zone included in the diet would increase with decreased mobility. Similarly, for Lapa Pintada, the patch choice strategy would predict a focus on resources found in the cerrado vegetation type that surrounds the site.

The inclusion of domesticated plant species within a patch choice strategy would result in the creation of new patches. The patch choice strategy would predict that the patches with the highly productive and rich spatial concentrations of highly ranked, domesticated plant resources would be utilized in preference to other patches. With an increased density of resources in specific patches, this strategy predicts decreased exploitation of other resource patches and the utilization of a narrower set of resources at these patches. As the patch choice strategy presumes exploitation of the proximal environmental zone, paleoethnobotanical assemblages would continue to be dominated by resources from that zone. And thus, the sites

expressing exploitation of domesticated plant resources would be spatially segregated within those zones appropriate to cultivation.

The model of risk aversion with decreased mobility is the foraging strategy least discussed in the literature to account for hunter-gatherer subsistence changes; however, it is more likely to apply to the management of native plant species or the cultivation of domesticated plant species. Winterhalder and colleagues (1999) suggest that higher mobility would be better at spreading risk. Social mechanisms such as sharing and food storage could work within any society. With decreased mobility and a subsistence strategy of foraging, a risk averse strategy would respond with dietary dependence on reliable plant species, species that are more predictable year to year. The nature of cultivation also allows for risk management through behaviors such as planting an excess quantity, spreading locations where plants are grown, increasing the number of species grown, and staggering the time of plantings. Native species that could easily be manipulated to produce high densities for reliable collection by such means as seed dispersal or controlled burning could be initially cultivated plants. The introduction of domesticated plants could fit well within a risk aversion strategy as productivity could be managed and predictable. Practices of cultivation would be expected to shift diet to the domesticated plant species and those native species amenable to the practices of cultivation.

Chapter 5. Archaeological backdrop: the sites of Lapa dos Bichos and Lapa Pintada

The São Francisco River is a major geographic feature in northern Minas Gerais state, the river valley that cuts through the surrounding plateaus on its journey from southern Minas Gerais northward to the Atlantic Ocean (Figure 5.1). The various tributaries of the river flow from the plateaus, and it is along these erosional courses that in some areas limestone cliffs are exposed. The limestone formations of this region are host to the majority of known archaeological sites, including the rock shelter sites of Lapa dos Bichos and Lapa Pintada from which paleoethnobotanical collections were studied. These sites are located at a distance of approximately 200 kilometers from each other along different tributaries of the São Francisco River.

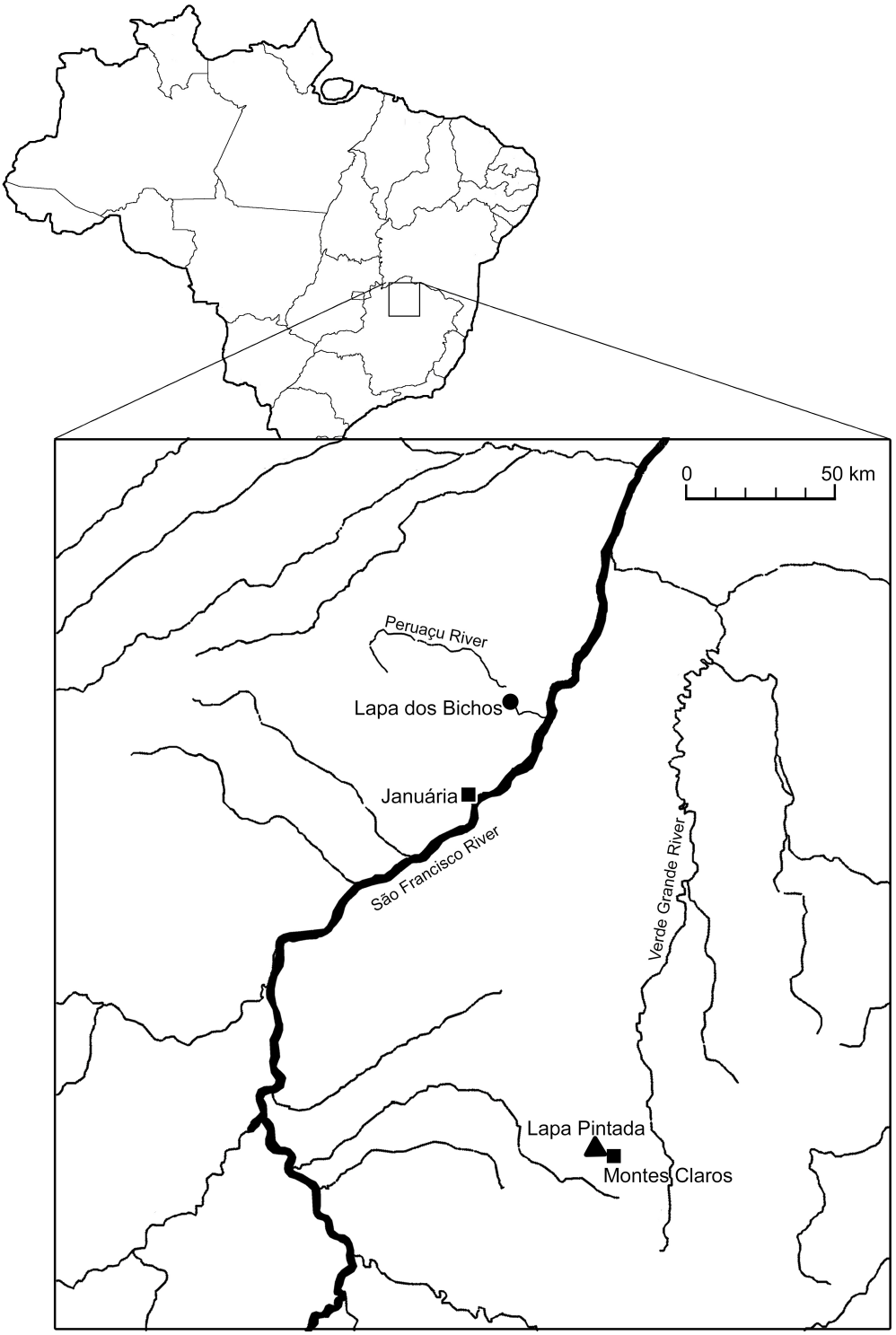


Figure 5.1. The sites of Lapa dos Bichos and Lapa Pintada are located in northern Minas Gerais within the watershed of the São Francisco River. The major modern cities in the region are Montes Claros and Januária.

Lapa dos Bichos and Lapa Pintada were chosen for analysis because organic materials, including plant remains, found at the sites were excellently preserved and because the sites are integrated into larger research projects. Areas with a tradition of archaeological research, or ongoing research, are desirable locations for further research, as archaeological interpretations are often reliant upon multiple classes of material culture and analyses of regional characteristics, such as site distribution. This chapter describes the research conducted at each site, the chronologies established from stratigraphy and radiocarbon dating, the features encountered during excavation, the results of concluded analyses, and the interpretations of site occupation.

Lapa dos Bichos

Lapa dos Bichos is located within the Peruaçu River valley. The Peruaçu river runs for approximately 80 kilometers, starting atop the exposed craton that is composed of gneiss and granite. The underlying geology changes along the river´s course. Approximately 17 kilometers upstream from the confluence of the Peruaçu and São Francisco Rivers, the Peruaçu River flows onto a newer sedimentary basin containing limestone and dolomite. The river has eroded these rocks into fluvial karst formations. There are several sections of the river that run as underground passageways. A portion of these last 17 kilometers is entrenched in a canyon with limestone and dolomite cliffs. This canyon was created when a portion

of the roof of the underground channel of the Peruaçu river collapsed (Rodet, J. et al. 2009). The Lapa dos Bichos rock shelter is located along these steep canyon walls (Figure 5.2). The region of the Peruaçu River valley is in a transitional zone between cerrado and caatinga vegetation.

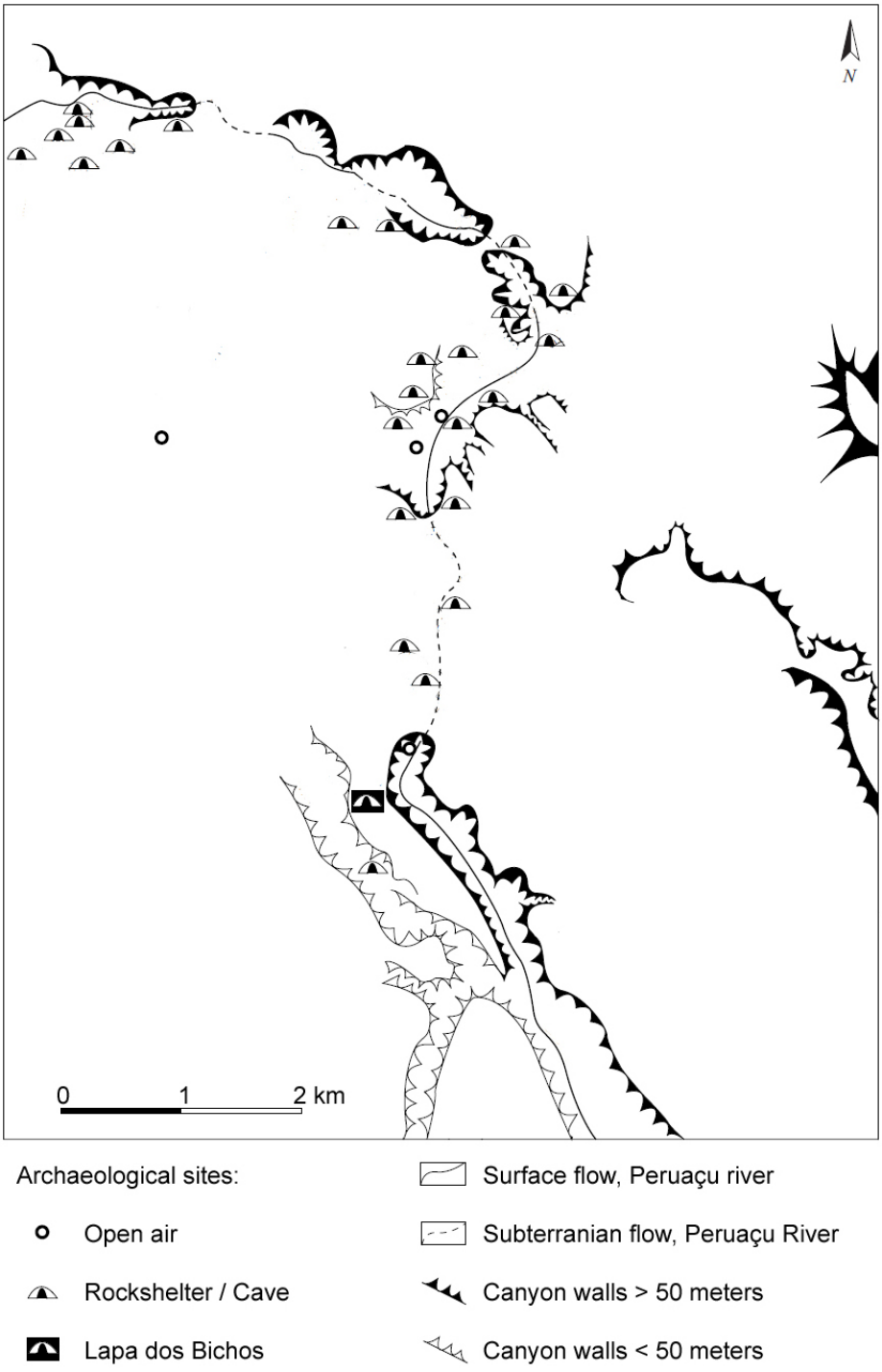


Figure 5.2. Lapa dos Bichos is located to the south of a subterranean portion of the Peruaçu River. Other archaeological sites in rockshelters and caves have been recorded along canyon walls in the area (Kipnis 2002a; Prous et al. 1994).

The Peruaçu River Valley region was explored by archaeologists Carlos Magnos Guimarães, Alan L. Bryan and Ruth Gruhn in 1978 after the limestone rock shelters and caves were located and partially mapped by speleologists (Prous and Rodet 2009). Between 1981 and 1996 the Sector de Arqueologia of the Universidade Federal de Minas Gerais (UFMG) engaged in survey, recording rock art and archaeological excavation in the valley. Survey located over 60 archaeological sites. Excavations were carried out in at least six sites over the fifteen year project. The majority of known archaeological sites are along the limestone cliffs and river course as the agricultural lands at the mouth of the Peruaçu river valley were not surveyed. What began as an academic archaeological research project was also adapted to assist in the writing of management plans for the *Parque Nacional Cavernas do Peruaçu,* created in 1999 (IBAMA 2005). This national park is situated with in a larger environmental protection area, or *Area de Proteção Ambiental* (APA) *Cavernas do Peruaçu*. The archaeological inventories will be important to guide the park in determining which archaeological locations will be open to the public for caving and viewing rock art. Within the national park new ranching operations or settlements are allowed. An APA is a region, generally chosen for good environmental integrity, in which exploitative activities are severely restricted. The APA Cavernas do Peruaçu is an area that encompasses the watershed (Figure 5.3).

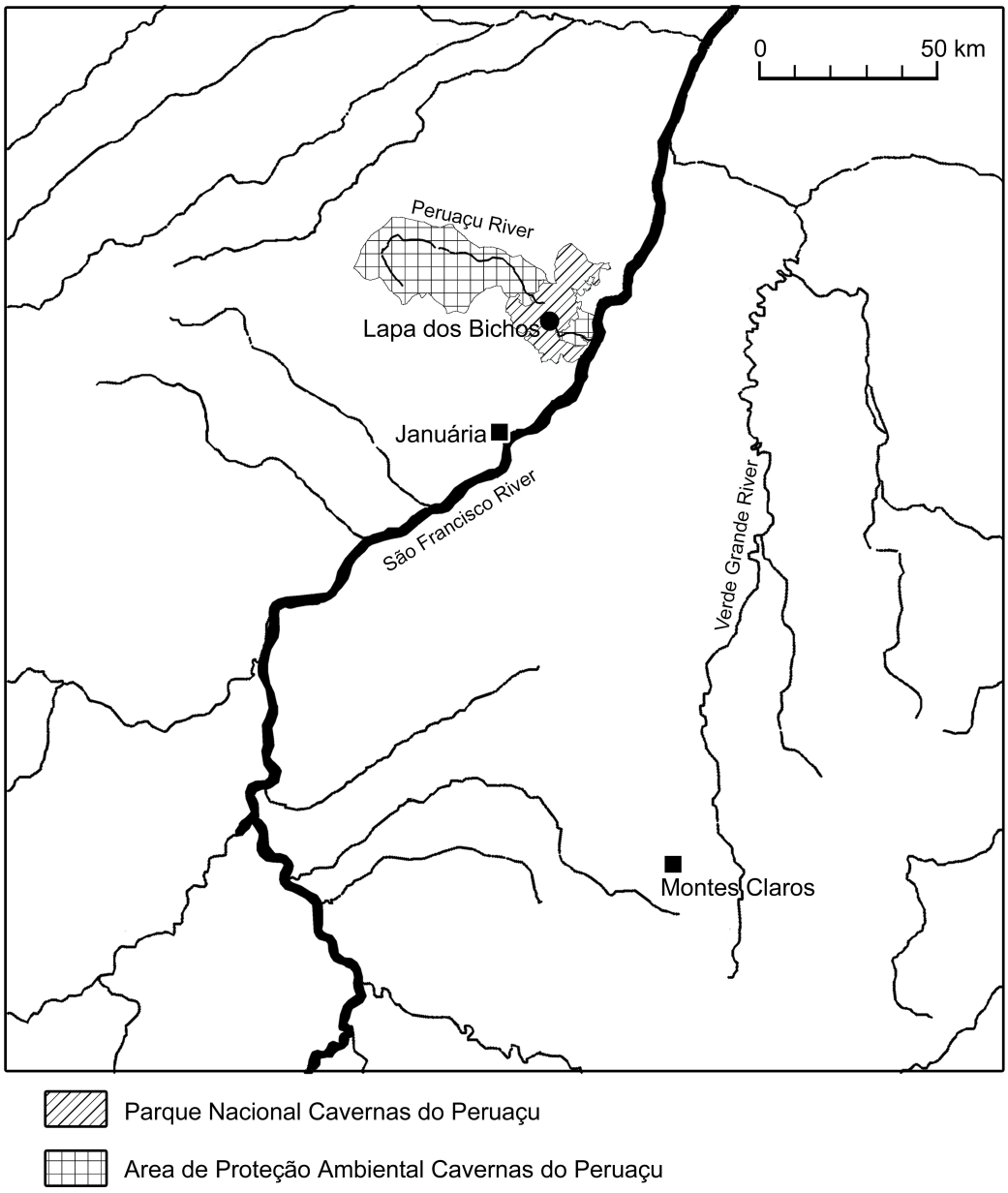


Figure 5.3. A region around the Peruaçu River has been designated as a national park due to the many caves in the areas limestone outcroppings. The entire watershed of the river is included in an environmentally protected area (IBAMA 2005).

Lapa dos Bichos was one of the sites excavated by the Sector de Arqueologia of UFMG. In 1983 a 2x2 meter test excavation was placed on a

flat area of the rock shelter floor (Kipnis 2002a). The archaeological investigations at Lapa dos Bichos continued in 1995 when Renato Kipnis excavated seven test pits (Figure 5.4). Further archaeological excavations were conducted in 2006 when an expansive area of three by four meters was opened along with two additional test pits. After a month long field season, excavation in the expansive area was suspended after the third cultural stratum and the excavation awaits completion.

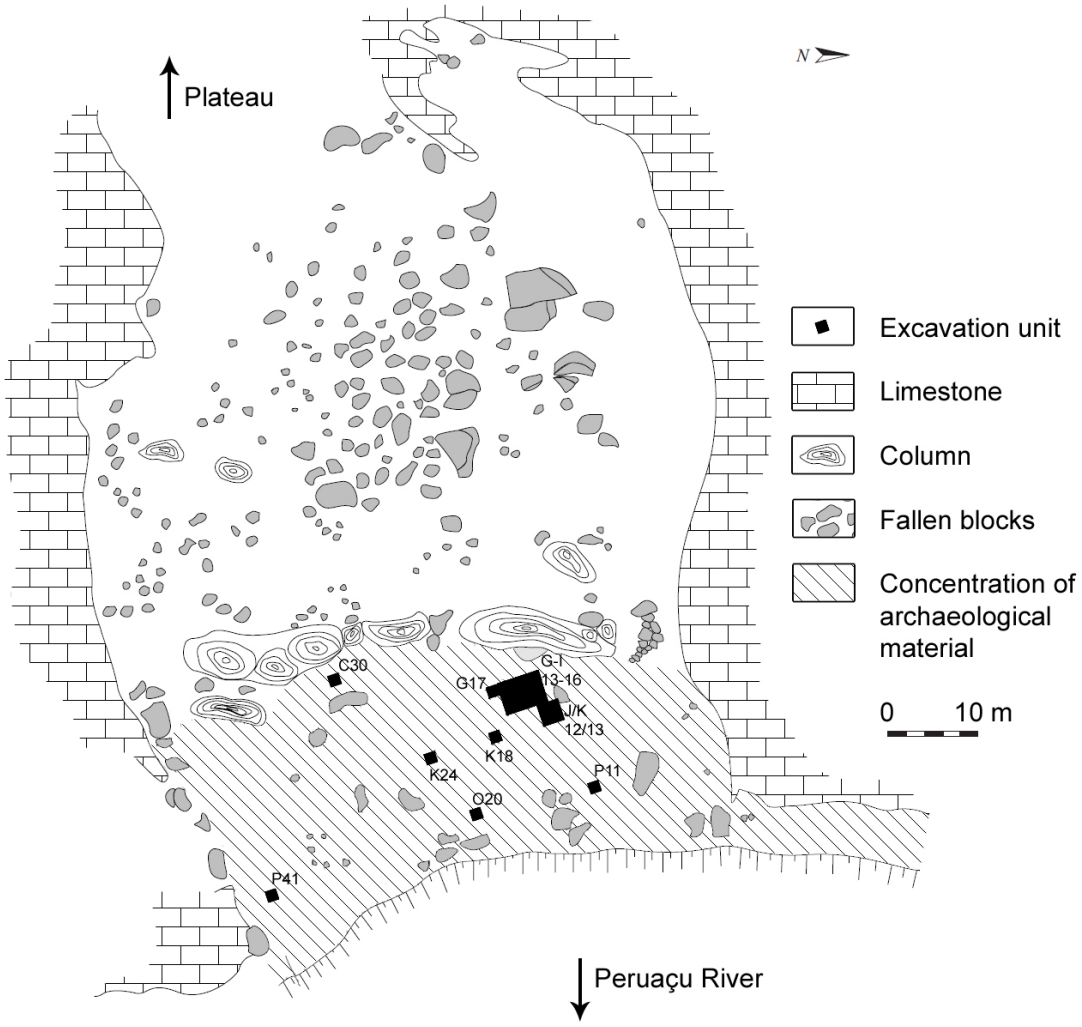


Figure 5.4. Plan of the Lapa dos Bichos site indicating the location of excavation units. The eastern portion of the rock shelter is relatively flat and contains the greatest density of archaeological material (adapted from Kipnis 2002a).

Lapa dos Bichos is a large rock shelter, approximately 50 by 25 meters, with a relatively flat floor surface in its northern portion. In parts the roof is over 10 meters high. Located approximately 50 meters below the limestone plateau, and equally high above the river, the rock shelter provides a connection between these two locations as shown in Figure 5.5.

The slopes on both sides are extremely steep, making access difficult and thus recent disturbances of the site are unlikely. The main floor area of Lapa dos Bichos is not flooded by run off because of the stalagmite pillars. Water drains predominantly along the southern wall of the rock shelter. Excavations within Lapa dos Bichos have shown that the cultural layer varies between 0.5 and1 meters in depth (Kipnis 2002a). These cultural sediments lie atop limestone blocks.

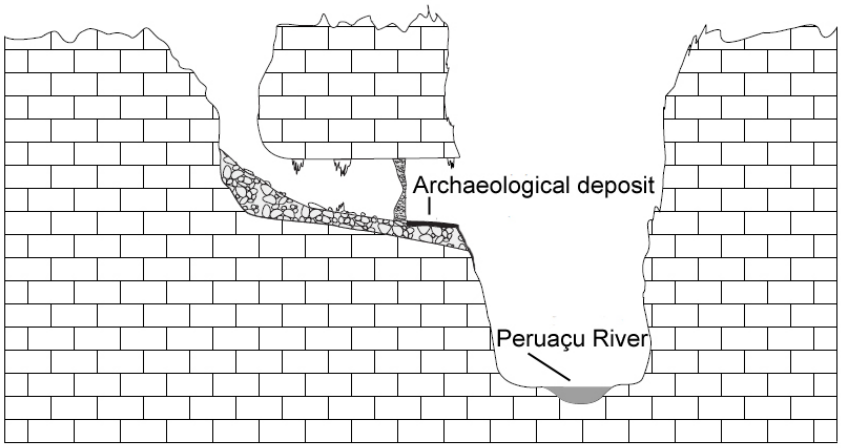


Figure 5.5. A cross section of the topography at Lapa dos Bichos shows how the rock shelter opens onto both the plateau and river canyon. The archaeological deposits are at the mouth of the rock shelter (adapted from Kipnis 2002a).

Excavation units at Lapa dos Bichos were named using an alphanumeric system: letters represent the west-east axis and numbers the north-south axis. The excavation from 1983 was designated J/K-12/13 due to its two meter square size. The units excavated in 1995 were C-30, G-17, K-18, K-21, O-20, P-11, and P-41. In 2006 twelve contiguous units were

opened G/H/I-13/14/15/16, and two isolated units, O-2 and O-11. In total at Lapa dos Bichos 13 m^2 have been fully excavated and 12 m^2 have been excavated to stratum 3.

During the 1995 excavation, each change in soil texture or characteristics led to a new level designation. These levels were subsequently dated and organized into strata. The 2006 excavations followed the natural strata from the adjoining excavation units; units G-17 and J/K-12/13 share boundaries with the area G/H/I-13/14/15/16. Kipnis (2002a) described nine strata at Lapa dos Bichos. All strata were present in unit G-17 (Figure 5.6). Some of the salient attributes of these strata are noted below:

> Stratum 1 (ca. 150 BP - present) is a very thin surface layer with remains dated to the last centuries, however the only non-native materials found were from the prior archaeological excavations. This surface layer contained decomposing leaves and other recent organic plant litter.
>
> Stratum 2 (ca. 150 BP - ca. 750 BP) is a compact layer with abundant organic material. In some units this organic material is expressed in the dark brown sediment color (Munsell 7.5YR 2.5/2). Elsewhere intact dessicated botanical remains have been found in shallow pits, both circular and unstructured. Hearths were also located.
>
> Stratum 3 (ca. 750 BP - ca. 2000 BP) is usually a white layer composed of ash and charcoal from a time of intense use. Several hearths and many thin white and black lenses have been found in this stratum. In some places stratum 3 has been cut through by pits containing organic matter and by bioturbations.

Stratum 4 (ca. 2000 BP - ca. 4250 BP) presents a sharp contrast to stratum 3 with generally red sediment. In places, charcoal concentrations are encountered in browner sediment, including a hearth in unit P-11.

Stratum 5 (ca. 4250 BP - ca. 6500 BP) is composed of layers of whitish gray sediment and reddish sediments, where intact. It is the last archaeological layer in unit K-24.

Stratum 6 (ca. 6500 BP - ca. 8000 BP) is composed of lenses of many colors made of less compact sediments. The white, gray, and black lenses contain little material.

Stratum 7 (ca. 8000 BP - ca.10,000 BP) is distinctly separated by sediment color and texture from stratum 6. In the unit O-20, archaeological materials occurred in lower quantities in comparison to the overlying stratum.

Stratum 8 (ca. 10,000 BP - ca. 11,000 BP) while rich archaeologically, was encountered in only two of the excavation units (G-17 and J/K-12/13). Some of the faunal material from this layer was fossilized.

Stratum 9 (> ca. 11,000 BP) is archaeologically sterile.

The approximate date ranges presented for the archaeological strata were based upon radiocarbon assays (Table 5.1).

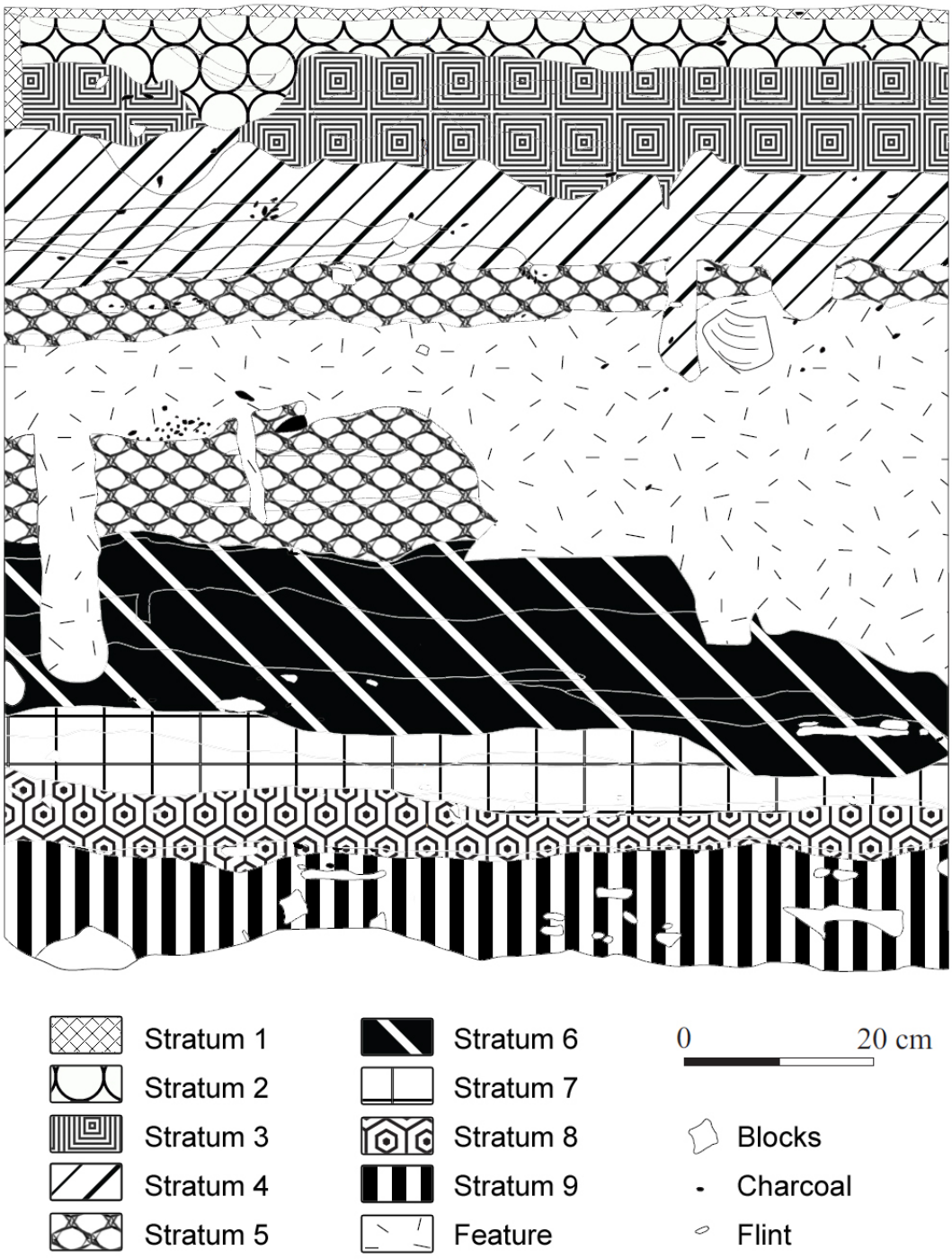


Figure 5.6. The western profile of unit G17 at Lapa dos Bichos shows the site's nine stratigraphic layers (adapted from Kipnis 2002a).

Table 5.1. Radiocarbon dates from Lapa dos Bichos by excavation unit. Radiocarbon dates are uncalibrated; the dates in gray were excluded as outliers; laboratories used were Beta Analytic, Miami and Centro de Desenvolvimento da Tecnologias Nucleares, Belo Horizonte, Brazil (Kipnis 2002a, personal communication).

STRATUM	PERIOD	C30 DATE	G17 DATE	J/K 12/13 DATE	K18 DATE	K24 DATE	O20 DATE	P11 DATE
1	**150 – present**							
2	**150 - 750**			130 ± 20 625 ± 125				
3	**750 – 2000**	910 ± 60	760 ± 50			780 ± 40		
4	**2000 - 4250**	3610 ± 40	2160 ± 60		3540 ± 80	2510 ± 80 3280 ± 50		4020 ± 70 9500 ± 130
5	**4250 – 6500**	4500 ± 70	1410 ± 50	4800 ± 270		4440 ± 60 4750 ± 70	5800 ± 70	
6	**6500 – 8000**						7500 ± 70	
7	**8000 – 10,000**		9390 ± 160				8890 ± 90 8640 ± 90 9140 ± 90	
8	**10,000 - 11,000**		10450 ± 70					

Faunal remains from strata five through eight at Lapa dos Bichos were studied in depth by Kipnis (2002a). The faunal remains include almost no large mammals; conspicuously absent are capybara, giant anteater, Brazilian tapir, and giant armadillo. The assemblages include a few deer and peccaries. Small mammals make up the majority of the faunal assemblage indicating a great diet breadth. Many small mammals that were calculated to fall outside of the optimal foraging set are represented in the archaeological record. Additionally all of the strata have very similar assemblages indicating no significant dietary changes in the early and middle Holocene. Kipnis (2002a) suggests as low-ranked faunal resources enter the diet, the diet would be more likely to include plant foods, which while generally low-ranked in comparison to animals, would rank near or better than the small rock cavy and mouse opossum that were included in the diet.

The analyses of other classes of archaeological materials are ongoing. The lithic materials from Lapa dos Bichos have not been fully analyzed. The earliest lithic assemblage, that from stratum 8, is like those from the rest of the Peruaçu River drainage. The lithic technology of the Peruaçu area is described in Chapter 4. It is documented that the later lithic traditions follow the local patterns and are informal and expedient in nature (Rodet, M. 2009). The ceramics found at Lapa dos Bichos appear in strata 1 and 2 and are of the Una tradition. Rock art occurs within Lapa dos Bichos, but there are far more impressive pictographs at many other sites in the

region. Rock art at a nearby site, the Abrigo Norte do Janelão, is predominantly from the São Francisco and Nordeste traditions (David 2009).

Analysis of the botanical remains at Lapa dos Bichos, or any other location, was dependent upon characteristics of the locations in which the remains were found as well as the specific items encountered. While features composed of botanical materials were located in the test excavations, the extensive excavation was better suited to reveal their extent and stratigraphic positioning. Figures 5.7, 5.8, and 5.9 show the evolution of features in strata 2 and 3. In the northeastern portion of the excavated area features were visible from the onset of stratum 2. The majority of features were visible midway through stratum 2. The features were very visible in excavation because of the contrast in quantity of botanical materials as well as the differently colored sediments. In the third stratum the sediments became predominantly white contrasting with the features.

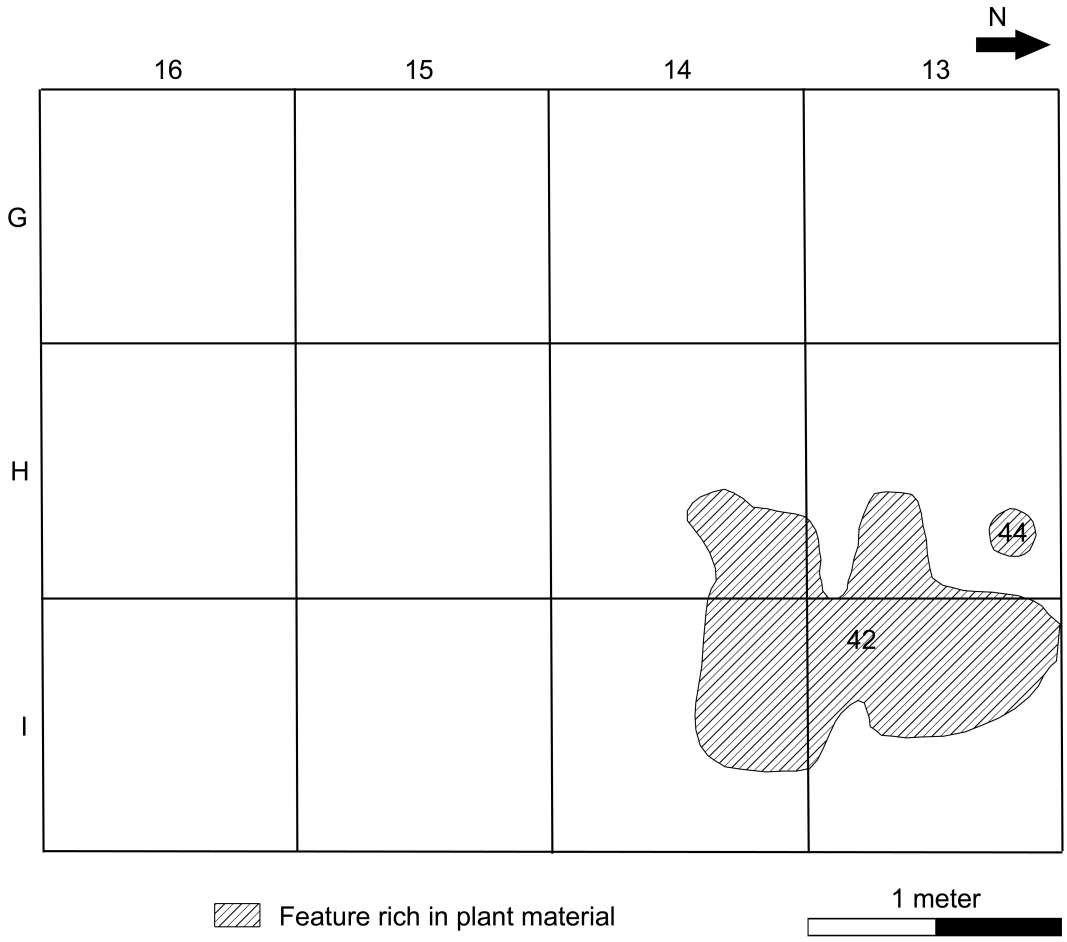


Figure 5.7. Plan of extensive excavation showing the location of features at the beginning of stratum 2.

The features at Lapa dos Bichos do not have a consistent shape or size. However what holds them together as a class is the abundance of organic material, in general dessicated plant seeds and fruits. Features also include the hearths. The majority of features rich in botanical material are unstructured and without a specific form. Only a few features, such as 51, 52 and 61 have clearly rounded pits. Some of the small features also clearly pass between strata. Most of the features have no clear pit, even when they

cut through older strata. Features did not contain woven material from fiber or palm fronds, making the placement of these remains within containers quite unlikely. The features with rich deposits of botanical material at Lapa dos Bichos had a physical appearance distinct from the lined pits at the neighboring site of Lapa do Boquete.

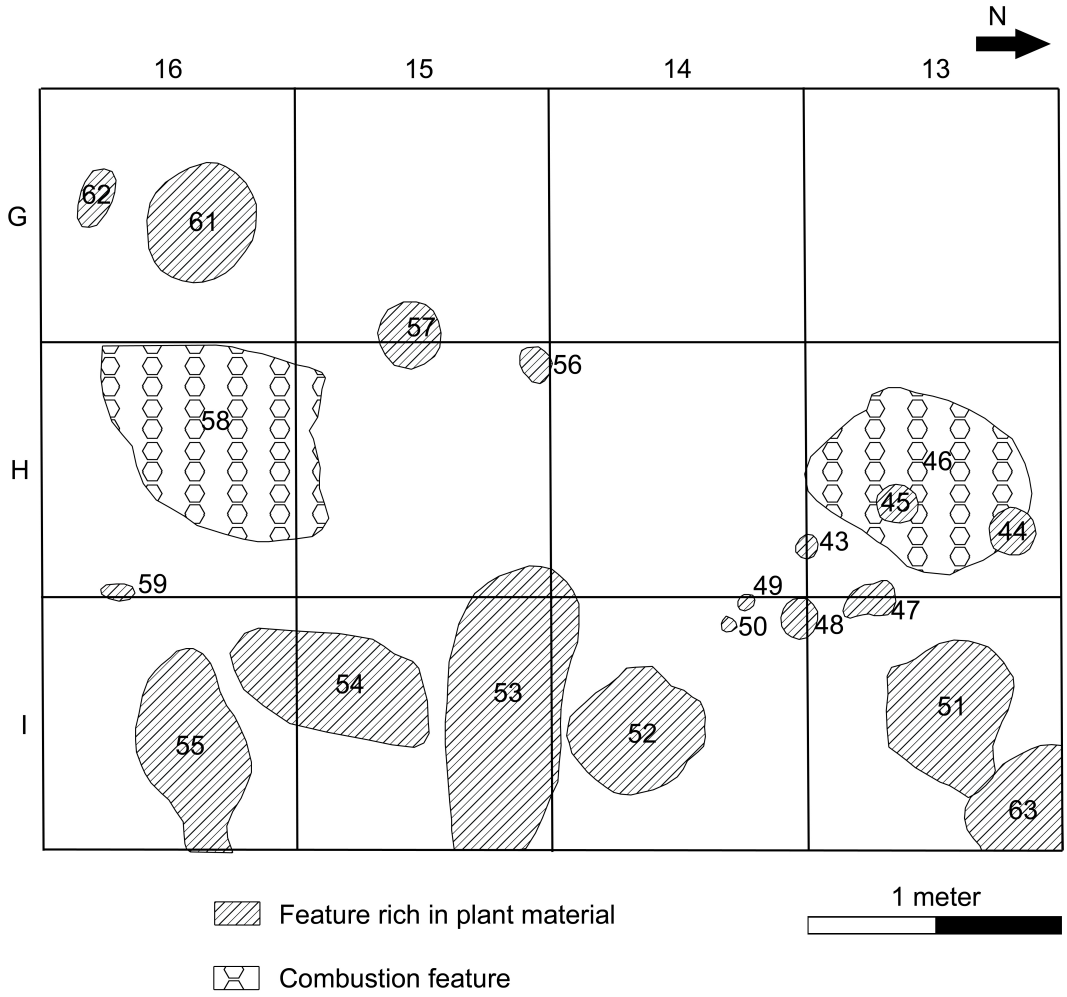


Figure 5.8. Plan of extensive excavation showing the location of features in the middle of stratum 2.

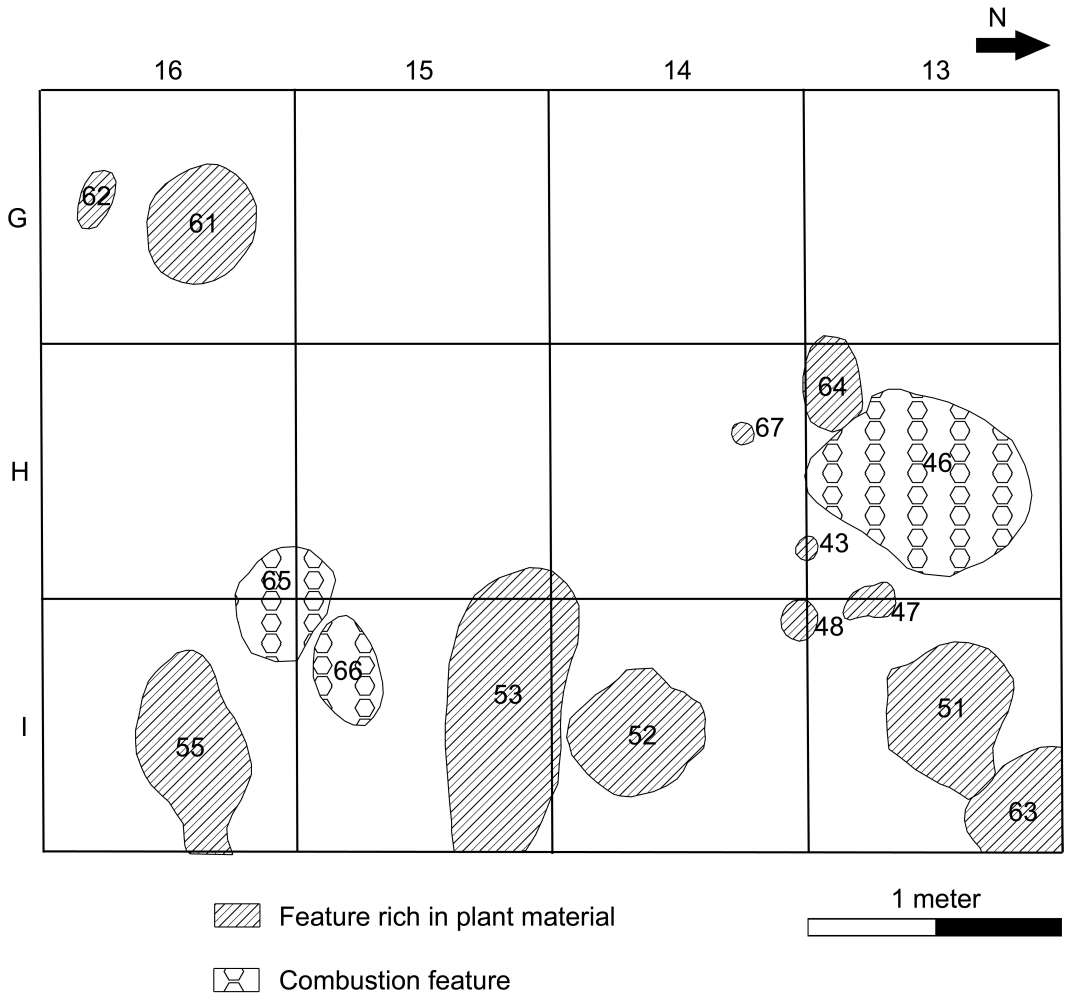


Figure 5.9. Plan of extensive excavation showing the location of features at the beginning of stratum 3.

The archaeological remains from Lapa dos Bichos provide us with the working hypothesis that the site functioned as a camp for hunter-gatherer populations with a strategy of logistical mobility. In the hunter-gatherer strata (4-8) there is no evidence for permanent structures or storage features (Kipnis 2002a). There are no distinctions that would suggest long-term residential stays, such as the segregation of space into activity areas for

stone knapping or garbage middens. The sites in the Peruaçu river valley which have been excavated reveal use throughout the Holocene, which along with site density, suggests that use was a transient part of a settlement pattern of dwelling in sequential locations. The strata more recent than 2000 BP show the introduction of remains from domesticated plants. Residence in the late Holocene at Lapa dos Bichos appears to have been transient as hearths and features rich in dessicated organic remains are not clearly organized (Kipnis 2002a). Nearby at the site of Lapa do Boquete, the late Holocene pattern of rock shelter use differs from earlier periods as the location was used for burial. Survey away from the limestone cliffs of the Peruaçu River Valley encountered sites with ceramics, but the reasons for this change from earlier land use patterns have not been investigated, nor is the survey complete as large regions of farmland were excluded (Prous n.d.). Perhaps, during the late Holocene, local differences in site use were related to a system where activities were spatially separated.

Lapa Pintada

Lapa Pintada is located in in the region of Montes Claros, northern Minas Gerais. The site was first excavated in the 1950's by an avocational archaeologist. The excavation recovered 14 skeletons and lithics from the site (Bueno in press; Filho 1994).

In 1977 and 1978, archaeologists Alan Bryan, Ruth Gruhn and Paulo Junqueira identified five sites near Montes Claros and excavated at one of

them. Activities by the Instituto de Arqueologia Brasileira in the 1980s included excavations in two sites and the locating of two more. Survey in the region has continued with the involvement of speleologists of the group Espeleogrupo Peter Lund, and as such over 20 sites with rock art or surface artifacts have been identified. Many of the archaeological sites that have been located lie within the boundaries of a state park that was established in 2006. The *Parque Estadual de Lapa Grande* occupies an area of approximately 7000 hectares, contains 35 caves, and is currently closed to the public (IEF 2006).

The city of Montes Claros is near the headwaters of the Verde Grande River drainage along the Vieira creek. The Verde Grande River drainage is very large and enters the São Francisco River at the border between Minas Gerais and Bahia, north of the confluence of the São Francisco and the Peruaçu Rivers. The limestone plateau to the north and east of the city is significantly eroded with wide shallow valleys between a patchwork of rock outcroppings. The shallow valleys have few streams and many seasonal drainages.

The site of Lapa Pintada is a C-shaped rock shelter with an opening 50 meters high and 30 meters wide, from mouth to limestone wall; the shelter is at most 20 meters deep (Figure 5.10). The sediments are on a slope dropping from the wall toward the opening, with what appears to be an erosional channel through the middle (Figure 5.11). As water does not

currently run through the rock shelter, the erosional channel may be a relic feature or a result of livestock entering the shelter during the tenure of this land as a ranch. The livestock´s past presence was also apparent in the rich fecal contribution to the surface layers of the site. The higher area of the rock shelter has a significant quantity of rock fall from the roof. Numerous scattered rocks are exposed further from the wall. Lapa Pintada is located in a limestone outcropping above an open and dry valley, and it is one and a half kilometers (9/10 of a mile) from the perennial creek. Current vegetation around the rock shelter is predominantly woody cerrado.

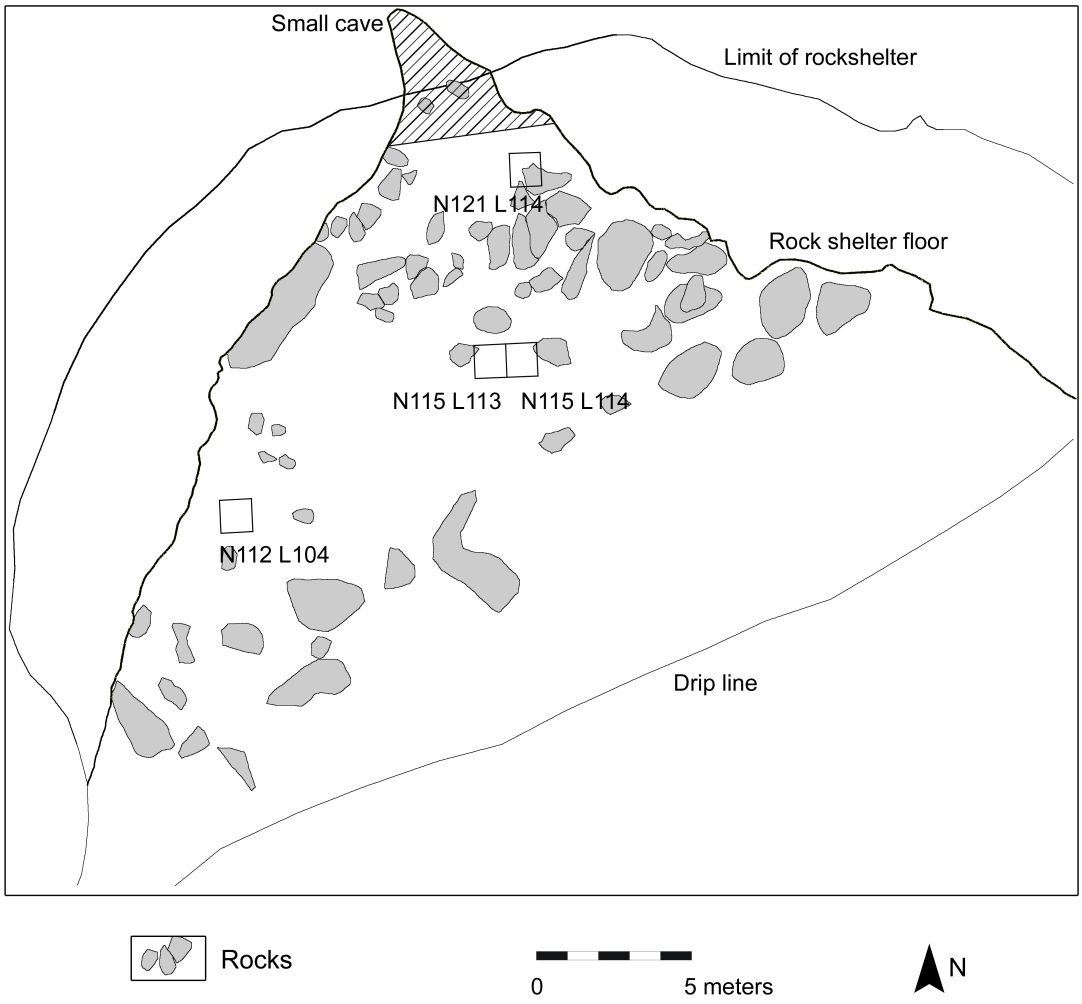


Figure 5.10. Plan drawing of the Lapa Pintada archaeological site showing the locations of the rock shelter's coverage, excavation units, and large rocks (adapted from Bueno in press).

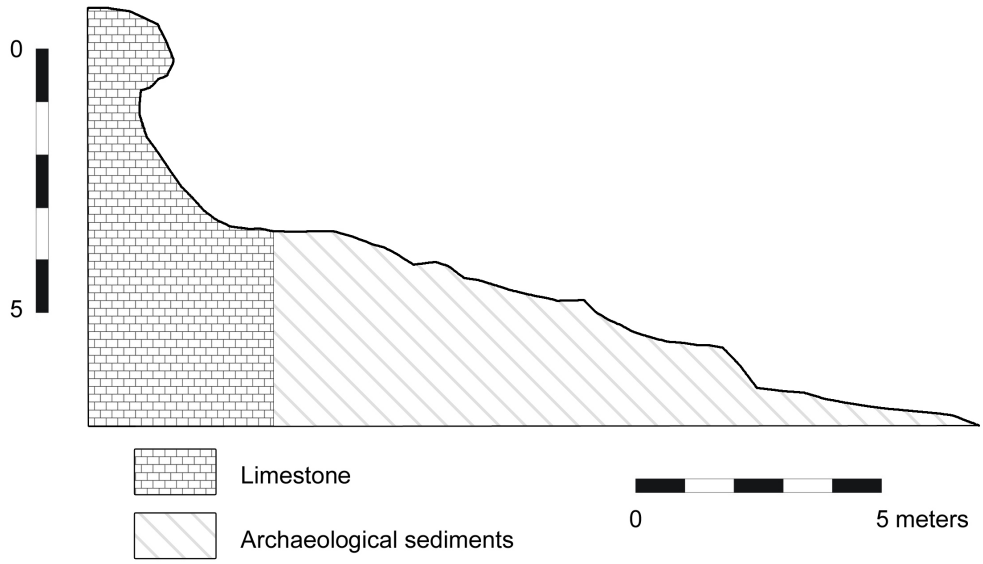


Figure 5.11. Partial profile of Lapa Pintada rock shelter. The sediments within the rock shelter slope downward to the drip line and, while not pictured, this slope continues out into the valley below. The division between limestone and archaeological sediments is schematic and the depth of archaeological deposits is unknown (adapted from Bueno in press).

Systematic excavations at Lapa Pintada under the direction of Lucas Bueno in 2008 and 2009 have included four excavation units designated by North (N) and East (L) coordinates. Units N112L104 and N121L114 were located near the rock shelter's back wall. Unit N112L104 reached a depth of 68 centimeters with archaeological remains throughout the stratigraphy and two hearths (Bueno in press). Meanwhile unit N121L114 contained historic material and encountered limestone within 25 centimeters (Bueno 2008). Two contiguous units, N115L113 and N115L114 have been excavated in a central location (Figure 5.10). These units were chosen for excavation because of the high quantities of organic matter visible on the surface When

the units' southern portion was cleaned, four distinct concentrations of botanical remains were identified in the north profile (Figure 5.12) (Bueno 2008). This unconventional profile from 20 centimeters into N115L113 and 40 centimeters into N115L114 clearly demonstrates the stratigraphic relationships between features A, B, and C. The features were within a stratum with various intercalated layers of fine sediment, ash and charcoal. As the features rich in botanical remains were not noted to contain burnt remains, Bueno (in press) hypothesized that the ash and charcoal were transported from elsewhere. The stratigraphy of N115L113 and N115L114 as seen in the true northern profile reveals that the natural layers slope downward to the east, and that this slope was more pronounced before a block capped the eastern side of the excavation unit (Figure 5.13). The units N115L113 and N115L114 have been excavated to 85 centimeters and the cultural deposits continue.

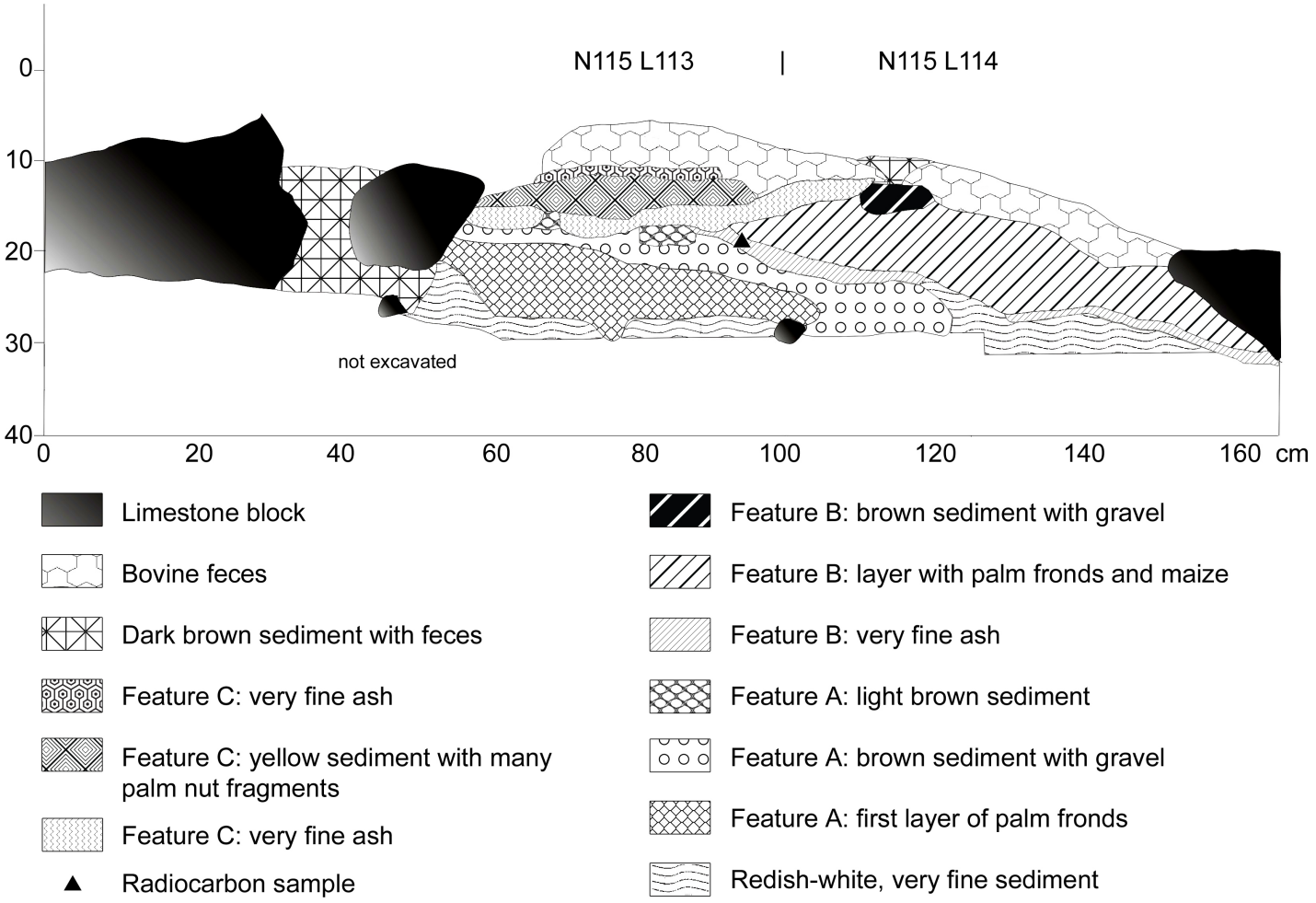


Figure 5.12. An untraditional north profile of units N115L113 and N115L114 was drawn in the southern portion of the units to demonstrate the relationship between features A, B and C (adapted from Bueno in press).

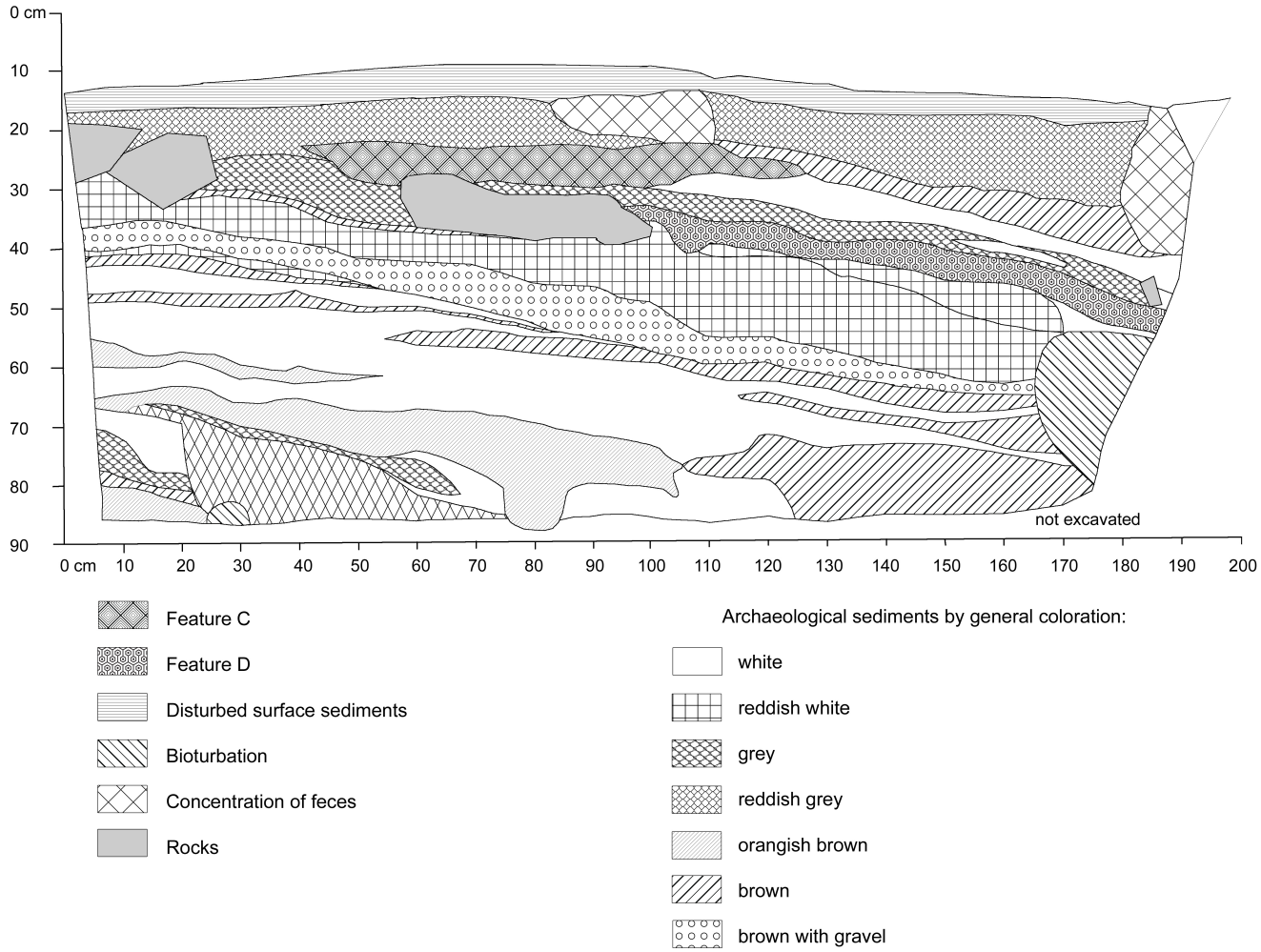


Figure 5.13. North profile of units N115L113 and N115L114. Features C and D are visible as well as the natural easterly slope of the natural strata.

Excavation sought to determine the size and structure of the features rich in botanical material. Two large portions of Feature B were removed as a block to be excavated in the laboratory (Bueno in press). The excavation of one of these portions by the author and Francini Medeiros da Silva revealed that while palm fronds and small sticks lay in horizontal positions, Feature B did not contain a systematic layer of these material or of woven palm fronds. None of the other botanical remains were located in such a way as to indicate that the botanical materials were organized prior to deposition. The concentration of botanical materials was extremely apparent due to areas within the feature with almost no sediment. In the sediment around the features, botanical materials were noticeable during excavation. Interpretation of botanical remains from the uppermost level will be complicated by the intrusive bovine feces.

The botanically rich features at Lapa Pintada were generally large, however the site plans do not show their total extent. Excavation was carried out by separating every sediment with different characteristics by provenience number within arbitrary five centimeter levels. Figures 5.14, 5.15, and 5.16 show successive cuts through the features and their relative stratigraphic positioning. While not drawn in the excavation plans, multiple bioturbations cut through the archaeological sediments. Immediately below features D, the apparent concentration of botanical remains dropped significantly.

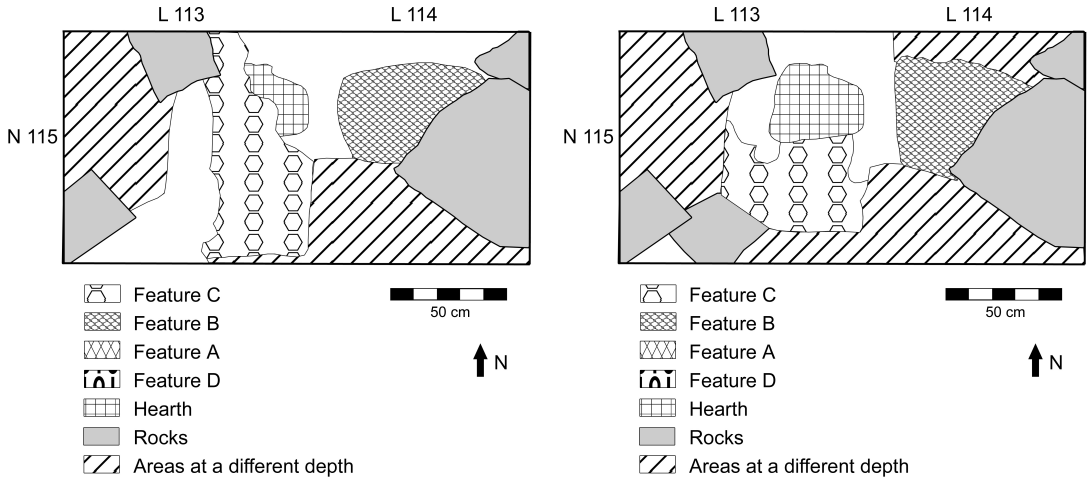


Figure 5.14. The evolution of features at Lapa Pintada is apparent in the sequential site plans. Plans are from October 20, 2008 (left) and October 22, 2008 (right).

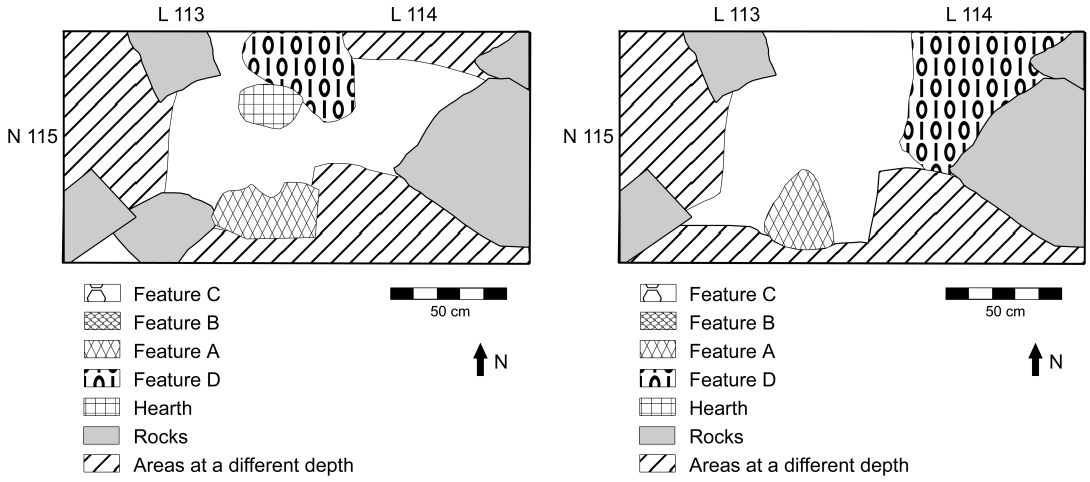


Figure 5.15. The evolution of features at Lapa Pintada is apparent in the sequential site plans. Plans are from October 23, 2008 (left) and October 24, 2008 (right).

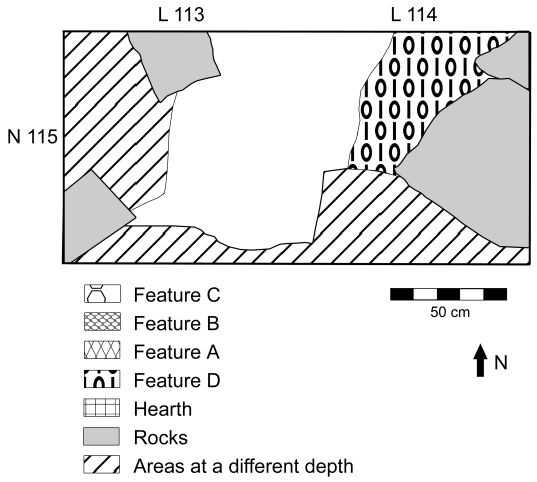


Figure 5.16. The evolution of features at Lapa Pintada is apparent in the sequential site plans. Plan from October 25, 2008.

Available data for two sites in the Montes Claros region indicate occupation during two distinct periods, 8000 to 7000 BP and 1200 to 500 BP (Bueno in press). Both these periods are represented at Lapa Pintada, bracketed by four radiocarbon dates (Table 5.2). The most recent dates come from two human teeth collected in the 1950's, placing occupation at Lapa Pintada as recently as 500 BP. The other bracketing date of 7000 BP comes from unit N112 L104 (Bueno in press). The features rich in botanical remains date to the period around 1200 BP on the basis of a date from below Feature B (Figure 5.12). It can be assumed that the layers excavated in units N115L113 and N115L114 without concentrations of botanical material lie between these two later dates.

Table 5.2. The chronology of archaeological deposits at Lapa Pintada is supported by four radiocarbon assays, here presented in uncalibrated format with a one sigma error range (Bueno in press).

Unit	Material	Level (cm)	Date BP	Laboratory number
Private collection	Human tooth	-	460±60	Beta 260110
Private collection	Human tooth	-	820±40	Beta 260111
N115L113	Charcoal	Below Feature B, collection from profile	1170±40	Beta 243215
N112L104	Charcoal (palm and wood fragments)	8 (45-50)	7000±70	Beta 243214

Rock art at Lapa Pintada is predominantly pictographs with rare engravings. While the imagery has not been recorded systematically, there are arrangements of figures which are similar to stylistic units defined for central Brazil (Bueno in press). The São Francisco tradition is reflected in geometric design groups which occur in different layers of painting as seen from the superimposition. Some zoomorphic figures in pictographs at Lapa Pintada are possibly associated with the Planalto tradition (Bueno in press).

The analyzed lithic assemblage from Lapa Pintada comes from unit N112L104. While the assemblage is small it is possibly related to the lithics from Lapa Pequena, a nearby rock shelter (Bueno in press). The characteristics of lithic technology and assemblage discussed here came from research that analyzed collections from Lapa Pequena and dates to the occupation from 8000 to 7000 BP (Bueno in press). The lithic technology associated with the botanical features has yet to be analyzed. At Lapa Pequena the predominant lithic raw materials are silex (70%) and quartz.

The assemblage is dominated by flakes and heat fractured pieces; there are few artifacts and cores. No local source of silex has been discovered in the vicinity. Silex flakes were small, rarely exceeding four centimeters in their maximum dimension. Artifacts, lithics both retouched and utilized, at Lapa Pequena generally had a single use edge (64%) and many of these show no evidence of retouch. The lithic technology utilized a technique of refreshing and reutilizing broken and burnt raw material. No formal tools were found in the assemblage. The lack of patterning in tool form and style observed by Bueno (in press) is characteristic of an informal, expedient lithic industry.

The cultural remains from Lapa Pintada include fauna which have not yet been analyzed. Ceramics are basically absent as only a few extremely small fragments were encountered. The human remains excavated from Lapa Pintada in the 1950's have yet to be analyzed, however the collection has been made available for analysis (Bueno personal communication).

Lapa Pintada has been interpreted as a special activity site due to the large number of human burials which were encountered at the location and the large quantity of pictographs in comparison to other known archaeological sites from the Montes Claros area. As the site appears, from radiocarbon assays, to have a temporal gap, the relationship between earlier and later settlement is unknown.

Two sites, one project

Very little of the material culture from the late Holocene occupations of Lapa dos Bichos and Lapa Pintada has been analyzed; however in the near future these data will be available to build a better picture of human habitation in the broader region. Occupations from the middle Holocene appear to be similar in their transitory nature, an expedient tool technology, and a probable reliance on a broad spectrum of fauna. Although slight, there are differences between the two sites for the middle Holocene. The Montes Claros area has a more expedient technology expressed in the lithic assemblage. In terms of ceramic assemblages, the Peruaçu River valley has a greater indication that this technology was utilized. A final note concerns the predominant rock art traditions; in the Peruaçu region figures are from the São Francisco and Nordeste tradition and in Montes Claros the traditions noted are the São Francisco and Planalto.

At first glance the assemblages of botanical remains from Lapa dos Bichos and Lapa Pintada appear to be similar due to the domesticated plant remains encountered and the predominantly unstructured features. This analysis will further consider the similarity of botanical assemblages from the sites to analyze whether or not these appearances are superficial. Potential variation in botanical remains at the two locations could be due to the slightly different environmental contexts, different economic activities, or differing practices leading to the deposition of plant remains.

Chapter 6. Materials and Methods: manipulation and management of archaeobotanical collections

Excavations at the sites of Lapa dos Bichos and Lapa Pintada followed different sample collection protocols which in turn influenced the methods adopted in the laboratory, and could thus affect the paleoethnobotanical observations. This chapter details the collection procedures, treatment of samples in the laboratory, potential biases created in the data, and the long term curation of the samples. A further section considers how the archaeological seed and fruit remains were identified. The final section describes the quantitative and statistical measures utilized in the subsequent analysis.

Collection of archaeobotanical samples

Archaeological research is inherently tied to primary observations from the field. Once excavated, cultural remains can not be returned to the ground for future researchers. Excavations, therefore, are undertaken with an eye toward recovering as many materials as possible for archaeological analysis. This constant drive for improvement and the adjustment of field methods concurrently makes our samples better as more is collected and makes collections made at different times difficult to compare.

Lapa dos Bichos and Lapa Pintada are sites where field collection methods were adapted during excavation to better sample

paleoethnobotanical remains. And thus, the collections did not follow a single protocol and the samples are inconsistent in volume and recovery method.

Lapa dos Bichos

The collections of sediment which resulted in paleoethnobotanical samples followed separate protocols during the excavations that occurred in 1995 and 2006 at Lapa dos Bichos.

1995 collection protocol (LBCH95)

In the excavation of each test unit (1 x 1 m), one quadrant was designated for flotation samples with all sediment collected. As the excavation was carried out by natural levels, as perceived through changes in the soil, individual collection size was small. The sediment was removed to a field lab where it was dry screened then floated. The dry screening used a set of geological sieves of 2 mm, 1 mm and 0.5 mm sized mesh (No. 10, 18 and 35, respectively). Subsequent to screening each size fraction was weighed and the volume measured. Then the size fractions were individually processed by flotation in a tank system where light and heavy fractions were captured in screens with mesh of 0.5 and 2 mm, respectively. After drying, the heavy fraction of material from the 2 mm screen was sorted by a field technician who discarded rocks and non cultural material. Another step of the process was apparent from working with samples in the laboratory. In the curation process, large materials, over approximately 1 cm, were almost entirely separated from from the light fraction samples. The other three

quadrants of the test excavation units were screened through 2 mm mesh and the cultural materials were collected in the field; these samples were not considered in this analysis.

Potential biases in the data from LBCH95 samples come from two sources. The first would be technician error in the field when heavy fraction samples were sorted. The second would be due to a mix up in the curation location as the larger botanical remains of the light fraction samples were not present in the material studied.

2006 collection protocol for general contexts (LBCH06)

The initial protocol for the collection of sediment samples from Lapa dos Bichos in 2006 called for the collection of two liters of sediment from every excavation context. This sediment was to be processed in a tank flotation system in the field using screen sizes of 0.5 mm and 1.5 mm, respectively, for the light and heavy fractions.

Aside from the two liter sediment samples collected in each level, the remaining sediment was screened through 2 mm mesh. Cultural materials were separated and sorted from the screens in the field. Visibility was generally good, as the sandy sediment passed easily through the screen, however recovery was dependent on excavator familiarity with botanical remains.

2006 collection protocol for features (LBCH06F)

Features encountered in the 2006 excavation of Lapa dos Bichos were collected in their entirety and the volume of sediment measured. Due to the large quantities of desiccated remains in these samples, flotation was not used. One of the fears was that introducing the samples to moisture might initiate a process of decomposition or molding. The samples were screened in nested geological screens of 2 mm, 1 mm and 0.5 mm mesh sizes. Screening was carried out in the field and the material collected in each screen size was bagged to be further sorted in the laboratory.

As the samples from features were dry screened and the samples from the surrounding matrix were processed by flotation, there may be some question of comparability. We do not know which seeds suffer differential breakage under the two collection methods. Due to collection method and differences in sample sizes these sets of data from 2006 are compared following analytical methods which address these biases as discussed in the later section of this chapter on the quantification and analysis of paleoethnobotanical samples.

Lapa Pintada

Excavations at Lapa Pintada followed a progression where greater emphasis was placed on the recovery of paleoethnobotanical remains over time.

February 2008 collection protocol (LP08)

The first excavation at Lapa Pintada followed a customary collection strategy for the region. Screened material from excavation was sorted into artifact classes at the field site. Botanical remains had to be recognized by excavators alongside the lithics, fauna, and charcoal generally recovered from the screens. While the standard screens have a mesh size of approximately 2 mm, sorting of remains in field led to a strong bias toward large-sized remains. Excavator familiarity with plant matter also influenced the type of material collected with a preference for common species.

October 2008 / April 2009 collection protocol (LP09)

The plenitude and diversity of organic remains observed in the February 2008 excavation led to a change in collection strategy for the October 2008 excavation. Extensive collections were made in two manners, five liter sediment samples for flotation and the collection of all material from the 2 mm screens. The sediment samples were floated in the field using a tank system. Screen sizes were approximately 1.5 mm for the heavy fraction and 0.5 mm for the light fraction. While sample size was ideally five liters, some layers did not reach this excavated sediment volume and the variations in volume were noted on field forms. The collection of all material in field from the 2 mm screening meant that everything was carried out in a bag to be sorted in the laboratory.

Two divergent procedures were used in special instances. When the excavation encountered especially well preserved botanical remains, they were placed in neutral foam, cut into a bed to accommodate the item. Thus some fragile materials were removed separately but received the same provenience number to be associated in the laboratory, however it is not known if these items come from the sediment when it was being collected for the 5 liter sediment sample or afterward from the general context. As previously discussed in chapter 5, another special instance was the removal of two pieces of one feature (Feature B) in block format. After careful excavation around the feature, the sediment underneath was cut with a machete and a wooden slab was introduced into this opened space. The feature was removed and a box of neutral foam was built about it to support it structurally during transit to the laboratory. The goal in removing these blocks was to allow for a more cautious excavation in the laboratory to determine if they were structured and, in particular, if the botanical remains were within or upon basketry or woven palm fronds.

Directions for sampling archaeobotanical remains

Due to the dry conditions of many Brazilian rock shelters, such as those studied by this project, collection procedures that avoid wetting the organic remains show the greatest promise for future research. Since the richness of dry cave deposits is unparalleled in most regions of the world, excavation should preserve this diversity. A strategy might consist of the

combination of general samples, where all material from standard 2 mm screens would be collected to enable additional sorting, discrete samples, such as a five liter sediment sample in which smaller remains, down to the 0.5 mm size, could be sampled, and fine sediment samples (approximately 300 g) for micro scale analyses such as pollen or phytolith analyses. Obviously sampling protocols will always be a dynamic and site specific process.

Laboratory flow of archaeobotanical samples

Samples from Lapa dos Bichos and Lapa Pintada were taken to São Paulo for analysis. Analysis was carried out at the Museu de Arqueológia e Etnologia of the Universidade de São Paulo over the course of twenty months. Due to the excellent preservation and local abundance of organic remains in the excavated rock shelters, samples containing large quantities of plant remains were acquired. I was assisted by interns in dealing with this great volume of materials; beyond the present study numerous potential directions remain for the analysis of these collections.

The large quantity of sample material, especially from features at Lapa dos Bichos presented a challenge for sorting. To facilitate this process a geological screen of 4.75 mm (size 4) was used to separate a large size class from the material collected in the 2 mm screen. The sample was treated as a single entity, but sorting was facilitated and palm nut fragments, the most plentiful remain, were only collected from the size fraction greater

than 4.75 mm. Flotation samples were also separated into size classes for sorting with the use of geological screens of 4.75 mm, 2 mm and 1 mm mesh sizes. This research only considered botanical remains greater than 2 mm. Remains were sorted by hand and generally without the aid of a dissecting microscope. From Lapa dos Bichos, all samples from 2006 were studied alongside material from three of the 1995 test excavation units. Of the samples from Lapa Pintada, study focused on the flotation samples and the excavation of one of the feature blocks. Furthermore, due to time, only a selection of samples from the 2009 excavation were analyzed.

The sorting of archaeological samples for botanical remains occurred prior to any other analysis. Therefore the researcher and interns sorted all classes of material. For this sorting it was decided that gastropod shell and charcoal less that 4.75 mm in size would not be separated due to its lower priority in general analyses. Plant structural organs, sticks, bark and leaves, were also not separated. These sorting decisions have not prejudiced future research as all materials have been bagged and saved.

Botanical remains were subject to an additional sorting procedure. All botanical remains were separated by morphology into types expressing the same characteristics. This method of typology creation resulted in 840 types. Desiccated and charred remains with the same morphology were assigned to the same type and stored together. Some species are known to be represented two times in the typology as the seeds are separated from the

fruits. The separated botanical materials were identified with unique container numbers. A sequential set of numbers were used for samples from Lapa dos Bichos (φ1 to φ2409). Samples from Lapa Pintada received unique numbers using the context provenience number (PN) and decimal notation (PN#.01, PN#.02, PN#.03, etc., in total there were 669 specimens). Both numbering systems allowed for accurate tracking and accounting of all individual sacks and vials (Appendix E). All botanical specimens were counted, weighed and photographed. Two balances were used as appropriate, an Ohaus Scout Pro 2001 capable of weighing up to 2000 grams with an accuracy of 0.1 g and an Ohaus Adventure Pro 53 capable of weighing up to 50 grams with an accuracy of 0.001 g. All botanical specimens of large size were photographed on a paper grid with one centimeter squares using a standard digital camera (*Canon Powershot A630*) on a tripod. Small specimens, generally those measuring less than eight millimeters in their largest dimension, were photographed with a *Moticam 2500* camera on the third optic of a *Zeiss Stemi 2000* dissecting microscope. The microscope camera program allowed size calibration using a target slide and photographs were taken using this calibration such as to include a one millimeter scale in both dimensions of the photographs.

The counting of seeds leads to a far more reliable measure than counts of less discrete plant organs. Some types of botanical remains received differential treatment. Maize cobs and cob parts were very fragile

and subject to frequent breakage with manipulation. Maize fragments were not counted due to the problems with breakage as well as the large numbers of loose cupules. Palm nut fragments were not counted due to their overwhelming numbers and the fact that extreme fragmentation means that the counts could be a poor representation of the number of original individual items. (A scientific sample splitter could allow for a representative sub-sampling from which to estimate the number of fragments, however this equipment of adequately large gauge for the plant remains was not available.) While counts were tabulated for many fruit parts such as jatobá and bottle gourd rind, these are less reliable measures than the mass, as fragment size varies (Appendix E).

Individual botanical samples were stored in plastic sacks or plastic vials. The documentation for each sample included a label inside a plastic bag placed within the container, as well as, written documentation on the external surface of the container. Plastic bags were found to not maintain air tight conditions, so silica desiccant was not placed with them. The plastic vials generally exhibit air tight conditions so commercial sacks of one gram of silica gel were included in every vial before its closure. Furthermore as the 15 ml plastic vials were over-sized for many small seeds and fragments, pieces of a pH neutral, non-organic foam were used to fill extra space. All analyzed botanical remains have been prepared for curation. The mode of

preparation will hopefully ensure the integrity of these samples for years to come.

Archaeological samples from sites in Minas Gerais are generally excavated under the curational responsibility of the Museu de História Natural Jardim Botânico of the Universidade Federal de Minas Gerais. Consultation with Martha Maria de Castro e Silva who is currently in charge of the organic collections aided in determining the organizational scheme for final curational and archival preparation. As the museum gives preference to organization by excavation unit and level, over provenience number, this sequence was respected in the preparation of boxes. The end product of curational preparation of botanical remains were boxes with accompanying inventories which were entrusted to the principal investigators, Renato Kipnis and Lucas Bueno, who will curate the materials upon completion of site analysis.

Identification of plants

Plants are generally identified by botanists from the leaf and flower organs. In archaeological samples the organs which are preserved are generally seeds and fruits. The first challenge for identification is the acquisition of comparative specimens, be they physical specimens or photographs of seeds and fruits, (Pearsall 2000). The second is the identification of fragmentary or burnt plant remains. The third challenge is a botanical question. To what extent and certainty can a particular

archaeological sample be identified: family, genus, or species. The analysis of botanical remains from Lapa dos Bichos and Lapa Pintada has addressed these topics and the end result is a collection with many identified specimens and numerous more that await identification.

Comparative collections

As botanical herbarium collections historically focus on flowers and leaves it can be difficult to locate taxonomic samples of dried seeds and fruit parts that were collected by botanists since it is often necessary to preserve fruits in formaldehyde. While difficult to locate, these collections are valuable because they will have an accurate species designation as they were collected in conjunction with flowers and leaves. Maria de Fatima Figueiredo Melo at the Instituto Nacional de Pesquisas da Amazonia (INPA) has initiated a collection of fruits and seeds with a focus on the Amazon, but the collection will take time to grow (personal communication).

I visited numerous herbariums in Brazil between 2006 and 2009 where I searched through hundreds of exicata in the hopes of finding seeds in envelopes. My search focused on those plants known to be edible (Appendix A). Staff and researchers at every herbarium were very helpful in assisting my search and in some cases aiding in comparing archaeological specimens with those in the herbarium. I visited herbariums at the Jardim Botânico de Brasília (Brasilia, Distrito Federal), EMBRAPA Centro Nacional de Pesquisa de Recursos Genéticos e Biotecnologia (CENARGEN) (Brasilia,

Distrito Federal), Universidade Federal de Brasília (Brasilia, Distrito Federal), Universidade Federal de Goiás (Goiana, Goiás), Museu de História e Jardim Botanico da Universidade Federal de Minas Gerais (Belo Horizonte, Minas Gerais), INPA (Manaus, Amazonia), and Museu Antropológico da Universidade Federal de Goiás (Goiana, Goiás). I also consulted with specialists in vegetation and germplasm preservation at EMBRAPA CENARGEN and EMBRAPA Cerrados (Planaltina, Distrito Federal) who work day to day with seeds. These herbarium visits and contacts with researchers resulted in taxonomic identifications as indicated in Appendix C.

Another direction to take in identifying archaeological plant remains is the collection of botanical material in the area of sites and subsequent identification of this material by comparison with exicatas at herbariums, an approach suggested by Pearsall (2000). In Brazil, national laws restrict the collection of botanical specimens by permit within environmental protection areas, those with the best plant diversity. When collection occurs the Brazilian laws require that the specimens be archived in herbariums and that they do not duplicate previous research in the protected area. The process of applying for a permit requires that a Brazilian national researcher, preferably a botanist, enter as the principal investigator. Foreign nationals can only serve as co-investigators on Brazilian projects (a requirement of the Conselho Nacional de Pesquisa). While two botanists showed interest in

cooperating with this project, neither participated due to other commitments and systematic collections were not undertaken.

While permits remain a required aspect of collection in environmentally protected areas, I discovered at the end of 2009 that the requirements for collection outside of these areas has changed. The new regulations allow researchers who engage in collection outside of protected areas to self register on a computerized system. The ease of registration and the simplified requirements for curation will facilitate future collections of botanical material for archaeological purposes.

Although systematic collections were not undertaken in this research, over two hundred plant specimens were collected in Brazilian markets, from seed distributors, and from residents in rural communities (Appendix D). This small comparative collection has been useful, especially as the seeds could be burnt to observe changes in morphology. As most of the samples are well known and identified species, such as squash and cotton, the collection is an excellent teaching tool. As paleoethnobotany is a new field of research in Brazil, the comparative collections of seeds and fruits will only improve.

Another source of material for identifying archaeological remains comes from photographs. Some digital resources from major herbariums and the US Department of Agriculture provide images of seeds and fruits. Comparison of images with archaeological material resulted in some

identifications. When possible, confirmation of these identifications was sought by looking specifically for exicatas of that species at herbariums so as to be able to see the three dimensional seed.

Fragmentary and burnt remains

The sorting of fragmentary and burnt remains can be frustrating as many must be left in an unidentifiable category. To type these specimens I depended upon specific elements of morphology, such as surface texture, curvature, holes, divots, connection scars and symmetry, that matched only one of the existing type designations in the other recovered archaeological materials. No thin sections or comparisons of cellular organization or morphology were used and no seeds were purposefully broken to aid classification. Classification of seeds by morphology did not mean they were identified taxonomically.

Certainty of taxonomic classification

While the creation of species lists for remains encountered at archaeological sites may seem to be an endeavor lacking in theory it takes us to the realm of biological theories. Species lists are the stage at which the degree of confidence in species identification is determined as well as where plants may be classified as food/non-food items.

Botanists use a combination of plant organs to taxonomically classify a plant. Taxonomy was used for centuries to place plants with others of similar morphologies. Recently available genetic analyses have

demonstrated that morphological similarities and differences are frequently linked to genetic similarities and differences (Sattler and Rutishauser 1997). In this regard, identifying a plant seed or fruit depends on comparison with those organs in closely related species. For example the hard case of a fruit thought to be *Manihot esculenta* (mandioca) would be compared to other species in the genus *Manihot* to see if the form and features are distinct. Luckily the organization of herbarium archives by genus facilitates this search. In the case of *Manihot esculenta*, the seed case has the same shape and grooves as other members of its genus, and while the size appears to be distinct from samples in two herbariums, alone this is an insufficient attribute for species designation. Thus, while *Manihot esculenta* is more useful to humans than the other species of the *Manihot* genus, botanical remains found at the archaeological site can only be accurately classified by morphology alone to the genus. In other cases the similarity of seeds within a family may be so close that paleobotanists would prefer to stop at the family level of classification, as is the case with Annonaceae (Bruce Tiffney, PhD Paleobotany, personal communication).

The classification of archaeological plant remains as edible or non-edible species depends upon both knowing which plants are edible and the degree of confidence in the botanical identification of archaeological remains. While the question of edibility is less pertinent to studies of agricultural economies as the species are well known, it is undeniable in the analyses of

diets that were based, wholly or in part, on native, less recognized foods. For the present study a list of edible Brazilian plants was compiled from botanical, agricultural, and ethnographic literature (Appendix A). This species list provides information on which modern plants are known to be edible, but the degree of certainty in an archaeological plant identification determines whether using the list is possible. If an archaeological specimen is identified to the genus and we know that some plants in that genus are edible, can we say that our specimen was edible? While plants found at an archaeological site will generally be useful, they might not have been food; the use of plants as medicine, industrial products, or for intoxication are well documented. Botanical literature can be consulted to determine if all plants of a given genus are edible. However, in many instances the members of a genus are numerous and different. Thus the degree of certainty which can be reached in identifying a plant will influence whether we can place it within a diet as an edible plant.

Use of comparative botanical material of all sorts allowed this project to move forward as the merging of plant identifications from recent collections with archaeological specimens is necessary before interpretations can be made. There are many botanical issues that determine the success of an archaeological analysis and as it becomes possible to identify more types of plant remains, our understanding of paleoethnobotany should improve.

Quantifying and analyzing paleoethnobotanical remains

Analysis begins once the plant specimens from an archaeological site have been sorted, typed, and identified. Paleoethnobotanical analysis utilizes a number of quantitative and analytical tools. The set of these tools applied to a given sample is based on the inherent data structure as well as the type of measurements needed to accurately address research questions.

Some procedures in paleoethnobotany

Initial quantification of samples includes the counting and weighing of specimens of each plant morphological type within each context. Counts are a good quantitative measure when the specimens are seeds and thus generally discrete entities. Weight as a measure of paleoethnobotanical specimens can represent species which easily break. Species may be underrepresented or overrepresented in counts due to context-specific conditions of preservation. However, weight becomes almost meaningless when a given specimen is extremely light. (Some specimens in this dissertation weighted less than a thousandth of a gram.) Absolute counts and weights are biased measures as they do not account for issues of preservation or abundance thus skewing results toward species with better preservation and/or greater abundance (Hastorf 1999; Wright 2010). Utilization of ratios and measures of presence/absence, in particular ubiquity, helps to minimize biases based on species-specific preservation and abundance (Hastorf 1999). However, ongoing attention to biases is needed throughout analysis. Wright (2010:50) notes:

> Various manipulations of counts and weights (e.g., conversion factors, diversity indices, rankings, ratios, and ubiquity measures) help to standardize the remains but do not necessarily alleviate all the biases. Even the use of more sophisticated methods like multivariate statistical analyses does not preclude the conditioning of the assemblage by cultural, natural, or analytical processes that may ultimately influence interpretations.

The mechanics and applications of some of these methods are discussed below.

Initial comparisons of paleoethnobotanical samples are often based on measures of ubiquity and ratios of counts or weights to sample volume. Ubiquity is an index of presence/absence that reflects plant presence on the basis of any part found. When ubiquity is used to measure prevalence of species within a stratum, it will reflect the percentage of units that contain a given species. The percentage of presence data on species provided by a ubiquity measure can be used comparatively between strata to track changes in species utilized. Ratios are generally employed to standardize count and weight data. These standardizations include comparisons between categories of materials, of a specific taxon in one sample to the total amount of that taxon, and of quantities in relation to sample size or volume (Wright 2010). The latter group includes density ratios comparing the count or weight of archaeobotanical materials in a sample to the sample volume. An advantage of density ratios is that they compensate for disparate sample volumes. Density measurements for the plant remains in a specific context can be robust to variation in sample size. The utility of measures of species ubiquity and species density may depend upon characteristics of the data set as well as the archaeological questions under consideration (Wright 2010). In general density measures by weight will not account for variability when a data set is full of plant remains that are too light to be accurately weighed.

Ubiquity measures may be complicated when comparing contexts in which samples of radically different volumes were collected: Where the distribution of plant types is very uneven, fewer of those items found at low densities will occur in small samples.

Species diversity is another measure frequently employed to describe the composition of paleoethnobotanical samples:

> Species diversity can be best understood as composed of two concepts – richness and evenness (or equitability). Richness refers to the number of taxa in a given assemblage; the more taxa present, the richer the assemblage. Evenness, or equitability, refers to the uniformity of the distribution of taxa in the assemblage; if each taxon is represented by the same number of specimens or individuals, then they are distributed more evenly than an assemblage dominated by a specific taxon. The most commonly used method among subsistence specialists is the Shannon–Weaver (or Shannon–Weiner) index, but Kintigh's DIVERS method is becoming more prevalent in the subsistence-based literature (VanDerwarker 2010a:67-68).

Diversity measures allow for the discussion of assemblage composition as a summary of data on the taxa found. The approach taken in this research has been to calculate and compare sample richness, one element of diversity.

A variety of multivariate statistical methods have also been applied to the analysis of paleoethnobotanical data, generally with the goal of comparing the distribution of species types between numerous samples or contexts. Applicable methods include correspondence analysis and principal

components analysis (VanDerwarker 2010b). As a test statistic, chi-squared is also useful, although it requires large samples.

Procedures utilized for data from Lapa dos Bichos and Lapa Pintada

Initial quantification of paleoethnobotanical remains included counting fragments and measuring their mass. While weight is the general measure used in paleoethnobotany, a balance rather than a scale was used in the laboratory. The measurements for the present data are actually of mass. For the data from Lapa dos Bichos and Lapa Pintada the number and mass of paleoethnobotanical remains within samples were divided by the sample volume to yield density measures. (As numbers of maize and palm nut fragments were not recorded due to breakage, the density measure based on count excludes these two plant morphological types.) These ratios allowed for the comparison of the density of remains between site contexts or levels. In some instances the density of remains could be associated with the activity which formed the deposit, as a purposeful location of deposition might have far greater densities of plant material. Densities specific to plant species have not been used in the comparison of contexts.

Presence/absence tables are presented by excavation context and plant type. To facilitate the construction and legibility of presence/absence tables for the plant morphological types, only those types that occurred in four or more samples were included in the tables. In general ubiquity was not calculated for plant types between contexts, although the presence/absence

tables would make this possible. The uneven nature of the species data, with many types occurring at very low frequencies, would artificially elevate the ubiquity of less frequently occurring plant types in features, a context where sample volume was generally higher. By contrast calculations of ubiquity between samples from the same type of context do not necessarily present the same complication. Ubiquity is used in the discussion of winged seeds (chapter 9), where comparison was between levels utilizing only data from features.

Analysis of variance (ANOVA) is used primarily as a descriptive statistical tool in this dissertation. The null hypothesis of ANOVA is that individuals are drawn from the same population, under the assumption that they are independent and identically distributed. As it pertains to this work, the *p*-value of an ANOVA test is the probability that an *F* statistic of the given magnitude would be observed under the null hypothesis that individuals are distributed uniformly, i.e., that there is no patterning in the deposition of paleoethnobotanical remains. The significance of an ANOVA test suggests that there is some pattern in deposition in relation to the variables compared; however, it does not establish the origin of such a pattern. ANOVA tests were predominantly used to compare measures of volumetric richness and plant density on the basis of context and strata.

The chi-squared (χ^2) statistic has been used to compare the composition of features with that of the sediment matrix, the composition of

strata with one another, and the composition of features with one another. Chi-squared is suited to the analysis of count data to determine if observations could have been drawn from a single population. Chi-squared has limitations that are not met by all of the plant types found at the sites. In particular, content of cells in the data matrix must meet minimal numerical values. In large tables it is recommended that eighty percent of the cells have an expected count value of five and that no cells have an expected cell count of zero. This limitation calls for high quantities of specific plant types in the majority of groups being compared. To overcome this limitation, plant types within the archaeological data set had to be combined in such a way that no double-counting of observations occurred (e.g., cucurbits and pumpkin seeds could not be used concurrently for grouping if the cucurbits include pumpkin seeds). For the present data set, the combination of plant types to obtain minimal values proceeded along a hierarchical structure: If insufficient numbers were observed in a species, that species was combined with others of the same genera, and if the numbers were still insufficient, combination occurred with other plant types of the same family. The use of criteria for grouping of unidentified plant types was explored, yielding the groups of winged seeds, flowers, and spines. Remaining unidentified plant types were condensed as a single column of observations.

A standardized measure of volumetric richness

Different volumes of sediment were collected in the LBCH95, LBCH06, LBCH06F, and LP09 sampling protocols. Given a scenario where the potential variability in plant remains is not captured by a one-liter sediment sample, a five-liter sediment sample, for example, should contain a greater variability of remains. The simple method of summarizing the number of types found would be to divide this number by the volume of sediment sampled. This would accurately compare richness if it varied in a linear manner with changes in the volume of sediment; however, we expect an upper limit on richness in a manner similar to the species area curve utilized by biologists and ecologist to determine species richness in a given geographical region. The relationship between volume and the number of types found should be nonlinear.

Comparing the richness of morphological types in samples of different volumes requires a standardized measure of volumetric richness. Such a measure, quantifying the expected number of morphological types observed in one liter of sediment, was used to compare samples of different volumes.

The standardized volumetric richness measure utilized in this work is a calculation of the statistical composition of a one-liter subsample of sediment taken at random from the total volume collected. This calculation is not a simple linear interpolation. It is a probabilistic model for the occurrence of a morphological type based upon its frequency within the larger volume.

Assuming that the larger volume is subsampled uniformly, the probability of observing a morphological type i in a subsample of standardized reference volume V_r is that of a Bernoulli random variable with

$$p_i = 1-(1-V_r/V_s)^{N_i} \quad ,$$

where N_i is the frequency with which type i is observed in the sample and V_s is the volume of the sample. (Throughout this work, the standardized reference subsample volume V_r is taken to be one liter.) The presence or absence of each morphological type within a subsample is thus a Bernoulli random variable with mean p_i and variance $(p_i)(1-p_i)$.

It is extremely likely that a ubiquitous type would be found in a one-liter reference sample. This is reflected in the calculation of the statistic, in which large values of N_i result in p_i close to 1. At the other extreme, a type with only one individual $(N_i=1)$ observed in the volume V_s will appear in a subsample with probability V_r/V_s .

It is not necessary to perform a Monte Carlo simulation to estimate either the expected richness of a subsample or the subsampling variance. Since the subsample is being selected from a homogenized representation of the sample, it can be assumed that the distributions of morphological types within the sample are independent. With this assumption, the expected richness of a subsample is given by the sum of probabilities of observing individual morphological types within the subsample:

$$richness = \sum_i p_i \quad .$$

Likewise, the variance of this richness measure is given by:

$$subsampling\ variance = \sum_i (p_i)(1 - p_i) \quad .$$

Assuming equal recovery rates in flotation and dry screening these measurements can be used to compare the richness of plant morphological types across sample volumes and between archaeological sites. Those archaeological samples with a volume of under one liter were not included in these calculations. The standard deviation of the volumetric richness measure is not a standard deviation of the sample because it does not reflect the variance that would have been observed, for example, had a seven-liter feature been collected as seven separate one-liter samples. For a particular sample the mean and standard deviation yield a range of one-liter richness measures that are consistent with that observed for the whole sample. This is a descriptive statistic rather than a test statistic, and cannot be used to reject the null hypothesis that two samples were taken from the same population. In the case that the ranges of two observed standardized volumetric richness measures overlap, then the two observations are consistent with being drawn from distributions of similar characteristics; however, the converse is not true.

Chapter 7. Analysis of paleoethnobotanical data

This chapter presents the analysis of archaeobotanical data collected from the Lapa dos Bichos site and the Lapa Pintada site. Presentation begins with a summary of the plant specimens identified. The identified specimens are a subset of the total number of distinct morphological types. Subsequently the paleoethnobotanical data from the sites of Lapa dos Bichos and Lapa Pintada are presented and analyzed independently. The data presentation is based around each archaeological provenience as a single sample. In some cases the presentation of single contexts has resulted in the combination of samples with different provenience numbers (PN). While presented as single samples in this chapter's tables, these samples have been preserved as independent entities in the physical collections.

Data presented for individual samples include the standardized volumetric measure of the richness of morphological types, the mass density of plant remains (mass in grams is the unit of measure given that a balance was used instead of a scale), the count density of plant remains, and presence/absence table of frequently encountered morphological types. The patterns observed in the first three of these measures are explored with analysis of variance (ANOVA) in relationship to archaeological context and strata. ANOVA is used primarily as a descriptive statistical tool to explore potential patterns in the paleoethnobotanical data. The significance (p value)

of an ANOVA test suggests that there is some pattern in deposition in relation to the variables compared; however, it does not establish the origin of such a pattern. Paleoethnobotanical interpretations of the data are based upon data from the samples themselves, sample contexts, stratigraphy, and the patterns observed.

Identified paleoethnobotanical remains

Paleoethnobotanical remains from Lapa dos Bichos and Lapa Pintada were analyzed from 155 samples with distinct provenience numbers that represent almost the same number of contexts. The remains were classified into 822 morphological types. Individual samples contained from as few as one morphological plant type to as many as hundreds in some features. Of the morphological types, 29 occur in ten or more of the samples and an additional 49 types occur in four or more samples. Due to the overwhelming number of plant morphological types that occurred in three or fewer samples, the presence/absence tables in this chapter only include those types that occurred in four or more of the samples.

The botanical identification of plant morphological types was a major focus of the research as the utility of plants to a human population can best be determined after the plants have been identified. Ninety-eight morphological types were identified and these are listed in Table 7.1. Taxonomic genera or families with more than one distinct morphological type are indicated with multiple entries, such as Fabaceae sp 1, Fabaceae sp 2,

etc. Naming conventions for the species identified follow the sources from which the identification was made. As such, the species names presented may be synonyms for a taxon, rather than the most current classification.

Table 7.1. Botanical taxa of identified morphological types from Lapa dos Bichos and Lapa Pintada. Those species which are known to be domesticated plants or edible are noted. Species identifications were made in reference to collections from many institutions (Appendix C). Photographs of identified species are presented in Appendix B.

Family	Genus or tribe	Specie	Known domes-ticate	Known to be edible	Common name	Morpho-logical type
Anacardiaceae	*Myracrodruon*	*urundeuva*				BA
Anacardiaceae	*Schinopsis*	*brasiliensis*				BT
Anacardiaceae	*Spondias*	*mombin*		yes	cajá	AP
Anacardiaceae	*Spondias*	*tuberosa*		yes	umbu	AE
Annonaceae	*Annona*	sp 1		yes	custard apple	AG
Annonaceae	*Annona*	sp 2		yes		BU
Apocynaceae	*Thevetia*	*peruviana*				BH
Arecaceae	*Acrocomia*	*aculeata*		yes	palm	JP
Arecaceae	sp 1				palm	DH
Arecaceae	sp 2				palm	BS
Arecaceae	sp 3				palm	EB
Arecaceae	sp 4				palm	GD
Arecaceae	*Syagrus*	*oleracea cf.*		yes	palm	CK
Arecaceae	*Syagrus*	*oleracea cf.*		yes	palm	AM
Arecaceae	*Syagrus*	*oleracea cf.*		yes	palm	AL
Asteraceae	*Chromolaena*					EQ
Asteraceae	Eupatorieae	sp 1				EC
Asteraceae	Eupatorieae	sp 2				SVI
Asteraceae	Gnaphalieae					DJ
Asteraceae	sp 1					JO
Asteraceae	sp 2					LZ
Asteraceae	*Trichogonia*					HJ
Asteraceae	Vernonieae	sp 1				JM
Asteraceae	Vernonieae	sp 2				SVJ
Asteraceae	Vernonieae	sp 3				SVM
Asteraceae	Vernonieae	sp 4 cf.				SVN
Bigonaceae	sp 1					GP
Bixaceae	*Bixa*					EK
Bixaceae	*Bixa*	*orellana*				BL
Bixaceae	*Bixa*	*orellana*				AY
Bombacaceae	*Chorisia*	*pubiflora*				JH
Bromeliaceae	sp 1					IT
Caricaceae	*Carica*					JQ
Caryocaraceae	*Caryocar*	*brasiliensis*		yes	pequí	AK

Continued on next page

Table 7.1 - continued from previous page.

Family	Genus or tribe	Species	Known domes-ticate	Known to be edible	Common name	Morpho-logical type
Cecropiaceae	*Cecropia*					AT
Celastraceae	*Salacia*	*campestris*		yes		BN
Combretacea	*Terminalia*	*argentea cf.*				AX
Cucurbitaceae	*Cucurbita*		yes	yes	squash	AQ
Cucurbitaceae	*Largenaria*		yes	yes	bottle gourd	AR
Cucurbitaceae	*Largenaria*		yes		bottle gourd	AD
Cyperaceae	*Scleria*					EG
Euphorbiaceae	*Cnidoscolous*	*pubescens*				AO
Euphorbiaceae	*Cnidoscolous*	*pubescens*				AN
Euphorbiaceae	*Manihot*	*esculenta cf.*	yes	yes	manioc	AF
Euphorbiaceae	sp 1					BW
Euphorbiaceae	sp 2					DV
Euphorbiaceae	sp 3					SVF
Fabaceae	*Amburana*	*cearensis*			legume	DU
Fabaceae	*Anadenanthera*	sp 1			legume	ND
Fabaceae	*Anadenanthera*	sp 2			legume	NG
Fabaceae	*Arachis*	*hypogaea*	yes	yes	peanut	AI
Fabaceae	*Desmodium*	*incanum*			legume	JJ
Fabaceae	*Hymenaea*			yes	jatobá	AC
Fabaceae	*Hymenaea*			yes	jatobá	AB
Fabaceae	*Lonchocarpus*				legume	AV
Fabaceae	*Machaerium*	sp 1			legume	BE
Fabaceae	*Machaerium*	sp 2			legume	JL
Fabaceae	*Macroptilium*				legume	ES
Fabaceae	*Mucuna*	*solanei*		yes	legume	CD
Fabaceae	*Phaseolus*	*vulgaris*	yes	yes	common bean	FJ
Fabaceae	*Phaseolus*	*lunatus*	yes	yes	lima bean	SVH
Fabaceae	sp 1				legume	NF
Fabaceae	sp 2				legume	CQ
Fabaceae	sp 3				legume	NP
Fabaceae	sp 4				legume	EN
Fabaceae	sp 5				legume	FL
Fabaceae	sp 6				legume	FM
Fabaceae	sp 7				legume	WH
Fabaceae	sp 8				legume	JR

Continued on next page.

Table 7.1 - continued from previous page.

Family	Genus or tribe	Specie	Known domes-ticate	Known to be edible	Common name	Morpho-logical type
Fabaceae	sp 9				legume	NM
Fabaceae	sp 10				legume	JU
Malpighiaceae	*Byrsonima*			yes		DE
Malpighiaceae	sp 1					AU
Malpighiaceae	sp 2			yes		CG
Malvaceae	*Cavanillesia*					FH
Malvaceae	*Gossypium*	*barbadense*	yes		cotton	AJ
Malvaceae	*Guazuma*	*ulmifolia*				BK
Melastomataceae	*Macairea*	*radula*				BX
Moraceae	*Ficus*					EW
Myrtaceae	*Myrciaria*			yes	jabuticaba	DO
Passifloraceae	*Passiflora*			yes	passion fruit	AH
Plumbaginaceae	*Plumbago*					NE
Poaceae	*Andropogon*	*angustatus*		yes	grass	GS
Poaceae	*Lasiacis*	sp 1		yes	grass	FW
Poaceae	*Lasiacis*	sp 2		yes	grass	STP
Poaceae	*Mesosetum*			yes	grass	EO
Poaceae	sp 1			yes	grass	FB
Poaceae	*Zea*	mays	yes	yes	maize	BP
Poaceae	*Zea*	mays	yes	yes	maize	BC
Poaceae	*Zea*	mays	yes	yes	maize	AA
Polygonaceae	*Ruprechtia*					AZ
Rhaminaceae	*Gouania*					IJ
Rubiaceae	*Alibertia*					HD
Rubiaceae	*Alibertia*	*edulis*		yes		EX
Rutacaeae	*Zanthoxylum*	sp 1				NA
Rutaceae	*Zanthoxylum*	sp 2				NZ
Solanaceae	sp 1					DC

Plants known to be edible can easily be explained in an archaeological context. Some of the species identified in this list are not listed as edible plants but likely can be consumed, specifically members of the Fabaceae and Poaceae families. The *Manihot* seed capsules from archaeological contexts are considered to come from edible plants as, while

the morphology may be shared with other species, the capsule size is consistent with samples of *Manihot esculenta* (manioc). In addition, some other members of the *Manihot* genus can be edible (Jennings 1959, Nassar et al. 2008). Moreover, the Nightshade family contains a mixture of edible and poisonous plants, but the occurrence of *Solanum* seeds in an archaeological context would suggest that they are likely from an edible species.

The plants not known to be edible deserve greater exploration. Some species have known economic uses, such as cotton (*Gossypium*) fiber and *Bixa orellana* (a pigment). A number of the nonedible plant species have wings and are known to be carried by the wind. These winged seeds include *Myracrodrun urundeuva, Machaerium* sp 1, *Machaerium* sp 2, Malpighiaceae sp 1, and type JL. A further example of non-edible species is *Cnidoscolous pubescens*, which is found in great quantities in Lapa dos Bichos. The seed pods are heavy and large and thus not transported by the wind, and furthermore they have been broken open. If the seed pods of *Cnidoscolous pubescens* had been transported and consumed by animals, teeth marks would be expected.

While it would seem that only identified morphological types could be used in analysis, the initial stage of analysis is quantification and comparison of plant types between excavation units and strata. Within this discussion unidentified morphological types are included. However, the interpretation of

unidentified morphological types is limited as the potential uses of these plant specimens is unknown. Unidentified morphological types are referred to by the two letter codes they were assigned during the sorting process, such as type BD (photo in Appendix B). Aside from the morphological types, many plant seeds and fruit pieces were considered too fragmentary or indistinct to merit assignment to a type. These remains, referred to as "unidentifiable fragments" are only included in the total quantities and mass of given samples.

Lapa dos Bichos paleoethnobotanical data analysis

The paleoethnobotanical samples from Lapa dos Bichos have been divided into two categories based upon their context within the site: those collected from features and those collected in the general excavation. It is expected that the observation of these two contexts as discrete types of deposition will be one of the major aspects of variability in the paleoethnobotanical data. The samples collected from features are punctual observations that refer to discrete locations with concentrations of botanical remains and the provenience will be referred to as "features". The general excavation collections are from the sediment matrix of a given stratum and thus are expected to represent aggregate characteristics of the stratum. For ease of identification in this chapter, these samples' provenience will be referred to as the "sediment matrix".

As in all data sets, there are elements of bias that may affect the patterns observed in analysis. At Lapa dos Bichos the paleoethnobotanical samples come from six archaeological strata. In the interpretation of changes by strata it is important to note that there is only one sample each from stratum 1 and stratum 6. A further variable of the data analysis concerns the difference between the collections of material from the 2006 and 1995 excavations at Lapa dos Bichos. Where possible the analysis utilizes both collections. However, in the case of plant density, data from the 1995 excavations have been excluded because only the light fraction was analyzed.

Volumes of features from Lapa dos Bichos

The volume of samples collected during excavation is one of the keys to data interpretation as a scaling by volume can provide the standardized measures from which to compare samples and contexts. The volume of some feature samples was not recorded in the 2006 excavation of Lapa dos Bichos; however, an estimation, described below, has been performed for use in a limited set of analyses.

Features from Lapa dos Bichos were collected in their entirety. All material from these features has been curated. Feature volume is integral to analysis of the botanical material; however, in some cases these volumes were not recorded. Due to the curation of all material from these features it was possible to estimate the volume of features where this data is missing.

An average sample density was calculated from known feature volumes and mass. The mass used was the total mass of all material above 0.5 millimeters captured in dry screening. The total masses include all botanical material, all artifacts, all rocks, and all particulate matter larger than 0.5 millimeters. The volume per mass was calculated for every feature with a known volume (Figure 7.1). Sample volume is correlated with total mass (slope=0.00425 liters/gram, r^2=92.8). The estimation of feature volumes was based on the constant of 0.004306 liters/gram obtained via a pooled average of the total volume of all features of known volume divided by the total mass of all features of known volume. This closely agrees with the slope of the regression line while giving greater weight to larger samples. This density is not based directly on the mass of paleoethnobotanical remains, which generally account for less than half of the total mass of a feature. The estimate may be biased because botanical material contribute to this measure and botanical material are typically lighter per unit volume than other materials in the sediment, such as rocks. Of the eight features for which volume is estimated, only four have an estimated volume over one liter (Table 7.2).

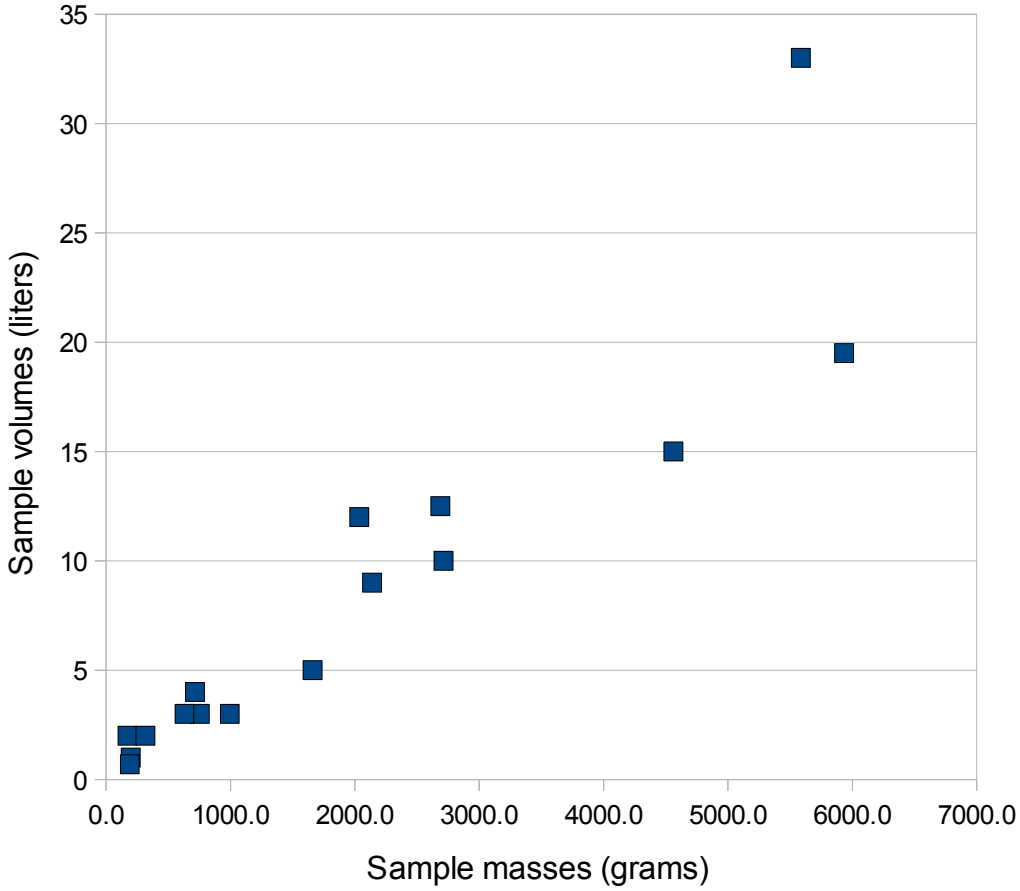


Figure 7.1. Correlation between known feature volumes and total mass of material from the features (slope=0.00425 liters/gram, r^2=92.8).

Table 7.2. Volume and mass of material from features at Lapa dos Bichos divided by size fractions. The total sample mass was used to estimate the original volume of some features.

Feature number	Volume in liters (l)	Total recorded sample mass (g)	Calculated liters per gram	Estimated original volume (l) from constant of 0.00431 liters per gram
42	-	4646.0		20.02
43	-	153.7		0.66
44	-	413.3		1.78
45	2	171.8	0.01164	
47	4	714.2	0.00560	
48	3	754.0	0.00398	
49	-	81.9		0.35
50	-	26.3		0.11
51	12.5	2688.0	0.00465	
52	9	2138.0	0.00421	
53	19.5	5934.0	0.00329	
54	12	2036.0	0.00589	
55	10	2712.0	0.00369	
56	1	197.4	0.00507	
57	3	630.0	0.00476	
58	33	5586.0	0.00591	
59	-	69.7		0.30
60	-	2604.0		11.22
61	15	4560.0	0.00329	
62	2	316.0	0.00633	
64	5	1660.0	0.00301	
65	3	994.7	0.00302	
66	-	204.8		0.88
67	0.7	190.3	0.00368	
Totals for features with known volumes	134.7	31282.4	0.00431	

The estimated sample volumes presented in Table 7.2 were used in subsequent calculations of the standardized volumetric richness measure of morphological plant types . In these cases the calculations are indicated in

gray lettering in the tables such that it is apparent that an estimation has been made.

Standardized volumetric richness of plant morphological types

The laboratory work separated all plant morphological types deemed to have identifying characteristics, and as such the number of morphological types in each provenience sample is known. These raw numbers are a representation of the diversity of types within a sample. Given the nature of the collections from Lapa dos Bichos, sample volumes varied. To draw comparisons, it is preferable to standardize the raw diversity values in relationship to sample size (Kintigh 1984). In this research the number of plant morphological types was standardized by sample volume for all collection types to give a standardize volumetric measure of richness. (The mathematical equation for measure of richness is given in the previous chapter.) The standardized volumetric richness (hereafter referred to as richness) is presented as a statistical one-liter sample taken at random from the number of liters collected (Tables 7.3 and 7.4). Alongside the richness of types per liter is a measure of standard deviation for the calculation. Sediment samples where less than one liter was collected have not been included in this calculation.

Table 7.3. The standardized volumetric richness of morphological plant types in one liter of sediment from features at Lapa dos Bichos. Features where less than one liter of sediment was collected have been excluded. Those features where estimated volumes were used in this calculation are indicated in grey.

PN	Feature number	Feature began in stratum	Volume in liters (l)	Number of morphological types	Richness of morphological types per liter	Standard deviation of richness
8941	42	1	20	167	29.56	3.43
8943	44	2	2	14	11.37	1.22
8944	45	2	2	24	17.58	1.87
8947	47	2	4	54	25.20	3.02
8948	48	2	3	57	31.73	3.12
8951	51	2	12.5	90	18.61	2.88
8952	52	2	9	58	16.39	2.67
8953	53	2	19.5	120	18.36	2.95
8954	54	2	12	37	9.61	1.90
8955	55	2	10	45	12.59	2.39
8956	56	2	1	14	14.00	0.00
8957	57	2	3	16	9.10	1.61
8958	58	2	33	78	10.43	2.21
8961	60		11	14	1.97	1.15
8962	61	2	15	50	10.03	2.16
3661	18	3	5.5	40	12.04	2.43
3683	19	3	1.1	11	10.36	0.76
8971	23	3	1.8	14	5.91	0.81
8972	24	3	6	17	7.58	1.47
8973	25	3	5.4	75	8.70	0.92
8963	62	3	2	13	9.24	1.44
8966	64	3	5	65	26.01	3.18
8967	65	3	3	8	4.67	1.15
8968	66	3	1	4	4.00	0.00
8974	28	4	1.7	5	3.34	0.99
8977	38	5	1.4	10	6.75	0.96
8978	39	5	1	2	2.00	0.00

Table 7.4. The standardized volumetric richness of morphological plant types in one liter of sediment from paleoethnobotanical samples from the sediment matrix at Lapa dos Bichos. Those samples without plant remains have been excluded.

PN	Unit	Stratum	Volume in liters (l)	Number of morphological types	Richness of morphological types per liter	Standard deviation of richness
8854	G13	2	2	7	4.81	1.08
8859	G14	2	2	17	10.62	1.86
8864	G15	2	2	10	6.23	1.40
8870	G16	2	2	10	6.42	1.35
8876	H13	2	2	8	5.23	1.26
8880	H14	2	2	7	5.56	0.93
8885	H15	2	2	10	7.40	1.00
8891	H16	2	2	10	6.75	1.35
8896	I13	2	2	8	6.25	1.05
8901	I14	2	2	13	7.87	1.46
8906	I15	2	2	11	8.34	1.23
8911	I16	2	2	9	6.81	1.08
3759	K24	2	1.5	10	8.44	0.65
8916	O11	2	2	7	4.99	1.00
8930	O2	2	2	1	0.88	0.33
4392	P41	2	6.9	47	6.99	0.72
8856	G13	3	2	1	0.50	0.50
8867	G15	3	2	8	5.69	1.17
8872	G16	3	2	5	3.22	0.98
8882	H14	3	2	4	2.81	0.82
8888	H15	3	2	1	0.50	0.50
8893	H16	3	2	6	3.50	1.17
8898	I13	3	2	2	1.63	0.54
8903	I14	3	2	5	3.38	0.93
8908	I15	3	2	1	0.50	0.50
8913	I16	3	2	5	3.48	0.94
8918	O11	3	2	8	6.09	1.04
4394, 4395	P41	3	2.8	12	4.06	0.84
4377, 4378, 4384	K24	4	11.8	26	5.48	1.62
8920	O11	4	2	6	4.59	0.91
8934	O2	4	2	1	0.75	0.43
4396, 4397	P41	4	10.2	20	1.35	0.92
4387, 4390, 4391	K24	5	6.5	14	3.68	1.54
8922	O11	5	2	3	2.00	0.71
8936	O2	5	2	2	1.00	0.71
8925	O11	6	2	2	1.25	0.66

The measure of standardized volumetric richness appears to have no patterning in relation to the original sample size (Figure 7.2). The values for richness vary over a large range. Analysis of variance is used to explore the structure of this data between features, site contexts, and strata.

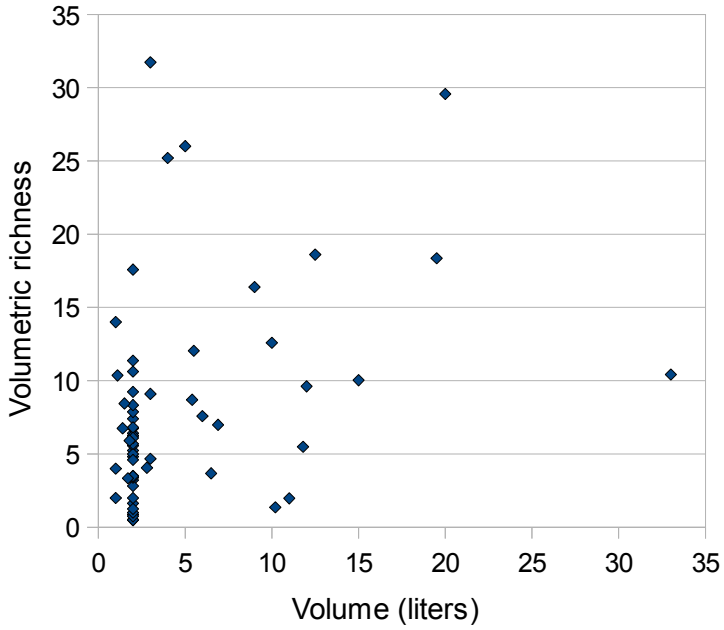


Figure 7.2. Scatter plot of the standardized measure volumetric richness by sample volume for data from Lapa dos Bichos.

Richness measures by feature

The designation of a feature during excavation was based on the observation of an elevated concentration of organic material in relation to sediment. The form, stratigraphic placement, and contents of features from Lapa dos Bichos add to the interpretation of the paleoethnobotanical remains. Features at Lapa dos Bichos do not follow a single pattern. There are great variations in size as well as form of the features (Table 7.5).

Features vary from 10 to 120 centimeters in diameter and range from circular shapes to the amorphous.

Table 7.5. Characteristics of features at Lapa dos Bichos from the 2006 excavation.

PN	Feature number	Observed feature form	Approximate diameter (cm)	Stratum where feature was first observed	Fire affected
8941	42	undefined	120	1	
8942	43	circular	10	2	
8943	44	circular	20	2	
8944	45	circular	20	2	
8945	46	semicircular	70	2	yes
8947	47	semicircular	25	2	
8948	48	circular	20	2	
8949	49	circular	10	2	
8950	50	circular	10	2	
8951	51	circular	60	2	
8952	52	circular	50	2	
8953	53	undefined	110	2	
8954	54	semicircular	75	2	
8955	55	undefined	70	2	
8956	56	circular	15	2	
8957	57	circular	25	2	
8958	58	undefined	80	2	
8960	59	semicircular	10	2	
8961	60	-	-	-	-
8962	61	circular	40	2	
8963	62	semicircular	20	3	
8964	63	circular	40	2	yes
8966	64	semicircular	30	3	
8967	65	semicircular	35	3	yes
8968	66	semicircular	40	3	yes
8969	67	circular	10	3	

Due to the variation in feature form and size the question arose as to whether or not these two characteristics predict the volumetric richness of plant morphological types in the features (Table 7.3). A generalized linear model combining the quantitative variable *size* and the categorical variable

form was used to compare volumetric richness to size (diameter) and form (circular, semicircular, or undefined) for features from Lapa dos Bichos (Figure 7.3). Volumetric richness did not vary significantly with size and form. Separate statistical tests demonstrate that neither size nor form, individually, varied significantly with volumetric richness (volumetric richness vs size, t = 0.62, p = 0.55; volumetric richness vs. form, F = 0.39, df = 15, p = 0.68).

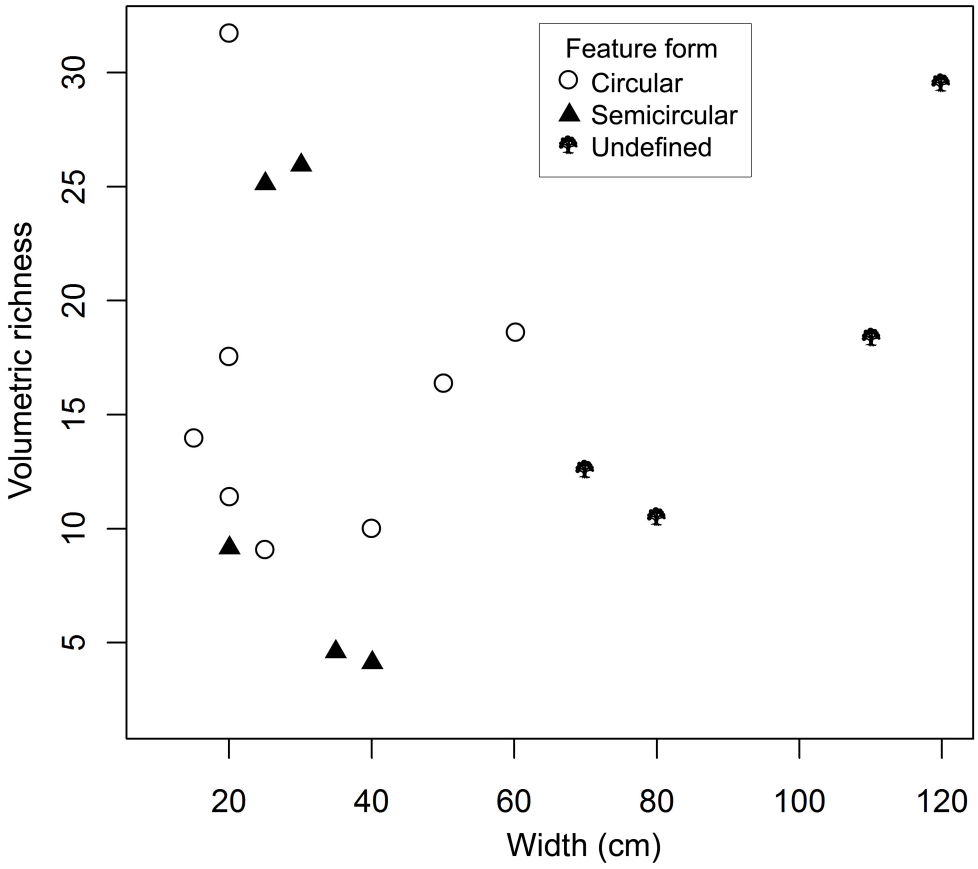


Figure 7.3. Lapa dos Bichos features plotted by volumetric richness and size. Form is indicated by the symbols. The richness measure did not vary significantly with feature size or form.

The variation in feature volumetric richness is not explained by the currently quantified variable of feature construction. It would be possible to

include other variables of feature construction in future tests if these data were recorded systematically. These variables could include whether the feature passed between strata, if it appeared to be lined, and whether apparent effects of fire were observed. Some features passed between layers, but the cessation of excavation in some units prior to sterile sediment would bias this observation, especially for features beginning in stratum 3. No features were found with basketry; however, in some features a substantial quantity of palm fronds were found that could be considered to be a lining (Figure 7.4). Various features showed signs of being affected by fire, but the specific indicators used to make this observation are unclear (Table 7.5).



Figure 7.4. Palm fronds found at base of feature 42.

Richness measures between contexts and strata

The paleoethnobotanical remains from Lapa dos Bichos have been classified into two major categories: those from features and those from the sediment matrix of the site. Features were observed to have had higher measures of volumetric richness than the surrounding sediment matrix, varying significantly with context ($F = 31.07$, $df = 61$, $p = 6.0 \times 10^{-7}$) (Figure 7.5).

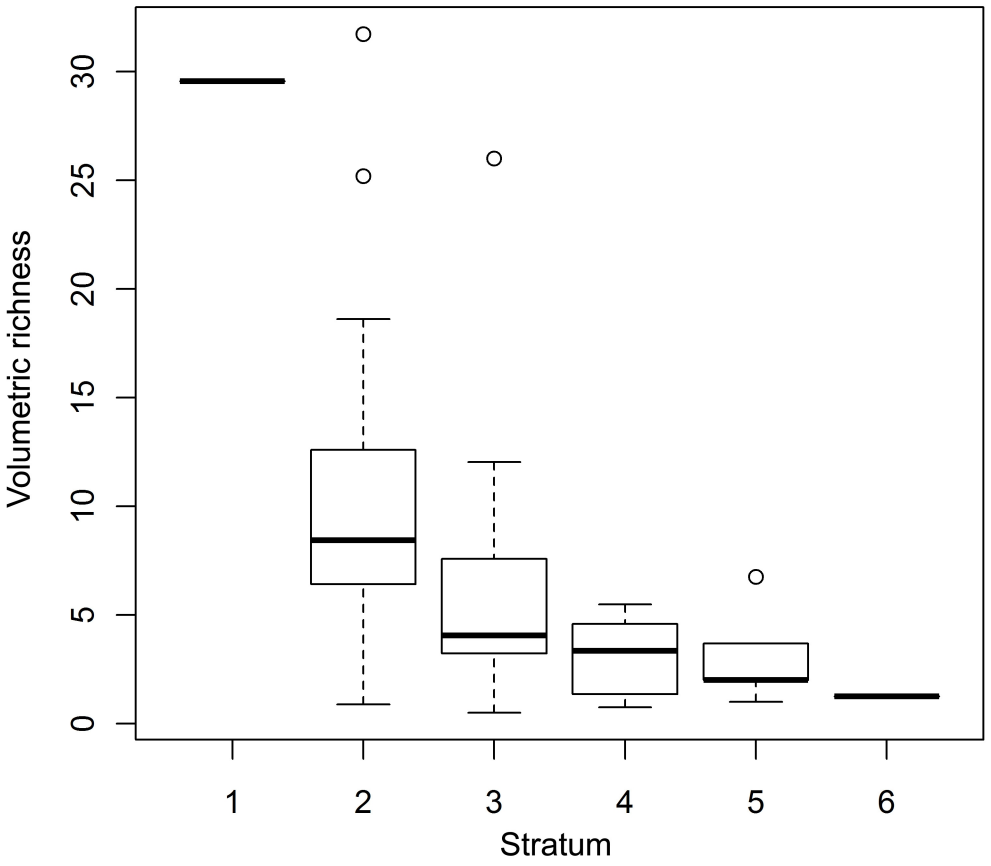


Figure 7.5. The features at Lapa dos Bichos have a higher measure of volumetric richness than the surrounding sediment matrix.

An additional question in regard to the richness measure is whether it changes through time. The richness of plant remains increases in the upper archaeological strata (Figure 7.6). The variation of richness by stratum is significant (F = 6.18, df = 56, p = 0.00013). When the observations for the stratigraphic profile are separated by context (features and sediment matrix), richness varies significantly by stratum within each context (within features F = 4.12, df = 21, p = 0.013; within sediment matrix F = 7.73, df = 31, p = 0.00020).

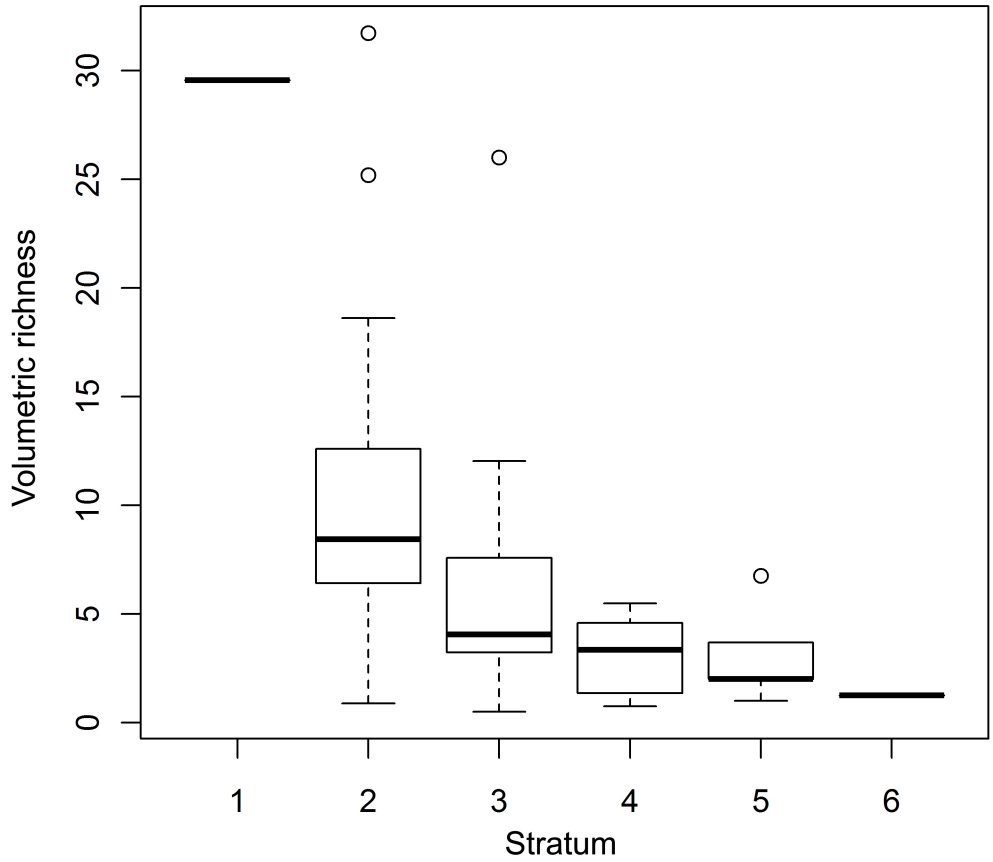


Figure7.6. The richness in plant remains increases with higher archaeological strata at Lapa dos Bichos.

Two patterns predominate in the volumetric richness measures from Lapa dos Bichos (Figure 7.7). First, the features have greater richness of plant morphological types than the surrounding sediment matrix. Second, the richness of plant remains increases in the upper archaeological strata. Cultural and taphonomic factors may influence these patterns. The distinction of features from the archaeological sediment matrix on the basis of plant richness was an expected result. The features contain concentrations of plant matter, whereas the sediment matrix contains dispersed botanical and artefactual materials. The second pattern, an increase in the richness of plant remains in the more recent archaeological strata, could be due to preservation. Even within the protection of a rock shelter these botanical remains are exposed to some of the elements. If preservation were a factor in the depositional pattern of the paleoethnobotanical remains, it might be expected that recent strata would contain a more diverse botanical assemblage. Alternatively, the diversity of plant remains brought into the site could have increased over time due to human actions, a cultural factor. At present we do not have a test that would determine if either factor is more prevalent. However, paired comparison of strata within ANOVA is informative. For this comparison the sediment matrix was selected due to its greater potential to reflect aggregate trends. From the analysis of variance between the richness in the sediment matrix and the strata, the paired strata with significant differences at Lapa dos Bichos are

strata 2 and 3, strata 2 and 4, and strata 2 and 5 (p = 0.00064, p = 0.036, and p = 0.017, respectively). This pattern in the richness of the sediment matrix, representing both years of excavation, is suggestive of a punctual change in the deposition of plant remains at the boundary between lower strata and stratum 2. A punctual change might be more consistent with changes in human behavior than with changes in preservation.

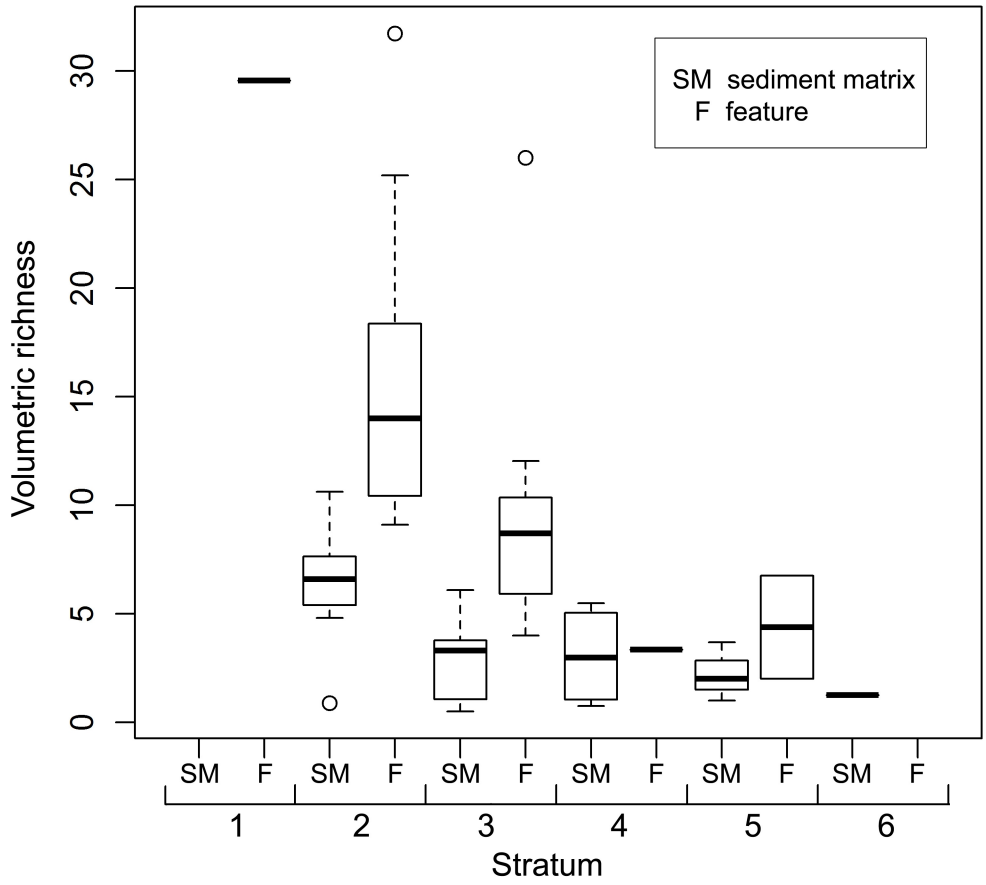


Figure 7.7. Two factors appear to explain the variation in volumetric richness measures at Lapa dos Bichos, the context of the paleoethnobotanical sample and the archaeological stratum.

Density of plant remains calculated from mass and number

Comparison of features excavated at Lapa dos Bichos with the surrounding sediment matrix indicated that the diversity of morphological types in the features was greater than in the surrounding sediment. A second consideration of the data is made on the basis of density. Two measures of density describe the concentration of paleoethnobotanical remains found in given samples. These are mass density, the mass in grams of remains per liter, and count density, the number of individual remains per liter. Due to the possibility that sample volume alone could be a major determinant of the density measure, the relationship between volume, mass, and count was explored graphically. Observation of this data set suggests that sample mass and count lack a clear relationship with respect to volume (Figure 7.8).

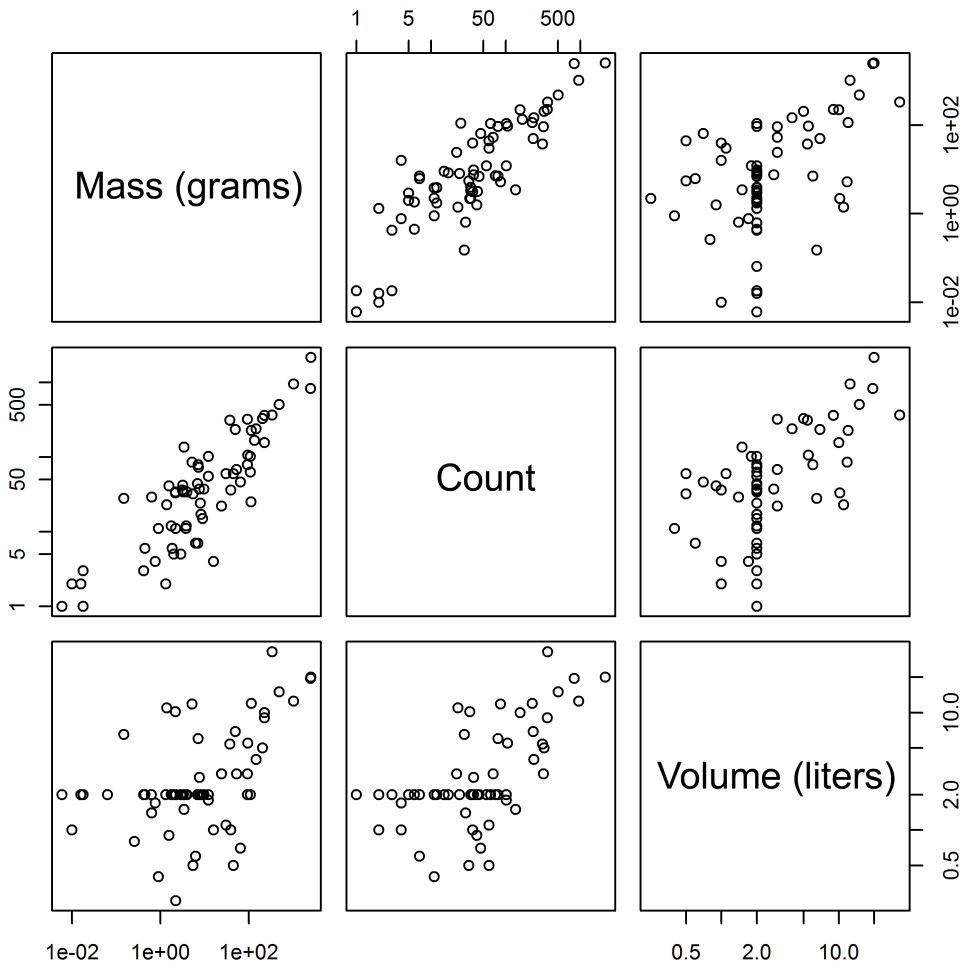


Figure 7.8. Graphical representation of a three dimensional space defined by the paleoethnobotanical sample masses, counts, and volumes from Lapa dos Bichos.

The data for mass, count and densities of macrobotanical remains from Lapa dos Bichos are presented in a series of tables. The count of plant fragments, as indicated in the previous chapter, excludes palm nut fragments and maize cob fragments. As palm nut fragments are the overwhelming contributors to plant sample mass, the exclusion of palm nut fragments from

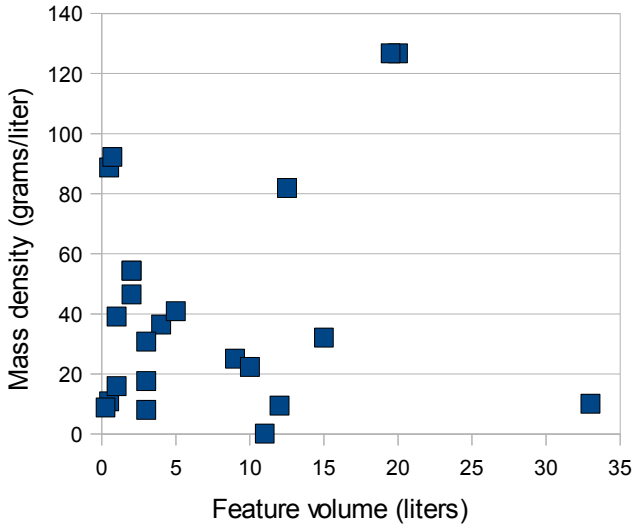
the quantities allows for a measure that is less influenced by fluctuations in the most plentiful species. While the count density may present a bias by exclusion of palm nut and maize cob fragments, the density measure will reflect the great majority of types; these are types that occur in lower quantities and for which variations would be masked by the magnitude of palm nut fragments.

Table 7.6. Mass and quantity of botanical material cataloged from features at Lapa dos Bichos. Mass and quantity by feature volume are given with calculations based on estimated volumes in gray.

PN	Feature number	Volume in liters (l)	Mass (g)	Quantity	Mass (g) per liter	Quantity per liter
8941	42	20	2534.66	2156	126.73	107.8
8942	43	0.5	44.37	60	88.74	120
8943	44	2	93.01	79	46.5	39.5
8944	45	2	108.76	102	54.38	51
8945	46	-	134.59	167	-	-
8947	47	4	145.82	239	36.46	59.75
8948	48	3	92.46	319	30.82	106.33
8949	49	0.5	5.47	32	10.94	64
8950	50	0.25	2.21	-	8.85	-
8951	51	12.5	1024.30	946	81.94	75.68
8952	52	9	225.83	359	25.09	39.89
8953	53	19.5	2471.30	822	126.73	42.15
8954	54	12	113.87	227	9.49	18.92
8955	55	10	223.26	156	22.33	15.6
8956	56	1	39.17	36	39.17	36
8957	57	3	53.03	68	17.68	22.67
8958	58	33	333.25	365	10.1	11.06
8960	59	0.25	-	-	-	-
8961	60	11	1.40	23	0.13	2.09
8962	61	15	481.73	502	32.12	33.47
8963	62	2	108.79	63	54.4	31.5
8964	63	-	111.11	25	-	-
8966	64	5	204.51	326	40.9	65.2
8967	65	3	24.25	22	8.08	7.33
8968	66	1	15.94	4	15.94	4
8969	67	0.7	64.57	46	92.25	65.71

There is a great range of variability in the mass and number of botanical remains in the features from the 2006 excavation at Lapa dos Bichos (Table 7.6). While this is partly a product of sample size, the density measures demonstrate that even some small features (e.g., features numbered 45, 56 and 62) contained a high concentration of plant matter (Figure 7.9).

A.



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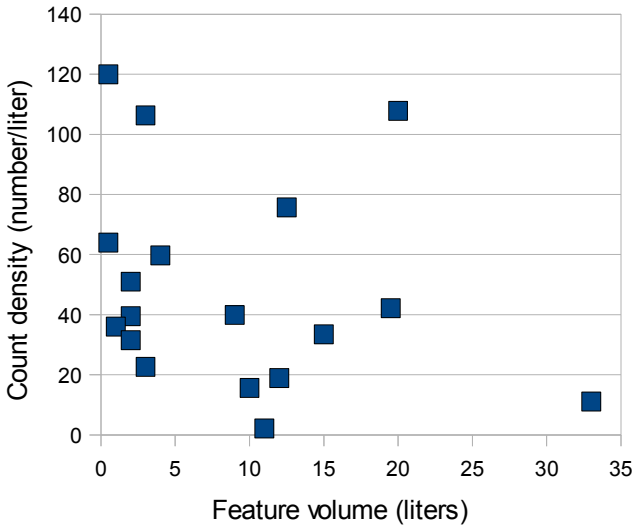


Figure 7.9. There is no apparent correlation between the volume of features and the density of remains, expressed in either terms of plant mass per liter (A) or number of plant fragments per liter (B).

Within the sediment matrix of the 2006 Lapa dos Bichos excavation the variation between density values was high. Mass density ranged from

zero to six grams per liter while count density ranged from one to 36.5 counted paleoethnobotanical remains per liter (Table 7.7).

Table 7.7. Mass and quantity of botanical material from the 2006 flotation samples at Lapa dos Bichos. All samples had a volume of two liters which was used to calculated the density of remains per liter.

PN	Unit	Stratum	Mass (g)	Quantity	Mass (g) per liter	Quantity per liter
8854	G13	2	2.235	11	1.118	5.5
8859	G14	2	8.065	24	4.033	12
8864	G15	2	9.067	15	4.534	7.5
8870	G16	2	8.299	17	4.150	8.5
8876	H13	2	1.756	12	0.878	6
8880	H14	2	3.145	36	1.573	18
8885	H15	2	9.702	37	4.851	18.5
8891	H16	2	6.936	44	3.468	22
8896	I13	2	2.185	34	1.093	17
8901	I14	2	3.318	34	1.659	17
8906	I15	2	7.226	73	3.613	36.5
8911	I16	2	12.133	55	6.067	27.5
8916	O11	2	3.202	42	1.601	21
8930	O2	2	0.018	3	0.009	1.5
8856	G13	3	0.064		0.032	0
8867	G15	3	3.811	11	1.906	5.5
8872	G16	3	2.903	5	1.452	2.5
8882	H14	3	2.000	5	1.000	2.5
8888	H15	3	0.018	1	0.009	0.5
8893	H16	3	0.448	6	0.224	3
8898	I13	3	0.622		0.311	
8903	I14	3	7.038	7	3.519	3.5
8908	I15	3	0.006	1	0.003	0.5
8913	I16	3	1.839	6	0.920	3
8918	O11	3	3.957	34	1.979	17
8932	O2	3	-	-	-	-
8920	O11	4	3.853	12	1.927	6
8934	O2	4	0.000	2	0.000	1
8922	O11	5	1.318	2	0.659	1
8936	O2	5	0.016	2	0.008	1
8925	O11	6	0.423	3	0.212	1.5
8938	O2	6	-	-	-	-

Density comparison between features and sediment matrix

High mass density and count density of plant remains were expected from features since features were defined as concentrations of botanical

material. Those feature samples where the volume was estimated, while included in the data table (Table 7.7), have not been included in the box plots or statistical calculations presented below. As predicted from observation of the archeological remains in excavation, features had a greater density of plant remains than the sediment matrix (Figures 7.10 and 7.11). The observed mass density was found to vary significantly with context ($F = 50.08$, $df = 46$, $p = 7.0 \times 10^{-9}$). Count density also varied significantly between contexts ($F = 27.39$, $df = 64$, $p = 2.0 \times 10^{-6}$).

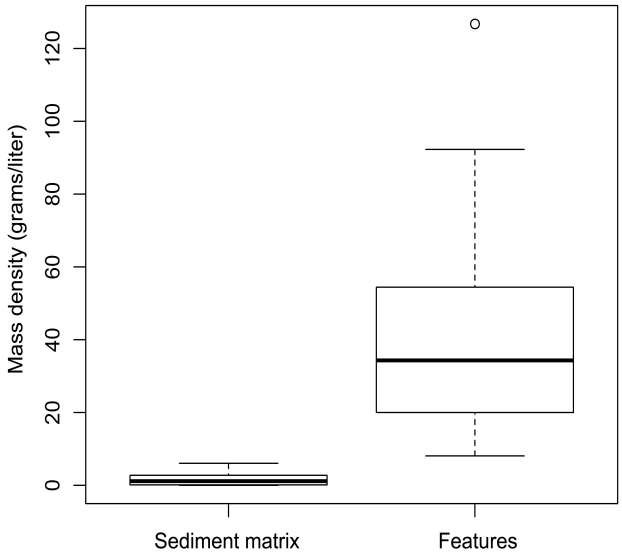


Figure 7.10. Mass density (mass/liter) of botanical remains from the sediment matrix and from features at Lapa dos Bichos, 2006 excavation.

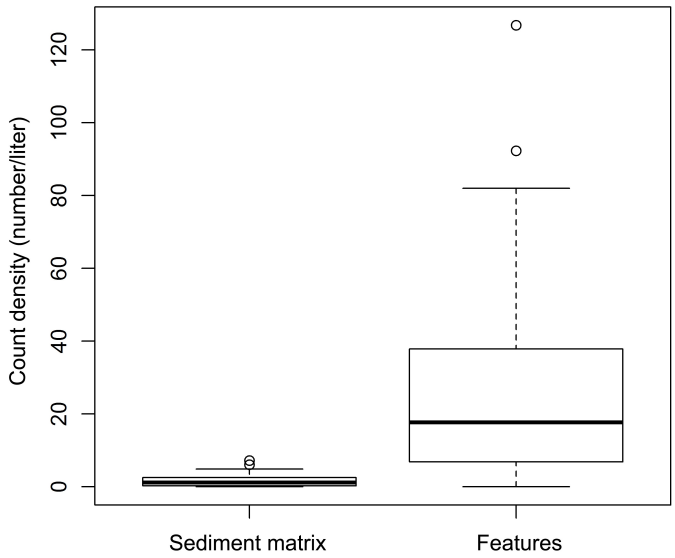


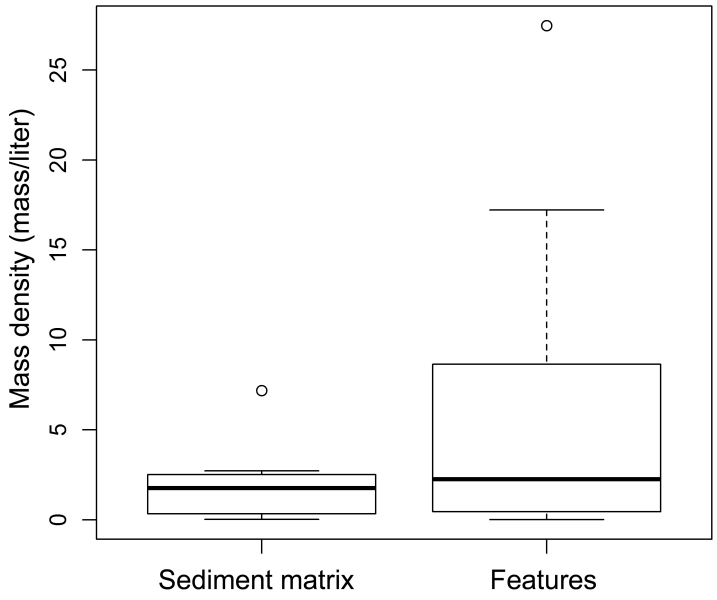
Figure 7.11. Count density of botanical remains from the sediment matrix and from features at Lapa dos Bichos, 2006 excavation.

The 1995 samples are presented separately for the density measures. These sorted remains came exclusively from the light flotation fraction, which is inherently biased for lighter weight plant remains (Table 7.8). Mean mass and count densities in the two contexts (feature and sediment matrix) were similar (Figure 7.12). The null hypothesis that Lapa dos Bichos 1995 samples from features and from the sediment matrix were drawn from the same population can not be statistically rejected (mass density vs context $F = 1.78$, $df = 16$, $p = 0.20$; count density vs context $F = 0.10$, $df = 14$, $p = 0.76$).

Table 7.8. Mass and quantity of botanical material cataloged from the light fraction of the 1995 flotation samples from Lapa dos Bichos. Samples come from both general excavation levels and features. Samples with a volume of less than 1.5 liters are indicated in gray.

PN	Unit	Strata	Feature	Sample volume (l)	Mass (g)	Quantity	Mass (g) per liter	Quantity per liter
3759	K24	2		1.5	3.452	135	2.301	90
4392	P41	2		6.9	49.562	233	7.183	33.77
3758	K24	3		0.9	1.584	41	1.760	45.56
4394, 4395	P41	3		2.8	7.600	37	2.714	13.21
4377, 4378, 4384	K24	4		11.8	5.240	85	0.444	7.2
4396, 4397	P41	4		10.2	2.190	33	0.215	3.24
4387, 4390, 4391	K24	5		6.5	0.150	28	0.023	4.31
3661	C30	3	18	5.5	94.697	106	17.218	19.27
3683	C30	3	19	1.1	30.207	60	27.461	54.55
8971	K24	3	23	1.8	12.099	102	6.722	56.67
8972	K24	3	24	6	7.120	79	1.187	13.17
8973	K24	3	25	5.4	37.445	312	6.934	57.78
8974	K24	4	28	1.7	0.769	4	0.452	2.35
8975	K24	4	29	0.4	0.902	11	2.255	27.5
8982	K24	4	34	0.6	6.214	7	10.357	11.67
3762	C30	5	20	0.8	0.258	-	0.323	-
8977	K24	5	38	1.4	0.641	29	0.458	20.71
8978	K24	5	39	1	0.009	2	0.009	2

A.



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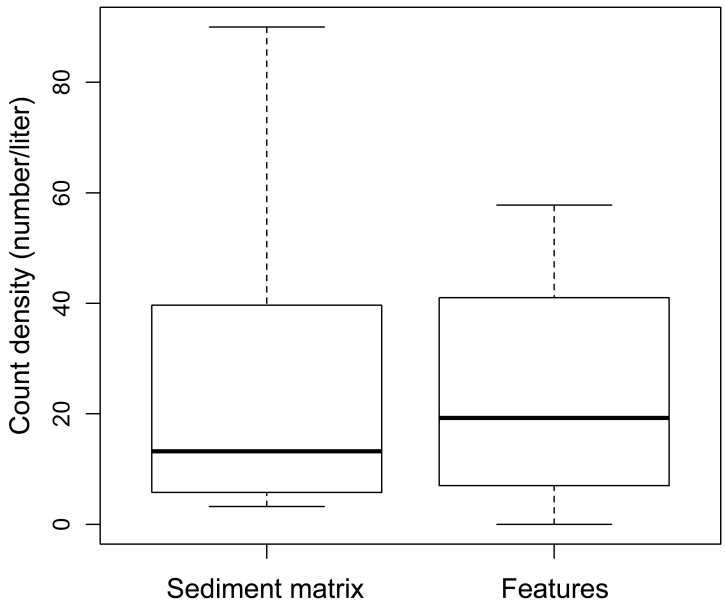

Figure 7.12. Densities of plant material from the Lapa dos Bichos 1995 excavation of the sediment matrix and features are compared by mass density (A) count density (B).

Density comparison between strata

The comparisons of density between strata are divided by excavation year due to the differences in sampling protocol in the 1995 and 2006 excavations at Lapa dos Bichos. This division reduces the sample size in each analysis. However, dividing the analysis by protocol accounts for a known bias in sample masses.

Samples from the 1995 excavations represent strata two through five. Analysis of variance shows that mass density does not vary significantly with respect to stratum ($F = 1.68$, $df = 14$, $p = 0.22$). Meanwhile, count density does vary significantly with respect to stratum ($F = 5.83$, $df = 14$, $p = 0.0084$) (Figure 7.13). Within this ANOVA model, pairwise comparison of means between strata shows three stratum pairs with significant differences: strata 2 and 4, strata 2 and 5, and strata 3 and 5 ($p = 0.025$, $p = 0.020$, and $p = 0.089$, respectively). This is suggestive of a change in the pattern of deposition of plant remains somewhere between stratum 2 and stratum 5. Visually the break in the raw data (Figure 7.13) occurs between stratum 3 and stratum 4.

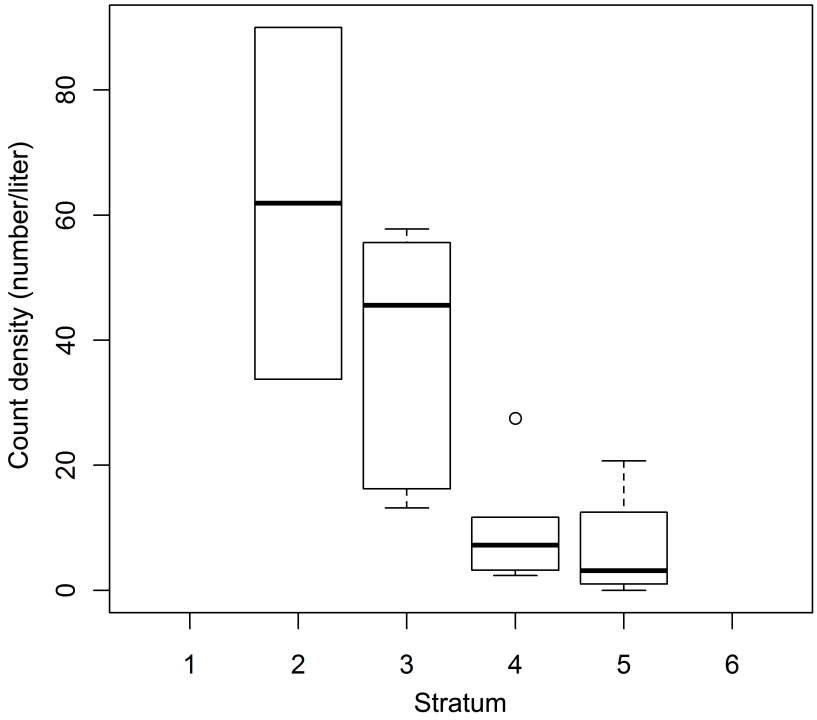

Figure 7.13. Stratigraphic differences in the count density of plant remains from the Lapa dos Bichos 1995 samples.

Differences in density of botanical remains by strata are further explored from the Lapa dos Bichos samples collected in 2006. The highest values of mass and count density come from stratum 2 samples (Figures 7.14 and 7.15). The pattern visible in the raw data appears to be one of increasing density in more recent strata. However, plant mass density does not vary significantly with respect to stratum ($F = 0.67$, $df = 43$, $p = 0.62$). In contrast, count density varies significantly by stratum (Figure 7.15) ($F=4.68$ $df = 67$, $p = 0.000998$).

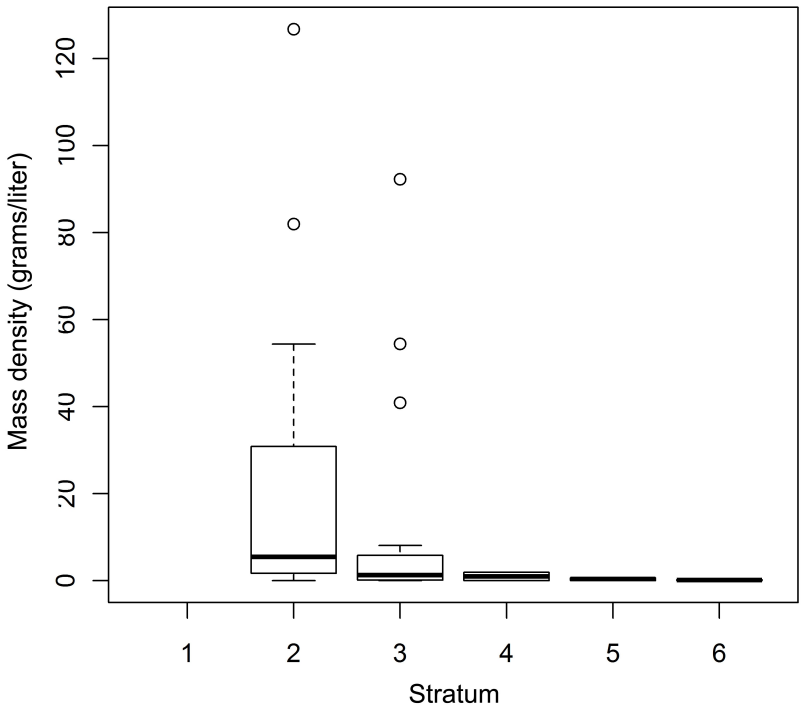

Figure 7.14. Mass density from Lapa dos Bichos 2006 samples. The higher values are found in recent strata. However, the variation of mass density with respect to stratum is not statistically significant.

The measures of mass density and count density, while both representing feature composition, have distinct characteristics. As mass density includes the palm nuts, this most plentiful species contributes substantially to the magnitude of the observed mass density. For example, in features from the 2006 excavation, this single plant type accounted for between 36% and 100% of the mass (mean 80%, standard deviation 15%). In the count density, the count values were obtained from less plentiful plant types (palm nuts were excluded). Based upon the set of paleoethnobotanical remains that densities measure and the evenness of the set, it appears that

a single species with values orders of magnitude above those of other types may obfuscate patterns in the assemblage as a whole.

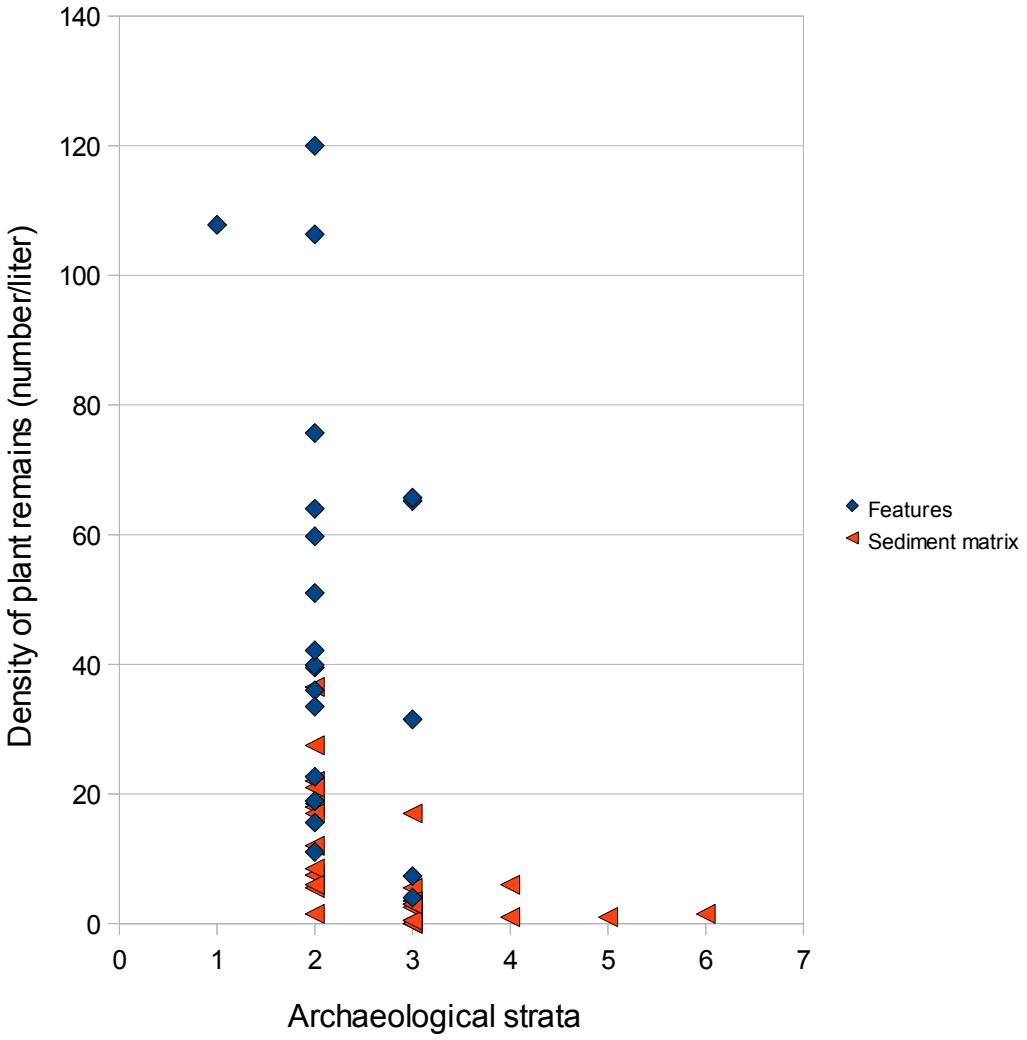

Figure 7.15. A plot of count density of botanical remains shows higher values in the recent strata for samples from the Lapa dos Bichos 2006 excavation.

Density measurements have been presented in relation to the archaeological context and to the archaeological strata. Consideration of these density measurements in relationship to the structure of the data set

suggests that a single variable, density of paleoethnobotanical remains in features, might account for the pattern in density by strata. The features excavated at Lapa dos Bichos in 2006 have mean mass and count densities higher than the surrounding sediment matrix. Within the archaeological strata the predominant visual pattern to the data is that of elevated densities in strata 2 and 3. As the 2006 feature samples come from strata 2 and 3, it is quite possible that the elevated densities in the features account for the higher densities perceived in these strata.

Plant types found at Lapa dos Bichos

A significant number of plant morphological types documented in this research occur in only one sample and as such their distribution can not be compared. The plant types presented in subsequent tables occurred in four or more of the samples analyzed from Lapa dos Bichos and Lapa Pintada.

The feature samples from the 2006 excavation at Lapa dos Bichos contain numerous domesticated plant species, an observation that is consistent with the strata dating between 150 and 2000 BP (Table 7.9). Many native edible wild plant types are also found in these samples.

Table 7.9. Presence of frequently encountered plant morphological types in feature samples from Lapa dos Bichos 2006 excavation (* known edible plant, + domesticated plant).

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
					Poaceae	*Zea mays* *+																											
					Fabaceae	*Hymenaea* *																											
					Fabaceae	*Hymenaea* *																											
					Cucurbitaceae	*Largenaria* +																											
					Anacardiaceae	*Spondias tuberosa* *																											
					Euphorbiaceae	*Manihot esculenta* cf. *+																											
					Passifloraceae	*Passiflora* *																											
					Fabaceae	*Arachis hypogaea* *+																											
					Malvaceae	*Gossypium barbadense*																											
					Caryocaraceae	*Caryocar brasiliensis* *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Anacardiaceae	*Spondias mombin* *																											
					Cucurbitaceae	*Cucurbita* *+																											
					Cucurbitaceae	*Largenaria* *+																											
					Cecropiaceae	*Cecropia*																											
					Piperaceae	sp 1																											
					Malpighiaceae	sp 1																											
					Fabaceae	*Lonchocarpus*																											
					Combretacea	*Terminalia argentea* cf.																											
					Bixaceae	*Bixa orellana*																											
					Polygonaceae	*Ruprechtia*																											
					Anacardiaceae	*Myracrodruon urundeuva*																											
8941		1	42				X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X			X	X	X	X
8942		2	43				X			X	X	X						X	X	X			X		X	X					X	X	
8943		2	44				X	X	X			X					X	X	X	X						X						X		X
8944		2	45				X		X	X							X	X	X	X										X	X	X	X
8945		2	46				X	X	X				X				X	X	X	X					X	X			X		X		
8947		2	47				X		X	X	X	X		X		X	X	X	X	X			X			X		X	X		X	X	
8948		2	48				X		X	X		X					X	X	X	X		X				X			X		X	X	
8949		2	49				X		X		X	X					X	X	X	X										X	X		X
8950		2	50															X															
8951		2	51				X	X	X		X		X		X		X	X	X	X			X				X		X	X	X	X	X
8952		2	52				X		X		X						X	X	X	X	X		X								X	X	
8953		2	53				X		X	X	X	X	X				X	X	X	X	X		X	X	X	X			X		X	X	
8954		2	54						X	X		X	X					X	X	X	X	X	X		X	X			X		X	X	
8955		2	55				X	X	X	X		X					X	X	X	X		X	X								X	X	
8956		2	56				X		X								X	X	X	X			X								X	X	
8957		2	57				X		X	X								X	X	X		X	X										

Continued on next page.

Table 7.9 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
					Poaceae	*Zea mays* *+																											
					Fabaceae	*Hymenaea* *																											
					Fabaceae	*Hymenaea* *																											
					Cucurbitaceae	*Largenaria* +																											
					Anacardiaceae	*Spondias tuberosa* *																											
					Euphorbiaceae	*Manihot esculenta* cf. *+																											
					Passifloraceae	*Passiflora* *																											
					Fabaceae	*Arachis hypogaea* *+																											
					Malvaceae	*Gossypium barbadense*																											
					CaryocaraceaeCaryocar	*brasiliensis* *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Anacardiaceae	*Spondias mombin* *																											
					Cucurbitaceae	*Cucurbita* *+																											
					Cucurbitaceae	*Largenaria* *+																											
					Cecropiaceae	*Cecropia*																											
					Piperaceae	sp 1																											
					Malpighiaceae	sp 1																											
					Fabaceae	*Lonchocarpus*																											
					Combretacea	*Terminalia argentea* cf.																											
					Bixaceae	*Bixa orellana*																											
					Polygonaceae	*Ruprechtia*																											
					Anacardiaceae	*Myracrodruon urundeuva*																											
8958		2	58				X	X	X	X		X	X				X	X	X	X		X	X								X	X	X
8961			60						X								X	X					X		X							X	
8962		2	61				X		X	X	X	X	X				X	X	X	X			X								X	X	
8963		3	62				X				X	X					X	X	X	X											X		
8964		2	63				X	X			X						X	X		X						X	X						
8966		3	64				X		X	X	X	X	X		X		X	X	X	X			X						X		X	X	X
8967		3	65				X	X										X		X											X	X	
8968		3	66															X		X													
8969		3	67				X										X	X	X	X			X								X	X	X

Continued on next page.

Table 7.9 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																													
					Malvaceae	*Guazuma ulmifolia*																													
					Malpighiaceae	sp 2 *																													
					Arecaceae	*Syagrus olearus* cf. *																													
					Solanaceae	sp 1																													
					Arecaceae	sp 1																													
					Myrtaceae	*Myrciaria* *																													
					Fabaceae	*Amburana cearensis*																													
					Asteraceae	Eupatorieae sp 1																													
					Cyperaceae	*Scleria*																													
					Bixaceae	*Bixa*																													
8941		1	42				X	X		X	X	X	X			X			X	X	X	X	X	X		X		X	X	X	X	X	X	
8942		2	43										X		X					X														
8943		2	44				X																											
8944		2	45				X												X				X								X		
8945		2	46								X		X					X		X						X				X	X		
8947		2	47				X	X	X				X		X				X					X			X					X	
8948		2	48				X	X					X										X		X			X	X	X	X		
8949		2	49				X						X							X													
8950		2	50																														
8951		2	51				X	X				X	X						X	X			X	X				X	X			X	
8952		2	52				X		X				X				X			X												X	X
8953		2	53				X		X				X	X	X		X		X	X			X	X			X			X			
8954		2	54										X			X		X		X								X	X	X			
8955		2	55						X				X							X	X		X			X					X		
8956		2	56											X																			
8957		2	57																	X							X						

Continued on next page.

Table 7.9 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																													
					Malvaceae	*Guazuma ulmifolia*																													
					Malpighiaceae	sp 2 *																													
					Arecaceae	*Syagrus olearus* cf. *																													
					Solanaceae	sp 1																													
					Arecaceae	sp 1																													
					Myrtaceae	*Myrciaria* *																													
					Fabaceae	*Amburana cearensis*																													
					Asteraceae	Eupatorieae sp 1																													
					Cyperaceae	*Scleria*																													
					Bixaceae	*Bixa*																													
8958		2	58				X							X		X	X					X					X			X		X
8961			60								X																						
8962		2	61										X						X		X		X				X		X				X
8963		3	62																			X											
8964		2	63								X																						
8966		3	64				X	X			X		X									X	X										
8967		3	65																														
8968		3	66																														
8969		3	67				X	X					X																			X	

Continued on next page.

Table 7.9 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																						
					Bombacaceae	*Chorisia pubiflora*																						
					Fabaceae	*Desmodium incanum*																						
					Fabaceae	*Machaerium* sp 2																						
					Rutacaeae	*Zanthoxylum* sp 1																						
					Fabaceae	*Anadenanthera* sp 1																						
					PlumbaginaceaePlumbago																							
					Fabaceae	sp 1																						
					Fabaceae	*Anadenanthera* sp 2																						
					Rutaceae	*Zanthoxylum* sp 2																						
8941		1	42					X	X	X	X	X			X				X	X		X	X	X	X	X	X	X
8942		2	43				X																					
8943		2	44																									
8944		2	45									X													X			
8945		2	46																		X							
8947		2	47					X							X	X							X		X			X
8948		2	48				X	X				X				X				X					X	X		X
8949		2	49																									
8950		2	50																									
8951		2	51						X	X		X			X					X			X	X		X	X	
8952		2	52						X		X	X				X				X			X	X	X			
8953		2	53				X	X	X						X					X		X		X			X	X
8954		2	54						X	X		X																
8955		2	55					X	X		X	X								X					X			
8956		2	56									X																
8957		2	57						X						X							X						

Continued on next page.

Table 7.9 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																						
					Bombacaceae	*Chorisia pubiflora*																						
					Fabaceae	*Desmodium incanum*																						
					Fabaceae	*Machaerium* sp 2																						
					Rutacaeae	*Zanthoxylum* sp 1																						
					Fabaceae	*Anadenanthera* sp 1																						
					PlumbaginaceaePlumbago																							
					Fabaceae	sp 1																						
					Fabaceae	*Anadenanthera* sp 2																						
					Rutaceae	*Zanthoxylum* sp 2																						
8958		2	58						X		X										X			X				X
8961			60																			X						
8962		2	61						X	X	X				X	X									X			X
8963		3	62																						X			
8964		2	63																				X					
8966		3	64				X		X						X							X	X	X		X		
8967		3	65								X																	
8968		3	66																									
8969		3	67																		X			X	X			

The general sediment from strata two and three at Lapa dos Bichos, as represented in the flotation samples from 2006, also contained domesticated plant species, specifically *Zea Mays, Manihot,* and *Largenaria* (Table 7.10). In stratum two, a majority of the flotation samples contained *Myracrodruon urundeuva* and *Terminalia argentia*, both species transported by the wind. The samples from unit O11 in strata four through six contained some edible native species: *Syagrus oleracea, Passiflora,* and *Spondias mombin*.

Table 7.10. Presence of frequently encountered plant morphological types in flotation samples from Lapa dos Bichos 2006 excavation (* known edible plant, + domesticated plant).

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
					Poaceae	*Zea mays* *+																											
					Fabaceae	*Hymenaea* *																											
					Fabaceae	*Hymenaea* *																											
					Cucurbitaceae	*Largenaria* +																											
					Anacardiaceae	*Spondias tuberosa* *																											
					Euphorbiaceae	*Manihot esculenta* cf. *+																											
					Passifloraceae	*Passiflora* *																											
					Fabaceae	*Arachis hypogaea* *+																											
					Malvaceae	*Gossypium barbadense*																											
					CaryocaraceaeCaryocar brasiliensis *																												
					Arecaceae	*Syagrus olearus* cf. *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Anacardiaceae	*Spondias mombin* *																											
					Cucurbitaceae	*Cucurbita* *+																											
					Cucurbitaceae	*Largenaria* *+																											
					Cecropiaceae	*Cecropia*																											
					Piperaceae	sp 1																											
					Malpighiaceae	sp 1																											
					Fabaceae	*Lonchocarpus*																											
					Combretacea	*Terminalia argentea* cf.																											
					Bixaceae	*Bixa orellana*																											
					Polygonaceae	*Ruprechtia*																											
					Anacardiaceae	*Myracrodruon urundeuva*																											
8854	G13	2																X											X			X	
8859	G14	2																X			X		X						X		X	X	
8864	G15	2																X		X	X				X							X	
8870	G16	2				X												X							X							X	
8876	H13	2			X		X											X							X				X		X	X	
8880	H14	2																X	X	X					X				X			X	
8885	H15	2					X											X		X	X				X				X		X	X	
8891	H16	2				X												X							X				X		X	X	
8896	I13	2															X		X	X					X				X		X	X	
8901	I14	2			X			X											X	X					X				X		X	X	
8906	I15	2						X									X	X		X					X	X			X		X	X	
8911	I16	2																X		X	X				X				X		X	X	
8916	O11	2																X						X	X				X				
8930	O2	2																								X							
8856	G13	3				X																											
8867	G15	3			X	X												X	X	X												X	

Continued on next page.

Table 7.10 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
							Poaceae	Fabaceae	Fabaceae	Cucurbitaceae	Anacardiaceae	Euphorbiaceae	Passifloraceae	Fabaceae	Malvaceae	Caryocaraceae	Arecaceae	Arecaceae	Euphorbiaceae	Euphorbiaceae	Anacardiaceae	Cucurbitaceae	Cucurbitaceae	Cecropiaceae	Piperaceae	Malpighiaceae	Fabaceae		Combretacea	Bixaceae	Polygonaceae	Anacardiaceae	
							Zea mays *+	*Hymenaea* *	*Hymenaea* *	*Largenaria* +	*Spondias tuberosa* *	*Manihot esculenta* cf. *+	*Passiflora* *	*Arachis hypogaea* *+	*Gossypium barbadense*	*Caryocar brasiliensis* *	*Syagrus olearus* cf. *	*Syagrus olearus* cf. *	*Cnidoscolous pubescens*	*Cnidoscolous pubescens*	*Spondias mombin* *	*Cucurbita* *+	*Largenaria* *+	*Cecropia*	sp 1	sp 1	*Lonchocarpus*		*Terminalia argentea* cf.	*Bixa orellana*	*Ruprechtia*	*Myracrodruon urundeuva*	
8872	G16	3																X	X	X	X												
8882	H14	3					X											X	X	X													
8888	H15	3																															
8893	H16	3																X	X														
8898	I13	3					X											X															
8903	I14	3					X		X											X													
8908	I15	3																													X		
8913	I16	3																X		X			X									X	
8918	O11	3																X							X				X		X	X	
8932	O2	3																															
8920	O11	4									X							X		X													
8934	O2	4																								X							
8922	O11	5											X					X															
8936	O2	5																								X							
8925	O11	6																		X									X				
8938	O2	6																															

Continued on next page.

Table 7.10 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																												
					Malvaceae	*Guazuma ulmifolia*																												
					Malpighiaceae	sp 2 *																												
					Arecaceae	*Syagrus olearus* cf. *																												
					Solanaceae	sp 1																												
					Arecaceae	sp 1																												
					Myrtaceae	*Myrciaria* *																												
					Fabaceae	*Amburana cearensis*																												
					Asteraceae	Eupatorieae sp 1																												
					Cyperaceae	*Scleria*																												
					Bixaceae	*Bixa*																												
8854	G13	2															X																
8859	G14	2																															
8864	G15	2																															
8870	G16	2																															
8876	H13	2																															
8880	H14	2																															
8885	H15	2						X																									
8891	H16	2																															
8896	I13	2																															
8901	I14	2																					X										
8906	I15	2																															
8911	I16	2																X															
8916	O11	2																															
8930	O2	2																															
8856	G13	3																															
8867	G15	3																															

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Table 7.10 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																													
					Malvaceae	*Guazuma ulmifolia*																													
					Malpighiaceae	sp 2 *																													
					Arecaceae	*Syagrus olearus* cf. *																													
					Solanaceae	sp 1																													
					Arecaceae	sp 1																													
					Myrtaceae	*Myrciaria* *																													
					Fabaceae	*Amburana cearensis*																													
					Asteraceae	Eupatorieae sp 1																													
					Cyperaceae	*Scleria*																													
					Bixaceae	*Bixa*																													
8872	G16	3																															
8882	H14	3																															
8888	H15	3																															
8893	H16	3																															
8898	I13	3																															
8903	I14	3																															
8908	I15	3																															
8913	I16	3																															
8918	O11	3																															
8932	O2	3																															
8920	O11	4					X																										
8934	O2	4																															
8922	O11	5																															
8936	O2	5																															
8925	O11	6																															
8938	O2	6																															

Continued on next page.

Table 7.10 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																						
					Bombacaceae	*Chorisia pubiflora*																						
					Fabaceae	*Desmodium incanum*																						
					Fabaceae	*Machaerium* sp 2																						
					Rutacaeae	*Zanthoxylum* sp 1																						
					Fabaceae	*Anadenanthera* sp 1																						
					PlumbaginaceaePlumbago																							
					Fabaceae	sp 1																						
					Fabaceae	*Anadenanthera* sp 2																						
					Rutaceae	*Zanthoxylum* sp 2																						
8854	G13	2																										
8859	G14	2							X																			
8864	G15	2																										
8870	G16	2																										
8876	H13	2											X															
8880	H14	2																										
8885	H15	2																										
8891	H16	2																						X				
8896	I13	2																						X				
8901	I14	2																						X				
8906	I15	2																										
8911	I16	2							X																			
8916	O11	2																										
8930	O2	2																										
8856	G13	3																										
8867	G15	3																						X				

Continued on next page.

Table 7.10 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																							
					Bombacaceae	*Chorisia pubiflora*																							
					Fabaceae	*Desmodium incanum*																							
					Fabaceae	*Machaerium* sp 2																							
					Rutacaeae	*Zanthoxylum* sp 1																							
					Fabaceae	*Anadenanthera* sp 1																							
					Plumbaginaceae	*Plumbago*																							
					Fabaceae	sp 1																							
					Fabaceae	*Anadenanthera* sp 2																							
					Rutaceae	*Zanthoxylum* sp 2																							
8872	G16	3																										
8882	H14	3																										
8888	H15	3																										
8893	H16	3									X																	
8898	I13	3																										
8903	I14	3																								X		
8908	I15	3																										
8913	I16	3																										
8918	O11	3																										
8932	O2	3																										
8920	O11	4																										
8934	O2	4																										
8922	O11	5																										
8936	O2	5																										
8925	O11	6																										
8938	O2	6																										

The Lapa dos Bichos 1995 flotation samples present similar data patterns to those from 2006. Samples from strata two and three have domesticated species, maize and bottle gourd, as expected (Table 7.11). In stratum four, domesticated plants present were *Manihot, Phaseolus lunatus* (lima bean) and bottle gourd. A number of native food plants were present throughout the samples.

Table 7.11. Presence of frequently encountered plant morphological types in flotation samples from Lapa dos Bichos 1995 excavation (* known edible plant, + domesticated plant).

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
					Poaceae	*Zea mays* *+																											
					Fabaceae	*Hymenaea* *																											
					Fabaceae	*Hymenaea* *																											
					Cucurbitaceae	*Largenaria* +																											
					Anacardiaceae	*Spondias tuberosa* *																											
					Euphorbiaceae	*Manihot esculenta* cf. *+																											
					Passifloraceae	*Passiflora* *																											
					Fabaceae	*Arachis hypogaea* *+																											
					Malvaceae	*Gossypium barbadense*																											
					CaryocaraceaeCaryocar brasiliensis *																												
					Arecaceae	*Syagrus olearus* cf. *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Anacardiaceae	*Spondias mombin* *																											
					Cucurbitaceae	*Cucurbita* *+																											
					Cucurbitaceae	*Largenaria* *+																											
					Cecropiaceae	*Cecropia*																											
					Piperaceae	sp 1																											
					Malpighiaceae	sp 1																											
					Fabaceae	*Lonchocarpus*																											
					Combretacea	*Terminalia argentea* cf.																											
					Bixaceae	*Bixa orellana*																											
					Polygonaceae	*Ruprechtia*																											
					Anacardiaceae	*Myracrodruon urundeuva*																											
3759	K24	2					X		X									X	X				X						X		X	X	
4392	P41	2											X				X	X		X									X		X	X	
3758	K24	3					X											X	X	X									X		X	X	
4394, 4395	P41	3									X						X	X											X		X	X	
4377, 4378, 4384	K24	4							X								X	X	X	X									X			X	
4396, 4397	P41	4														X		X											X		X		
4387, 4390, 4391	K24	5																					X									X	
3661	C30	3	18				X		X				X			X		X	X				X						X		X	X	
3683	C30	3	19						X	X								X					X							X				
8971	K24	3	23				X		X									X											X		X	X	
8972	K24	3	24				X		X									X	X	X			X						X		X	X	
8973	K24	3	25				X		X				X					X	X	X			X						X		X	X	
8974	K24	4	28						X									X														X	
8975	K24	4	29						X		X																		X		X	X	
8982	K24	4	34									X											X						X			X	
3762	C30	5	20															X															
8977	K24	5	38						X									X											X			X	
8978	K24	5	39																														

Continued on next page.

Table 7.11 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																													
					Malvaceae	*Guazuma ulmifolia*																													
					Malpighiaceae	sp 2 *																													
					Arecaceae	*Syagrus olearus* cf. *																													
					Solanaceae	sp 1																													
					Arecaceae	sp 1																													
					Myrtaceae	*Myrciaria* *																													
					Fabaceae	*Amburana cearensis*																													
					Asteraceae	Eupatorieae sp 1																													
					Cyperaceae	*Scleria*																													
					Bixaceae	*Bixa*																													
3759	K24	2											X																				
4392	P41	2						X	X																								
3758	K24	3											X							X													
4394, 4395	P41	3																															
4377, 4378, 4384	K24	4							X				X							X													
4396, 4397	P41	4																															
4387, 4390, 4391	K24	5											X							X													
3661	C30	3	18										X			X							X										X
3683	C30	3	19																	X													
8971	K24	3	23										X																				
8972	K24	3	24																		X						X						
8973	K24	3	25					X											X														
8974	K24	4	28																														
8975	K24	4	29																														
8982	K24	4	34																														
3762	C30	5	20																														
8977	K24	5	38										X			X				X													
8978	K24	5	39																														

Continued on next page.

Table 7.11 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																						
					Bombacaceae	*Chorisia pubiflora*																						
					Fabaceae	*Desmodium incanum*																						
					Fabaceae	*Machaerium* sp 2																						
					Rutacaeae	*Zanthoxylum* sp 1																						
					Fabaceae	*Anadenanthera* sp 1																						
					PlumbaginaceaePlumbago																							
					Fabaceae	sp 1																						
					Fabaceae	*Anadenanthera* sp 2																						
					Rutaceae	*Zanthoxylum* sp 2																						
3759	K24	2																										
4392	P41	2																										
3758	K24	3												X						X								
4394, 4395	P41	3																										
4377, 4378, 4384	K24	4							X		X		X			X												
4396, 4397	P41	4																										
4387, 4390, 4391	K24	5											X	X														
3661	C30	3	18						X					X														
3683	C30	3	19																									
8971	K24	3	23																									
8972	K24	3	24													X			X									
8973	K24	3	25																									
8974	K24	4	28																									
8975	K24	4	29																									
8982	K24	4	34											X														
3762	C30	5	20																									
8977	K24	5	38																									
8978	K24	5	39											X														

Chi-squared statistics for Lapa dos Bichos

Chi-squared statistics allow for the exploration of archaeological contexts by counts of categorical observations. In this section the relevant observations are plant counts by type. To employ chi-squared methods, these counts must be within the limitations of the statistical test (explained in the previous chapter). A basic limitation is that an expected count of five under the null hypothesis should fill eighty percent of the cells in a large table. This limitation requires the grouping of plant data prior to performing chi-squared analysis. The chi-squared statistics presented for the comparison of contexts (features vs. sediment matrix), strata, and specific features indicate the level to which grouping was necessary to carry out the statistical analysis. Additionally, counts were necessary for all data types; missing counts for palm nuts and maize were estimated from the recorded data for counts and associated masses by the application of a constant value for count per gram. (This was possible as a number of the individuals had been weighed and counted).

The chi-squared statistic comparing the composition of the sediment matrix to that of the features was significant (χ^2 = 3254.77, df = 17, $p < 2.2 \times 10^{-16}$). This demonstrates that plant types were not evenly distributed between the two contexts. Plant types were placed into 18 groups to meet the test limitations. The type groupings that expressed greater-than-expected proportions in the sediment matrix were *Cecropia* (Cecropiaceae) (p

<0.0001), *Terminalia argentea* (Combretaceae) (p <0.0001), *Ruprechtia* (Polygonaceae) (p <0.0001), and *Myracrodruon urundeuva* (Anacardiaceae) (p <0.0001). Those with greater-than-expected proportions in the features were Poaceae (p <0.0001), *Cnidoscolous pubescens* (Euphorbiaceae) (p <0.0001) and Arecaceae (p <0.001). When the characteristics of the types are considered, the types represented with greater proportion in the sediment matrix are three winged seed types and *Cecropia*, for which the flower spike is the organ found. Meanwhile, Poaceae and Arecaceae are families with edible seeds and fruits. Due to the number of *Cnidoscolous pubescens* that have been broken open it could possibly be edible. The major distinguishing characteristic between the sediment matrix and the features is the proportion of weedy taxa in relation to useful taxa in the sediment matrix. We might expect that wind-borne seeds would be represented in greater-than-expected proportions on surfaces that were open to accumulation of plant material over a long period of time as opposed to features which might have been temporally restricted.

It was not possible to calculate the chi-squared test for strata at Lapa dos Bichos as the plant remains from strata 4, 5, and 6 did not produce sufficient numbers of plant remains to overcome the limitations of the statistical test. The same problem was present when an attempt was made to compare individual features at Lapa dos Bichos.

A chi-squared statistic was calculated for the composition of features grouped by stratum. For this the plant types were grouped into three categories: Arecaceae, Euphorbiaceae, and the entire remainder. The chi-squared statistic was signifcant (χ^2 = 384.1316, df = 8, p-value < 2.2×10^{-16}). In stratum 2 the Euphorbiaceae were present in greater-than-expected proportion ($p < 0.001$), and the remaining types were present in lower-than-expected proportion ($p < 0.0001$). In stratum 3 both Euphorbiaceae ($p < 0.0001$) and Arecaceae ($p < 0.05$) occur in less-than-expected proportion and the remaining types in greater-than-expected proportion ($p < 0.0001$). The interpretation of these results for archaeological analysis is complicated by the fact that the majority of features were documented in strata 2 and 3. These statistics show that there is significant variability in the plant type composition of features between strata, specifically with respect to the proportions of Arecaceae and Euphorbiaceae found therein.

Paleoethnobotanical data from Lapa Pintada

The assemblage of botanical remains from Lapa Pintada is predominantly restricted to two excavation units, N115 L113 and N115 L114. While these two units may not be representative of the entire site, they were well sampled. Samples from these units were analyzed with priority given to processing of samples from different layers and features; additional samples from these units exist. As with Lapa dos Bichos, the features at Lapa Pintada were defined during excavation due to large visible concentrations of

botanical material and thus it is expected that the densities of plant material will be greater in the features.

Flotation samples, October 2008 / April 2009

The excavation of units N115 L113 and N115 L114 at Lapa Pintada included the collection of standardized volume (five liter) flotation samples. Standardized samples from eleven excavation levels were analyzed. Sediment samples of features were collected separately with a target sample size of five liters. Stratigraphically the features coincide with levels three through six. While not designated by level, the field notes allow for association of the highest portion of the feature with the surrounding excavation level. Two samples from Lapa Pintada are included in the data tables but not in the statistical analyses. The sample from level one is likely a mixture of archaeological and contemporary remains. The bioturbated sediments cut through a number of layers and may contain both prehistoric and historic material.

Richness of paleoethnobotanical remains from Lapa Pintada

An initial prediction was that feature contexts at Lapa Pintada would have higher values of standardized volumetric richness than the sediment matrix at the site. This prediction is based on the understanding that the variability in plant morphological types was higher in features. An analysis of variance demonstrated that variation in richness by context was statistical significant ($F = 12.86$, $df = 19$, $p = 0.0020$).

Table 7.12. The volumetric richness of morphological types from Lapa Pintada samples.

PN	Unit	Level	Feature	Volume (l)	Number of morphological types	Richness of morphological types per liter	Standard deviation of richness
7772	N114 L114	1		5	6	2.45	0.98
7762	N115 L113	3		5	24	7.94	1.92
7761	N115 L114	3		5	9	2.76	1.16
7769	N115 L113	4		5	13	4.67	1.41
7779	N115 L114	4		5	14	4.77	1.50
7778	N115 L113	5		5	26	8.28	2.09
7798	N115 L114	5		5	12	4.91	1.33
7788	N115 L113	6		5	21	8.19	1.82
7793	N115 L113	7		5	5	2.55	0.89
6221	N115 L114	7		5	4	2.13	0.72
6415	N115 L113	8		5	3	1.85	0.69
6437	N115 L113	9		5	3	1.40	0.57
6706	N115 L113	10		5	3	1.40	0.57
6703	N115 L114	10		5	6	1.87	1.00
6726	N115 L113	11		5	5	2.72	0.93
6736	N115 L114	12		5	2	0.48	0.60
7824	N115 L113		hearth	1	13	10.00	0.00
7801, 7803	N115 L113		C	8	57	13.91	2.59
7777	N115 L114		B/C	2.5	20	10.06	2.06
7776, 7829	N115 L114		B	6	20	7.58	1.46
7822	N115 L113		A	5	11	5.22	1.42
7825, 7837	N115 L113		D	9	17	5.10	1.29
7830	N115 L113		bioturbation	6	18	6.55	1.74

From the values for richness of morphological plant types there is a distinction between levels three through six and levels seven through twelve (Table 7.12). The upper levels contain a greater volumetric richness of plant types (Figure 7.16). These levels are stratigraphically contemporaneous with the features. The stratigraphic boundary between level six and seven coincides with a shift in the occurrence of feature remains and thus is a likely stratigraphic boundary that represents a temporal change. While the values for richness are different in the upper and lower levels at Lapa

Pintada, the analysis of variance between richness and level was not statistically significant (F = 1.75, df = 11, p = 0.19).

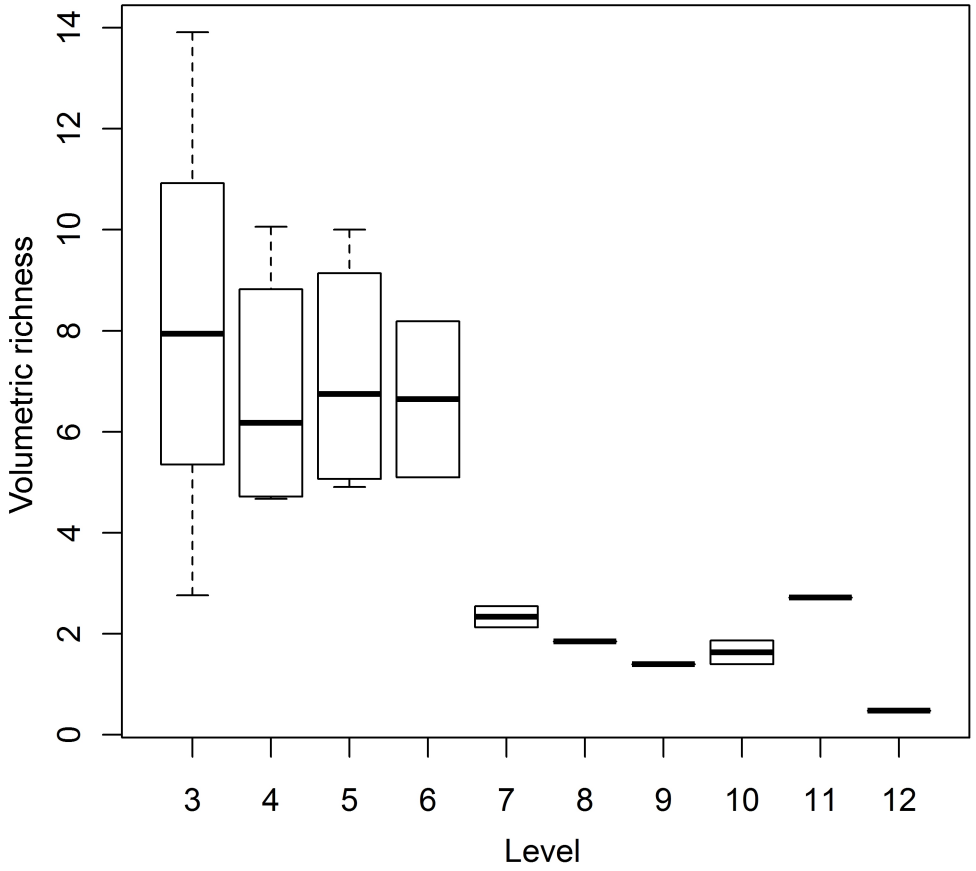


Figure 7.16. Volumetric richness by level at Lapa Pintada.

Density of paleoethnobotanical remains from Lapa Pintada

The mass density and count density measure have been used to compare variation by context and by level at Lapa Pintada.

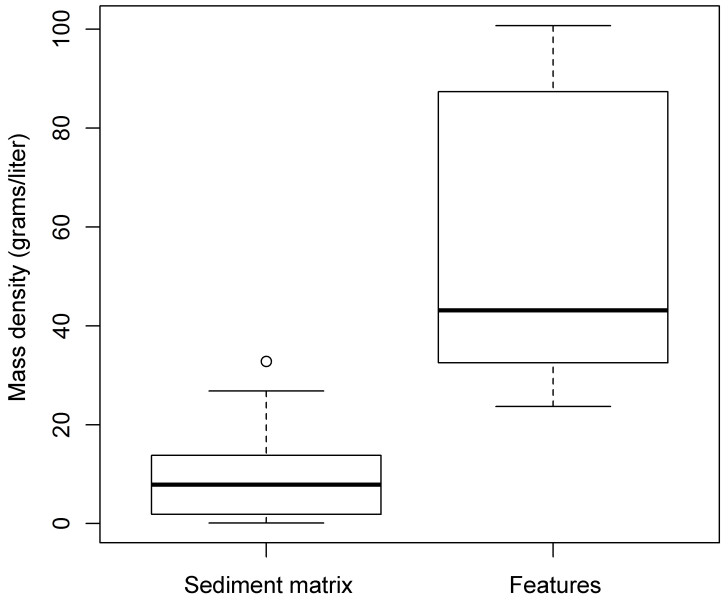
For both types of densities, the paleoethnobotanical samples from features at Lapa Pintada have numerically higher values than the samples from the sediment matrix. (Table 7.13). The density of macrobotanical remains in the features is higher than the surrounding context as would be

expected from their designation as concentrations of botanical materials (Figure 7.17). The mass density was found to vary significantly with the context ($F = 25.94$, $df = 19$, $p = 6.5 \times 10^{-5}$). The other measure of density, the count density, also varied significantly with context ($F = 20.75$, $df = 19$, $p = 0.00022$)

Table 7.13. Mass and quantity of macrobotanical remains from flotation samples at Lapa Pintada. Density measures, of mass and quantity per liter, are included.

PN	Unit	Level	Feature	Volume (l)	Mass (g)	Quantity	Mass (g) per liter	Quantity per liter
7772	N114 L114	1		5	255.04	7	51.01	1.4
7762	N115 L113	3		5	164.05	54	32.81	10.8
7761	N115 L114	3		5	55.46	9	11.09	1.8
7769	N115 L113	4		5	52.61	36	10.52	7.2
7779	N115 L114	4		5	89.19	21	17.84	4.2
7778	N115 L113	5		5	82.35	46	16.47	9.2
7798	N115 L114	5		5	134.19	32	26.84	6.4
7788	N115 L113	6		5	55.55	65	11.11	13
7793	N115 L113	7		5	39.38	10	7.88	2
6221	N115 L114	7		5	6.09	8	1.22	1.6
6415	N115 L113	8		5	9.37	5	1.87	1
6437	N115 L113	9		5	9.23	2	1.85	0.4
6706	N115 L113	10		5	11.19	2	2.24	0.4
6703	N115 L114	10		5	2.37	11	0.47	2.2
6726	N115 L113	11		5	12.53	11	2.51	2.2
6736	N115 L114	12		5	0.60	1	0.12	0.2
7824	N115 L113		hearth	1	32.50	16	32.5	16
7801, 7803	N115 L113		C	8	805.69	330	100.71	41.25
7777	N115 L114		B/C	2.5	86.45	41	34.58	16.4
7776, 7829	N115 L114		B	6	310.12	156	51.69	26
7822	N115 L113		A	5	118.42	31	23.68	6.2
7825, 7837	N115 L113/4		D	9	786.45	127	87.38	14.11
7830	N115 L113		bioturbation	6	176.65	47	29.44	7.83

A.



B.

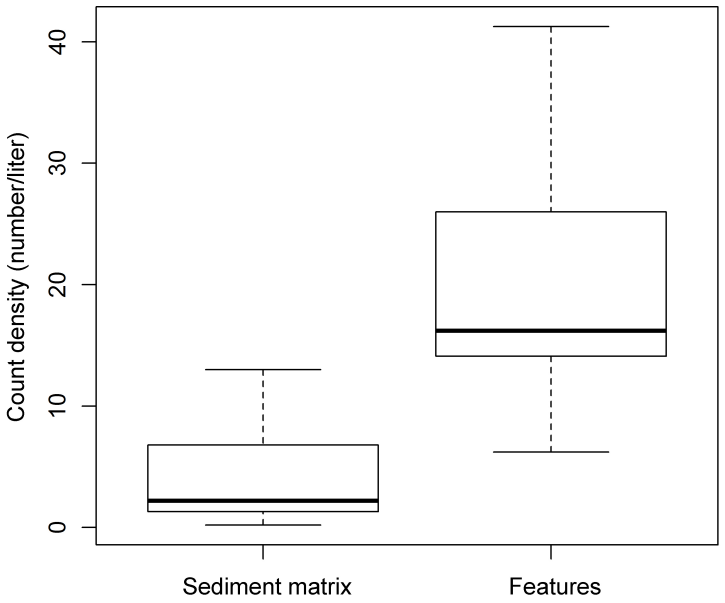


Figure 7.17. Densities of plant material from the Lapa Pintada excavation of the sediment matrix and features are compared by mass density (A) count density (B).

Mass density and count density measures were compared to excavation levels to examine change through time (Figure 7.18). In an

analysis of variance neither mass density or count density varied significantly with level (mass density vs. level F = 0.99, df = 11, p = 0.50; count density vs. level F = 0.85, df = 11, p = 0.59). In comparing the analysis for context with that for level, the variability in density of paleoethnobotanical remains appears to pattern by context. And as such, the occurrence of the features in levels three to six likely affects the box plot means such as in Figure 7.18.

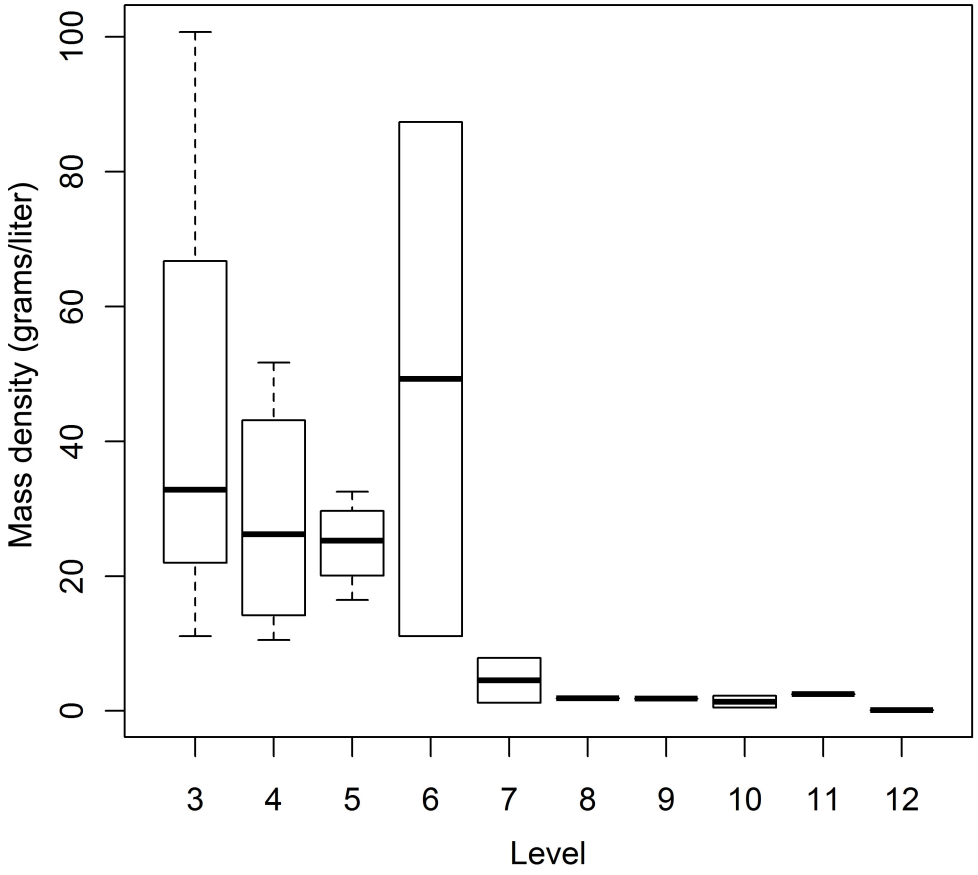


Figure 7.18. Mass density measures for Lapa Pintada graphed by level.

Presence of select plant types found at Lapa Pintada

The distribution of frequently encountered plant morphological types is detailed in a table of presence/absence. The set of morphological types that occurred in four or more samples from Lapa dos Bichos and from Lapa Pintada are included as one axis in Table 7.14. The decrease in plant diversity at level seven is apparent in the types of species encountered. Palm nut and bract fragments (*Syagrus oleracea*) were encountered in these levels. One occurrence of bottle gourd (*Largenaria*) was found in level nine.

Table7.14. Presence of frequently encountered plant morphological types in samples from Lapa Pintada (* known edible plant, + domesticated plant).

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
					Poaceae	*Zea mays* *+																											
					Fabaceae	*Hymenaea* *																											
					Fabaceae	*Hymenaea* *																											
					Cucurbitaceae	*Largenaria* +																											
					Anacardiaceae	*Spondias tuberosa* *																											
					Euphorbiaceae	*Manihot esculenta* cf. *+																											
					Passifloraceae	*Passiflora* *																											
					Fabaceae	*Arachis hypogaea* *+																											
					Malvaceae	*Gossypium barbadense*																											
					CaryocaraceaeCaryocar	*brasiliensis* *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Arecaceae	*Syagrus olearus* cf. *																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Euphorbiaceae	*Cnidoscolous pubescens*																											
					Anacardiaceae	*Spondias mombin* *																											
					Cucurbitaceae	*Cucurbita* *+																											
					Cucurbitaceae	*Largenaria* *+																											
					Cecropiaceae	*Cecropia*																											
					Piperaceae	sp 1																											
					Malpighiaceae	sp 1																											
					Fabaceae	*Lonchocarpus*																											
					Combretacea	*Terminalia argentea* cf.																											
					Bixaceae	*Bixa orellana*																											
					Polygonaceae	*Ruprechtia*																											
					Anacardiaceae	*Myracrodruon urundeuva*																											
7772	N114 L114	1					X										X	X														
7762	N115 L113	3															X	X														X
7761	N115 L114	3											X					X														
7769	N115 L113	4											X					X														X
7779	N115 L114	4					X		X								X	X														
7778	N115 L113	5					X						X				X	X					X									X
7798	N115 L114	5					X		X								X	X														
7788	N115 L113	6					X						X				X	X														
7793	N115 L113	7															X	X														
6221	N115 L114	7															X	X														
6415	N115 L113	8																X														
6437	N115 L113	9																X					X									
6706	N115 L113	10															X	X														
6703	N115 L114	10							X									X														
6726	N115 L113	11															X	X													X	
6736	N115 L114	12																X														

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Table 7.14 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	AA	AB	AC	AD	AE	AF	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
						Zea mays *+	X		X			X	X				X	X																
7822	N115 L113		A		Poaceae																												
7776, 7829	N115 L114		B		Fabaceae	*Hymenaea* *	X		X				X				X	X																
7777	N115 L114		B/C		Fabaceae	*Hymenaea* *	X		X								X	X																
7801, 7803	N115 L113		C		Cucurbitaceae	*Largenaria* +	X		X	X			X				X	X					X								X		
7825, 7837	N115 L113/4		D		Anacardiaceae	*Spondias tuberosa* *			X			X	X			X	X	X					X									X	
7824	N115 L113		hearth		Euphorbiaceae	*Manihot esculenta* cf. *+	X		X								X	X					X										
7830	N115 L113		bioturbation		Passifloraceae	*Passiflora* *	X		X			X					X	X					X										
					Fabaceae	*Arachis hypogaea* *+																												
					Malvaceae	*Gossypium barbadense*																												
					Caryocaraceae	*Caryocar brasiliensis* *																												
					Arecaceae	*Syagrus olearus* cf. *																												
					Arecaceae	*Syagrus olearus* cf. *																												
					Euphorbiaceae	*Cnidoscolous pubescens*																												
					Euphorbiaceae	*Cnidoscolous pubescens*																												
					Anacardiaceae	*Spondias mombin* *																												
					Cucurbitaceae	*Cucurbita* *+																												
					Cucurbitaceae	*Largenaria* *+																												
					Cecropiaceae	*Cecropia*																												
					Piperaceae	sp 1																												
					Malpighiaceae	sp 1																												
					Fabaceae	*Lonchocarpus*																												
					Combretacea	*Terminalia argentea* cf.																												
					Bixaceae	*Bixa orellana*																												
					Polygonaceae	*Ruprechtia*																												
					Anacardiaceae	*Myracrodruon urundeuva*																												

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Table 7.14 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																													
					Malvaceae	*Guazuma ulmifolia*					X																									
					Malpighiaceae	sp 2 *																													
					Arecaceae	*Syagrus olearus* cf. *						X																							
					Solanaceae	sp 1																	X											
					Arecaceae	sp 1																													
					Myrtaceae	*Myrciaria* *																			X										
					Fabaceae	*Amburana cearensis*																													
					Asteraceae	Eupatorieae sp 1																													
					Cyperaceae	*Scleria*																													
					Bixaceae	*Bixa*																													
7772	N114 L114	1																																
7762	N115 L113	3									X												X										
7761	N115 L114	3																																
7769	N115 L113	4																																
7779	N115 L114	4																															X	
7778	N115 L113	5										X																						
7798	N115 L114	5																							X									
7788	N115 L113	6																					X		X						X			
7793	N115 L113	7																																
6221	N115 L114	7																																
6415	N115 L113	8																																
6437	N115 L113	9																																
6706	N115 L113	10																																
6703	N115 L114	10																																
6726	N115 L113	11																																
6736	N115 L114	12																																

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Table 7.14 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	BD	BE	BF	BG	BJ	BK	BY	CG	CK	CL	CM	CN	CS	CW	CZ	DA	DC	DH	DO	DS	DU	EA	EC	EG	EI	EJ	EK	ER
					Fabaceae	*Machaerium* sp 1																													
					Malvaceae	*Guazuma ulmifolia*																													
					Malpighiaceae	sp 2 *																													
					Arecaceae	*Syagrus olearus* cf. *																													
					Solanaceae	sp 1																													
					Arecaceae	sp 1																													
					Myrtaceae	*Myrciaria* *																													
					Fabaceae	*Amburana cearensis*																													
					Asteraceae	Eupatorieae sp 1																													
					Cyperaceae	*Scleria*																													
					Bixaceae	*Bixa*																													
7822	N115 L113		A																														
7776, 7829	N115 L114		B																												X		
7777	N115 L114		B/C																														
7801, 7803	N115 L113		C								X												X		X								
7825, 7837	N115 L113/4		D																														
7824	N115 L113		hearth												X																		
7830	N115 L113		bioturbation																						X								

Continued on next page.

Table 7.14 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																						
					Bombacaceae	*Chorisia pubiflora*																						
					Fabaceae	*Desmodium incanum*																						
					Fabaceae	*Machaerium* sp 2																						
					Rutacaeae	*Zanthoxylum* sp 1																						
					Fabaceae	*Anadenanthera* sp 1																						
					Plumbaginaceae	*Plumbago* sp 1																						
					Fabaceae	*Anadenanthera* sp 2																						
					Rutaceae	*Zanthoxylum* sp 2																						
7772	N114 L114	1																X										
7762	N115 L113	3																X	X					X				
7761	N115 L114	3															X							X				
7769	N115 L113	4															X				X			X				
7779	N115 L114	4																										
7778	N115 L113	5												X			X	X						X				
7798	N115 L114	5																						X				
7788	N115 L113	6											X				X	X						X				
7793	N115 L113	7																X						X				
6221	N115 L114	7																										
6415	N115 L113	8																										
6437	N115 L113	9																										
6706	N115 L113	10																										
6703	N115 L114	10															X							X				
6726	N115 L113	11																										
6736	N115 L114	12																										

Continued on next page.

Table 7.14 - continued from previous page.

PN	Unit	Strata/ Level	Feature	Type	Family	Taxa	EY	FA	FF	FY	FZ	GH	GP	HQ	JG	JH	JJ	JL	JN	KF	KG	NA	NC	ND	NE	NF	NG	NZ
					Bigonaceae	sp 1																						
					Bombacaceae	*Chorisia pubiflora*																						
					Fabaceae	*Desmodium incanum*																						
					Fabaceae	*Machaerium* sp 2																						
					Rutacaeae	*Zanthoxylum* sp 1																						
7822	N115 L113		A		Fabaceae	*Anadenanthera* sp 1																	X					
7776, 7829	N115 L114		B		PlumbaginaceaePlumbago																		X					
7777	N115 L114		B/C		Fabaceae	sp 1													X				X					
7801, 7803	N115 L113		C		Fabaceae	*Anadenanthera* sp 2					X						X	X	X				X					
7825, 7837	N115 L113/4		D		Rutaceae	*Zanthoxylum* sp 2																	X					
7824	N115 L113		hearth															X										
7830	N115 L113		bioturbation															X					X					

The plant remains present in levels one through six and in the features included a number of edible plants. Among the domesticated plants, *Zea mays* (maize) was present throughout and *Manihot* occurred in features. While seeds of *Phaseolus vulgaris* (beans) were found at Lapa Pintada none came from the flotation samples. The native plant foods present included *Sagrus olearus, Caryocar brasiliensis, Hymenaea, Myrciaria*, and *Passiflora*.

Chi-squared statistics for Lapa Pintada

The chi-squared statistics for Lapa Pintada compare the plant data by context, level, and feature. The same criteria as discussed in Chapter 6 and previously for Lapa dos Bichos must be met by the count values of plant types in order to use the statistic.

The chi-squared test for Lapa Pintada by context (features vs. sediment matrix) used ten plant type categories, the tenth of which included all types not grouped in the other nine categories. Chi-squared was significant (χ^2 = 217.34, df = 9, $p < 2.2 \times 10^{-16}$). Asteraceae and Fabaceae were not distributed evenly across the site. The sediment matrix had higher than expected counts of Asteraceae ($p < 0.0001$), Fabaceae ($p < 0.001$), and types grouped in the tenth category ($p < 0.05$).

It was not possible to conduct a chi-squared test by level at Lapa Pintada due to the inability to group the count data for plant types into two or more categories that satisfy the requirements of the statistic across all levels.

Among the features from Lapa Pintada, palms and non-palm remains were not distributed in the same way (χ^2 = 90.09, df = 5, $p < 2.2x10^{-16}$). There were disproportionately many non-palm remains in feature B ($p < 0.001$) and disproportionately few non-palm remains in feature D ($p < 0.001$). The utility of this result is very low as the patterning relates to the count of paleoethnobotanical remains excluding Arecaceae. The chi-squared test has a narrow ability to address the question of relationships between features by plant types due to the requirements of the test to have expected count values of over 5 items. This limitation due to sample size applies to many multivariate statistical methods.

General screen samples, February 2008

The samples from units N112 L104 and N121 L114 from Lapa Pintada would appear to be of little use as they are plant remains collected from sediment screened in the field. The predominant materials collected were palm nuts and fragments and woody material. However, one of the two dates for Lapa Pintada comes from N112 L104. Palm nut and wood fragments from level 8 were dated to 7000±70 BP.

The samples from N112 L104 show a marked decrease in botanical material between levels three and four (Table 7.15). The decrease in plant material is apparent in the palm nut fragments, but less obvious from the unburnt woody and fibrous material. No palm nut fragments are curated for level 8, but they were present as some were sent for dating. The decrease in

plant material in lower levels of this unit reflects the pattern seen in units N115 L113 and N115 L114.

Table 7.15. Quantities and masses of plant material from the excavation of unit N112 L104 at Lapa Pintada. The palm nuts from level 8 were used for dating.

PN	Level	Palm nuts	Other seeds or fruits	Woody material	Palm nuts (g)	Other seeds or fruits (g)	Woody material (g)
7054	0	11	2	2	39.1	0.49	2.6
7055	1	39	1	12	48.7	0.48	7.2
7060	2	15	1	11	18.7	0.05	3.8
7061	2 (feature)	9		6	12.6		0.8
7062	3	19	1	31	19.3	1.13	3.2
7065	4	2		11	3.4		8.7
7067	5	4		2	5.3		1.6
7068	6	1		3	2.2		2.1
7069	7	2			4.2		
	8	present					

The unit N121 L114 at Lapa Pintada has a distinctly different signature of botanical remains from those found in unit N112 L104. A larger quantity of woody material was excavated and a buried hearth was encountered in level three (Table 7.16). The unit N121 L114 is a historic deposit as indicated by wood cut by metal and paper fragments.

Table 7.16. Quantities and masses of plant material excavated from unit N121 L114 at Lapa Pintada. Accompanying archaeological remains date this unit to the historic time period.

PN	Level	Palm nuts	Other seeds or fruits	Palm nuts (g)	Other seeds or fruits (g)	Woody material (g)
7164	0	10		17.1		1.6
7165	1	71		128.6		65.2
7166	2	38	1	71.8	0.72	234.5
7167	3	9	10	22.8	11.29	30.7
7168	3 (hearth)	13	1	25.5	4.94	36.3

Chi-squared comparison of plant assemblages at Lapa dos Bichos and Lapa Pintada

The compositions of the paleoethnobotanical assemblages from Lapa dos Bichos and Lapa Pintada were compared using the chi-squared test. The null hypothesis for the chi-squared test is that samples were drawn from the same population. We would expect archaeological sites in different regions to fail to conform to this hypothesis. However, the analysis identifies those types that were found in significantly different proportions in different regions. The morphological plant types were grouped into 28 categories for this statistic. Plant types were not distributed evenly across the two sites (χ^2 = 3257.69, df = 27, $p < 2.2 \times 10^{-16}$).

At Lapa dos Bichos the types that occur in greater proportion than expected are *Ruprechtia* (Polygonaceae) ($p < 0.0001$), Anacardiaceae ($p < 0.0001$), Poaceae ($p < 0.0001$), and Euphorbiaceae ($p < 0.0001$). At Lapa Pintada the types that occur in greater proportion than expected are *Machaerium* sp 2 (Fabaceae) ($p < 0.0001$), *Anadenanthera* (Fabaceae) ($p < 0.0001$), *Syagrus oleracea* bracts (Arecaceae) ($p < 0.0001$), and *Syagrus oleracea* palm nuts (Arecaceae) ($p < 0.0001$).

Considering these types on the basis of utility indicates a difference in the distribution of food types at these sites. At Lapa dos Bichos there is a higher than expected contribution of Poaceae (the individuals of which are predominantly *Zea mays*) and a lower than expected contribution of palm

nuts, *Syagrus oleracea.* Two additional categories that could indicate a contribution by food plants to the assemblage are Anacardiaceae and Euphorbiaceae; however, as these families also contain possible winged or inedible species, their greater-than-expected contribution to the assemblage of Lapa dos Bichos is less easily interpreted. The distribution of food plants between the two sites and its possible meanings in subsistence are directions for future research, especially considering that Lapa Pintada is represented by two excavation units in comparison to the multiple excavated contexts at Lapa dos Bichos. Additionally, the sites may have had different functions within their region that could also influence the plant assemblage deposited at them. Of the remaining types that were unevenly distributed, two are winged seeds (*Ruprechtia* and *Machaerium* sp 2) where the prevalence is likely due to local microenvironmental conditions; in particular, no individuals of *Machaerium* sp 2 have been found at Lapa dos Bichos. The final category consists of the fruit pods of *Anadenanthera,* which occur in greater-than-expected proportion at Lapa Pintada.

Summary

The sites of Lapa dos Bichos and Lapa Pintada were utilized during the Holocene; at Lapa dos Bichos deposition is continuous while there may be a temporal gap at Lapa Pintada. While the majority of samples analyzed from these sites coincide with the period when domesticated plants were utilized, some of the samples are from earlier site use. These earlier samples

have a lower density of plant remains and lower richness of plant morphological types. The remains from these contexts are almost exclusively burnt. The almost ubiquitous plant type is *Syagrus oleracea* (palm nuts), which occurs in almost every sample. Other native foods were present, but were found in few samples. It is unknown if an increase in the volume of sediment processed from these early stratigraphic layers would impact frequency with which other species are encountered. Additionally, the degree to which these layers vary, on the basis of plant preservation, from those subsequently deposited is unknown. It would be safe to assume that the better preservation of desiccated remains in higher stratigraphic levels adds to the richness, diversity (total number of plant types found), and density of plant types found therein.

The presence of domesticated plant foods in the archaeological stratigraphy (strata 3 and above at Lapa dos Bichos and level 6 and above at Lapa Pintada) coincides with an increase in volumetric richness, density of plant remains, and presence of native plant foods.

At both Lapa dos Bichos and Lapa Pintada a broad range of domesticated plants are found in the upper strata. The domesticated plants can be tentatively separated into groups by their stratigraphic occurrences. This separation is tentative as it is based on the presence of species; the absence of a species does not necessarily mean it was not present in a specific time period. The domesticated plant species found in older contexts

are *Largenaria* (bottle gourd), *Manihot* (manioc) and possibly *Phaseolus lunatus* (lima bean). In higher stratigraphic positions *Zea mays* (maize), *Phaseolus vulgaris* (bean), *Cucurbita* (squash), *Arachis hypogaea* (peanut) and *Gossypium* (cotton) are also found.

Chapter 8. Inferences about plant food choice and human behavior

The archaeological data presented in the two preceding chapters allow us to draw inferences about human behaviors and choices that led to the archaeological record at Lapa dos Bichos and Lapa Pintada. This project was initiated due to the presence of well preserved botanical remains in rock shelters of northern Minas Gerais state. As a quantity of these remains were found in features, an initial research question related to site formation. What type of activity formed the features? As this project was framed in terms of foraging theory models for subsistence change, the central research question was how did subsistence plant use change over the course of the sites' use? Within a broader context, subsistence studies can also inform upon economic systems, thus the third question. What were the subsistence practices of the populations that used the sites?

Feature function

Both Lapa dos Bichos and Lapa Pintada have features rich in organic material. The nature of deposition that led to the creation of these features may be distinguishable from their characteristics. The possible functions of features as storage, garbage disposal, and ritual deposition are explored. Garbage disposal and food storage activities are widely documented ethnographically. The use of features in ritual has been suggested as a possibility at the site of Lapa do Boquete (Peruaçu River Valley) due to the

physical proximity of pit features with burials (Renato Kipnis, personal communication).

If features were constructed for the storage of food, we would expect that they would have been made with dimensions appropriate to the task, that stored items would have been protected from the surrounding friable soil, and that the storage would have been used for a few specific foods. While an ideal storage pit would have extremely low richness of plant types, it is unlikely that any pit would have been abandoned unopened. Thus the removal of stored food would allow for new fill. However, the purposeful construction and preparation of the location should be preserved.

If features were garbage depositions, we would expect them to serve as concentrations with a higher density of plant remains. Furthermore, the types of plant remains found in garbage should be the same as the domestic debris found across the contemporary habitation.

If features were created in the context of ritual, we could expect that a set of replicable ideas directed their creation and composition. Thus the features should have standard structures and specific sets of items. Archaeologically we should then observe repetition in the set of items found in each feature and shared construction practices.

During excavation, all distinct concentrations were called features. As the goal of these alternative sets of explanations is to examine behavior

involved in the deposition of concentrations of organic remains, the features clearly associated with burning activities were separated. From Lapa dos Bichos, features that were either clearly or potentially hearths (features 20, 24, 28, 29, 38, 39, 46, 63, 65 and 66) were excluded from the following discussion of feature function and formation. Thus at Lapa dos Bichos the sample included seven features from stratum 3, seventeen features from stratum 2, and one feature from stratum 1. For the analysis of Lapa Pintada, the feature labeled "hearth" was not considered due to its probable function. Samples came from four features (labeled C, B, A, and D) and the interface between two of the features (labeled B/C). All of the features at Lapa Pintada were documented within excavation levels 3 to 6. These levels appear to pertain to a single stratum. The characteristics of features that were rich in organic remains are discussed separately by site.

The features from Lapa dos Bichos have diameters ranging from ten centimeters to over a meter. The depths were also variable as some remained within a single stratum and other were within depressions that cut through earlier deposits. In addition to having occurred in a variety of sizes, the features vary in format from circular to amorphous. The variety of forms can be seen in Figures 5.7, 5.8, and 5.9. Of the features excavated to date, none were lined with woven basketry or palm fronds in contrast to some of the features at other sites in the Peruaçu region such those as Lapa do Boquete, where basketry was found. Furthermore, only two circular features

were reported as having fibrous material at their bases. The fibrous material could have served in some manner as a lining for the pit. Moving from format to context, the features contained denser accumulations of organic material (2006 excavation data only - average mass density for features = 45.5 grams/liter vs sediment matrix = 1.8 grams/liter; average count density for features = 50.4 number/liter vs sediment matrix = 8.9 number/liter). A greater richness of morphological plant types was documented for features than for the surrounding sediments (mean volumetric richness for features = 14.7 vs. sediment matrix = 4.4).

These two contexts are differentiated on the basis of plant richness and density, leaving a remaining question of the relationship between items that were consistently included in each context. The chi-squared statistic comparing the composition of the sediment matrix to that of the features (excluding hearths) was significant (χ^2 = 3289.05, df = 17, $p < 2.2x10^{-16}$). Plant types were placed into 18 groups to meet the test limitations. In the sediment matrix the type groups that expressed greater-than-expected proportions were *Cecropia* (Cecropiaceae) ($p < 0.0001$) and three winged seeds types (*Terminalia argentea* (Combretaceae) ($p < 0.0001$), *Ruprechtia* (Polygonaceae) ($p < 0.0001$), and *Myracrodruon urundeuva* (Anacardiaceae) ($p < 0.0001$)). The type groups with less-than-expected proportions in the sediment context were Arecaceae ($p < 0.001$) and *Cnidoscolous pubescens* ($p < 0.0001$). The composition of the sediment matrix contains greater

proportions of plant materials than would randomly enter into the site, such as winged seeds. By contrast the features have less-than-expected values for these windblown seed types, an observation that is consistent with the the disposal of domestic garbage at discrete times. Domestic debris from consumption are not restricted to the features as these plant types are found across the contexts. Other patterns might exist between the contexts, however the chi-squared test provides a set of observations which are significant. It was not possible to calculate the chi-squared test for individual non-hearth features due to inadequate expected cell counts for the plant remains. In conclusion, the format and fill of features at Lapa dos Bichos does not express patterned behaviors such as those proposed if they had functioned in storage or ritual capacities. The prediction for an accumulation of debris, however, was met at the features.

When considering the features from Lapa Pintada the sample is smaller; however, the features share some basic characteristics with those from Lapa dos Bichos. Features B, C, and D were amorphous, large, and fairly shallow. These features were very dense concentrations of organic matter, principally desiccated organic matter that spread over a large area (average mass density for features = 59.6 grams/liter vs. 22.2 grams/liter in the sediment matrix; average count density for features = 20.8 number/liter vs. 6.8 number/liter in the sediment matrix). The exact dimensions of the features are not well delineated as they continued into various profiles of the

excavation unit. Feature A was distinct in format as it was circular and dug as a pit. The feature sediment was not rich in organic material, had a less dense accumulation of plant materials than in the other features, and the pit was not lined. The volumetric richness of plant types from the features was higher than the surrounding sediment matrix (mean for features = 8.4 vs. 5.5 for sediment matrix). In measures of density and richness the sediment matrix is only considered to be material in levels 1 through 6 due to a possible hiatus in site utilization. The difference in richness between features and the sediment matrix at Lapa Pintada is of a low magnitude.

The chi-squared statistic comparing the composition of features (excluding the hearth) and the sediment matrix at Lapa Pintada was significant (χ^2 = 219.31, df = 9, $p < 2.2x10^{-16}$). Plant types were placed into ten groups to meet the test limitations. The plant type groups found in significantly different proportions are the Asteraceae ($p < 0.0001$) and Fabaceae ($p < 0.0001$) families, and the group that includes the counts of all unidentified paleoethnobotanical remains ($p < 0.05$). These three types occurred in greater-than-expected proportions in the sediment matrix. The types of Fabaceae found at Lapa Pintada include many winged seeds and in the Asteraceae remains both winged seeds and flower parts. Both of these plant categories could have been introduced to the sediment matrix in higher proportions by incidental deposition. Thus, at present, the distinction in composition of features and the surrounding contexts is best related to

characteristics that might vary between deposition occurring over an extended period of time and deposition occurring at a specific moment.

Distinctions between individual features (excluding the hearth) were explored with a chi-squared test. Due to low expected cell counts the plant data were placed into three groups: Arecaceae family (palms), non-palms identified to the family level, and unidentified remains. Among the features from Lapa Pintada, these plant groups were not distributed in the same way (χ^2 = 109.07, df = 8, $p < 2.2x10^{-16}$). Significant differences were observed in features B and D. Feature B had a higher-than-expected proportions of non-palms identified to family ($p < 0.01$) and Feature D had less-than-expected proportions of unidentified plant materials ($p < 0.001$). This statistic demonstrates significant differences between features, however it would be difficult to interpret these differences. The categories are of limited analytical value in archaeological discussions as the ability to classify a plant by family is based on our comparative collections and not necessarily attributes of the same.

The features from Lapa Pintada best fit a hypothesis of garbage disposal. No formal characteristics of composition or items selected for deposition would suggest the alternate hypotheses.

Features at Lapa dos Bichos and Lapa Pintada with concentrations of organic material are quite similar in form and seem to be composed of

domestic debris. Determining the regional extent of features with these types of depositional characteristics may lead to a better understanding of the cultural interactions between regions. Documentation of similar features in southern Minas Gerais at Santana do Riacho, in the Serranopolis region of Góias, or in Bahia within the Serra Geral project was not encountered. (Prous et al. 1991; Resende and Prous 1991; Rosa 1997; Schmitz et al. 1996, 2004).

Paleoethnobotanical data that address models of temporal change in subsistence

The predictions of four models were presented in Chapter 4 to examine plant foods in subsistence and their change through time in north-central Minas Gerais: no change, environmentally caused change, change caused by resource stress, and change caused by the introduction of domesticated plants. Further characteristics that could be used to distinguish between the specific foraging strategies, diet breadth, risk aversion, and patch choice were discussed.

A conscientious examination of the four hypotheses for temporal change in subsistence for each of the applicable foraging strategies depends upon a wealth of environmental and agronomic data. These data were not created within this project, and thus the conclusions about the archaeological fit of the models must be superficial. Examination of environmentally driven subsistence changes relies upon detailed, local climatic records. There is a

paucity of data on the distribution of plant food species within the landscape, data that would be relevant to considering both climatologically driven movement of plant species between environmental zones and composition of food resources within microenvironmental zones necessary to consider patch choice strategies. An accurate ranking of plant food resources requires information on both food nutrition and productivity. Data on plant productivity and the reliability of this production are lacking for many native plant foods. Nutritional information exists for few species. As such, the consideration of plants found within the archaeological assemblage can be based only upon select foods' caloric values and the assumption that similar food types (nuts or fruits) would have similar nutritional values.

While a complete consideration of the hypotheses suggested by optimal foraging theory is not feasible, an application of these principles will be discussed in relation to the ranking of food resources and the paleoethnobotanical data from this research project. For this we first turn to the distribution of food plants within the archaeological strata at Lapa dos Bichos (Table 8.1) and Lapa Pintada (Table 8.3).

Table 8.1. The distribution of food plants within archaeological strata 2 to 5 of Lapa dos Bichos. Radiocarbon date ranges are uncalibrated.

	Domesticated food plants	Native food plants
Stratum 2	manioc	palm nuts
150 - 750 BP	maize	jatobá
	squash	pequí
	peanut	umbu
	common bean	Solanaceae
		cajá
		passion fruit
		Lasiacis sp. (grass)
		murici
Stratum 3	manioc	palm nuts
750 - 2000 BP	maize	jatobá
		umbu
		Solanaceae
		cajá
		passion fruit
Stratum 4	(possibly manioc)	palm nuts
2000 - 4250 BP	(possibly lima bean)	jatobá
		pequí
		umbu
Stratum 5		palm nuts
4250 - 6500 BP		jatobá

The distribution of foods from Lapa dos Bichos shows a shift from palm nuts and jatobá to an assortment of plants in the archaeological record. The results indicate increased diet breadth. While the issue of preservation must be further analyzed for the transition from stratum 4 to stratum 3 at Lapa dos Bichos, the other two transitions also reflect increased diet breadth. Confidence in the patterns of plant utilization represented in the site stratigraphic are dependent upon sample size. The volumes of samples from

strata 4 and 5 are low and thus these results must be taken as provisional rather than final (Table 8.2).

Table 8.2. Total volume (liters) of sediment analyzed from the strata at Lapa dos Bichos.

Stratum	Liters of sediment
1	20.0
2	36.4
2 (features)	127.5
3	27.7
3 (features)	31.5
4 (including features)	28.1
5 (including features)	13.7
6	4.0
All strata	288.9

The transition from stratum 4 to stratum 3 introduced the substantial volumetric contribution by desiccated botanical remains. Changes in the paleoethnobotanical assemblage might also be related to changes in the utilization of the rock shelter. The features documented from early occupations are almost exclusively hearths; however. once again this factor would influence the transition from stratum 4 to stratum 3. One possible change in human behavior, resulting in the disposal of garbage within features in a semi-organized manner, might have been the use of the rock shelter over more extended periods of time as a result of increased sedentism.

At the site of Lapa Pintada the food remains also indicate increased diet breadth (Table 8.3). Potential preservation issues do not appear to be a

contributing factor at Lapa Pintada, as there are desiccated remains in earlier levels of the profile, and thus the occurrence of only palm nuts and jatobá in the earlier levels of this site is not driven exclusively by preservation. A shift in how rock shelters were used deserves additional exploration at Lapa Pintada; other researchers have suggested a break in utilization between levels 7 and 6. A detailed program of dating could address this question more accurately than material culture alone.

Table 8.3. Distribution of domesticated and native plant foods within the archaeological deposits of Lapa Pintada.

	Domesticated food plants	Native food plants
Levels 3 through 6	maize	palm nuts
		jatobá
		Solanaceae
		passion fruit
Features	maize	palm nuts
(levels 3 to 6)	manioc	jatobá
		Solonaceae
		pequí
		Lasiacis sp. (grass)
Levels 7 through 12		palm nuts
		jatobá

The pattern of changes observed in plant foods found at these two sites can be contextualized within the hypotheses previously detailed and in relation to the ranking of resources by caloric returns. Regionally available native food plants for which caloric data are known were discussed in Chapter 2. The ranking of these species indicates that the nuts and palm

kernels are highest ranked resources (Table 8.4). These rankings do not consider the time investment necessary for the acquisition or processing of these foods.

Table 8.4. Native cerrado foods ranked on the basis of calories provided from 100 grams of edible tissue (Franco 1992; Silva, Dijalma et al 2001).

Plant species	Common name	Plant part	Calories	Sugar (g)	Protein (g)	Fat (g)
Dipteryx alata	Barú	mesocarp	616.7	25.5	26.3	
Anacardium othonianum	Cashew nut	seed	556.0	37.9	17.9	37.0
Solanum lycocarpum	Lobeira	fruit	345.0	86.0	9.5	
Orbygnia phalerata	Babaçu palm	kernel	334.3	13.3	3.9	19.5
Attalea speciosa	Palm	kernel	313.0	13.3	3.9	29.5
Acrocomia aculeata	Palm	kernel	243.0	28.0	4.4	27.9
Hymenaea stigonocarpa	Jatobá	seed pod pulp	115.0	29.4	1.0	0.7
Mauritia flexuosa	Palm	kernel	114.9	2.2	3.0	10.5
Inga spp.	Ingá	seed pod pulp	97.7	21.6	2.6	0.1
Caryocar brasiliense	Pequi nut	seed	89.0	21.6	1.2	0.9
Genipa americana	Jagua	fruit	81.7	18.3	1.2	0.4
Campomanesia cambessedeana		fruit	64.0	13.9	1.6	1.0
Byrsonima verbascifolia		fruit	60.5	11.7	1.4	1.2
Ananas ananassoides	Wild pineapple	berries	56.0	13.5	0.4	0.1
Annona crassiflora	Custard apple	fruit	52.0	10.3	0.4	1.6
Bromelia balansae	Heart of flame	fruit	51.0	13.5	0.6	0.1
Hancornia speciosa	Mangaba	fruit	47.5	10.5	0.7	0.3
Eugenia calycina	Pitanga	fruit	46.7	6.4	1.0	1.9
Psidium firmum	Brazilian guava	fruit	37.8	8.0	1.0	0.2
Anacardium othonianum	Cashew fruit	peduncle	36.5	8.4	0.8	0.2

The addition of domesticated plant species to the ranking shifts many of the native plant foods down the list as the domesticated species have higher caloric content (Table 8.5). Within the expectations of optimal foraging theory, the addition of highly ranked resources would result in a more restricted optimal set (fewer species exploited), independent of the specific strategies of diet breadth, patch choice, or risk aversion. If applicable to the sites studied, this prediction should lead to the presence of fewer native fruit species, the lower ranked resources, concurrent with the introduction of domesticated plant foods. The pattern demonstrated in Tables 8.1 and 8.3 is one of continually increasing diet breadth, and thus the prediction of narrowing diet breadth is not supported by the data. Specifically, there is a temporal shift toward increased diet breadth at the transitions at Lapa dos Bichos from stratum 4 to stratum 3 and from stratum 3 to stratum 2. The second of these transitions coincides with the introduction of more domesticated plant species in the archaeological record.

Table 8.5. The caloric ranking of plant food resources, both domesticated and native to the cerrado, based on 100 grams of edible flesh (Franco 1992; Silva, Dijalma et al 2001).

Plant species	Common name	Plant part	Domestic	Calories	Sugar (g)	Protein (g)	Fat (g)
Dipteryx alata	Barú	mesocarp		616.7	25.5	26.3	
Arachis hypogaea	Peanut	seeds raw	yes	576.9	6	28.1	48.5
Cucurbita sp.	Squash	seeds	yes	573.4	7.5	36.9	44
Anacardium othonianum	Cashew nut	seed		556	37.9	17.9	37
Zea mays	Corn	dried ear	yes	362.7	70.1	9.8	5
Solanum lycocarpum	Lobeira	fruit		345	86	9.5	
Manihot esculenta	Manioc	root, flour	yes	342	83.2	1.4	0.5
Phaseolus vulgaris	Bean	raw seed	yes	340.1	67.1	14.2	1.7
Orbygnia phalerata	Babaçu palm	kernel		334.3	13.3	3.9	19.5
Zea mays	Corn	green ear	yes	325.6	63.5	6.2	5.2
Attalea speciosa	Palm	kernel		313	13.3	3.9	29.5
Acrocomia aculeata	Palm	kernel		243	28	4.4	27.9
Manihot esculenta	Manioc	root, boiled		119	28.9	0.6	0.2
Hymenaea stigonocarpa	Jatobá	seed pod pulp		115	29.4	1	0.7
Mauritia flexuosa	Palm	kernel		114.9	2.2	3	10.5
Inga spp.	Ingá	seed pod pulp		97.7	21.6	2.6	0.1
Manihot esculenta	Manioc	leaves	yes	91	18.3	7	1
Caryocar brasiliense	Pequi nut	seed		89	21.6	1.2	0.9
Genipa americana	Jagua	fruit		81.7	18.3	1.2	0.4
Campomanesia cambessedeana		fruit		64	13.9	1.6	1
Byrsonima verbascifolia		fruit		60.5	11.7	1.4	1.2
Ananas ananassoides	Wild pineapple	berries		56	13.5	0.4	0.1
Annona crassiflora	Custard apple	fruit		52	10.3	0.4	1.6
Bromelia balansae	Heart of flame	fruit		51	13.5	0.6	0.1
Hancornia speciosa	Mangaba	fruit		47.5	10.5	0.7	0.3
Eugenia calycina	Pitanga	fruit		46.7	6.4	1	1.9
Cucurbita sp.	Squash	flesh	yes	40	9.8	1.2	0.3
Psidium firmum	Brazilian guava	fruit		37.8	8	1	0.2
Anacardium othonianum	Cashew fruit	peduncle		36.5	8.4	0.8	0.2

For the Peruaçu region, diet in the early and middle Holocene has been shown to be poor in animal foods from both stable isotope studies and the modeling of diet breadth for hunting (Hermenegildo 2009; Kipnis 2002a). This suggests that additional considerations for the inclusion of plants in the diet would be their contribution of protein or fat to the diet. When the set of plant foods, including domesticated species, is ranked on the basis of fat or protein content, the highly ranked native species still include the palms and nuts (Table 8.6). The high resource ranking of palm kernels in terms of calories and fats is consistent with their presence throughout the archaeological record of human occupation, as these would have been desirable food resources. However, the ranking by fat calories does not significantly alter the relative rankings of native plant foods, as those high in fat are also highly caloric overall.

Table 8.6. An alternative ranking of plant foods based upon their fat composition (Franco 1992; Silva, Dijalma et al 2001).

Plant species	Common name	Plant part	Domestic	Calories	Sugar (g)	Protein (g)	Fat (g)
Arachis hypogaea	Peanut	seeds raw	yes	576.9	6.0	28.1	48.5
Cucurbita sp.	Squash	seeds	yes	573.4	7.5	36.9	44.0
Anacardium othonianum	Cashew nut	seed		556.0	37.9	17.9	37.0
Attalea speciosa	Palm	kernel		313.0	13.3	3.9	29.5
Acrocomia aculeata	Palm	kernel		243.0	28.0	4.4	27.9
Orbygnia phalerata	Babaçu palm	kernel		334.3	13.3	3.9	19.5
Mauritia flexuosa	Palm	kernel		114.9	2.2	3.0	10.5
Caryocar brasiliense	Pequi fruit	endocarp			6.8	1.0	10.0
Zea mays	Corn	green ear	yes	325.6	63.5	6.2	5.2
Zea mays	Corn	dried ear	yes	362.7	70.1	9.8	5.0
Eugenia calycina	Pitanga	fruit		46.7	6.4	1.0	1.9
Phaseolus vulgaris	Bean	seed, raw	yes	340.1	67.1	14.2	1.7
Annona crassiflora	Custard apple	fruit		52.0	10.3	0.4	1.6
Byrsonima verbascifolia		fruit		60.5	11.7	1.4	1.2
Manihot esculenta	Manioc	leaves	yes	91.0	18.3	7.0	1.0
Campomanesia cambessedeana		fruit		64.0	13.9	1.6	1.0
Caryocar brasiliense	Pequi nut	seed		89.0	21.6	1.2	0.9
Hymenaea stigonocarpa	Jatobá	seed pod pulp		115.0	29.4	1.0	0.7
Manihot esculenta	Manioc	root, flour	yes	342.0	83.2	1.4	0.5
Genipa americana	Jagua	fruit		81.7	18.3	1.2	0.4
Hancornia speciosa	Mangaba	fruit		47.5	10.5	0.7	0.3
Cucurbita sp.	Squash	flesh		40.0	9.8	1.2	0.3
Manihot esculenta	Manioc	root, boiled	yes	119.0	28.9	0.6	0.2
Psidium firmum	Brazilian guava	fruit		37.8	8.0	1.0	0.2
Anacardium othonianum	Cashew fruit	peduncle		36.5	8.4	0.8	0.2
Inga spp.	Ingá	seed pod pulp		97.7	21.6	2.6	0.1
Ananas ananassoides	Wild pineapple	berries		56.0	13.5	0.4	0.1
Bromelia balansae	Heart of flame	fruit		51.0	13.5	0.6	0.1

As predicted in every foraging strategy, once introduced, domesticated plant foods should have been included in the diet of foragers from north-central Minas Gerais due to their high resource ranking, potential to be concentrated in patches, and presumed temporal harvest. The inclusion of domesticated plant foods in diet is observed. Concurrently, none of the predictions for how domesticated plants should affect the use of native plant foods were satisfied. Increased diet breadth was observed. Data do not support a model of subsistence change in which the domesticated plant foods served as a driving force behind subsistence change. As paleoethnobotanical data clearly do not support any of the expectations for a model of no subsistence change, both the alternative of environmentally driven change and that related to increased resource stress or population pressure should be considered. Since there are multiple temporal moments of change as indicated in the remains from Lapa dos Bichos, an environmentally driven model is not likely. While environmental data for the local region are not detailed, general information for the cerrado environment does not indicate multiple, extreme fluctuations during the last 5000 years (De Oliveira et al. 1999; Grimm et al. 2001; Salgado-Labouriau 1997). Increased diet breadth is an expectation of increased sedentism, or population density, resulting in resource stress. Thus one direction for research is a more extensive examination of population trends. At present, however, there are no settlement pattern data to support increased or

decreased sedentism in the Peruaçu region. Data on settlement distributions are not present for the Montes Claros region. The one potential indicator of increased sedentism in north-central Minas Gerais is the deposition of large quantities of botanical materials within the rock shelters; however, this measure may be problematic. The overall rate of sediment deposition in recent strata at Lapa dos Bichos appears to have been slower than that documented for the Early to Middle Holocene (sediment deposition between 8000 and 4250 BP averaged 1cm/75yr while that in the strata from 4250 to 150 BP was significantly slower, 1cm/150yr), yet the population is thought to have become increasingly sedentary. Other archaeological studies from the cerrado have implied an increase in sedentism as descriptive of changes in cultural practices, especially lithic technology, at the Early to Middle Holocene transition (Prous 1991a).

Subsistence economies

With the introduction of domesticated plant foods, how did the economy and associated behaviors of populations in northern Minas Gerais change?

This question moves beyond the specific plant foods consumed and demands the context for their consumption. The extreme positions would be to claim that no economic changes occurred or that the region's population adopted intensive agriculture. The middle ground would be a mixed economic situation of foraging and cultivation to acquire plant foods. While

the data in previous chapters would lead the reader to opt for the middle-ground hypothesis, the logical reasons for rejection of the other hypotheses are presented as they inform upon human behavior and choice. The economic scenarios are examined entirely on the basis of plant resources as, in the absence of domesticated animals, hunting and fishing continued in the lowland Neotropics. Some reliance is placed on the foraging theory models previously examined, but additional conditions should be satisfied in each economic model.

If the introduction of domesticated plant species brought about no economic change, then the population should have continued gathering activities with a focus on the highest ranked resources. As most domesticated plants are highly ranked (see Table 8.5 for a potential ranking scenario), their inclusion within the diet is predicted by optimal foraging models. However, the long-term inclusion of domesticated plants in the diet, without behavioral changes, depends upon one of two factors being true: the population acquires the domesticated plant foods from neighbors who grew them, or the fitness of the domesticated plant species to grow as volunteers within the local environment is high.

If the introduction of domesticated plants species brought about an economic shift to intensive cultivation practices, generally termed agriculture, the signature of this economic shift should be present within the archaeological record of plant utilization. The shift to agriculture would

require a significant amount of time input into producing a substantial harvest. It is hard to measure the investment of labor into cultivation; however, its proximal effects may be registered. Within the diet we would expect domesticated plant foods to take the place of formerly utilized native plant foods. While this would not necessarily lead to decreased diet breadth it should result in the exclusion or decreased importance of lower ranked native resources in favor of domesticated plant foods which are higher ranked. One indicator of the shift in labor investment would be the movement of people to live in proximity to land desirable for cultivation. In the Peruaçu region this land would be near the São Francisco River. In the vicinity of Lapa Pintada, these lands would be along the creeks or on the floodplain where the modern city of Montes Claros is located. Due to the amount of time necessary for intensive cultivation practices it would further be expected that some of the other plant species utilized in the diet would be abandoned. The individuals not involved in the intensive cultivation practices could be expected to follow optimal foraging predictions of prioritizing highly ranked resources. Due to the lowered exploitation of wild food resources necessary to meet nutritional needs, less abundant or less caloric resources would be bypassed for higher ranked resources. Thus an economic shift to agriculture would be registered archaeologically in both settlement choices and dietary remains.

At the site of Lapa dos Bichos, there is evidence for the long-term inclusion of domesticated plant foods within the diet, as seen in the archaeological assemblages of strata 3 and 2. To obtain these plants through trade would require the existence of a group engaged in cultivation within reasonably close geographic range. Archaeological remains from the surrounding regions with substantially different characteristics have not been reported. Therefore, there is no evidence of a group that could have traded foods with the population in the Peruaçu region. The other means by which domesticated plants could appear in the diet with no economic change is if the species could have survived as wild plants within the local environment. Plants of the *Manihot* genus would survive untended in this region; 41 species are reported as occurring within the greater cerrado by Mendoça and colleagues (1998) and, similarly, in the small region of the Distrito Federal, 12 *Manihot* species were documented by Proença et al. (2001) . Meanwhile, the suite of domesticated plants including maize, squash, peanut and beans do not occur as wild volunteer plants in this region and therefore are unlikely to have survived without cultivation. The two lines of data examined allow us to reject the hypothesis that no change in the economic behaviors of the community occurred. The long-term inclusion of domesticated plants in the diet at Lapa dos Bichos indicates that they maintained productivity under local practices of cultivation as plants not producing a sufficient yield under cultivation would likely have been considered marginal food sources.

From the site of Lapa Pintada the evidence for domesticated plant use appears to follow the same lines of reasoning. While the duration during which domesticated plant foods were used is unknown, the archaeological accumulation of over 20 cm of sediment in various distinguishable levels is an indicator of sustained use. Once again the environment is such that the suite of domesticated food plants would not independently survive as volunteer plants.

From the site of Lapa dos Bichos there is little indication that activities shifted to intensive cultivation. The site is located along a steep canyon portion of the river course. As such, the land adjacent to the site is not extremely desirable for agricultural activities. However the site itself was not abandoned. Additionally the search for sites in the Peruaçu region has documented only one site along the floodplains of the São Francisco River with a significant ceramic assemblage (Mello 2009). The movement of settlement to focus on productive agricultural lands would be predicted by an elevated input of labor into cultivation. In regard to the species composition of the archaeological record, there is no indication that fewer native plant foods were utilized during the period of domesticated plant cultivation. Thus there is no evidence that domesticated plant cultivation interfered with the gathering of native food plants. These observations do not support an economic model where human behavior shifted to intensive plant cultivation.

At Lapa Pintada there is less evidence which can be brought to bear upon the hypothesis for intensive plant cultivation. This is due in part to the discontinuity within the archaeological deposits, making it difficult to know if the earlier stratum can be directly compared to those with domesticated plant remains. When a settlement pattern for the Montes Claros region is considered, at present, there is little data from the areas adjacent to productive agricultural lands. The exception is a single test pit from a single undated site, Lapa Grande, where the paleoethnobotanical record reflects domesticated plants without the contribution of native food plants (Appendix F). This site is undated. This difference between sites indicates that there is the potential that studies of settlement and diet in the Montes Claros region will indicate distinct activities occurring at different locales. At present the paleoethnobotanical record from Lapa Pintada is suggestive of low-intensity economic practices involving domesticated plants; practices that would not be consistent with intensive agriculture. Site locations within a settlement pattern could influence the assemblage of plants found at the sites and is an avenue for additional study.

A great range of variation in economic practices falls within the middle ground of mixed economies; however, labor input must be made into both cultivation and foraging. The archaeological data from Lapa dos Bichos suggest that cultivation in the Peruaçu region was incidental and episodic. The behaviors necessary for cultivation did not disrupt foraging or transform

settlement patterns. From the site of Lapa Pintada there is evidence for continued foraging practices alongside plant cultivation; the intensity of the cultivation practices and thus change in human behavioral patterns is, as yet, unknown.

This chapter has demonstrated how the paleoethnobotanical data from Lapa dos Bichos and Lapa Pintada are applicable to questions from site formation processes to temporal change and, ultimately, human economic systems.

Chapter 9: Plants and culture, maize variability, and future research opportunities

The research conducted during this project provides a substantial body of knowledge about paleoethnobotany in central Brazil. The two sites from which data were collected had rich paleoethnobotanical assemblages that allowed for consideration of the subsistence practices during the Late Holocene occupation of the region. Domesticated plants were progressively adopted within an extant foraging and hunting economy.

Specific aspects of the archaeological record have provoked additional investigations, a few lines of which are discussed in this chapter. Topics addressed include the challenges presented by the observed Peruaçu and São Francisco River Valleys' diverse paleoethnobotanical assemblages, the cultural transmission of technology, the nature of archaeological maize, and questions specific to continuing paleoethnobotanical research.

Plant composition in diverse paleoethnobotanical assemblages

Paleoethnobotanical assemblages are quite manageable from a research perspective when their components can be identified. The identification of edible plant foods is generally facilitated by the limited set of cultivated and native species to be considered for the ecological conditions of each site. However, identification of many species from central Brazil is

complicated by the great diversity of species which are adapted to the growing conditions of the area (Oliveira-Filho and Ratter 2002).

Identification of botanical remains is not always possible. As archaeologists we seek ways to interpret human behavioral patterns. Some alternatives can be considered in relation to plant remains in archaeological assemblages that are hard to identify.

As the remains of plant seeds and fruits from this research project have been classified into 822 types, it is obvious that not all of these have been identified. The species most likely to have been identified from paleoethnobotanical remains fall into the categories of domesticated plants and currently known edible native plants. However, it is possible to move beyond these categories when specialized categories are considered. Specialized categories might include winged seeds, flower parts, plant spines and thorns, nuisance plants and suspected medicinal or useful plants (on the basis of ethnographic or folk medicine). These categories have been used infrequently due to a focus on species specific identification; however, they help describe the breadth of human plant utilization.

Of the categories proposed, only the suspected medicinal plants must be identified. While the ethnographic literature can never provide a perfect analogy for prehistory, it is a basis for inference. The archaeological assemblage from this project includes chapeu-de-napoleão (*Thevetia*

peruviana), and amburana (*Amburana cearensis*) at Lapa dos Bichos, both of which are used in modern folk medicine. Additionally, a common red pigment, urucum (*Bixa orellana*), has been found. All these species were likely introduced to the site by human action, and their low frequency of occurrence corresponds with the expectation of utilization of medicinal plants. Similarly, the fibers from palm fronds and bromeliad leaves occurring within the site were likely useful. These were somewhat plentiful, despite not having been quantified in this research.

Table 9.1 The distribution of winged seeds within features at Lapa dos Bichos indicates their prevalence in all contexts. Specific winged seed types are identified for each feature. (- no winged seed types, + no plant types collected)

Feature	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	63	Presence of winged seeds
Strata 2	AU, AZ, BA, BE, CI, CL	AU, AZ, BA, FH	AU, AZ	AZ, BA	AU, AX, AZ	AU, AX, AZ, BA, BE	AU, AX, AZ, BA, BE, EQ, SVI	AZ, CI	-	AX, AZ, BA, BE, CI, JC	AZ, BA	AU, AX, AZ, BA	AX, AX, AZ, BA, CL	AZ, BA, HJ	AZ, BA	-	AZ, BA, CL	+	BA	AZ, BA, CL	AU	18 of 21 (86%)
Feature	62	64	65	66	67	18	19	23	24	25												
Strata 3	AZ	AX, AZ, BA, BE	AZ, BA	-	AZ, BA, BE	AX, AZ, BA, CL	AZ	AX, AZ, BA	AX, AZ, BA	AX, AZ, BA, BE												9 of 10 (90%)
Feature	28	29	34																			
Strata 4	BA	AX, AZ, BA	AX, BA																			3 of 3 (100%)
Feature	20	38	39																			
Strata 5	-	AX, BA, CL	-																			1 of 3 (33%)

Examination of the distribution of winged seeds in archaeological contexts indicates their extremely high ubiquity (Tables 9.1, 9.2). Winged seeds are generally transported by the wind and could naturally be introduced to the archaeological site. These remains could thus be discounted as unrelated to human behavior. However when the assemblage of winged seeds was closely examined, many seeds were found burnt. How would such a number of winged seeds, likely brought in by the wind, end up burnt? One possibility is that the seeds were deliberately burnt, and this could occur as a result of cleaning activities, a human behavior.

Table 9.2 Most excavation contexts at Lapa dos Bichos contained winged seeds. Specific winged seed types are identified for each context. (- no winged seed types, + no plant material found, ++ no collection for plant material, * unexcavated context)

Unit Strata	G13	G14	G15	G16	H13	H14	H15	H16	I13	I14	I15	I16	O2	O11	K24	P41	Presence of winged seeds
2	AX, BA, BE	AX, AZ, BA	BA	BA	AX, AZ, BA, GP	AX, AZ, BA	AX, AZ, BA, BE	AX, AZ, BA, SVJ	AS, AZ, BA	AX, AZ, BA	AU, AX, AZ, BA	AX, AZ, BA	AU	AS	AX, AZ, BA	AX, AZ, BA, BE	16 of 16 (100%)
3	-	++	BA	-	AX	AZ	-	-	AZ, BE	AX	AZ	BA	-	AS, AZ, BA	AX, AZ, BA	AX, AZ, BA	10 of 15 (67%)
4	*	*	*	*	*	*	*	*	*	*	*	*	AU	-	AX, BA, GP	AX, AZ	3 of 4 (75%)
5	*	*	*	*	*	*	*	*	*	*	*	*	AU	-	BA, GP	*	2 of 3 (67%)
6	*	*	*	*	*	*	*	*	*	*	*	*	+	AX	BA	*	2 of 3 (67%)
7	*	*	*	*	*	*	*	*	*	*	*	*	+	+	*	*	0 of 2 (0%)
8	*	*	*	*	*	*	*	*	*	*	*	*	*	+	*	*	0 of 1 (0%)

The remaining categories are of use, but their association with human behavior remains tenuous. Remains of flower parts are found at both Lapa Pintada and Lapa dos Bichos (Table 9.3). As flowers would be unlikely to grow within the rock shelters, the logical conclusion is that flowers were introduced to the sites. Plant spines and thorns could be included in the archaeological assemblage by the collection of wood or fiber plants. A few additional seeds with burrs could have arrived at the archaeological sites inadvertently on clothing. Paleoethnobotanical assemblages that contain not only probable edible species but parts of plants that were probably not edible present opportunities to investigate other aspects of human behavior.

Table 9.3 Plant morphological types found at Lapa dos Bichos and Lapa Pintada that belong to the specialized categories of winged seeds, flowers, plant spines and thorns, nuisance plants and suspected medicinal or useful plants. (* Asteraceae seeds might alternatively be associated with flowers.)

	Winged seeds	Flowers	Spines / thorns	Nuisances	Medicinal / useful
Lapa dos Bichos	AU	DJ	IT		AY / BL
	AX	EC	JB		BH
	AZ	EY	JH		DU
	BA	HQ	JI		
	BE	LZ	NA		
	CI	PU	ND		
	CL	WQ	NV		
	FH		NZ		
	GP		OQ		
	JC		QU		
	EQ*		TC		
	HJ*		TQ		
	SVI*				
	SVJ*				
Lapa Pintada	AZ	DN	ND	EE	BL
	BA	EY	SQN	JJ	
	DF	HQ	SQZ	JX	
	DF	HW			
	IJ	JO			
	JL	SPO			
	JM*	SVL			
		SVM			
		SVN			

Technology transfer - domesticated plants.

Domesticated plants are not generally considered or analyzed as technologies, however I would argue that the plant itself is a form of technology, a specific new item with certain inherently useful or interesting characteristics that could be transferred between people. The general models for the conveyance of technology are horizontal and vertical transmission (Mulder et al. 2006). Applied regionally, horizontal transmission

is group to group diffusion, frequently driven by trade between neighboring groups. Vertical transmission of technology is generally related to maintenance of cultural traditions over generations. These methods of technology transfer establish cultural and temporal expectations for the spread of domesticated plants. A very rapid spread of knowledge is feasible in group-to-group diffusion. In this scenario the acquisition of domesticated plants may occur without the disruption of cultural continuity within other aspects of life. In human migration, the populations often move with their entire set of cultural knowledge and the pace of expansion of technology would be based on population growth or the submission of other populations. While neither model can be taken as purely predictive for the archaeological record, they provide a general context within which to examine the adoption of domesticated plants in north-central Minas Gerais.

The maintenance of material culture and subsistence practices documented at Lapa dos Bichos, and the Peruaçu River Valley in general, contradicts a model of population migration being responsible for the adoption of domesticated plants. Further supporting evidence is the existence of a chronological gap, as evidenced stratigraphically, between the introduction of maize and the subsequent appearance of squash, beans, and peanuts. A model of group-to-group diffusion is the better explanation for the timing and nature of the introduction of domesticated plants to north-central Minas Gerais.

The concurrent transmission of multiple technologies is often suggested by archaeologists, in particular a linkage between plant and ceramic technologies. Few ceramics are found at the archaeological sites. At Lapa dos Bichos ceramics are found in strata 3, 2 and 1, however the distribution is counterintuitive. The density of ceramics in features from stratum 3 is four times higher (1.28 ceramic fragments/liter) than in stratum 2 or stratum 1 (0.27 and 0.2 ceramic fragments/liter, respectively). At Lapa Pintada almost no ceramic fragments have been found. Present archaeological research has not determined how the spread of ceramic technologies across north-central Minas Gerais related to the introduction of domesticated plant technology. There is no general pattern, as the model linking ceramics and plants appears to be a possibility for Lapa dos Bichos, where maize and ceramics may have been introduced concurrently, but does not apply to Lapa Pintada.

Why does the archaeological maize appear so primitive?

Maize (Zea mays) is a human-managed plant. The characteristics of modern maize landraces have been maintained by human selection. Landraces are plant populations with recognizable, shared morphological characteristics that are often selected for productivity within local, environmental growing conditions. Maintenance of a landrace is achieved by selection of those maize plants or ears possessing the characteristics most desired in subsequent generations for seed. The characteristics that are

desired in a corn population can be selected for over the course of multiple plant generations. The repeated selection for the same traits leads to stable landraces which are distinguishable from other landraces that were selected for a different set of phenotypical characteristics (Compton and Bahadur 1977; Webel and Lonnquist 1967). The process of seed selection has been documented among many agricultural societies; ethnographies note cultural practices that select standardized seed for the next generation of plants (Johannessen et al. 1970).

For the archaeologist it is quite interesting to note what occurs in a plant population if human selective activities do not occur or when the selection of seeds is random. Assuming that a maize population starts from a single landrace, without the cultural practice of seed selection, the make-up of subsequent generations will be influenced by plant physiology. With a constant energy input of a plant to producing fruit, those plants that produce more, small seeds could quickly outnumber those that produced fewer larger seeds (Clinton Shock, PhD agronomy, personal communication; Vasal et al. 1997; Weyhrich et al. 1998). In addition, plants that direct more energy into the production of vegetative growth might stifle adjacent plants, and the investment of these successful competitors in vegetative growth would limit the energy available for fruit production, leading to lower yields of fruit. As a vigorous plant will produce less seed, it would be expected that a plant with the ability to produce high yields should continue to contribute more seed for

subsequent plant generations; however, vigorous plants can overgrow and stifle their productive neighbors. Without access to space and sunlight, the potentially productive plant's ability to produce fruit and contribute to the next generation is restricted.

Through the mechanisms described above, a population of maize harvested by humans would express significantly different characteristics if it were deliberately seeded or randomly seeded. Furthermore, the processes associated with random seed selection could be accelerated by human behaviors. Optimal foraging theory suggests that people seek out the highest caloric returns for the least effort invested. In the context of maize cultivation the highest returns would come from selection of the largest cobs and seeds for human consumption. The consumption of maize for the greatest immediate gains would lead to a suboptimal selection of seed available for subsequent planting, accelerating the natural process of plant selection toward lower productivity. This process is known as reversion. Thus foraging theory predicts a situation within the cultivation of plants where logical human choices for a greater immediate yield would work alongside plant physiology to lead, over the longer term, to reduced yields from cultivation. The differing trajectories of plant change, based on the presence or absence of seed selection, can be used to interpret human behaviors that influenced morphological characteristics of the archaeological assemblage of maize.

Cultural knowledge of plant seed selection was imperative to both the maintenance of maize landraces and the maintenance of crop productivity. Therefore, considering the variable and small sized maize cob and cupule remains from north-central Minas Gerais documented in this research project, one likely scenario can be framed through the human choices predicted by optimal foraging theory. The non-selection of seed would have led to a maize population with a great degree of phenotypic variability. The non-selection of seed is coherent with the behavior of a population engaged in incidental cultivation for the immediate gains that it could provide. As domesticated plant foods provide high caloric returns, they would be included within the diet. However when the human choice was for episodic investments into cultivation with no investment in seed selection, the plants themselves could revert to variable and less productive characteristics.

Logically, this suspected reversion in maize phenotypic traits seen in north-central Minas Gerais was based upon the spread of one or more established landraces. If the domesticated maize that spread into north-central Minas Gerais was already phenotypically variable, this would indicate that a reversion had occurred elsewhere along the geographic path of the spread of maize. Even in this scenario, the cultivation engaged in by the population in north-central Minas Gerais did not include substantial plant selection, for if cultivation had involved conscious selection of seed, local maize landraces would have developed.

Neither the founder effect nor hybrid maize varieties would account for the variability of prehistoric maize. The founder effect results from a small subset of variability being introduced to a new region. While this effect is common in relation to the spread of some material-culture technologies where less variability is expressed when technology is transferred between groups, the founder effect is less likely among plant technologies. The potential phenotypic variability in plants, including maize, is great and will be expressed in the absence of outside pressures. This variability is genetically inherent. The introduction of distinct plant types with characteristics of enhanced food productivity leads to a consistently productive population with the active selection of consistent seed material for the subsequent generation.

Hybrid corn, a common modern creation, is different from a landrace in the means by which it is selected and produced. Inbred lines are maintained by the selection of seed from those fruits with the characteristics most desired within the line. Hybrids are made when highly inbred lines are crossed with one another to produce seed from which the offspring will express specific characteristics. However, the hybrid seed is rich in genetic diversity as the subsequent planting of seed from the hybrid crop can be highly varied and undesirably inconsistent at harvest. The production and maintenance of hybrid types is not a process expected for early maize cultivation.

Rindos (1984) proposed a co-evolutionary theory for how plants come to have the characteristics of domesticated species, specifically those characteristics which make the plants dependent upon humans. This perspective sees humans' inadvertent behaviors selecting for plant characteristics. It is unlikely that the unconscious behavior of human foragers would account for increased productivity in plants. Optimal foraging theory holds as a basic assumption human optimization of energetic gains. The greatest gains would be made with the harvesting of the best and most productive foods. The harvesting of the most productive foods would limit the changes to plant physiology which could occur in the context of symbiotic-like relationships between humans and plants.

Humans work against the nature of plant reproduction in foraging. Anywhere a specific plant can grow, within its natural habitat or under cultivation, there will be volunteers, individual plants that appear without intentional selection, planting, and cultivation. The easiest form of cultivation or collection would be to depend upon volunteers. However, volunteer plants may not possess the characteristics that are easiest to gather and process by the preferred collection technique. Optimal foraging theory suggests that resource extraction, and thus routine human behavior, would lead to rotation between resources rather than expenditures in production. As long as a portion of the plant seed was returning to the ground, then a stand, even if poor, is expected during the next year. For a human population engaged in

resource extraction, the diminished size in one plant stand would lead them to skip over it in favor of higher ranked patches or resources, thus allowing the stand to regain productivity before a subsequent harvest. If resource shortage were a problem, some conscious reseeding could be a logical behavioral choice, a choice that could involve cultivation. The immediate goal would be to leave just enough seed for the next year's stand to be as productive at the time of an anticipated return. Further conscious decisions must occur to discriminate in the selection of seed such that the abnormally productive or easy to collect plants become the progenitors. This behavior would involve both human planning and intentions to return to a given patch in the future.

Collection of the best fruit for human consumption effectively removes the best characteristics from the subsequent generation's seed and the same process by which characteristics are propagated would lead, successively, to the predominance of less desirable characteristics; thus human optimization of foraging behavior would select against increased food production.

The maintenance of plant characteristics that are desirable for human harvesting depends not upon the spread of a plant to new geographic ranges, but rather to the selection of seed. Seeding a plant in a new geographic range will not eliminate the genetic characteristics that enabled that plant to express a variety of phenotypical types (both those desired and not by human collectors). Rather it is a consistent, conscious choice of seed

for specific characteristics that results in the development of landraces and in some cases, over time, new species. The ability of these landraces to retain productivity and viability both within and beyond their wild range occurred through purposeful human behaviors and choices. The selection of specific fruit or plants as the seed for the next plant generation is an activity of conscious human choice and human cultural tradition. This most basic activity that determines plant productivity also determines the usefulness of domesticated plant species to humans and their economy.

Cultivation potential of woody native perennial plant food resources

Domesticated plant foods are not the only potential plant resources that could have been cultivated. As human behavior changed to include practices of plant cultivation, it is likely that the knowledge gained through cultivation practices was applied beyond the domesticated plant foods which were introduced from other regions. Native plant species could have been brought under cultivation during prehistory. There are multiple native species which would have been amenable to practices of cultivation. A snapshot into those species which would have been amenable to cultivation comes from current practices and agronomy. Foods such as cashew, guava, araticum, and passion fruit are grown across central Brazil today.

While the modern cultivars of these species are likely to be more productive than those that may have existed in the past, the ease with which

these plants can be grown indicates that they would have been good choices for prior cultivation (Marler et al. 1994; Silva, Dijalma et al. 2001). Cultivation of native fruit tree and shrub species, woody native perennials, is so successful that the Brazilian development agencies promote them (Avidos and Ferreira 2000; Pott and Pott 2003; Silva, A. et al. n.d.; Silva, Dijalma et al. 2001). Modern agricultural practices and the woody native perennial plant selections produce yields which are sold regionally, marketed in urban centers, and manufactured into commercial juices. In the past, the knowledge of cultivation could have led to the cultivation of woody native perennial fruits and nuts. In some instances the spread of selected woody perennials across the Neotropics is well substantiated, such as peach palm, however this is based upon the spread of the plant away from locations where it originally grew (Mora-Urpí et al. 1997). The cultivation of a species which originated within the same area is less likely to leave a distinctive archaeological signature. There are many productive fruit, nut, and palm woody perennials native to the cerrado and caatinga environments for which cultivation by human manipulation would have been a possibility.

In addition to native woody perennials that have been brought under intensive agricultural cultivation, some additional native food species such as pequi and jatobá are still collected within the cerrado. The influence and use of these species is indicated not only by their presence in regional markets but by contemporary investments of research into their better use, nutrition,

and potential cultivation by specialists (Almeida et al. 1998, Fonseca and Muniz 1992, Ribeiro 1980).

The modern utilization of woody native perennial cerrado plants, both cultivated and gathered, indicates their nutritional qualities, economic profitability, and possible cultural value. The possibility that some woody native perennials were cultivated during the Holocene and the potential to encounter archaeological evidence of human behaviors related to cultivation should not be overlooked.

Additional investigations of temporal change

The paleoethnobotanical data from the present research project do not address changes in the subsistence and settlement of the Early Holocene and subsequent transition to the Middle Holocene, one of the original goals of the research. Examination of this time period would require analysis of samples from additional contexts.

The dynamic period of the Late Holocene, when domesticated plants were introduced to north-central Minas Gerais has been examined by this research. At both Lapa dos Bichos and Lapa Pintada the paleoethnobotanical assemblage changed with the introduction of domesticated plants to include not only the domesticated species, but also more edible native plants. This temporal shift and its causes deserve analysis through additional material culture and settlement pattern analysis.

The long-term and continual occupation of the Peruaçu River Valley is well-documented. The paleoethnobotanical data support a continuous occupation. Furthermore the use of domesticated plant species was not an abrupt occurrence; some species were utilized before others. This temporal pattern within the paleoethnobotanical remains, and the associated inference of group-to-group diffusion of domesticated plant types, could be confirmed with the addition of data from other local archaeological sites. This information may exist for Lapa do Boquete, another site in the Peruaçu River Valley , but as yet the stratigraphic change in plant food resources is unpublished.

The times when domesticated plants were available to inhabitants in different parts of the lowland Neotropics is still a question of research; however, the data from north-central Minas Gerais suggests that domesticated plants were not introduced as a single package. While we can never know if species may have been available before their inclusion in the archaeological record, the progressive nature by which domesticated plants were added to the diet of the Peruaçu region suggests that the spread of individual species was somewhat distinct. With further studies it is likely that we will be able to distinguish overlapping temporal and spatial webs of species dispersal. In the eastern United States the temporally distinct adoption of maize and beans, introduced domesticates, has been well documented (Scarry 2008; Yarnell 1993). In the lowland Neotropics, distinct

knowledge transfers might be predicted for plants on the basis of the probable locations of their domestication and subsequent directions of dispersal, among them manioc, maize, and peanuts. The lowland Neotropics are a large and culturally diverse region. The diffusion of plant technology into north-central Minas Gerais in no way precludes the spread of a suite of domesticated plants into other locations by means of cultural expansion.

Methodological considerations

The rock shelters of north-central Minas Gerais where archaeological research was conducted and from which paleoethnobotanical remains were analyzed have a long history of research, but a short history for the analysis of subsistence remains. This project can offer a few insights into practical considerations for the collection of paleoethnobotanical samples.

At Lapa dos Bichos the flotation samples collected from the general excavation context were two liters, a smaller quantity than that collected from most features. While many plant materials were found in the general excavation flotation samples, comparison with the botanical remains recovered from the general screen indicates that some plant types, including maize, were not always represented in the flotation sample, but were found within the associated context from the excavation screens. The data from these contexts might have been more representative if a larger volume than two liters had been collected for flotation; however, it is not known at what point an increase in the volume of sediment will lead to diminishing

information returns for the labor invested in collection and sorting. As there is no single sample size appropriate for the collection of sediment, a review of the quantity of material recovered from given volumes can suggest a sediment volume to collect for new excavations.

Both flotation and dry screening were used as collection methods. Both methods resulted in good data recovery. Due to the dry nature of the sediments of the rock shelter, dry screening was the easier method to maintain preservation. The flotation samples had to be dried in a timely manner to avoid the onset of mold to the desiccated botanical materials. Data analysis is facilitated by the collection of comparably sized samples from a single method. Where flotation has already been established as the method of collection, it is advisable to maintain it.

A further enhancement of methodologies would be the collection of large features in volume increments equal to the standard collection size. Breaking the collection of a 20 liter feature into four, five-liter samples if, for example, five liters were the standard sample size, would not lead to data loss. Rather, these collections would facilitate comparison of the feature with other samples of five liters from the same site. This technique was utilized at Lapa Pintada with the collection of more than one five-liter sample from a single feature and it simplified analysis.

The incipient nature of paleoethnobotanical studies in central Brazil indicates the potential for significant advances in interpreting the region's prehistory through data from more extensive regional sampling and a consideration of greater time depth.

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Appendix A. Edible Brazilian plants

Knowledge of edible plants native to Brazil is inherently necessary to an archaeological analysis of prehistoric diet. Knowledge of these plants guides both the identification of archaeological remains and directions for the creation of reference collections. A compilation of plants both edible and native to Brazil that are cited in academic literature is presented here.

Table A.1. Plants identified as being edible and from Brazil.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
Amaranthaceae	*Amaranthus spinosus*	bredo-de-espinho	verdura		Albuquerque and Andrade 2002a; Martin 2005
	Amaranthus viridis	bredo-de-porco	verdura		Albuquerque and Andrade 2002a
Anacardiaceae	*Anacardium giganteum*	cajuí, cajuaçu, caju-da-mata	fruit and nut after toasting		Lorenzi et al. 2006; Cavalcante 1972
	Anacardium humile	caju do campo, cajui, cajuzinho do cerradoc	fruit and nut after toasting		Ferreira 1973a, 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Resende and Prous 1991
	Anacardium microcarpum	caju do campo, cajuí, caju-miniatura	fruit and nut after toasting		Lorenzi et al. 2006; Cavalcante 1972
	Anacardium nanum	caju	fruit and nut after toasting		Ferreira 1973a, 1980
	Anacardium negrense	cajutim	nut after roasting		Cavalcante 1972
	Anacardium occidentale	caju (Este é o que se cultiva hoje em dia para o amêndoa)	fruit and nut after toasting	probable	Ferreira 1980; Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972; Martin 2005
	Anacardium othonianum	caju do árvore do cerrado	fruit and nut after toasting		Ferreira 1973a; Silvia et al. 2001
	Anacardium pumilum	caju rasteiro, caja de moita, caju mirim, cajuí	fruit and nut after toasting		Silvia et al. 2001
	Anacardium spruceanum	cajuaçu	fruit and nut after toasting		Cavalcante 1972
	Mangifera indica	manga	fruit		Cavalcante 1972, disputes Asiatic origin
	Poupartia amazonica	fruta-de-cedro	fruit		Cavalcante 1972
	Spondias dulcis	cajarana	fruit		Cavalcante 1972
	Spondias lutea	cajá; cajazinho do cerrado; taperebá	fruit		Silvia et al. 2001; Andersen and Andersen 1988; Cavalcante 1972; Posey 2002
	Spondias macrocarpa	cajá-redondo	fruit		Lorenzi et al. 2006
	Spondias mombin	taperebá, cajá, cajá-mirim, acaíba, acajá	fruit	probable	Lorenzi et al. 2006

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domes-ticate?	References
	Spondias purpurea	ciriguela	fruit		Albuquerque and Andrade 2002a
	Spondias tuberosa	umbu, imbu, ambu, giqui	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Andersen and Andersen 1988; Martin 2005
	Spondias venulosa	cajá-grande, cajá-de-pescoço, cajá-graúdo	fruit		Lorenzi et al. 2006
	Tapirira guianensis				Gottsberger and Silberbauer-Gottsberger 2006
Annonaceae	*Annona cacans*	cortição, aratiucum-cagão, araticum-de paca, coração-de-boi, quaresma	fruit		Lorenzi et al. 2006
	Annona coriacea	araticum, araticum-liso, araticum-do-campo, araticum-dos-grandes, aratícum-de-casca-lisa, aratícum-coração-de-boi	fruit		Ferreira 1973b; Silvia et al. 2001; Lorenzi et al. 2006; Martin 2005
	Annona crassiflora	araticum, marolo, bruto, araticum-cortiça, cabeça-de-negro, araticum-de-bóia, araticum-do-campo, araticum-dos-grandes, marolo	fruit		Ferreira 1973b, 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Resende and Prous 1991; Posey 2002
	Annona densicoma	araticum-do-mato	fruit		Cavalcante 1972; Gottsberger and Silberbauer-Gottsberger 2006
	Annona glabra	araticum-de-brejo, araticum-da-água, araticum-da-praia, araticum-da-lagoa, araticum-do-mangue, araticum-de-jangada, araticum-paná, araticupana, panã	fruit		Lorenzi et al. 2006
	Annona montana	araticum-açu, araticum-apé, araticum-ponhe, araticum	fruit		Lorenzi et al. 2006; Cavalcante 1972
	Annona muricata	graviola	fruit	Yes	Albuquerque and Andrade 2002a; Cavalcante 1972; Clement 1999b
	Annona pisonis	araticum apê			Martin 2005
	Annona pygmaea	araticum rasteiro, araticum de moita e araticum do campo	fruit		Silvia et al. 2001
	Annona salzmannii	araticum-da-praia, araticum-verdadeiro	fruit		Lorenzi et al. 2006

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Annona spinescens	araticum de espinho			Martin 2005
	Annona squamosa	pinha, ata	fruit		Albuquerque and Andrade 2002a; Cavalcante 1972
	Annona cf. tormentosa	araticum tomentoso			Silvia et al. 2001
	Duguetia bracteosa	pinhão			Martin 2005
	Duguetia furfuracea	araticum, marolinho-do-cerrado	fruit		Lorenzi et al. 2006
	Duguetia lanceolata	pindaíba, pindaíva, pindaúva, perovana, pindabuna, cortiça, biribá	fruit		Lorenzi et al. 2006
	Guatteria gracilipes				Gottsberger and Silberbauer-Gottsberger 2006
	Porcelia macrocarpa	banana-de-macaco, louro-branco, pindaíva-do-mato	fruit		Lorenzi et al. 2006
	Rollinia deliciosa	biribá			Posey 2002
	Rollinia emarginata	araticum-mirim, araticum-da-praia	fruit		Lorenzi et al. 2006
	Rollinia mucosa	biribá, araticum, ariticum, fruta-do-conde	fruit	Yes	Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972; Clement 1999b
	Rollinia salcifolia	cortiça, cortiça-lisa	fruit		Lorenzi et al. 2006
	Rollinia sericea	cortiça, cortiça-ouriça, araticum-pecanine, pinha-da-mata, curtição	fruit		Lorenzi et al. 2006
	Rollinia sylvatica	cortiça, araticum-do-mato, araticum-do-morro, embira, embira-de-araticum	fruit		Lorenzi et al. 2006
	Xylopia aromatica	Pimenta de macaco, pimenta do campo, pindaíba, pimenta de bugre	seeds and fruit are used as a condiment		Ferreira 1980; Silvia et al. 2001; Almeida et al. 1998
Apocynaceae	*Ambelania acida*	pepino-do-mato	fruit		Lorenzi et al. 2006
	Couma guianensis	sorva	fruit		Cavalcante 1972
	Couma macrocarpa	sorva grande	fruit		Cavalcante 1972
	Couma utilis	sorvinha, sorva, sorva-miúda, cumã	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Hancornia speciosa	mangaba, mangaba-da-restinga, mangaba-do-cerrado	fruit		Ferreira 1973b, 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972; Resende and Prous 1991; Posey 2002
	Parahancornia amapa	amapá	fruit		Cavalcante 1972
Araceae	*Monstera pertusal*	imbé			Martin 2005
	Xanthosoma brasiliense		vegetable	Yes	Clement 1999b
	Xanthosoma sagittifolium		root	Yes	Clement 1999b
Araucariaceae	*Araucaria angustifolia*	pinhão-do-paraná	seed		Andersen and Andersen 1988
Arecaceae	*Acrocomia aculeata*	macaúba, bocaiúva, coco-babão, macaúva, macaíba, macajuba, mucajá, mucajuba, macacaúba	fruit, seed, and palm heart		Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Resende and Prous 1991
	Acrocomia sclerocarpa	macaúba, macujá, coco de catorro, coco baboso, mucajuba	fruit and nut		Ferreira 1980; Cavalcante 1974
	Acrocomia tucuma	tucumã	fruit		Cavalcante 1974
	Aiphanes aculeata	cariota-de-espinho	fruit		Lorenzi et al. 2006
	Allagoptera arenaria	guriri, buriri, buri-de-praia, caxandó, pissandó, coco-de-praia	fruit		Lorenzi et al. 2006
	Allagoptera pseudocalyx	piaçaba			Posey 2002
	Arykuryroba capanemae	arikuryroba			Martin 2005
	Astrocaryum aculeatum	tucumã, tucumã-do-amazonas	fruit		Lorenzi et al. 2006
	Astrocaryum campestre				Ferreira 1980
	Astrocaryum murumuru	murmuru, murumuru	fruit		Lorenzi et al. 2006
	Astrocaryum tucuma	tucum			Posey 2002
	Astrocaryum vulgare	tucumã, tucumã-do-praia, tucum-bravo, tucum-piranga	fruit		Lorenzi et al. 2006; Posey 2002
	Attalea apoda	loli			Ferreira 1980
	Attalea dubia	indaiá, indaiá-açu, camarinha, inaiá, naiá	fruit and nut		Lorenzi et al. 2006
	Attalea exigua	catolé, Indaiá do campo, pxindoba			Ferreira 1980; Almeida et al. 1998

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Attalea funifera	piaçaba			Martin 2005
	Attalea geraensis	indaiá do campo, catole			Ferreira 1980
	Bactris sp.	yucum, tucum do brejo, uva de terra	fruit		Silvia et al. 2001
	Bactris ferruginea	mané-véio, tucum, coquinho, coco-de-fuso	fruit		Lorenzi et al. 2006
	Bactris gasipaes	pupunha	fruit and nut	Yes	Andersen and Andersen 1988; Clement 1999b
	Bactris maraja	marajá, marajá-açu, tucum-bravo	fruit		Lorenzi et al. 2006
	Bactris setosa	tucum, jacum, tucum-do-brejo, tucum-piranga, marajá-iba, tucum-bravo	fruit		Lorenzi et al. 2006
	Butia capitata	butiá, butiá-azedo, butiá-vinagre, cabeçudo	fruit		Ferreira 1980; Lorenzi et al. 2006
	Butia eriospatha	butiá, butiá-da-serra, macuma, butiá-veludo	fruit		Lorenzi et al. 2006
	Butia leiospatha	butiá			Ferreira 1980; Resende and Prous 1991
	Butia odorata	butiá, butiá-da-praia, butiá-branco, butiá-miúdo, butiá-grande, butiá-azedo	fruit		Lorenzi et al. 2006
	Butia purpurascens	butiá, butiá-jataí, butiá-roxo	fruit		Lorenzi et al. 2006
	Butia yatay	yataí, butiá, butiá-yataí	fruit		Lorenzi et al. 2006
	Coco nucifera	coco, coco-da-baía, coco-da-praia	fruit and coconut milk		Lorenzi et al. 2006
	Coco oleracea				Ferreira 1980
	Cocos coronata	uricuri			Martin 2005
	Cocos schizophylla	uricuri			Martin 2005
	Cocos ventricosa	macaúba			Martin 2005
	Cocos vagans	arirys			Martin 2005
	Copernicia cerifera	carnaúba			Martin 2005
	Diplotemium sp.	imburi			Resende and Prous 1991
	Diplotemium campestre	ariri, coco de vassoura, buri do campo			Ferreira 1980

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Euterpe edulis	jaçara, içara, ensarova, palmito-doce, palmito-da-mata, palmiteiro, riperira, açaí-do-cerrado	fruit and palmito		Silvia et al. 2001
	Euterpe oleracea	açai, açai-do-pará, uaçaí, palmito-açai	fruit		Lorenzi et al. 2006; Cavalcante 1974; Posey 2002
	Euterpe precatoria	açai, açai-do-mato, jaçura	fruit		Lorenzi et al. 2006
	Guilielma gasipaes	pupunha	fruit after cooking, palmito		Cavalcante 1974
	Jessenia bataua	patauá	fruit, oil extracted from fruit		Cavalcante 1974
	Mauritia flexuosa	muriti, buriti, buriti-do-brejo	fruit, palmito and oil extracted from the fruit		Almeida et al. 1998; Lorenzi et al. 2006; Cavalcante 1974; Mistry et al. 2005
	Mauritia martiana	caraná, caraná-í, buritirana, buritizinho	fruit		Cavalcante 1974; Posey 2002
	Mauritia vinifera	buriti			Silvia et al. 2001; Posey 2002
	Maximiliana maripa	inajá, inajaí, anajá, anajaí	fruit		Lorenzi et al. 2006; Posey 2002
	Maximiliana regia	inajá	fruit and nut		Cavalcante 1974
	Oenocarpus bacaba	bacaba, bacaba-açu, bacabão	fruit		Lorenzi et al. 2006; Cavalcante 1974; Mistry et al. 2005; Posey 2002
	Oenocarpus bataua	patauá	fruit		Lorenzi et al. 2006
	Oenocarpus distichus	bacaba, bacaba-de-leque, bacaba-norte-sul	fruit		Lorenzi et al. 2006; Cavalcante 1974
	Oenocarpus multicaulis	bacaba, bacabinha, bacaba-i	fruit		Cavalcante 1974
	Oenocarpus minor	bacabinha, bacaba-mirim, bacabí	fruit		Cavalcante 1974
	Orbignya martiana	babassú			Posey 2002; Martin 2005
	Orbygnia phalerata	babaçu, baguaçu, uauaçu, guaguaçu, coco-de-macaco	nut, mesocarp used to make flour		Silvia et al. 2001; Lorenzi et al. 2006; Mistry et al. 2005
	Pyrenoglyphis maraja	marajá	fruit		Cavalcante 1974
	Scheelea butyracea	jaci, aricuri	fruit, nut		Lorenzi et al. 2006

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Scheelea phalerata	acuri, bacuri, aricuri, uricuri	fruit, nut		Lorenzi et al. 2006
	Syagrus sp.	licuri			Resende and Prous 1991
	Syagrus campestres				Ferreira 1980
	Syagrus cearensis	catolé, coco-catolé, babão, coco-babão	fruit, nut		Lorenzi et al. 2006
	Syagrus coccoides				Gottsberger and Silberbauer-Gottsberger 2006
	Syagrus comosa				Gottsberger and Silberbauer-Gottsberger 2006
	Syagrus coronata	licuri, ouricuri, coqueiro-cabeçudo	fruit, nut		Lorenzi et al. 2006
	Syagrus flexuosa	coquinho-do-cerrado, palmeirinha-do-cerrado, coco-babão, acumã, acumão, coco-do-campo, coco-de-vaqueiro, ariri, coco-vassoura	fruit, nut		Ferreira 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Mistry et al. 2005
	Syagrus macrocarpa	maria-rosa, mari-rosa, jurua, arioba	fruit, nut		Lorenzi et al. 2006
	Syagrus oleracea	coco-guariroba, palmito-amargo, gueroba, guariroba, gueiroba, gariroba, palmito-amargoso, catolé, coco-babão	fruit, nut, palmito		Silvia et al. 2001; Lorenzi et al. 2006; Martin 2002
	Syagrus petraea				Ferreira 1980
	Syagrus romanzoffiana	jerivá, jeribá, coqueiro-jerivá, baba-de-boi, coco-babão	fruit, nut		Silvia et al. 2001
	Syagrus schizophylla	luciriroba, aricuriroba, aricuri, ariri, guriri, nicuri, nicuriroba, coco-babão, coco-caboclo	fruit		Lorenzi et al. 2006
	Syagrus vagans	ariri, licuriroba, licurioba, pindoba, licuri-roba-das-caatingas	fruit		Lorenzi et al. 2006
Bombacaceae	*Pachira aquatica*	munguba	nut		Andersen and Andersen 1988
Brassicaceae	*Crataeva tapia*	tapiá, cabaceira, cabeceira, trapiá	fruit		Lorenzi et al. 2006
Bromeliaceae	*Ananas ananasoides*	Ananás e abacaxi nativa			Silvia et al. 2001; Almeida et al. 1998
	Ananas comosus	abacaxi, ananás	fruit	Yes	Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972; Clement 1999b
	Ananas sativus	ananás	fruit		Resende and Prous 1991; Martin 2005
	Bromelia sp.	gravatá			Resende and Prous 1991

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Bromelia antiacantha	gravatá, banana-do-mato	fruit		Lorenzi et al. 2006
	Bromelia balansae	gravatá, caraguatá	fruit		Silvia et al. 2001
	Bromelia laciniosa	macambira			Martin 2005
Burseraceae	*Bursera leptophloes*	imburana			Martin 2005
	Crepidospermum goudotianum				Gottsberger and Silberbauer-Gottsberger 2006
	Protium heptaphyllum		fruits for drink, rosin for glazing pottery		Lévi-Strauss 1950
	Protium unifoliolatum				Gottsberger and Silberbauer-Gottsberger 2006
	Tetragastris altissima				Gottsberger and Silberbauer-Gottsberger 2006
Cactaceae	*Cereus gounellei*	xique-xique			Martin 2005
	Cereus jamacaru	mandacarú, jamacaru, cardeiro, cumbeba	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Martin 2005
	Epiphyllum phyllanthus	pitáia-rósea, pitainha	fruit		Lorenzi et al. 2006
	Melocactus zehntneri	coroa-de-frade	fruit		Albuquerque and Andrade 2002a
	Opuntia monacantha	urumbeba, monducuru, palmatória	fruit		Lorenzi et al. 2006
	Opuntia paraguayensis	arumbeva, arumbé, palmatória, palma	fruit		Lorenzi et al. 2006
	Pereskia aculeata	ora-pro-nóbis, barbados-gooseberry	fruit		Andersen and Andersen 1988; Martin 2005
	Pereskia bahiensis	quiabento			Martin 2005
	Pilosocereus arrabidae	facheiro-da-praia	fruit		Lorenzi et al. 2006
Cannabaceae	*Celtis iguanaea*	jameri, joá-miriam	fruit		Lorenzi et al. 2006
Cannaceae	*Canna edulis*		root	Yes	Clement 1999b
Capparaceae	*Capparis jacobinae*	icó, icó-preto	fruit		Albuquerque and Andrade 2002a; Martin 2005
	Capparis yco	icó-branco			Martin 2005
	Crataeva tapia	trapiá	fruit		Albuquerque and Andrade 2002a
Caricaceae	*Carica gladulosa*	mamãozinho do mato	fruit		Ferreira 1972, 1973b
	Carica papaya	mamão	fruit	Yes	Cavalcante 1972; Clement 1999b

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Opuntia ficus-indica	palma	fruit		Albuquerque and Andrade 2002a
	Carica papaya	mamão	fruit		Albuquerque and Andrade 2002a
	Jacaratia dodecaphylla	jaracatiá			Martin 2005
	Jacaratia heptaphylla	jaracatiá, mamão natifo de árvore, mamão veado, mamão de espinho	fruit		Silvia et al. 2001
	Jacaratia spinosa	jaracatiá, mamãozinho, chamburu, mamoeiro-bravo, mamoeiro-de-espinho, barrigudo	fruit		Lorenzi et al. 2006
	Vasconcella quercifolia	mamãozinho-do-mato	fruit		Lorenzi et al. 2006
Caryocaraceae	*Caryocar brasiliense*	pequí, piqui, piquiá-bravo, pequia-pedra	fruit, seed, and oil extracted from both		Ferreira 1973b; Silvia et al. 2001; Almeida et al. 1998; Lévi-Strauss 1950; Lorenzi et al. 2006; Andersen and Andersen 1988; Resende and Prous 1991; Gottsberger and Silberbauer-Gottsberger 2006; Mistry et al. 2005
	Caryocar brasiliense subsp. *intermedium*	pequi-anão, pequi-rasteiro, pequi-de-moita	fruit, seed, and oil extracted from both		Silvia et al. 2001
	Caryocar coriaceum	pequi, pequiá	fruit, seed, and oil extracted from both		Lorenzi et al. 2006; Martin 2005
	Caryocar microcarpum	piquiarana, piquiarana-de-várzea, piquiarana-do-igapó, piquiá-bravo, piquiá-amarelo	fruit		Lorenzi et al. 2006
	Caryocar villosum	piquiá, pequiá, piquiá-verdadeiro, sauri, petiá	fruit after cooking		Lorenzi et al. 2006; Cavalcante 1972; Posey 2002; Martin 2005
Celastraceae	*Cheiloclinium cognatum*	uarutama, sapatá, siputá	fruit		Lorenzi et al. 2006
	Peritassa campestris	bacupari, bacupari-do-cerrado	fruit		Lorenzi et al. 2006
	Salacia elliptica	siputá, saputá, bacupari	fruit		Lorenzi et al. 2006
	Tontelea micrantha	bacupari, bacupari-do-cerrado	fruit		Lorenzi et al. 2006
Chrysobalanaceae	*Chrysobalanus icaco*	ajuru, ajiru, cajuru, guajuru, uajuru	fruit		Lorenzi et al. 2006; Cavalcante 1972

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Couepia bracteosa	pajurá, pajurá-de-racha, pajurá-verdadeiro	fruit		Lorenzi et al. 2006; Cavalcante 1972
	Couepia longipendula	castanha-de-galinha,castanha-pêndula	nut		Lorenzi et al. 2006; Cavalcante 1972
	Couepia martiana	oiti-de-porco			Martin 2005
	Couepia rufa	oiti-coróia			Martin 2005
	Couepia subcordata	marirana, umarirana	fruit		Lorenzi et al. 2006; Cavalcante 1972
	Licania dealbata	manja-graúdo			Martin 2005
	Licania salzmannii	oiti-da-baía, oiti, guaiti, oiti-coró	fruit		Lorenzi et al. 2006
	Licania tomentosa	oiti	fruit		Cavalcante 1972; Martin 2005
	Parinari montana	pajurá-da-mata	fruit		Cavalcante 1972; Posey 2002
	Parinari obtusifolia	fruta-de-ema	fruit		Lorenzi et al. 2006
Clusiaceae	*Garcinia acuminata*	bacuri, bacuri-azedo, bacuri-de-espinhos, bacuri-coroa, bacuri-de-anta, bacuri-pari-selvagem, limãozinho	fruit		Lorenzi et al. 2006
	Garcinia brasiliensis	bacupari, bacupari-miúdo, bacuparizinho	fruit		Lorenzi et al. 2006
	Garcinia gardneriana	bacupari, bacoparé	fruit		Lorenzi et al. 2006
	Garcinia macrophylla	bacuripari, bacuripari-verdadeiro, bacuri, bacuri-da-várzea	fruit		Lorenzi et al. 2006
	Garcinia madruno	bacuri, bacuri-verdadeiro	fruit		Lorenzi et al. 2006
	Mammea americana	abricó	fruit		Cavalcante 1972, Caribbean origin
	Platonia insignis	bacuri, bakuri, bacuri-açu, landirana	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972; Posey 2002; Martin 2005
	Rheedia macrophylla	bacuripari	fruit		Cavalcante 1972
	Rheedia benthamiana	bacuripari selvagem	fruit		Cavalcante 1972
	Vismia cayennensis				Gottsberger and Silberbauer-Gottsberger 2006
Convolvulaceae	*Ipomoea batatas*		root	Yes	Clement 1999b
Cucurbitaceae	*Cucurbita maxima*	abobora	vegetable	Yes	Clement 1999b
	Cucurbita moshata	abobora	vegetable	Yes	Clement 1999b

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Cyclanthera pedata		vegetable	Yes	Clement 1999b
	Melancium campestre	melancia-do-cerrado, melancia-do-campo, cabacinha	fruit		Silvia et al. 2001; Lorenzi et al. 2006
	Sicana odorifera	cruá, melão-caboclo, melão-caipira	vegetable	Yes	Lorenzi et al. 2006
Dioscoreaceae	*Dioscorea trifida*		root	Yes	Clement 1999b
Ebenaceae	*Diospyros artanthaefolia*				Gottsberger and Silberbauer-Gottsberger 2006
	Diospyros brasiliensis	caqui-do-mato, olho-de-boi, fruta-de-boi	fruit		Lorenzi et al. 2006
	Diospyros hispida	fruta-de-boi, caqui-do-cerrado, bacupari-bravo, fruta-de-jacu-fêmea, olho-de-boi	fruit		Lorenzi et al. 2006
	Diospyros inconstans	marmelinho, marmelinho-do-mato, maria-preta, cinzeiro, fruta-de-jacu-macho	fruit		Lorenzi et al. 2006
	Diospyros praetermissa				Gottsberger and Silberbauer-Gottsberger 2006
	Gaylussacia angustifolia	camarinha-da-serra	fruit		Lorenzi et al. 2006
	Gaylussacia brasiliensis	camarinha	fruit		Lorenzi et al. 2006
Euphorbiaceae	*Manihot esculenta*	mandioca	root	Yes	Clement 1999b
Fabaceae	*Arachis hypogaea*	amendoim, mudubim, mendubi	seed	Yes	Cavalcante 1972; Clement 1999b
	Arachis pusilla	amendoim bravo			Martin 2005
	Bauhinia cheilantha	mororó	seed		Albuquerque and Andrade 2002a
	Canavalia ensiformis		seed	Yes	Clement 1999b
	Canavalia plagiosperma		seed	Yes	Clement 1999b
	Cassia leiandra	marimari, mari-mari, seruaia, ingá-mari, marimari-da-várzea, fava-marimari	fruit		Lorenzi et al. 2006; Cavalcante 1972
	Dioclea grandiflora	mucunã	seeds		Albuquerque and Andrade 2002a; Martin 2005
	Dipteryx alata	baru, cumbaru, cumaru, barujo	fruit, nut (raw and toasted)		Ferreira 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006
	Hymenaea courbaril	jatobá, jataí, jataí-amarelo, jataí-peba, jitaí, jataíba, jutaí, jutaí-grande, jutaí-açu	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Cavalcante 1972; Gottsberger and Silberbauer-Gottsberger 2006; Posey 2002

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Hymenaea stignocarpa	jatobá, jatobá-do-cerrado, jatobá-do-campo, jataí-do-campo, jataí, jutaí, jitaí, jutaicica	fruit		Ferreira 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Mistry et al. 2005
	Hymenaea stilbocarpa	jatobá da mata, jataí, jutaí	fruit		Silvia et al. 2001; Andersen and Andersen 1988; Resende and Prous 1991
	Inga alba	ingá, ingá chichica	fruit		Almeida et al. 1998; Cavalcante 1972
	Inga cinnamomea	ingá-açu, ingá-chinela, ingá-grossa	fruit		Lorenzi et al. 2006; Cavalcante 1972
	Inga edulis	ingá-cipó, ingá, rabo-de-mico, ingá-macarrão	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1972
	Inga fagigolia	ingá-curumim	fruit		Cavalcante 1972
	Inga falcistipula	ingá-chichica	fruit		Cavalcante 1972
	Inga heterophylla	ingá-chichica	fruit		Cavalcante 1972
	Inga laurina	Ingá-do-cerrado, angá, ingá-cururu, ingá-branco, ingá-da-praia, ingá-curumim, ingá-de-macaco, ingá-mirim	fruit		Silvia et al. 2001; Lorenzi et al. 2006
	Inga marginata	ingá-feijão, ingá, ingá-dedo, ingá, mirim	fruit		Lorenzi et al. 2006
	Inga sessilis	ingá-macaco, ingá-ferradura, ingá-preto, ingá-carneiro	fruit		Lorenzi et al. 2006
	Inga thibaudiana	ingá-chichica	fruit		Cavalcante 1972
	Inga velutina	ingá-de-fogo	fruit		Cavalcante 1972
	Inga vera subsp. *affinis*	ingá-do-brejo, ingá-banana, ingá-de-quatro-quinas, ingá, angá	fruit		Lorenzi et al. 2006
	Inga vulpina	ingá-cabeludo, ingá, ingá-miudo	fruit		Lorenzi et al. 2006
	Pachyrhizus tuberosus		root	Yes	Clement 1999b
	Phaseolus lunatus	feijão	seed	Yes	Clement 1999b
	Phaseolus vulgaris	feijão	seed	Yes	Clement 1999b
	Prosopis julifora	algaroba	fruit, seeds		Albuquerque and Andrade 2002a
	Swartzia langsdorfii	banha de galinha, banana de papagaio, cacová de macaco			Silvia et al. 2001

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
Hippocrateaceae	*Peritassa campestris*	bacupari do campo, capicuru, saputa, uvacupari	Fruto		Ferreira 1980; Almeida et al. 1998
	Salecia	bacupari			Ferreira 1972
	Salecia campestris	bacupari			Silvia et al. 2001
	Salecia crassifolia	bacupari	fruit		Almeida et al. 1998
	Salecia elliptica	saputá o bacupari de mata	fruit		Silvia et al. 2001
Humiriaceae	*Duckesia verrucosa*	uxi-coroa	fruit, raw or cooked		Cavalcante 1972
	Endopleura uchi	uxi, uxi-amarelo, uxi-liso, uxi-pueu	fruit		Lorenzi et al. 2006; Cavalcante 1972; Posey 2002
	Humiriastrum cuspidatum				Gottsberger and Silberbauer-Gottsberger 2006
	Sacoglottis ceratocarpa				Gottsberger and Silberbauer-Gottsberger 2006
Icacinaceae	*Emmotum fagifolium*				Gottsberger and Silberbauer-Gottsberger 2006
	Emmotum nitens				Gottsberger and Silberbauer-Gottsberger 2006
	Poraqueiba paraensis	mari	fruit	Yes	Cavalcante 1972; Clement 1999b
	Poraqueiba sericea	umari, mari, mari-preto, umari-roxo	fruit	Yes	Lorenzi et al. 2006; Clement 1999b
Lacistemaceae	*Lacistema aggregatum*				Gottsberger and Silberbauer-Gottsberger 2006
Lamiaceae	*Vitex cymosa*	tarumã, tarumã-de-várzea, tarumã-do-alagado, tarumã-guaçu	fruit		Lorenzi et al. 2006
	Vitex montevidensis	tarumã, tarumã-preta, tarumã-azeitona, azeitona-do-mato, azeitona-brava, tapinhoã	fruit		Lorenzi et al. 2006
	Vitex polygama	tarumã-do-cerrado, maria-preta, velame-do-campo, tarumã, tarumã-tuíra, mameira	fruit		Lorenzi et al. 2006
Lauraceae	*Chlorocardium rodiei*	green-heart, bebeeru	seeds – complicated preparation		Lévi-Strauss 1950
	Persea americana	abacate	fruit	Yes	Cavalcante 1972; Clement 1999b; Posey 2002

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
Lecythidaceae	*Bertholletia excelsa*	castanha-do-pará, castanha-do-brasil, castanha, castanha-verdadeira, castanha-mansa	nuts		Lorenzi et al. 2006; Cavalcante 1972; Posey 2002
	Lecythis amapaensis	sapucaia-do-amapá	nut		Cavalcante 1972
	Lecythis eliptica	sapucaia	nut		Andersen and Andersen 1988
	Lecythis lanceolata	sapucaia-mirim, sapucaia-miúda, sapucaia, sapucaia-branca, sapucaiú	nuts		Lorenzi et al. 2006
	Lecythis pisonis	sapucaia, castanha-sapucaia, sapucaia-vermelha, cumbuca-de-macaco, caçamba-do-mato	nut		Lorenzi et al. 2006; Andersen and Andersen 1988
	Lecythis usitata	sapucaia	nut		Cavalcante 1972; Posey 2002
	Lechylecythis egleri	sapucaia grande	nut		Cavalcante 1972
Malpighiaceae	*Bunchosia armeniaca*	ciruela	fruit		Cavalcante 1974
	Byrsonima basiloba	murici da folha branca, murici do campo			Ferreira 1975, 1980
	Byrsonima coriaceae				Gottsberger and Silberbauer-Gottsberger 2006
	Byrsonima crassa	murici da casca grossa, murici do campo			Ferreira 1975, 1980
	Byrsonima crassifolia	murici, murici-do-campo, murici-da-praia	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1974; Gottsberger and Silberbauer-Gottsberger 2006; Posey 2002
	Byrsonima crispa	muruci-da-mata	fruit		Cavalcante 1974
	Byrsonima lancifolia	muruci-de-capoeira	fruit		Cavalcante 1974
	Byrsonima sericea	murici	fruit		Arévalo-Pinedo et al. 2006
	Byrsonima verbascifolia	murici, orelha-de-veado, orelha-de-burro, murici-rasteiro, murici-do-campo, murici-guaçu	fruit		Ferreira 1975, 1980; Silvia et al. 2001; Almeida et al. 1998; Cavalcante 1974
	Dicella nucifera	castanha-de-cipó	nuts (raw or toasted)		Lorenzi et al. 2006
	Malpighia glabra	acerola	fruit		Albuquerque and Andrade 2002a
	Malpighia punicifolia	cereja-do-pará	fruit		Cavalcante 1974

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
Malvaceae	*Bombacopsis glabra*	castanha-do-maranhão, castanha-da-praia, cacau-do-maranhão, amendoim-de-árvore	nuts (generally toasted)		Lorenzi et al. 2006
	Guazuma ulmifolia	Mutamba, camacã, embira, periqueiteira, pojó, fruta de macado, guamaca	fruit		Almeida et al. 1998
	Pachira aquatica	monguba, mamorana, castanha-das-guianas, cacau-selvagem, carolina, castanha-da-água	nuts (generally toasted)		Lorenzi et al. 2006
	Quararibea cordata	sapota-do-solimões, sapota, sapota-do-peru	nuts (raw)		Lorenzi et al. 2006
	Sterculia apetala	madovi, manduvi, xixá, chichá, amendoim-de-bugre	nuts (generally toasted and not very good)		Lorenzi et al. 2006
	Sterculia chicha	chichá	nut (cooked or toasted)		Andersen and Andersen 1988; Resende and Prous 1991
	Sterculia striata	chichá-do-cerrado, xixá-do-cerrado, aracha-chá, chechá-do-norte, castanha-de-macaco	nuts (raw and toasted)		Lorenzi et al. 2006; Silvia et al. 2001; Almeida et al. 1998
	Theobroma bicolor	cacau-do-peru, pataste, macambo	fruit		Lorenzi et al. 2006
	Theobroma cacao	cacau, cacao, cacau-verdadeiro	fruit, seeds (dried and ground)		Andersen and Andersen 1988; Cavalcante 1974; Lorenzi et al. 2006; Posey 2002
	Theobroma grandiflorum	cupuaçu, cupuaçu-verdadeiro	fruit		Andersen and Andersen 1988; Cavalcante 1974; Lorenzi et al. 2006; Posey 2002
	Theobroma mariae	cacau-jacaré	fruit		Cavalcante 1974
	Theobroma speciosum	cacauí	fruit		Cavalcante 1974; Lorenzi et al. 2006
	Theobroma subincanum	cupuí, cupuaí, cupurana	fruit		Cavalcante 1974; Lorenzi et al. 2006
	Urena sinuata	carapicu			Martin 2005
Marantaceae	*Calathea allouia*		root	Yes	Clement 1999b
	Maranta arundinacea		root	Yes	Clement 1999b; Martin 2005

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
Melastomataceae	*Bellucia grossularioides*	araça-de-anta, goiaba-de-anta, papa-terra	fruit		Lorenzi et al. 2006
	Bellucia imperialis	goiaba-de-anta, goiaba-de-anta-vermelha, araçá-de-anta-vermelha, papa-terra-vermelha	fruit		Lorenzi et al. 2006
	Mouriri elliptica	croadinha, croada, coroa de frade	fruit		Silvia et al. 2001
	Mouriri pusa	puçá, mandapuçá, jaboticaba-do-campo, manapuçá, puçá-preta, munduru	fruit		Silvia et al. 2001; Lorenzi et al. 2006; Resende and Prous 1991; Mistry et al. 2005; Martin 2005
	Mouriri sp.				Gottsberger and Silberbauer-Gottsberger 2006
Menispermaceae	*Chondrodendron platyphyllum*	jabuticaba-de-cipó, abutua-grande, parreira-brava, uva-do-mato, batata-brava, bútua	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988
Monimiaceae	Siparuna guianensis				Gottsberger and Silberbauer-Gottsberger 2006
Moraceae	*Artocarpus integrifolia*	jacá			Posey 2002
	Bagassa guianensis	tatajuba, amaparana, bagaceira, bagasse	fruit		Cavalcante 1974
	Brosimum gaudichaudii	mama-cadela, mamica-de-cadela, algodãozinho, irerê, maminha-cadela, inharé	fruit		Ferreira 1973a; Silvia et al. 2001; Almeida et al. 1998; Pereira et al. 2006; Lorenzi et al. 2006; Resende and Prous 1991
	Maclura tinctoria	taiúva, tajuva, tatajuva, tatajuba, taúba, amora-branca, amoreira, tatané, jataíba, pau-de-fogo	fruit		Lorenzi et al. 2006
	Pourouma cecropiifolia	mapati	fruit		Cavalcante 1974; Posey 2002
	Sorocea guilleminiana				Gottsberger and Silberbauer-Gottsberger 2006
Myrtaceae	*Acca sellowiana*	goiaba-serrana, araçá-do-rio-grande, goiaba-do-campo, goiaba-silvestre, goiaba-crioula	fruit		Lorenzi et al. 2006
	Campomanesia sp.	gabiroba	fruit		Resende and Prous 1991
	Campomanesia adamantinum	guabiroba-do-campo, guabiroba-do-cerrado, guabiroba-lisa, guabiroba-branca, gabiroba	fruit		Ferreira 1980; Lorenzi et al. 2006
	Campomanesia aurea	guabirobinha-do-campo, araçá-rasteiro			Lorenzi et al. 2006

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Campomanesia cambessedeana	gabiroba, gabiroba do campo, guavira	fruit		Ferreira 1972, 1980; Silvia et al. 2001
	Campomanesia coerulea	gabiroba			Ferreira 1980
	Campomanesia corimbosa	gabiroba			Ferreira 1980
	Campomanesia discolor	gabiroba			Ferreira 1980
	Campomanesia fenzliana	guabiroba	fruit		Andersen and Andersen 1988
	Campomanesia gardneriana	gabiroba			Ferreira 1972
	Campomanesia guaviroba	guabiroba-do-litoral, guabirova, gaviroba	fruit		Lorenzi et al. 2006
	Campomanesia guazumifolia	sete-capotes, sete-capas, araçá-do-mato	fruit		Lorenzi et al. 2006
	Campomanesia lineatifolia	guabiroba	fruit		Lorenzi et al. 2006
	Campomanesia multiflora	Gabiroba			Ferreira 1980
	Campomanesia neriiflora	guabiroba-branco	fruit		Lorenzi et al. 2006
	Campomanesia phaea	cambuci	fruit		Lorenzi et al. 2006
	Campomanesia pubescens	gabiroba, guabiroba-felpuda, guabiroba-do-campo	fruit		Ferreira 1980; Almeida et al. 1998; Lorenzi et al. 2006
	Campomanesia salviaefolia	Gabiroba			Ferreira 1972, 1980
	Campomanesia schlechtendaliana	guabiroba-rugosa	fruit		Lorenzi et al. 2006
	Campomanesia sessiliflora	guabiroba-verde	fruit		Lorenzi et al. 2006
	Campomanesia suaveolens	gabiroba			Ferreira 1980
	Campomanesia xanthocarpa	gabiroba, guabiroba, guabirova, guariba	fruit		Ferreira 1980; Lorenzi et al. 2006
	Campomanesia xantocarpa var. littoralis	guabiroba-rasteira, guabiroba-da-restinga	fruit		Lorenzi et al. 2006

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	Eugenia brasiliensis	grumixama, grumixaba, cumbixaba, ibaporoiti	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1974
	Eugenia calycina	pitanga-vermelha, cereja-do-cerrado	fruit		Ferreira 1972, 1980; Silvia et al. 2001; Lorenzi et al. 2006
	Eugenia candollerana	ameixa-da-mata, murta, murtinha	fruit		Lorenzi et al. 2006
	Eugenia copacabanensis	cambuí-amarelo-grande, cambuí-de-copacabana	fruit		Lorenzi et al. 2006
	Eugenia dysenterica	cagaita	fruit (large quantities provoke diarrhea)		Ferreira 1972, 1980; Silvia et al. 2001,2001B; Almeida et al. 1998; Lorenzi et al. 2006; Andersen and Andersen 1988; Resende and Prous 1991
	Eugenia eurycheila				Gottsberger and Silberbauer-Gottsberger 2006
	Eugenia florida	guamirim, pitanga	fruit		Lorenzi et al. 2006
	Eugenia involucrata	cereja-do-rio-grande, cereja, cereja-do-mato	fruit		Lorenzi et al. 2006
	Eugenia inaguahiensis	gumixama-mirim, grumixama-anã	fruit		Lorenzi et al. 2006
	Eugenia jambos	jambo			Posey 2002
	Eugenia klotzschiana	pêra-do-cerrado, cabacinha-do-campo	fruit		Ferreira 1980; Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Andersen and Andersen 1988
	Eugenia kunthiana	pitanga			Ferreira 1980
	Eugenia langsdorfii	pitanga			Ferreira 1980
	Eugenia leitonii	araça-piranga, goiabão, araçandiva, araçanduba, araçatunga, goiabarana	fruit		Lorenzi et al. 2006
	Eugenia luschnathiana	pitomba-da-baía, curuiri	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988; Martin 2005
	Eugenia lutescens	perinha	fruit		Silvia et al. 2001; Lorenzi et al. 2006
	Eugenia multicostata	araça-piranga, sapiranga, pau-alazão, pau-mulato, pau-brasil, araçá-vermelho	fruit		Lorenzi et al. 2006
	Eugenia myrcianthes	pêssego-do-mato, ivaí, ibajaí, ubajaí	fruit		Lorenzi et al. 2006
	Eugenia neonitida	pitangatuba, pitangola, pitangão	fruit		Lorenzi et al. 2006

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Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Eugenia patrisii	ubaia	fruit		Lorenzi et al. 2006; Gottsberger and Silberbauer-Gottsberger 2006
	Eugenia pitanga	pitanga-do-cerrado	fruit		Lorenzi et al. 2006
	Eugenia pyriformis	uvaia, uvalha, uvalha-do-campo	fruit		Lorenzi et al. 2006
	Eugenia sellowiana	Pitanga			Ferreira 1980
	Eugenia stipitata	araçá-boi	fruit		Lorenzi et al. 2006; Cavalcante 1974
	Eugenia speciosa	laranjinha-do-mato, araçá	fruit		Lorenzi et al. 2006
	Eugenia sprengelli	pitanga			Ferreira 1980
	Eugenia subcordata	pitanga			Ferreira 1980
	Eugenia tomentosa	cabeludinha	fruit		Andersen and Andersen 1988
	Eugenia triphylla	pitanga			Ferreira 1980
	Eugenia uniflora	pitanga, ginja	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Andersen and Andersen 1988; Cavalcante 1974
	Eugenia uvalha	uvaia, uvalha, uvaia-do-mato	fruit		Andersen and Andersen 1988
	Feijoa sellowiana	feijoa	fruit		Andersen and Andersen 1988
	Marlierea edulis	cambucá	fruit		Andersen and Andersen 1988
	Myrcianthes edulis	cereja-do-rio-grande	fruit		Andersen and Andersen 1988
	Myrcianthes pungens	guabiju, guabiroba-açu, guabiju-açu, guabiju-gauçu, guabira-guaçu, guavira-graçu	fruit		Lorenzi et al. 2006
	Myrciaria aureana	jabuticaba-branca	fruit		Lorenzi et al. 2006
	Myrciaria cauliflora	jaboticaba, jabuticaba-paulista, jabuticaba-ponhema, jabuticaba-açu	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Andersen and Andersen 1988
	Myrciaria coronata	jabuticaba-coroada, jabuticaba-de-coroa	fruit		Lorenzi et al. 2006
	Myrciaria dubia	caçari, camu-camu, araçá-de-água	fruit		Lorenzi et al. 2006
	Myrciaria floribunda	camboim	fruit		Lorenzi et al. 2006
	Myrciaria glazioviana	cabeludinha, cabeluda, peludinha	fruit		Lorenzi et al. 2006

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	Myrciaria grandifolia	jabuticabatuba, jabuticaba-graúda	fruit		Lorenzi et al. 2006
	Myrciaria jaboticaba	jabuticaba-murta, jabuticaba-sabará	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988
	Myrciaria oblongata	jabuticaba-azeda, jabuticaba-ácida	fruit		Lorenzi et al. 2006
	Myrciaria phitrantha	jabuticaba-costada, jabuticaba-branca-vinho	fruit		Lorenzi et al. 2006
	Myrciaria tenella	camboim, cambuí, cambuim, camboí	fruit		Lorenzi et al. 2006
	Myrciaria trunciflora	jabuticaba-de-cabinho, jabuticaba-de-penca, jabuticaba-café, jabuticaba-preta	fruit		Lorenzi et al. 2006
	Paivea langsdorffii	cambuci	fruit		Andersen and Andersen 1988
	Plinia edulis	cambucá, cambucá-verdadeiro	fruit		Lorenzi et al. 2006
	Plinia rivularis	guaburiti, guavoreti, guapuriti, jaboticabarana, cambucá-peixoto	fruit		Lorenzi et al. 2006
	Psidium acutangulum	araçá-pêra, araçandiva, goiaba-do-pará, araçanduba, araçá-piranga	fruit		Lorenzi et al. 2006; Cavalcante 1974
	Psidium araça	araçá	fruit		Andersen and Andersen 1988
	Psidium bergiana	goiaba, araçá			Ferreira 1980
	Psidium cattleianum	araçá, araçá-commun araçá-de-coroa	fruit		Lorenzi et al. 2006; Andersen and Andersen 1988
	Psidium cinereum	goiaba, araçá, araçá-cinzento, araçá-do-campo	fruit		Ferreira 1980; Lorenzi et al. 2006; Resende and Prous 1991
	Psidium grandiflorum	araçá de folha grande			Ferreira 1980
	Psidium grandifolium	goiabinha-do-mato	fruit		Resende and Prous 1991
	Psidium guajava	goiaba, goiava, guaiaba, buaiava, araçá-goiaba	fruit		Albuquerque and Andrade 2002a; Andersen and Andersen 1988; Lorenzi et al. 2006; Cavalcante 1974; Posey 2002
	Psidium guineense	araçá-do-campo, goiaba-do-morro.	fruit		Lorenzi et al. 2006; Cavalcante 1974
	Psidium incanescens	goiaba, araçá			Ferreira 1980
	Psidium firmum	araçá, araçá-do-cerrado	fruit		Ferreira 1972, 1980, Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Psidium pubescens	araça-de-pernambuco			Martin 2005
	Psidium rufum	araçá-cagão, araçá-roxo, araçá-perinha	fruit		Ferreira 1980; Lorenzi et al. 2006
	Psidium salutare	araçá-rasteiro	fruit		Lorenzi et al. 2006
Nyctaginaceae	*Neea sp.*				Gottsberger and Silberbauer-Gottsberger 2006
Ochnaceae	*Ouratea nitida*				Gottsberger and Silberbauer-Gottsberger 2006
Olacaceae	*Ximenia americana*	limão-bravo, limãozinho-da-praia, ameixa-da-caatinga	fruit		Lorenzi et al. 2006; Martin 2005
	Ximenia coriacea	ameixeira do Brasil			Martin 2005
Onagraceae	*Fuchsia regia*	brinco-de-princesa	fruit		Lorenzi et al. 2006
Oxalidaceae	*Oxalis repens*	azeda rasteira			Martin 2005
Passifloraceae	*Passiflora sp.*	maracujá	fruit	some	Silvia et al. 2001; Albuquerque and Andrade 2002a; Andersen and Andersen 1988; Lorenzi et al. 2006; Cavalcante 1974; Resende and Prous 1991; Martin 2005
Poaceae	*Zea mays*	milho	grain	Yes	Clement 1999b
Polygonaceae	*Coccoloba uvifera*	baga da praia			Martin 2005
Quinaceae	*Lacunaria jenmani*	moela-de-mutum	fruit		Cavalcante 1974
	Lacunaria grandiflora	moela-de-mutum	fruit		Cavalcante 1974
Rhamnaceae	*Rhamnidium elaeocarpum*	saguaraji, saguaraji-amarelo, tarumaí, cafezinho, azeitona, cabrito, cabriteiro	fruit		Lorenzi et al. 2006
	Ziziphus joazeiro	juá, joá, juá-espinho, juá-fruta	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006; Martin 2005
	Ziziphus mistol	olho-de-boi, mistol	fruit		Lorenzi et al. 2006
Rosaceae	*Rubus brasiliensis*	amora-preta			Silvia et al. 2001
	Rubus erythrocladus	amora-verde, amora-branca, amora-do-mato	fruit		Lorenzi et al. 2006
	Rubus rosifolius	amora-vermelha, moranguinho-silvestre	fruit		Lorenzi et al. 2006
	Rubus sellowii	amora-preta, amora-do-mato	fruit		Lorenzi et al. 2006

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
Rubiaceae	*Alibertia edulis*	puruí, apuruí, marmelada, marmelada-de-cavalo, marmelada-de-bezerro, marmelada-nativa, amanina	fruit		Silvia et al. 2001; Almeida et al. 1998; Lorenzi et al. 2006; Cavalcante 1974; Gottsberger and Silberbauer-Gottsberger 2006; Posey 2002
	Alibertia elliptica	marmelada de pinto, marmelada nativa	fruit		Silvia et al. 2001
	Alibertia myrciifolia				Gottsberger and Silberbauer-Gottsberger 2006
	Alibertia sessilis	marmelada de cachorro, marmelada nativa	fruit		Silvia et al. 2001
	Cordiera elliptica	marmelada-de-pinto	fruit		Lorenzi et al. 2006
	Cordiera humilis	marmelada-rasteira	fruit		Lorenzi et al. 2006
	Cordiera sessilis	marmelada-de-cachorro	fruit		Lorenzi et al. 2006
	Duroia saccifera	cabeca-de-urubu	fruit		Cavalcante 1974
	Genipa americana	jenipapo, jenipá, jenipaba, janipapo	fruit		Silvia et al. 2001; Andersen and Andersen 1988; Lorenzi et al. 2006; Cavalcante 1974; Resende and Prous 1991; Posey 2002
	Genipa infudibuliformes	jenipapo-liso, jenipapo-do-seco, jenipapo-do-morro	fruit		Lorenzi et al. 2006
	Posoqueria latifolia	baga-de-macaco, fruta-de-macaco, papa-terra	arilo dos frutos		Lorenzi et al. 2006
	Thieleodoxa sorbilis	puruí grande	fruit		Cavalcante 1974
Salicaceae	*Casearia decandra*	cambroé, pitumba, guaçatunga, café-do-mato	fruit		Lorenzi et al. 2006
	Casearia rupestris	pururuca, guaçatunga-grande	fruit		Lorenzi et al. 2006
Santalaceae	*Acanthosyris aluinii*	mata-cacau			Martin 2005
	Acanthosyris spinescens	sombra-de-touros	fruit		Lorenzi et al. 2006
Sapindaceae	*Paullinia cupana*	guaraná	seeds as pow der after drying or roasting		Lorenzi et al. 2006
	Melicocca bijuga	pitomba	fruit		Cavalcante 1974

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Talisia esculenta	pitomba-do-mato, pitomba-de-macaco, pitomba-do-norte, olho-de-boi, pitomba	fruit		Silvia et al. 2001; Albuquerque and Andrade 2002a; Andersen and Andersen 1988; Lorenzi et al. 2006
Sapotaceae	*Achras sapota*	sapotí	fruit		Cavalcante 1974
	Bumelia sartorum	quixaba			Martin 2005
	Chrysophyllum soboliferum	fruto de tatu	fruit		Silvia et al. 2001
	Maikara huberi	maçaranduba, maçaranduba-da-terra-firme, maçaranduba-balata, maçaranduba-mansa	fruit		Lorenzi et al. 2006; Cavalcante 1974; Posey 2002
	Manikara salzmannii	maçaranduba, maçaranduba-preta	fruit		Lorenzi et al. 2006
	Manikara subsericea	maçaranduba	fruit		Lorenzi et al. 2006
	Pouteria bullata	bapeba, bapeva, guapeba, guapeva	fruit		Lorenzi et al. 2006
	Pouteria caimito	abiu, caimito, abiurana, abiurana-acariquara	fruit		Andersen and Andersen 1988; Lorenzi et al. 2006; Cavalcante 1974; Clement 1999b
	Pouteria guardneriana	guapeva, pêssego-do-campo, cabo-de-machado, mata-olho, aguaí-guaçu	fruit		Silvia et al. 2001; Lorenzi et al. 2006
	Pouteria gardnerii	maçaranduba-vermelha, sapotinha, tadumo	fruit		Lorenzi et al. 2006
	Pouteria grandiflora	bapeba, bapeba-da-restinga, bapeba-preta	fruit		Lorenzi et al. 2006
	Pouteria macrocarpa	cutite-grande	fruit		Cavalcante 1974
	Pouteria macrophylla	cutite, cutitiribá, abiu-cutite, abiurana, abiurana-cutitiribá, acara-uba, juturuba	fruit		Lorenzi et al. 2006; Cavalcante 1974; Posey 2002
	Pouteria pachycalyx	bapéba, guapeba	fruit		Lorenzi et al. 2006
	Pouteria pariry	pariri	fruit		Cavalcante 1974
	Pouteria ramiflora	curriola, abiu-do-cerrado, guapeva, guajara, pitomba-de-leite, leiteiro-preto	fruit		Lorenzi et al. 2006
	Pouteria speciosa	pajurá-de-óbidios	fruit		Cavalcante 1974
	Pouteria torta	bacupari-de-árvore, bacupari, abiu-do-cerrado, abiu-piloso, guapeva, guapeba, curriola, abiurana, pessego-do-cerrado	fruit		Ferreira 1975, 1980; Lorenzi et al. 2006; Resende and Prous 1991

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Table A.1 - continued from previous page.

Family	Genus and species	Some of the common Portuguese names	Edible parts	Domesticate?	References
	Pouteria ramiflora	bacupari-do-liso, curriola, grão-de-galo, massaranduba	fruit		Ferreira 1975, 1980; Silvia et al. 2001; Almeida et al. 1998
	Pouteria venosa	aboirana, bapeba, bapeba-pêssego, guacá-de-leite, quebra-serra	fruit		Lorenzi et al. 2006
	Pradosia brevipes	curriola-rasteira, fruta-de-tatu	fruit		Lorenzi et al. 2006
	Pradosia lactescens	marmixa, buranhém, bacupari, bacuri	fruit		Lorenzi et al. 2006
	Sideroxylon obtusifolium	quixaba, sapotiaba, sacutiaba, coronilha, coca, maçaranduba-da-praia, miri, rompe-gibão	fruit		Albuquerque and Andrade 2002a; Lorenzi et al. 2006
Solanaceae	*Lycopersicum sp.*	tomatinho			Resende and Prous 1991
	Physalis angulata	camapu	fruit		Cavalcante 1974
	Physalis pubescens	camapu, balãozinho, joá-de-capote, bucho-de-rã	fruit		Lorenzi et al. 2006
	Solanum agrarium	babá			Martin 2005
	Solanum lycocarpum	lobeira, fruto de lobo	fruit		Silvia et al. 2001
	Solanum paniculatum	jurubeba			Resende and Prous 1991; Posey 2002
	Solanum sessiliflorum	cubiu, maná, tomate-de-índio	fruit	Yes	Lorenzi et al. 2006; Clement 1999b
Urticaceae	*Pourouma cecropiifolia*	mapati, cucura, cucuva, imbaúba-do-vinho, purumã, sucuúba, imbaúba-mansa, uva	fruit		Lorenzi et al. 2006
Verbenaceae	*Vitex montevidensis*	tarumã, azeitona do mato	fruit		Lorenzi 1992
Vitaceae	*Cissus gongyloides*		vegetable	Yes	Clement 1999b
	Vitis sp.	uva nativa, uva da serra, uva do campo	fruit		Silvia et al. 2001
Vochysiaceae	*Qualea parviflora*				Gottsberger and Silberbauer-Gottsberger 2006

Appendix B. Photographs of selected plant types

A selection of plant types are presented below as photographs. The types included are those that have been identified (Table 7.1) as well as those discussed in the notes on plant identification with directions for identification (Appendix C). Two photographic scales were used. Some photographs are on a background grid, the cells of which are one by one centimeter. Other photographs were taken with a microscope and the small line is one millimeter long. All photographs are identified by type, plant identification where present, and the sample's unique identifier and site. Context can be determined in Appendix E where the data is organized by the unique identifier of the samples.

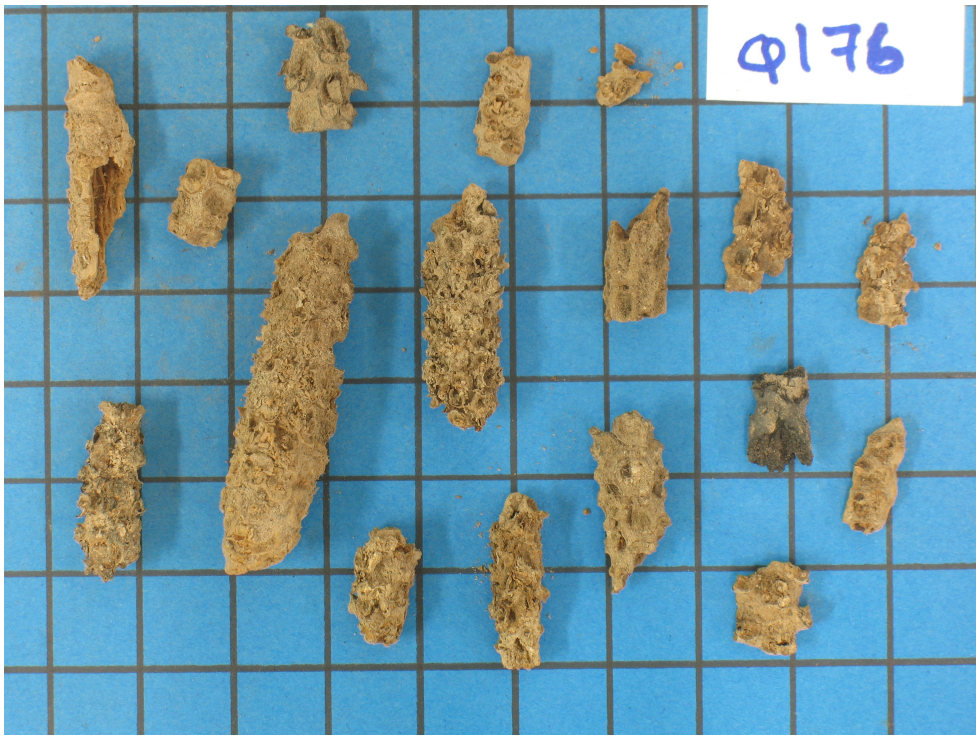

Figure B.1. Type AA - *Zea mays;* sample φ176, Lapa dos Bichos.

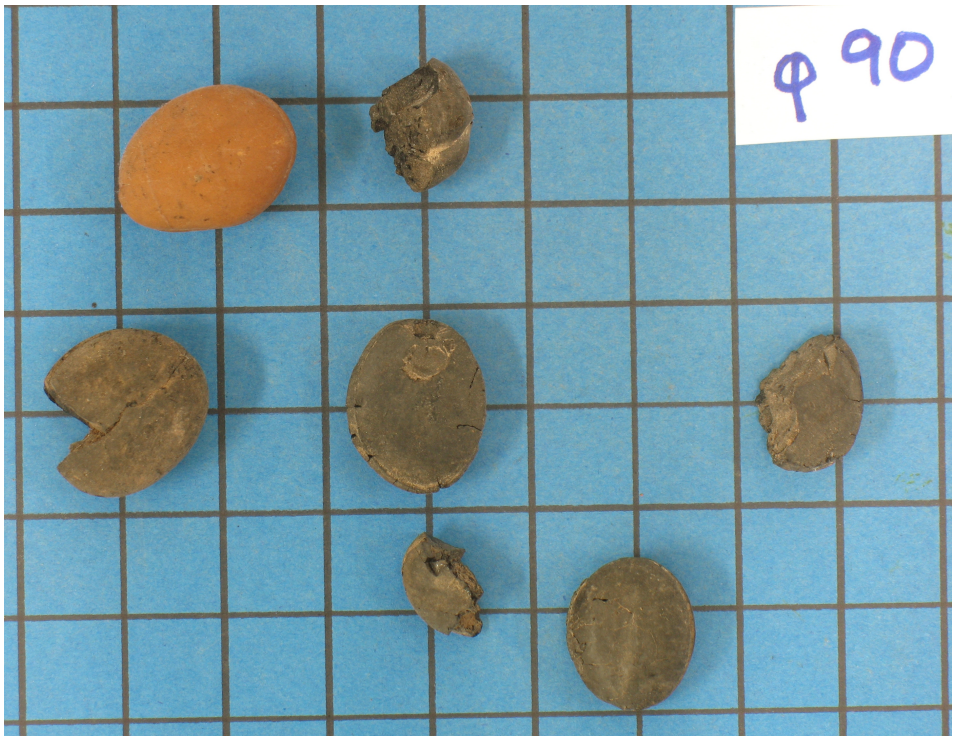

Figure B.2. Type AB - *Hymenaea;* sample φ90, Lapa dos Bichos.

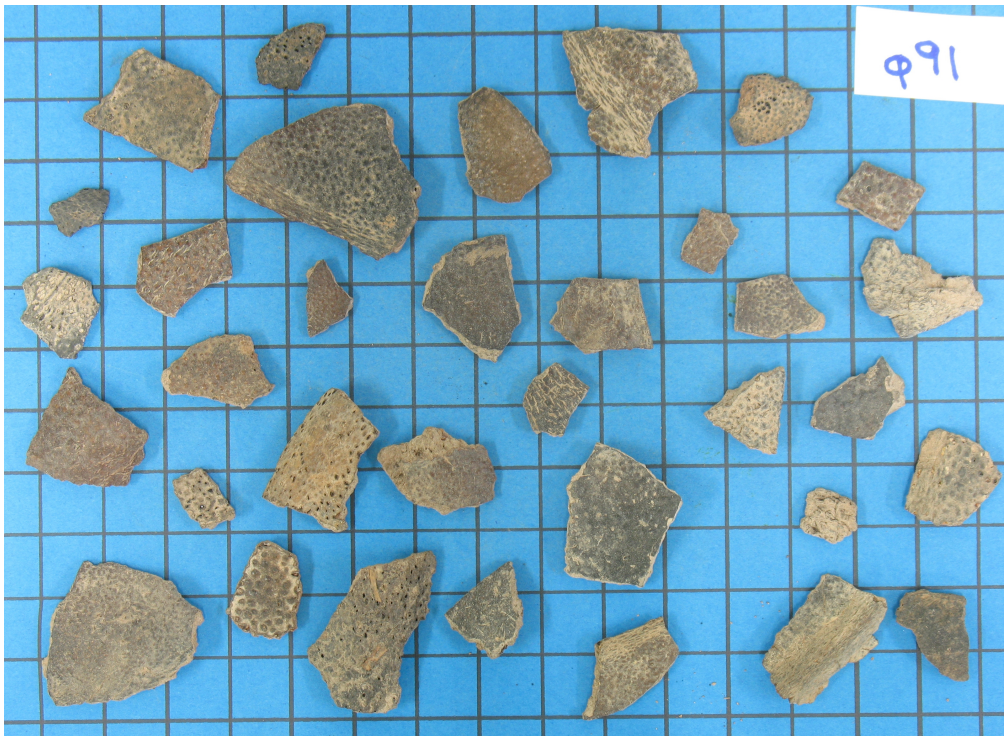

Figure B.3. Type AC - *Hymenaea;* sample φ91, Lapa dos Bichos.



Figure B.4. Type AD - *Lagenaria;* sample φ218, Lapa dos Bichos.



Figure B.5. Type AE - *Spondias tuberosa;* sample φ469, Lapa dos Bichos.

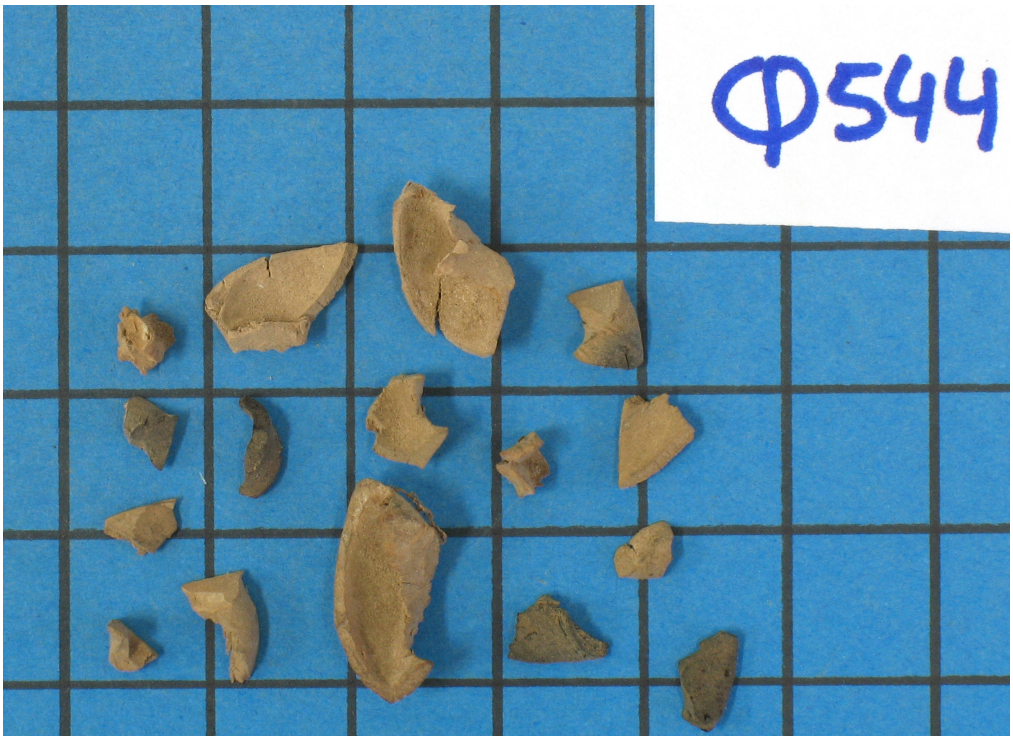

Figure B.6. Type AF - *Manihot esculenta* cf.*;* sample φ544, Lapa dos Bichos.



Figure B.7. Type AG - *Annona;* sample φ82, Lapa dos Bichos.

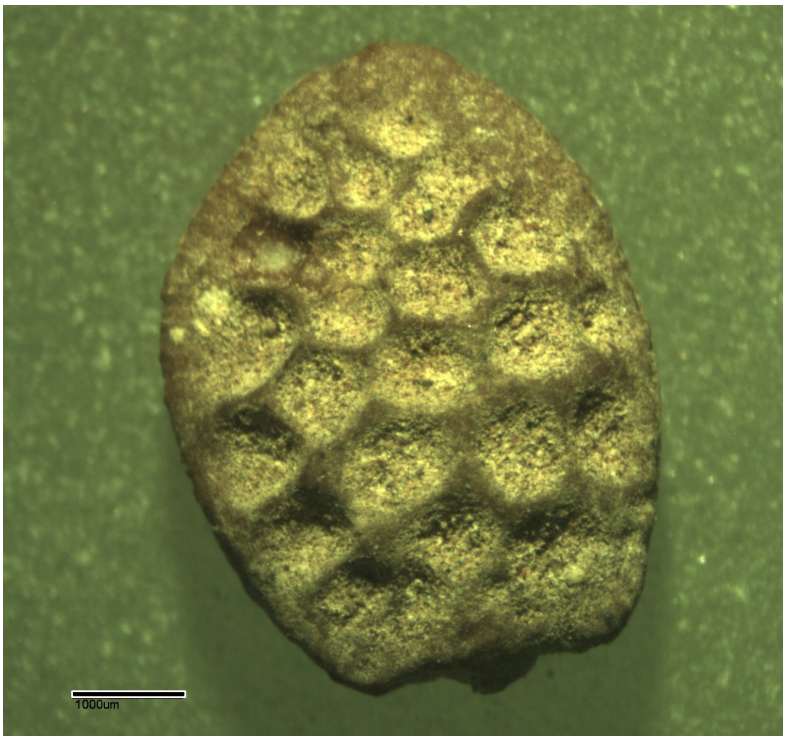

Figure B.8. Type AH - *Passiflora;* sample φ41, Lapa dos Bichos.



Figure B.9. Type AI - *Arachis hypogaea;* sample φ110, Lapa dos Bichos.

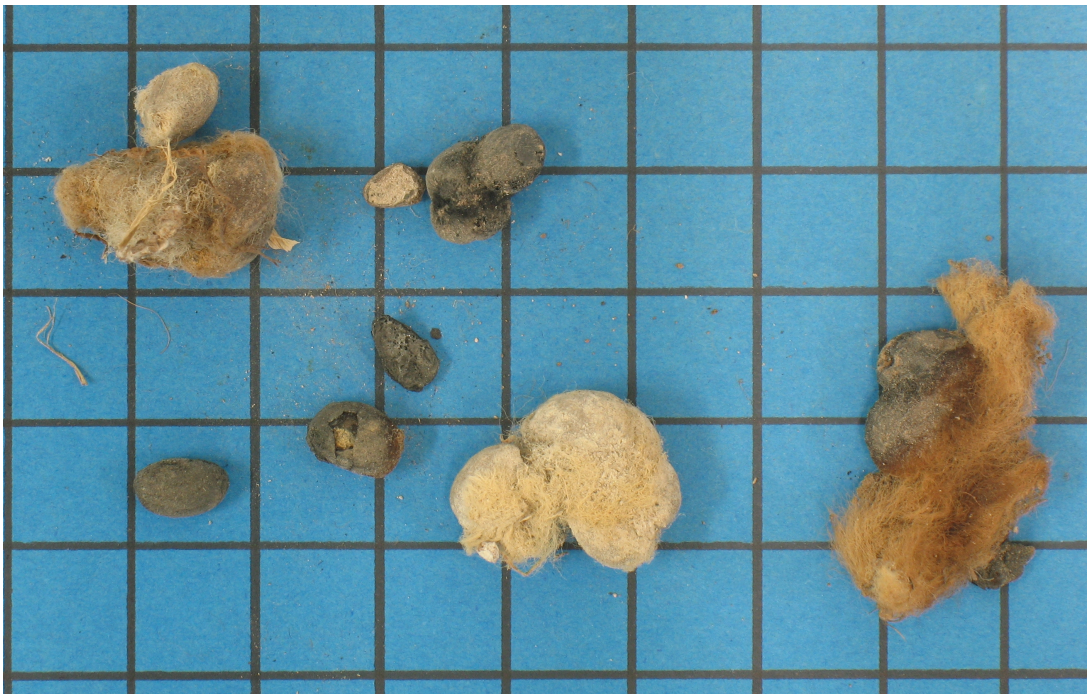

Figure B.10. Type AJ - *Gossypium barbadense;* sample φ432, Lapa dos Bichos.



Figure B.11. Type AK - *Caryocar brasiliensis;* sample φ224, Lapa dos Bichos.



Figure B.12. Type AL - *Syagrus oleracea;* sample φ433, Lapa dos Bichos.



Figure B.13. Type AM - *Syagrus oleracea;* sample 7776-07, Lapa Pintada.

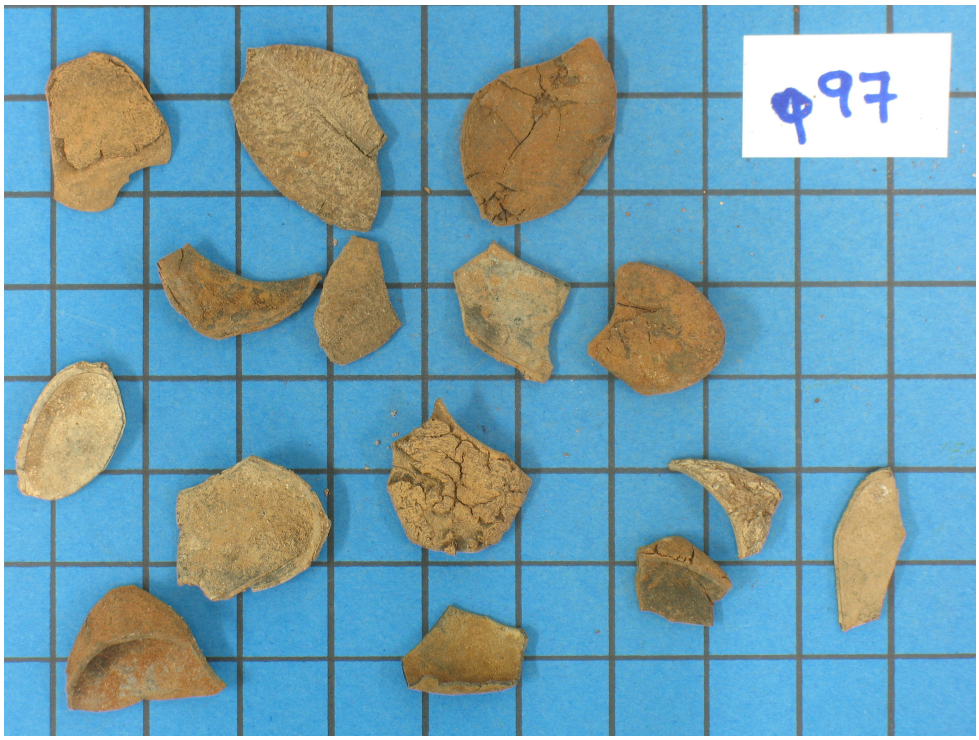

Figure B.14. Type AN - *Cnidoscolous pubescens;* sample φ97, Lapa dos Bichos.



Figure B.15. Type AO - *Cnidoscolous pubescens;* sample φ5089, Lapa dos Bichos.



Figure B.16. Type AP - *Spondias mombin;* sample φ21, Lapa dos Bichos.

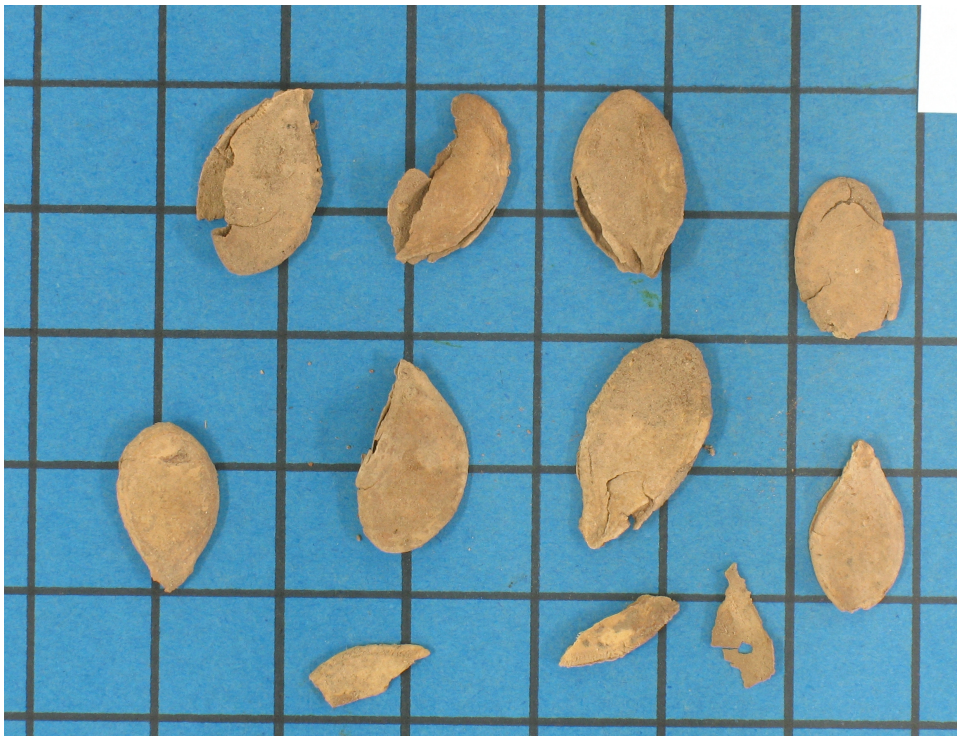

Figure B.17. Type AQ - *Cucurbita;* sample φ382, Lapa dos Bichos.



Figure B.18. Type AR - *Largenaria;* sample φ129, Lapa dos Bichos.



Figure B.19. Type AT - *Cecropia;* sample φ95a, Lapa dos Bichos.

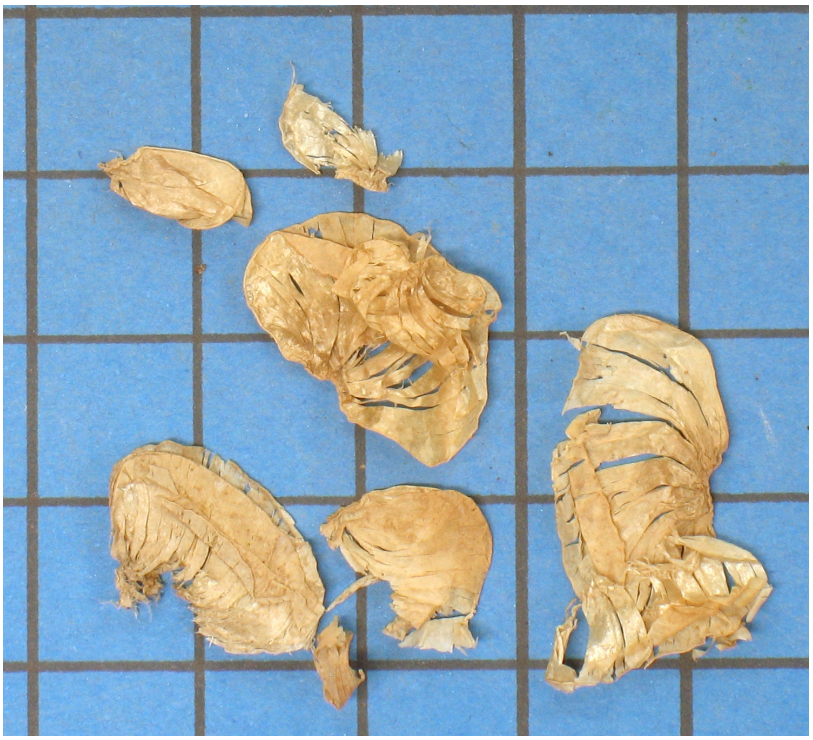

Figure B.20. Type AU - Malpigiaceae*;* sample φ228, Lapa dos Bichos.

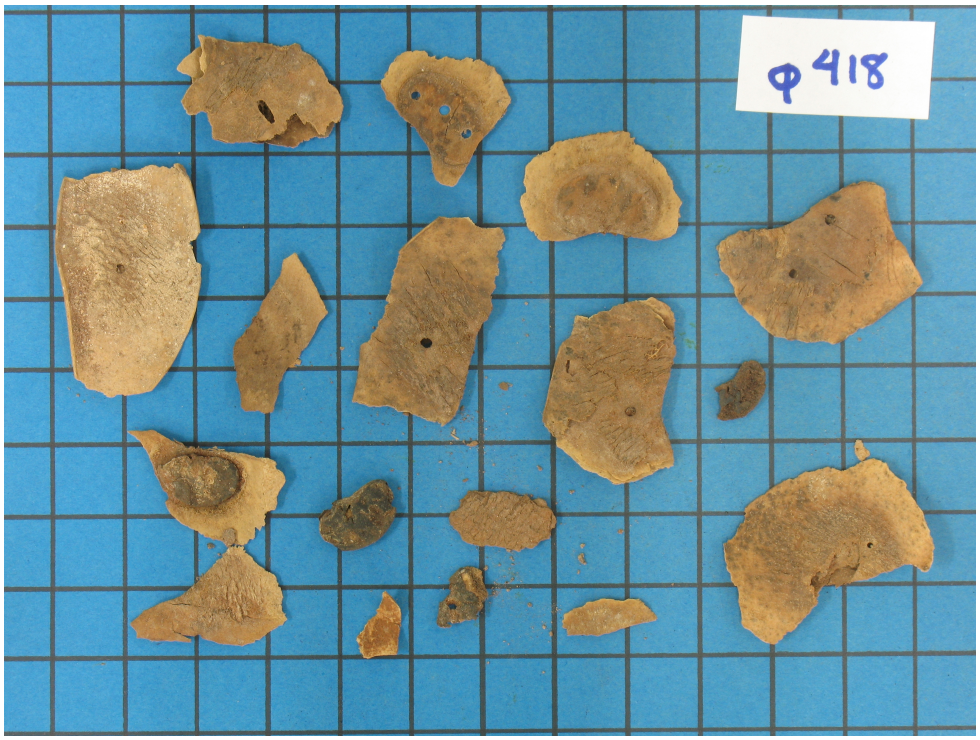

Figure B.21. Type AV - *Lonchocarpus;* sample φ418, Lapa dos Bichos.

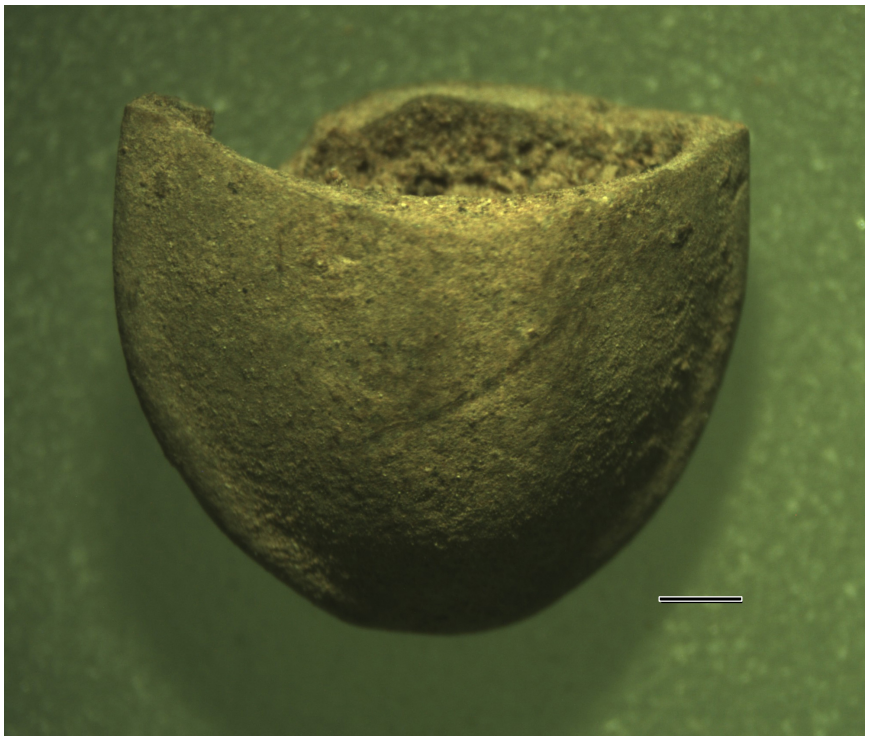

Figure B.22. Type AW*;* sample φ25, Lapa dos Bichos.



Figure B.23. Type AX - *Terminalia argentea* cf.*;* sample φ359, Lapa dos Bichos.

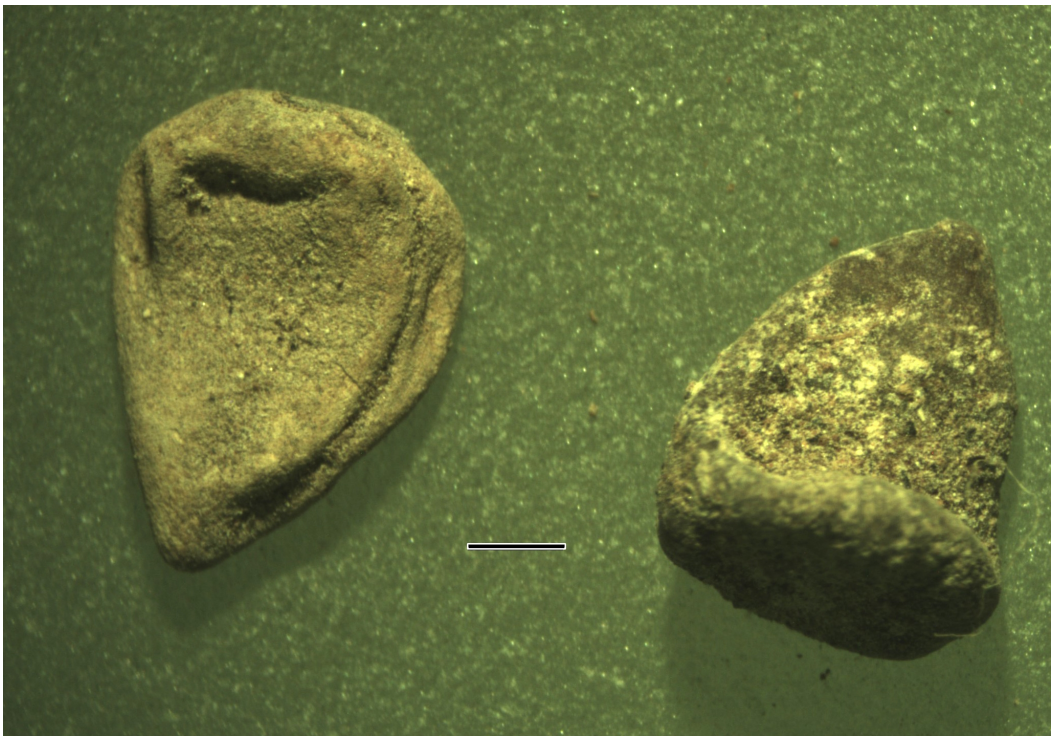

Figure B.24. Type AY - *Bixa orellana;* sample φ677, Lapa dos Bichos.



Figure B.25. Type AZ - *Ruprechtia;* sample φ385, Lapa dos Bichos.

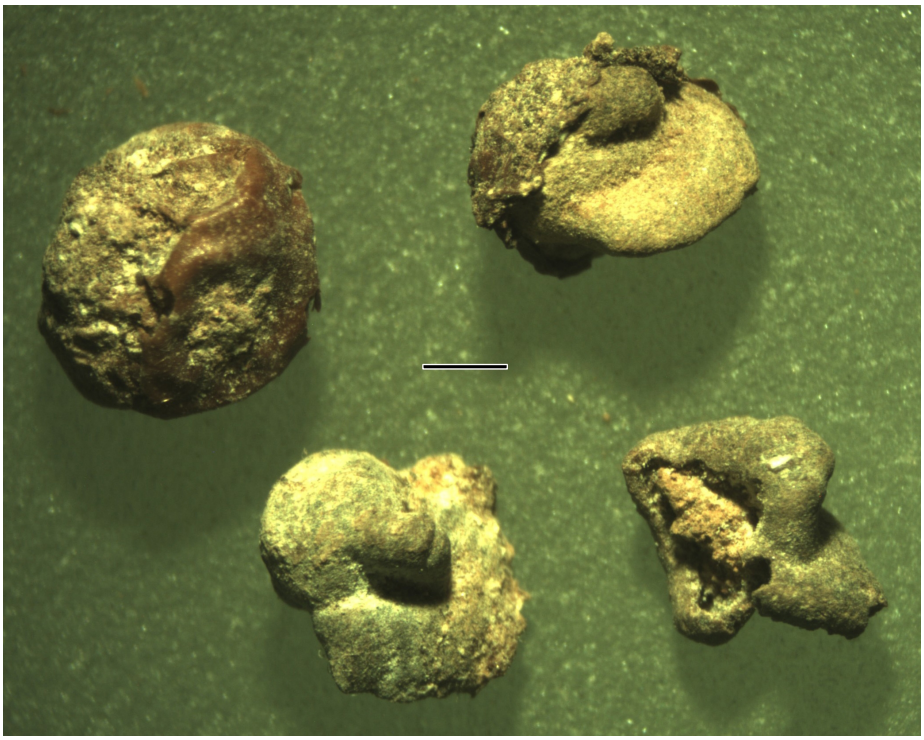

Figure B.26. Type BA - *Myracrodruon urundeuva;* sample φ420, Lapa dos Bichos.

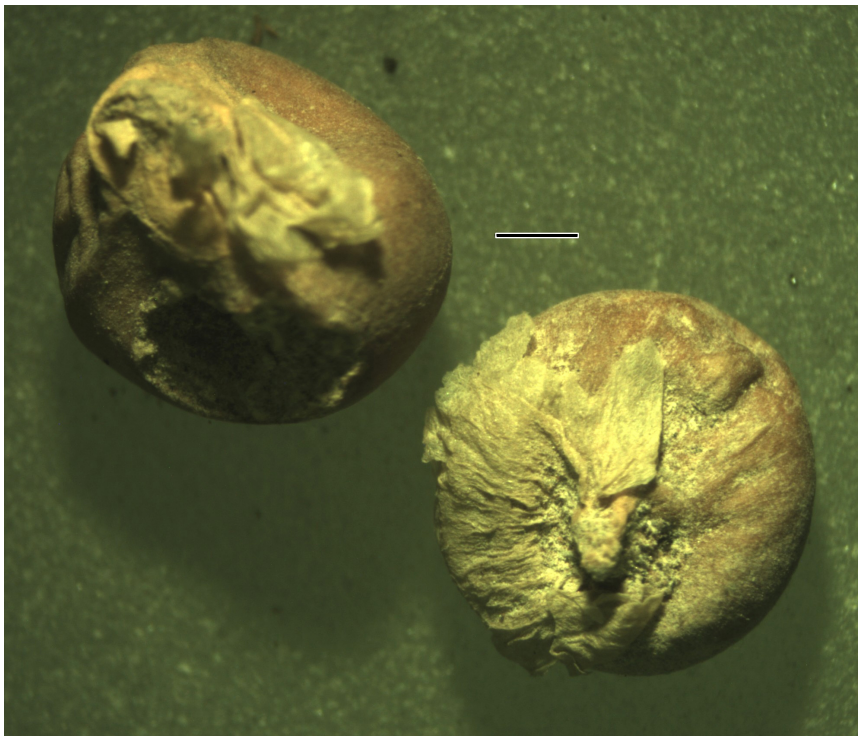

Figure B.27. Type BB*;* sample φ249, Lapa dos Bichos.

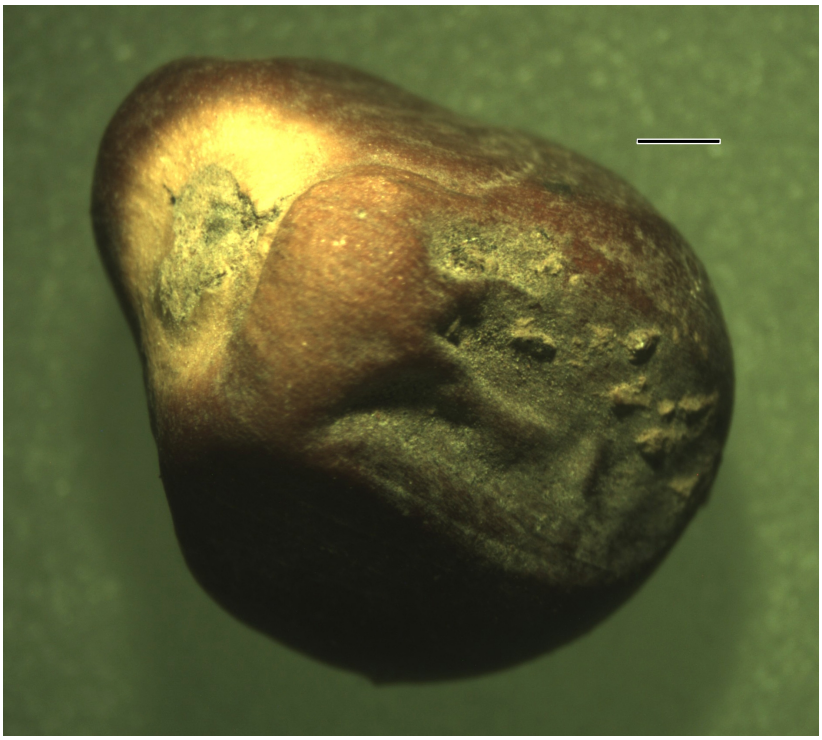

Figure B.28. Type BC - *Zea mays;* sample φ44, Lapa dos Bichos.



Figure B.29. Type BD*;* sample φ438, Lapa dos Bichos., Lapa dos Bichos.

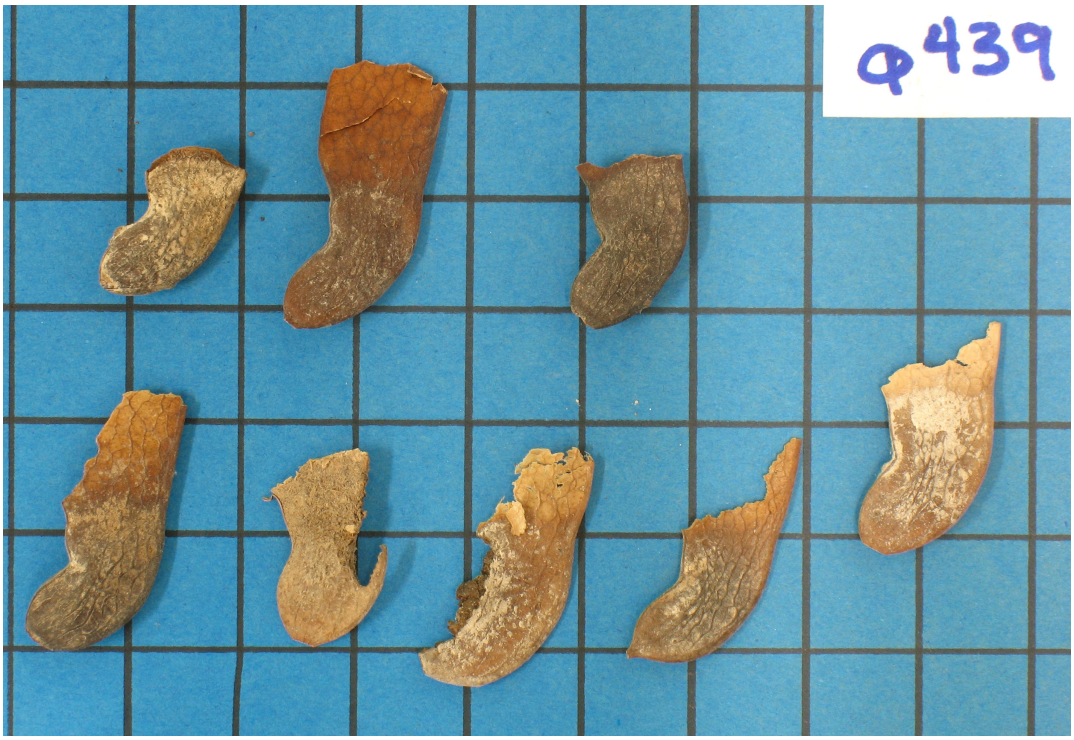

Figure B.30. Type BE - *Machaerium;* sample φ439, Lapa dos Bichos.

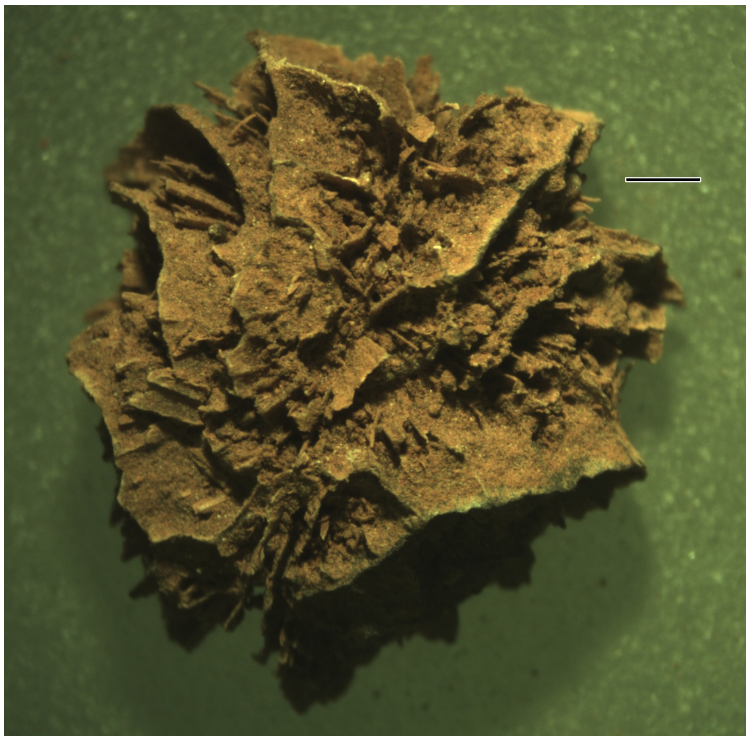

Figure B.31. Type BF*;* sample φ35, Lapa dos Bichos.



Figure B.32. Type BH - *Thevetia peruviana;* sample φ237, Lapa dos Bichos.

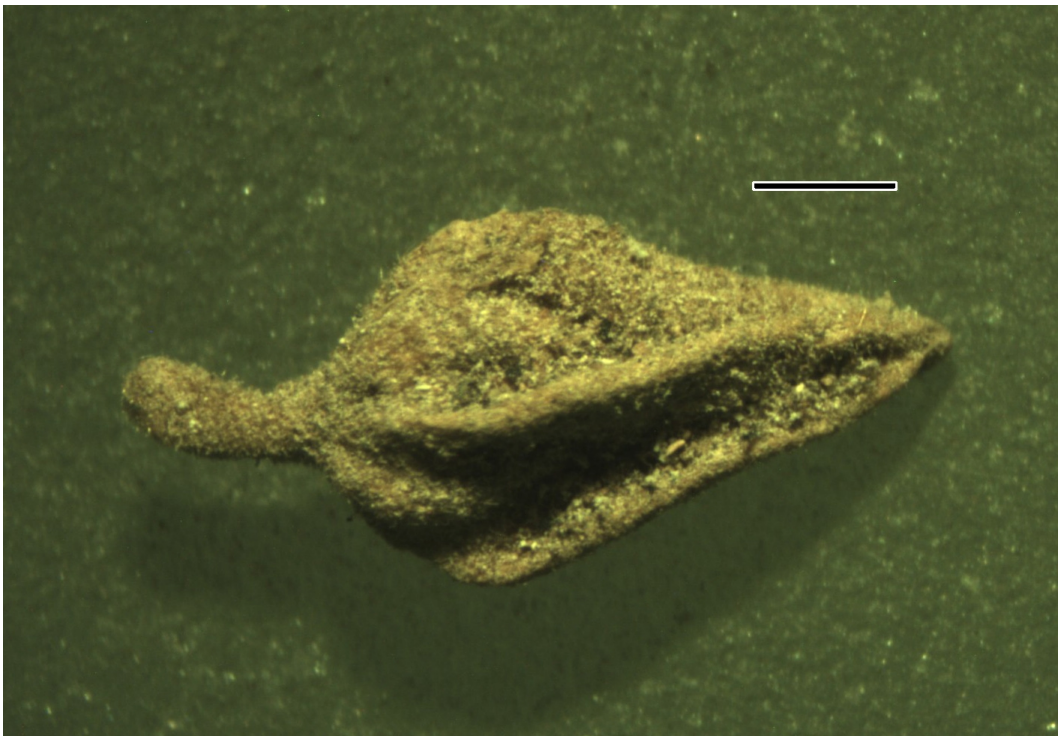

Figure B.33. Type BI*;* sample φ1154, Lapa dos Bichos.

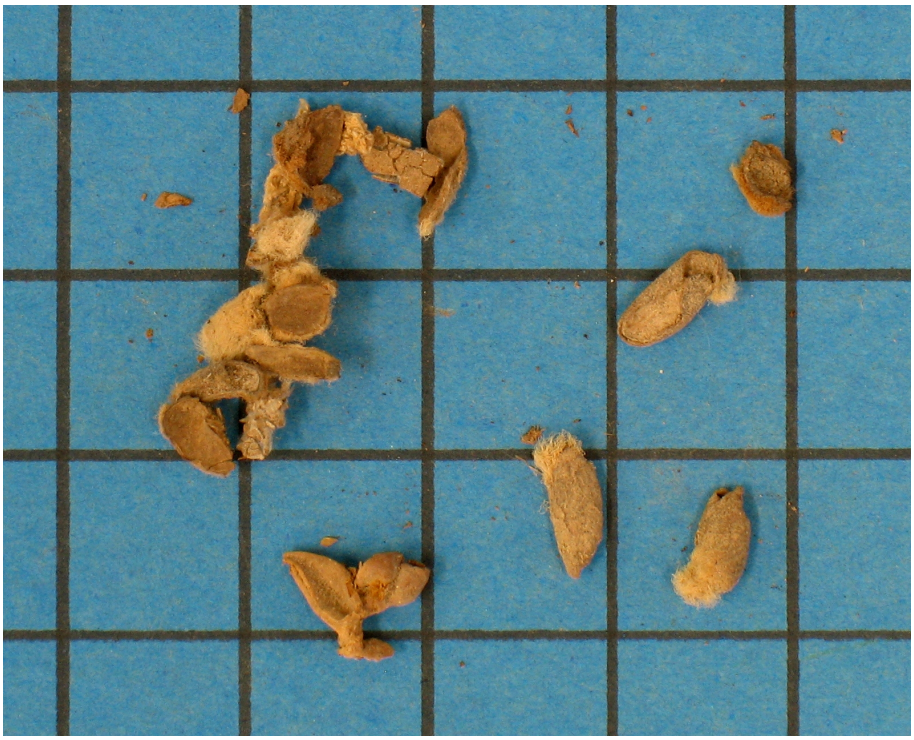

Figure B.34. Type BJ*;* sample φ510, Lapa dos Bichos.

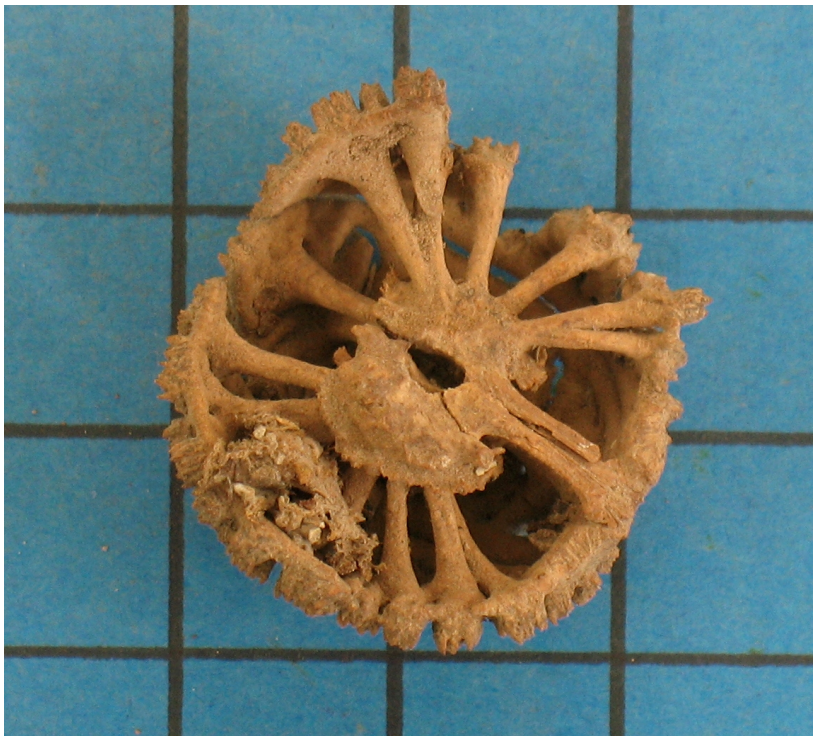

Figure B.35. Type BK - *Guazuma ulmifolia;* sample φ128, Lapa dos Bichos.

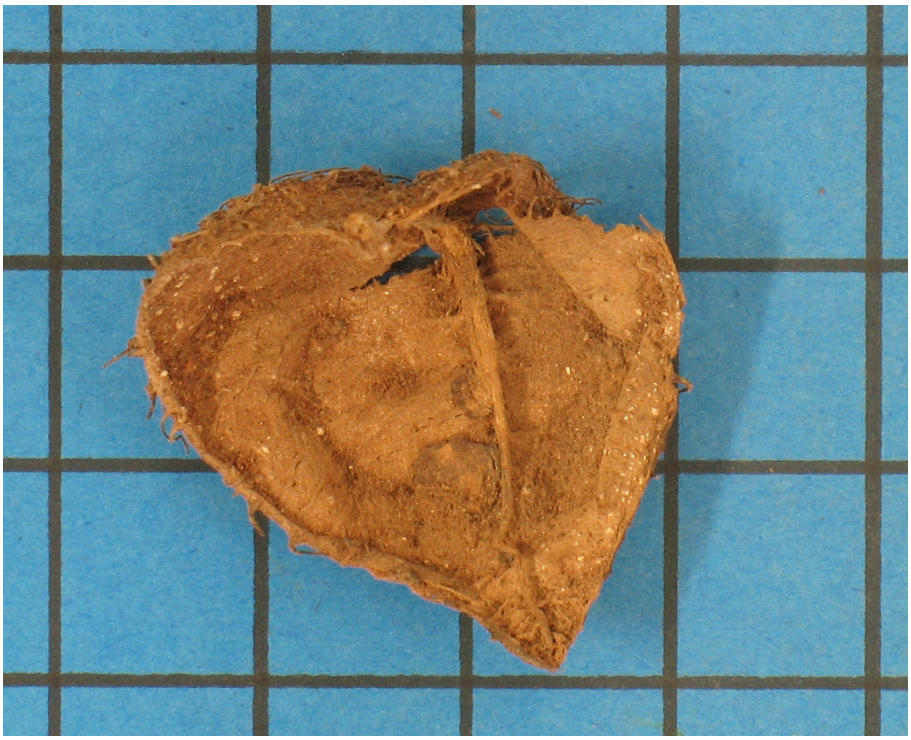

Figure B.36. Type BL - *Bixa orellana;* sample φ411, Lapa dos Bichos.



Figure B.37. Type BN - *Salacia;* sample φ240, Lapa dos Bichos.



Figure B.38. Type BO*;* sample φ87, Lapa dos Bichos.

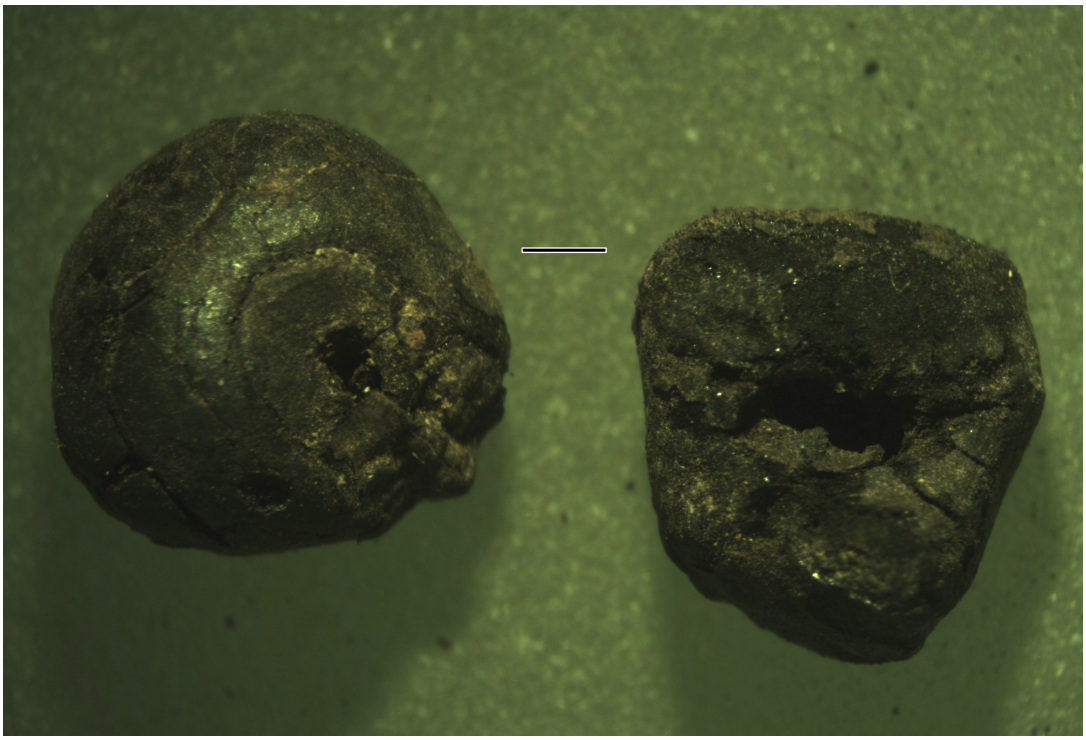

Figure B.39. Type BP - *Zea mays;* sample φ160, Lapa dos Bichos.



Figure B.40. Type BR; sample φ52, Lapa dos Bichos.

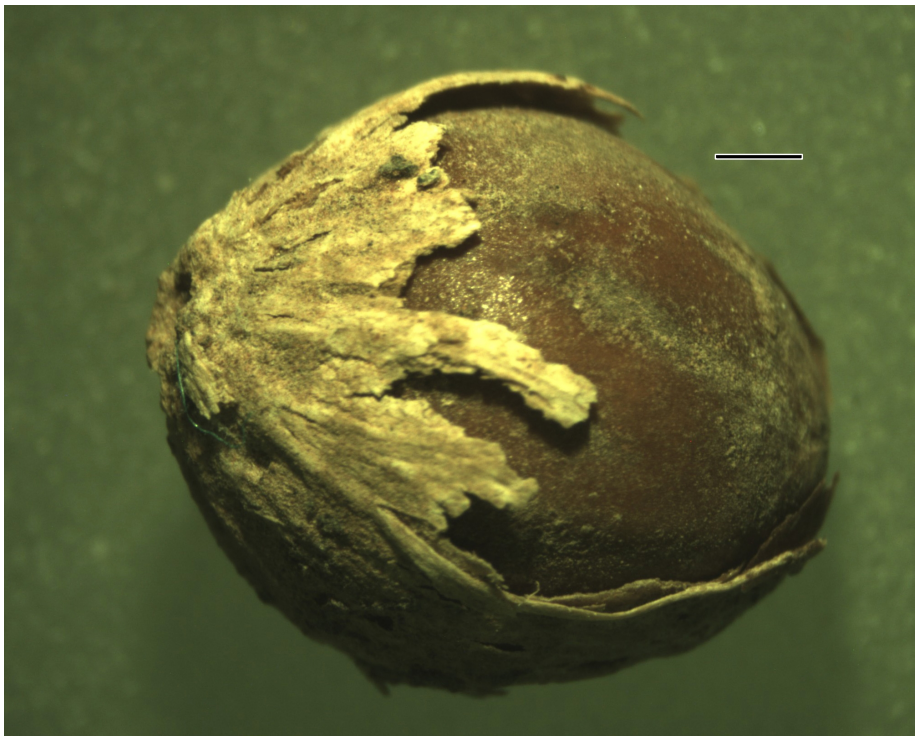

Figure B.41. Type BS - Arecaceae; sample φ27, Lapa dos Bichos.



Figure B.42. Type BT - *Schinopsis brasiliensis;* sample φ79, Lapa dos Bichos.



Figure B.43. Type BU - *Annona;* sample φ242, Lapa dos Bichos.

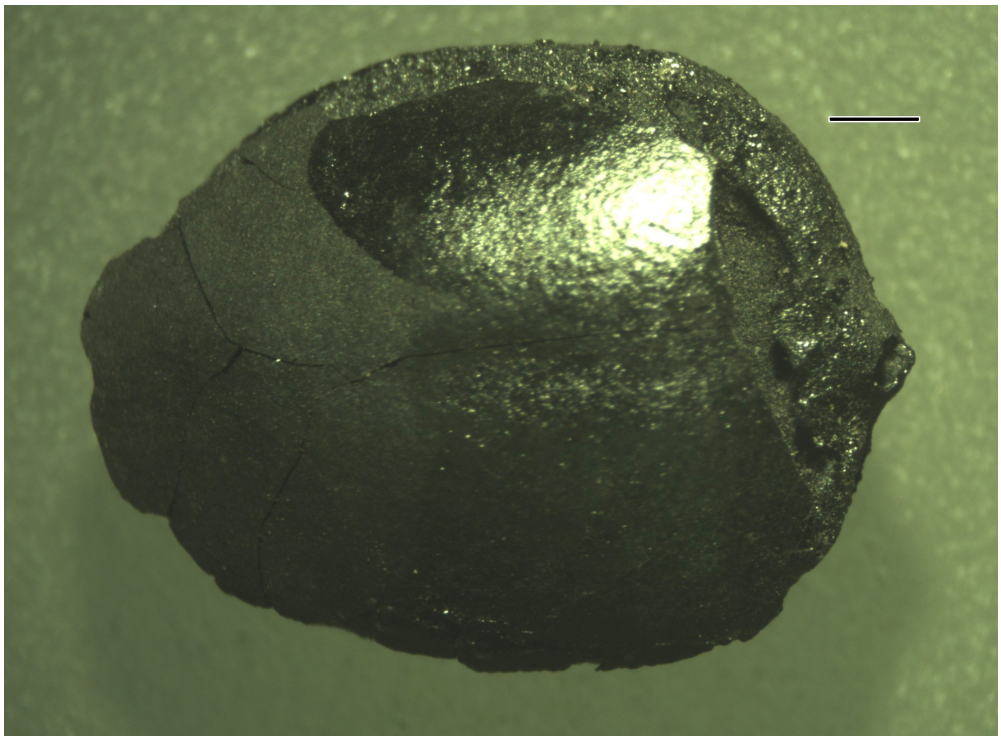

Figure B.44. Type BW - Euphorbiaceae*;* sample φ67, Lapa dos Bichos.

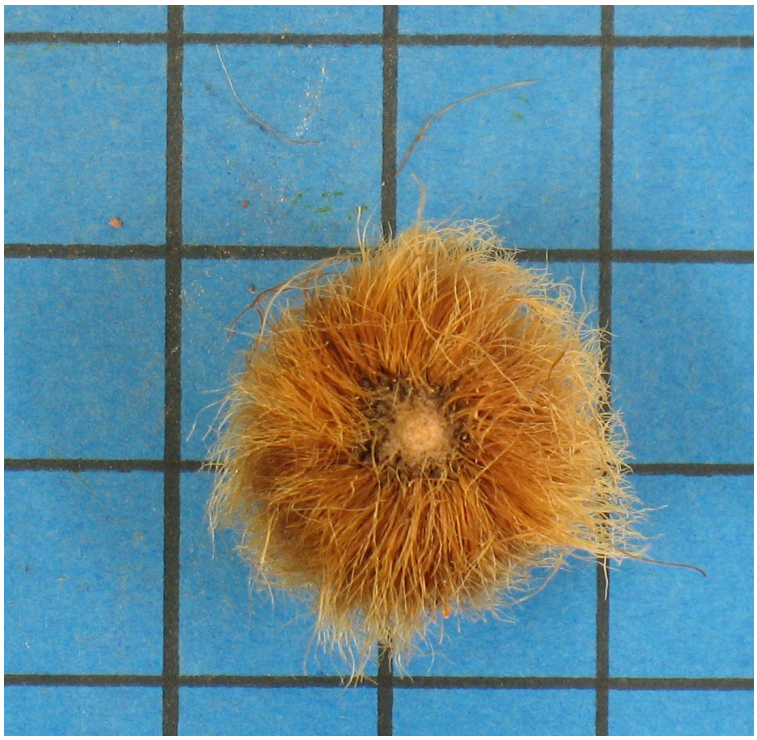

Figure B.45. Type BX - *Macairea radula;* sample φ142, Lapa dos Bichos.



Figure B.46. Type BY; sample φ389, Lapa dos Bichos.



Figure B.47. Type CA; sample φ483, Lapa dos Bichos.



Figure B.48. Type CD - *Mucuna sloanei;* sample φ245, Lapa dos Bichos.

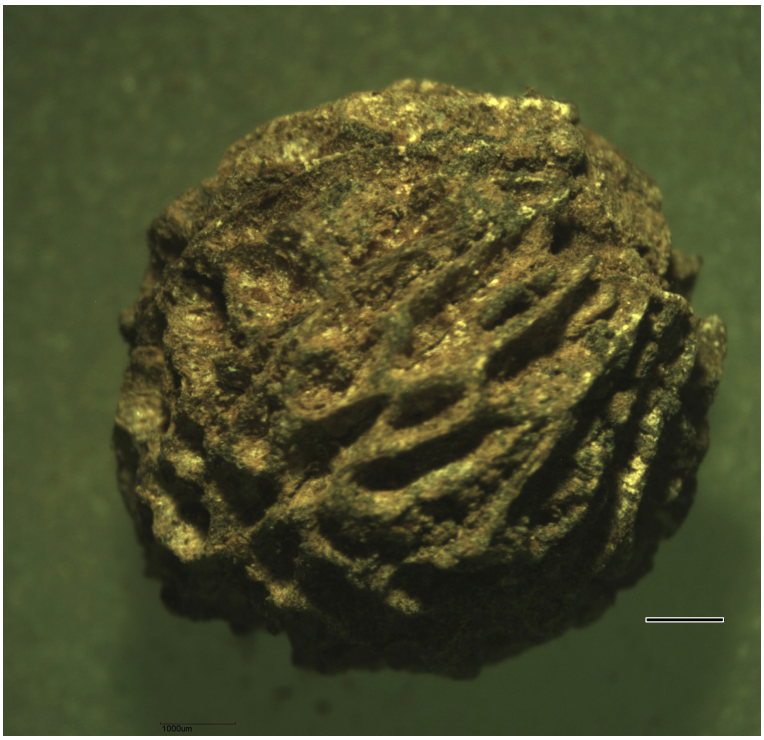

Figure B.49. Type CG - Malpigiaceae*;* sample φ210, Lapa dos Bichos.

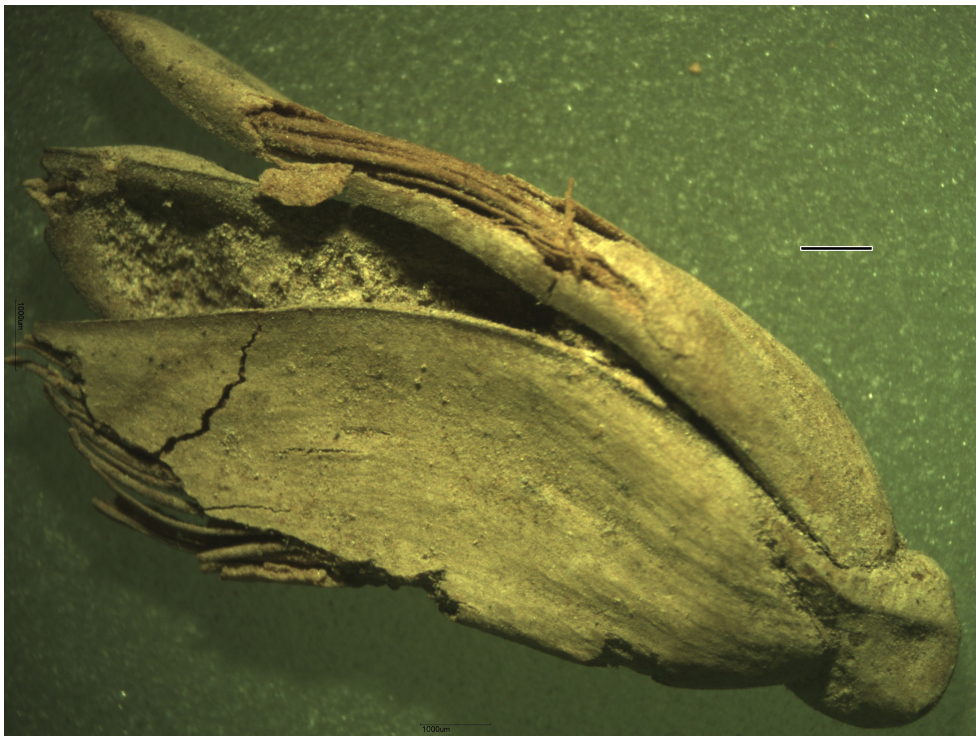

Figure B.50. Type CK - *Syagrus;* sample φ597, Lapa dos Bichos.

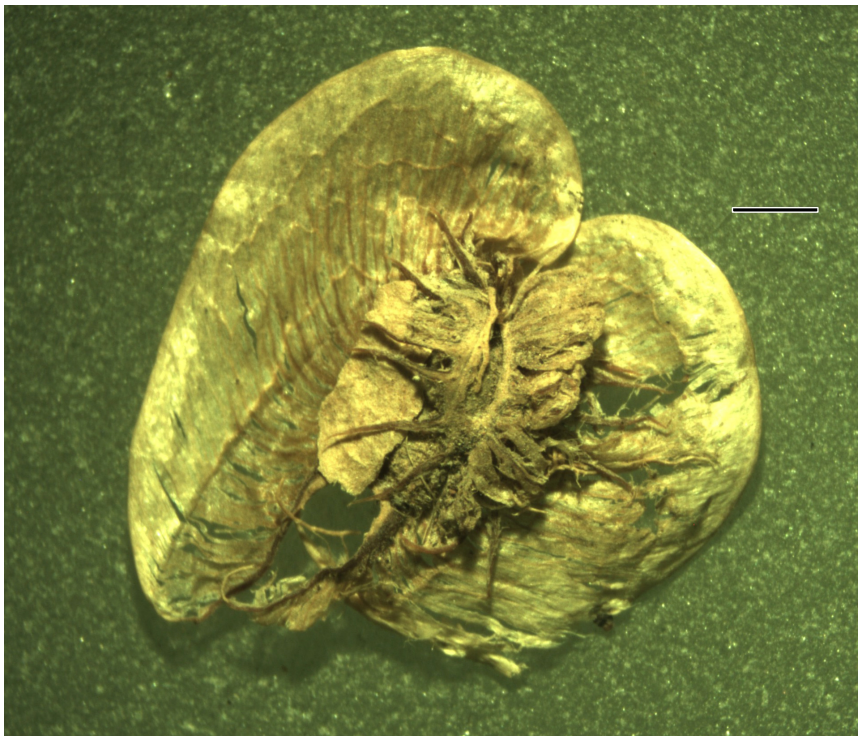

Figure B.51. Type CL - Malpigiaceae*;* sample φ256, Lapa dos Bichos.

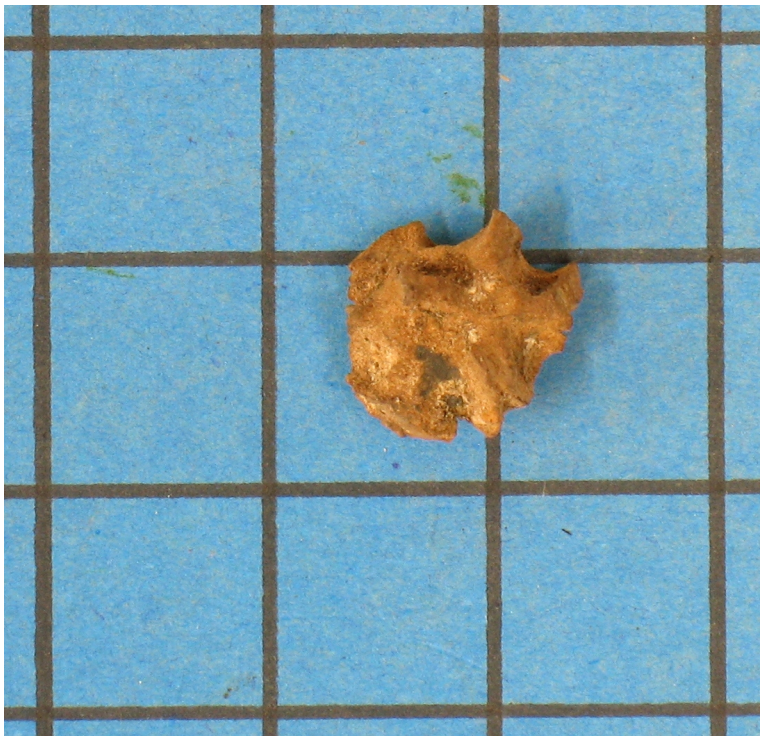

Figure B.52. Type CO*;* sample φ486, Lapa dos Bichos.

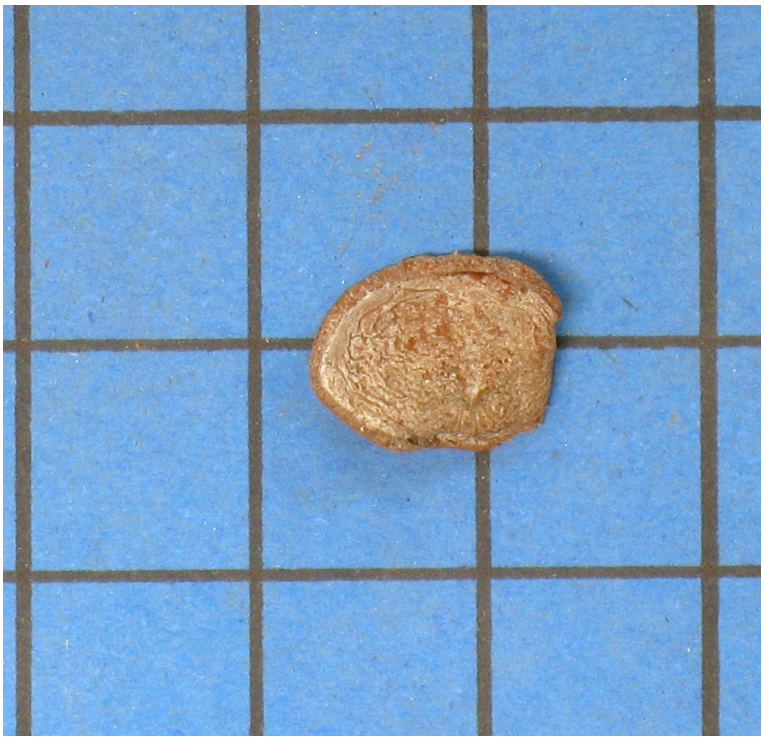

Figure B.53. Type CQ - Fabaceae*;* sample φ247, Lapa dos Bichos.

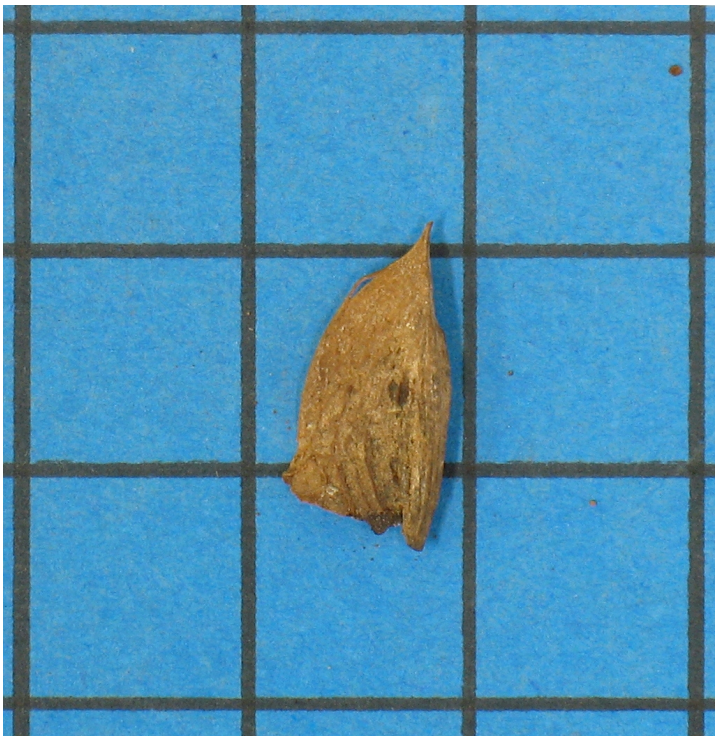

Figure B.54. Type CU*;* sample φ488, Lapa dos Bichos.

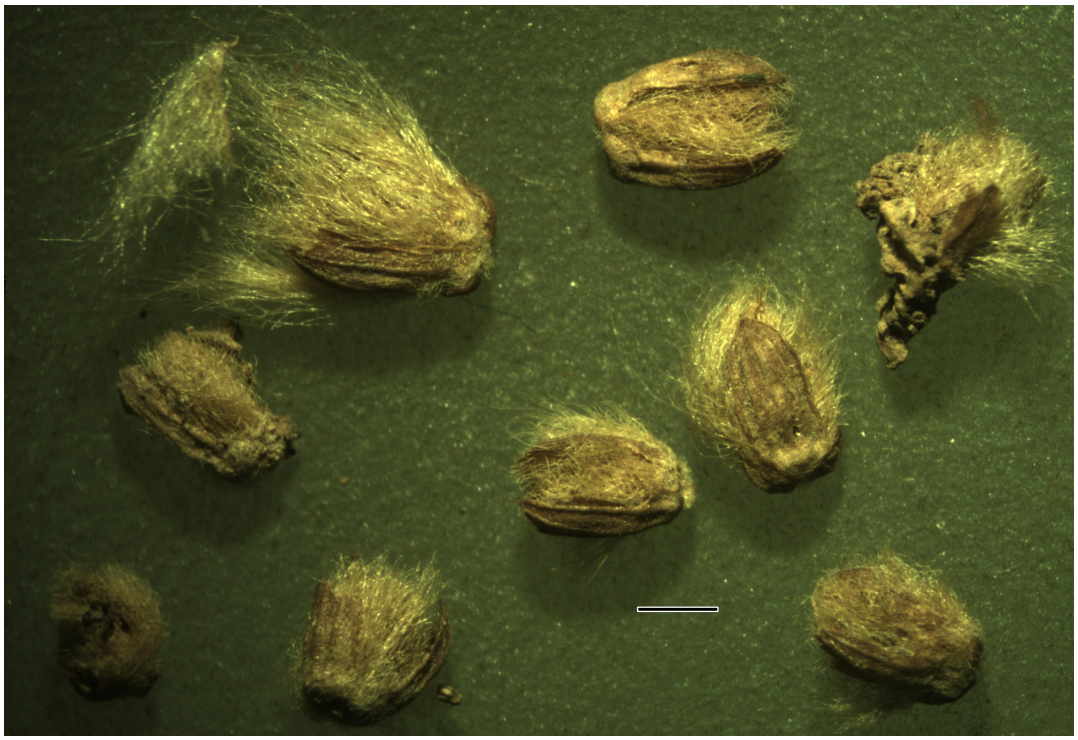

Figure B.55. Type CW*;* sample φ1496, Lapa dos Bichos.

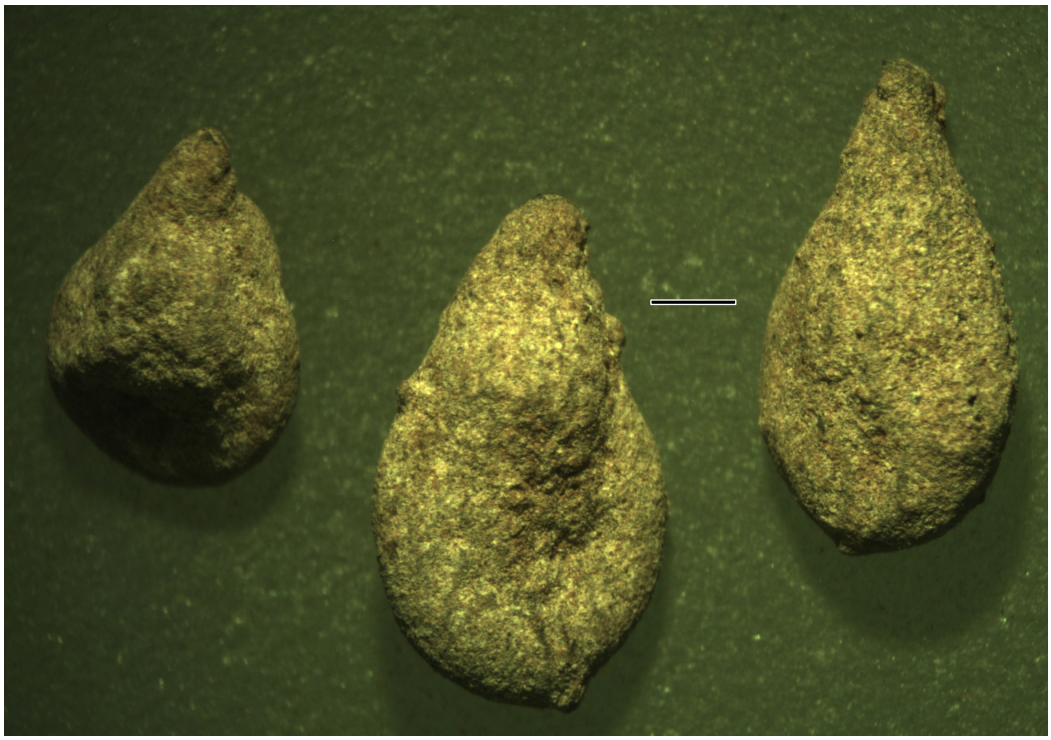

Figure B.56. Type CX; sample φ1195, Lapa dos Bichos.



Figure B.57. Type DA; sample φ74, Lapa dos Bichos.

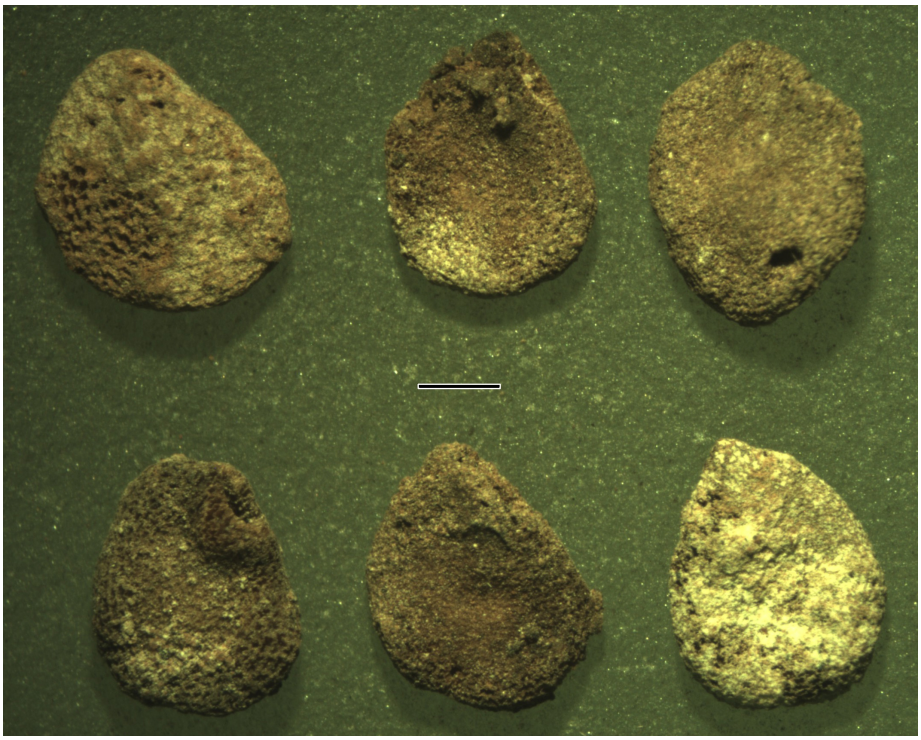

Figure B.58. Type DC - Solanaceae*;* sample φ1170, Lapa dos Bichos.

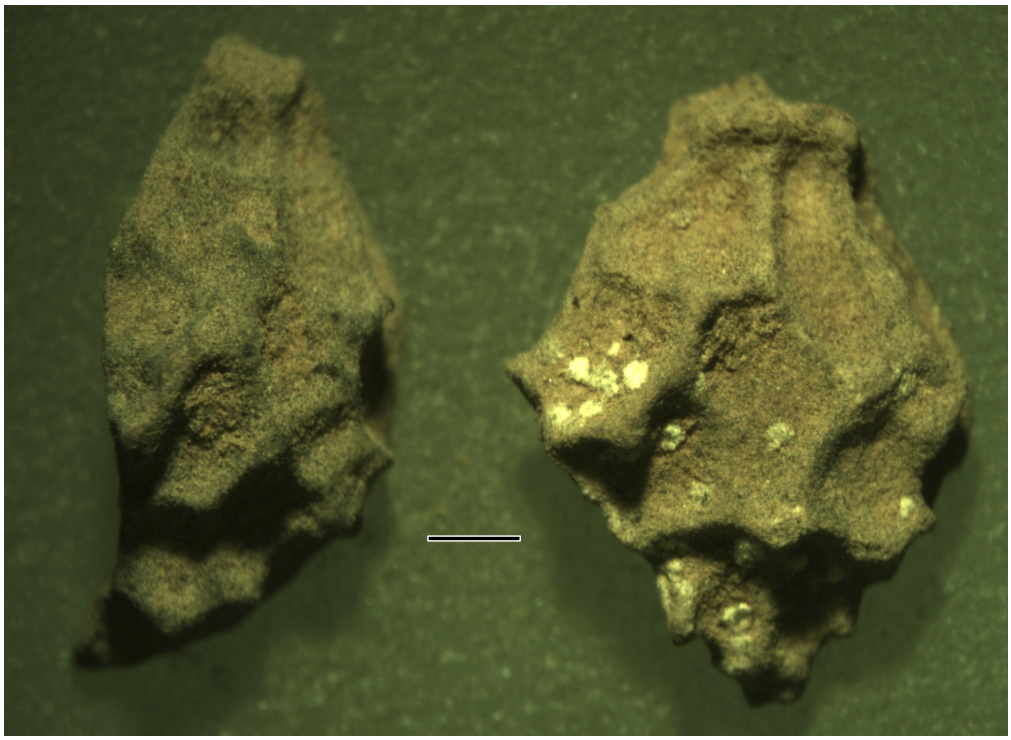

Figure B.59. Type DE - *Byrsonima;* sample φ1173, Lapa dos Bichos.



Figure B.60. Type DH - Arecaceae*;* sample φ122, Lapa dos Bichos.



Figure B.61. Type DJ - Gnaphalieae*;* sample φ252, Lapa dos Bichos.

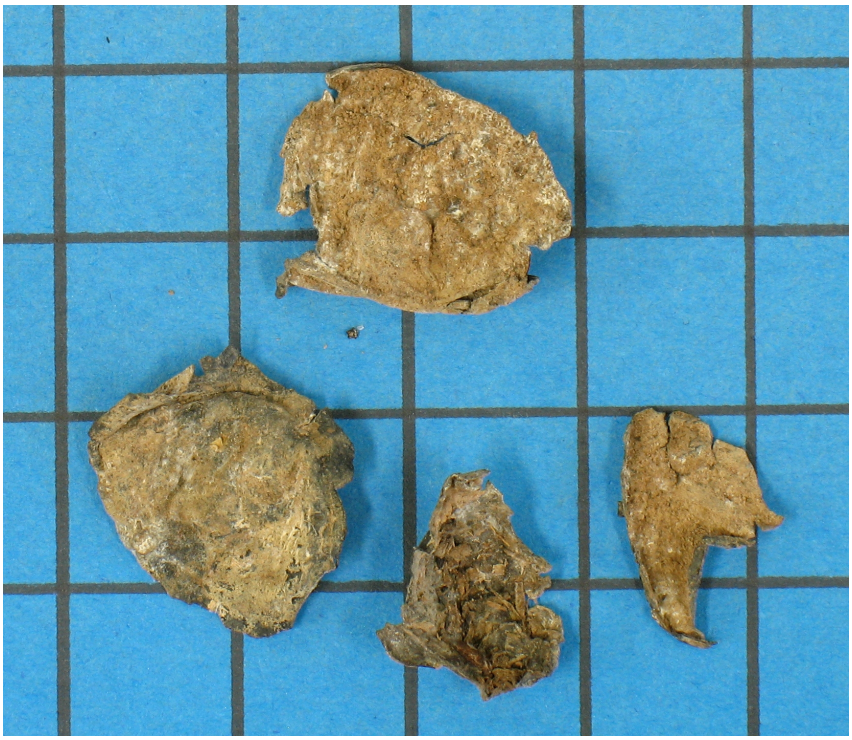

Figure B.62. Type DO - *Myrciaria;* sample 7788.14, Lapa Pintada.



Figure B.63. Type DS*;* sample φ254, Lapa dos Bichos.



Figure B.64. Type DU - *Amburana cearensis* cf.*;* sample φ81, Lapa dos Bichos.

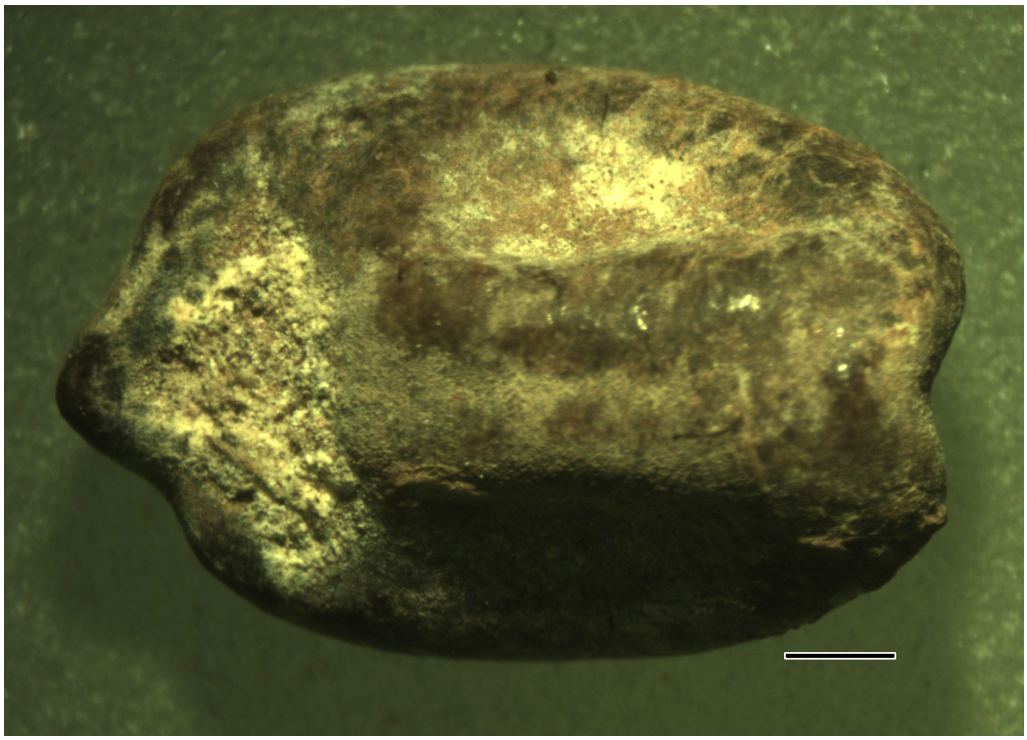

Figure B.65. Type DV - Euphorbiaceae*;* sample φ492, Lapa dos Bichos.

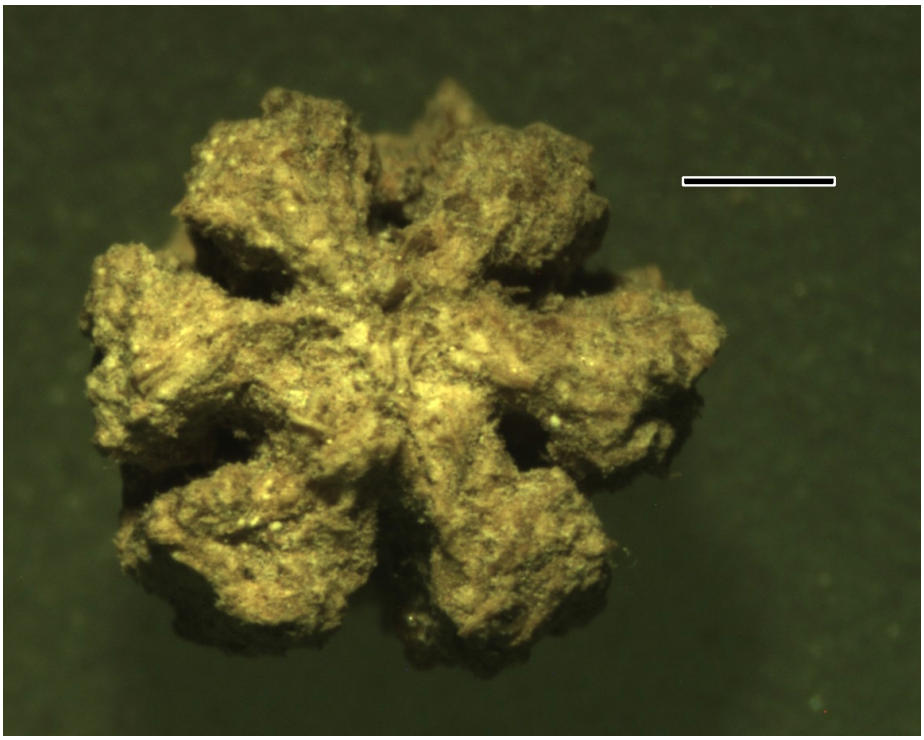

Figure B.66. Type DW*;* sample φ1308, Lapa dos Bichos.

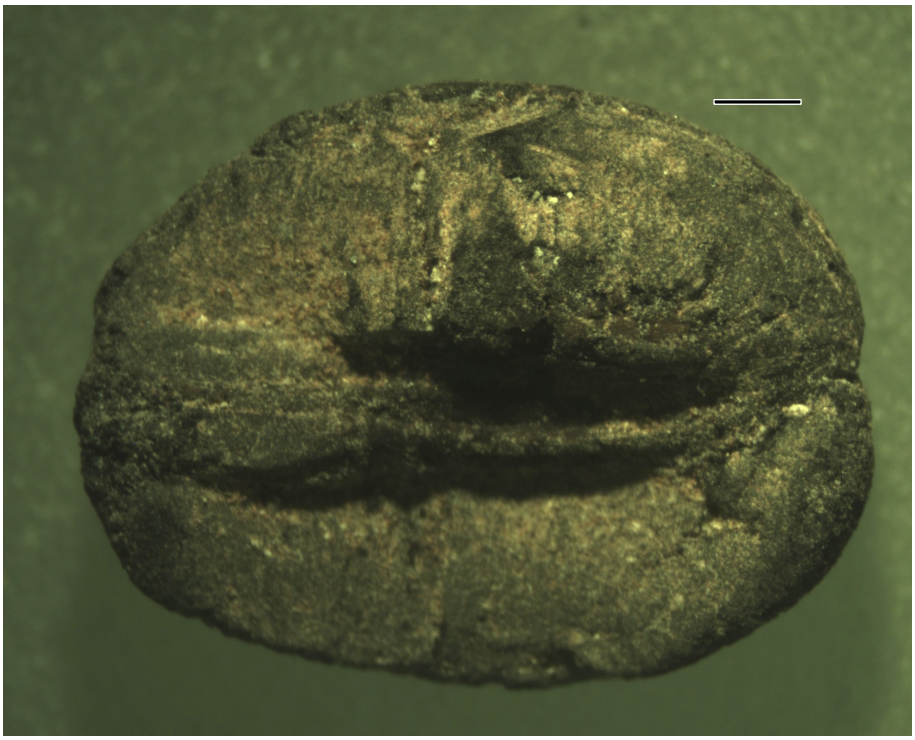

Figure B.67. Type DX*;* sample φ77, Lapa dos Bichos.

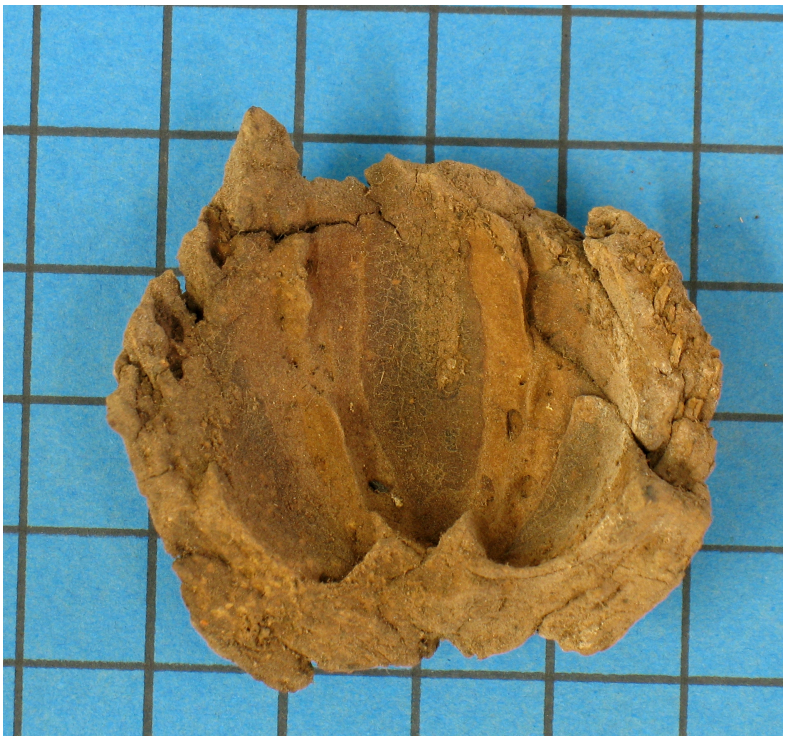

Figure B.68. Type EB - Arecaceae*;* sample φ493, Lapa dos Bichos.

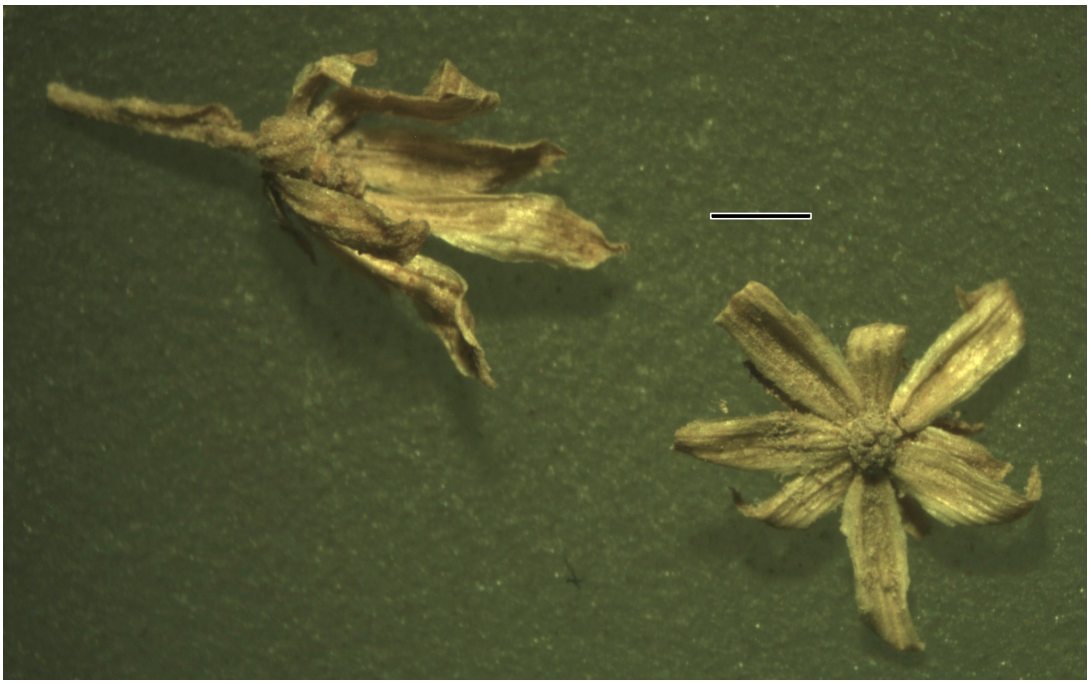

Figure B.69. Type EC - Eupatorieae*;* sample φ1323, Lapa dos Bichos.

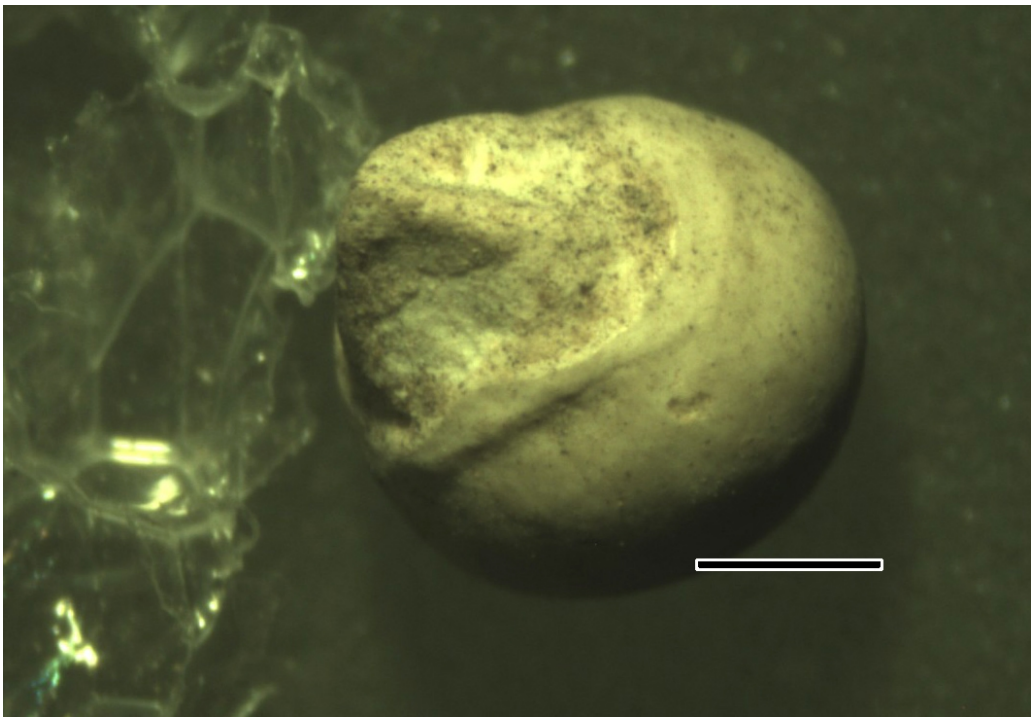

Figure B.70. Type EG - *Scleria;* sample 7819-07, Lapa Pintada (material to support sample to left of sample).



Figure B.71. Type EJ*;* sample φ1317, Lapa dos Bichos.

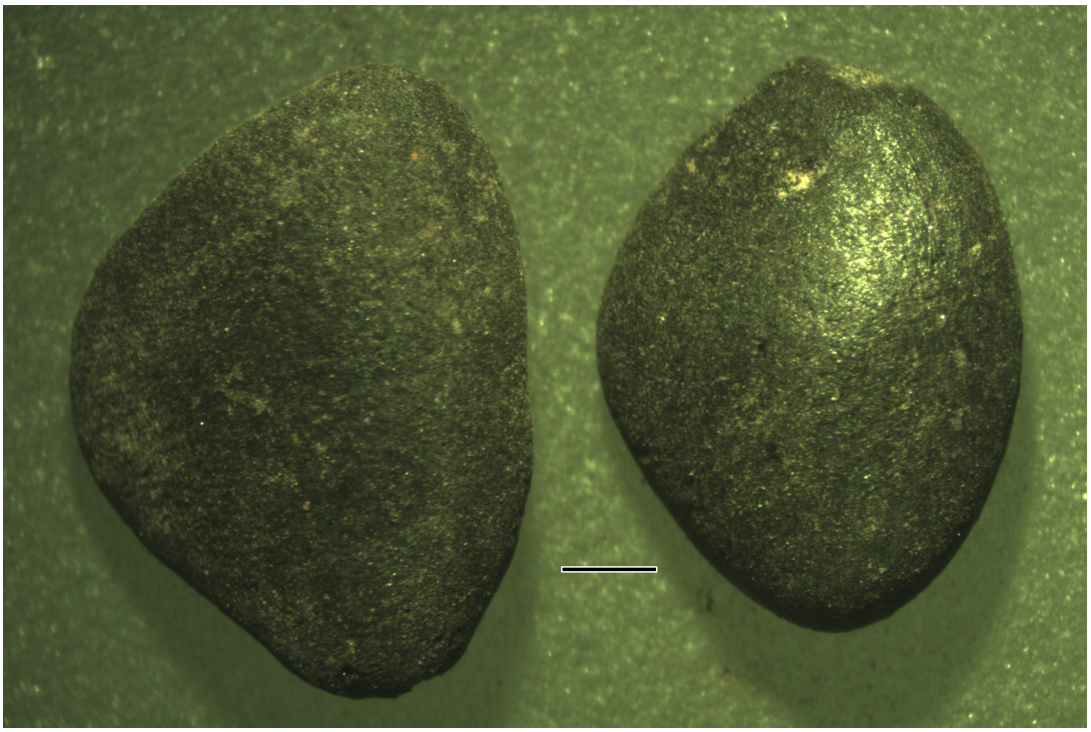

Figure B.72. Type EK - *Bixa;* sample φ423, Lapa dos Bichos.

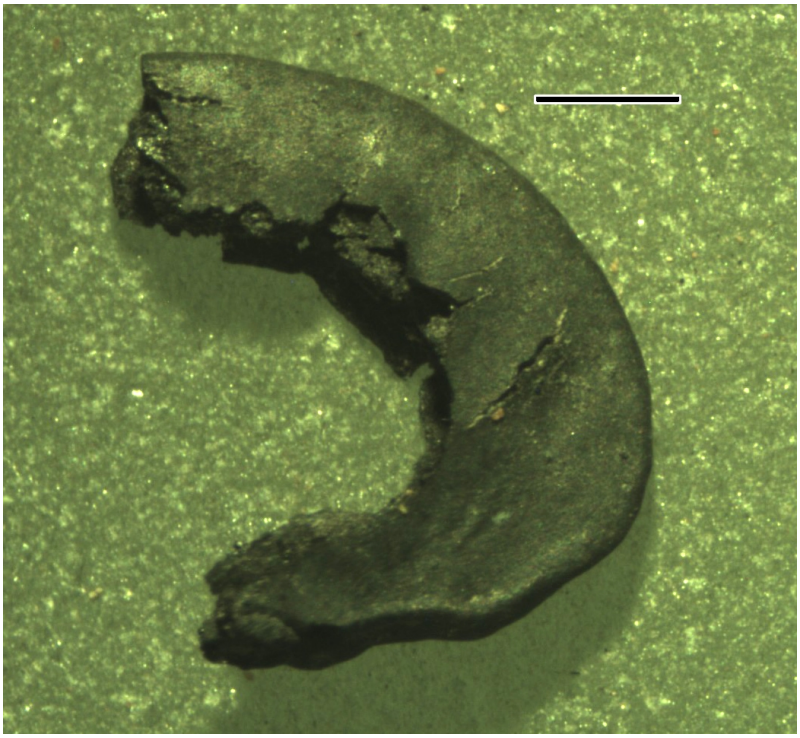

Figure B.73. Type EN - Fabaceae*;* sample φ259, Lapa dos Bichos.

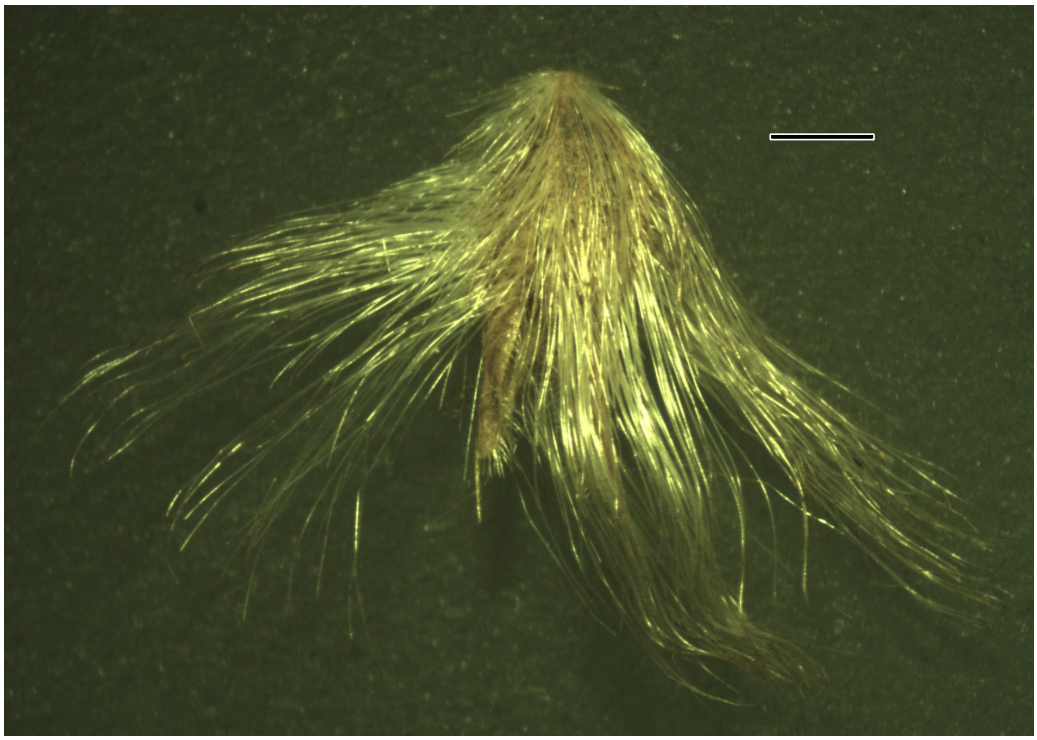

Figure B.74. Type EO - *Mesosetum;* sample φ1316, Lapa dos Bichos.

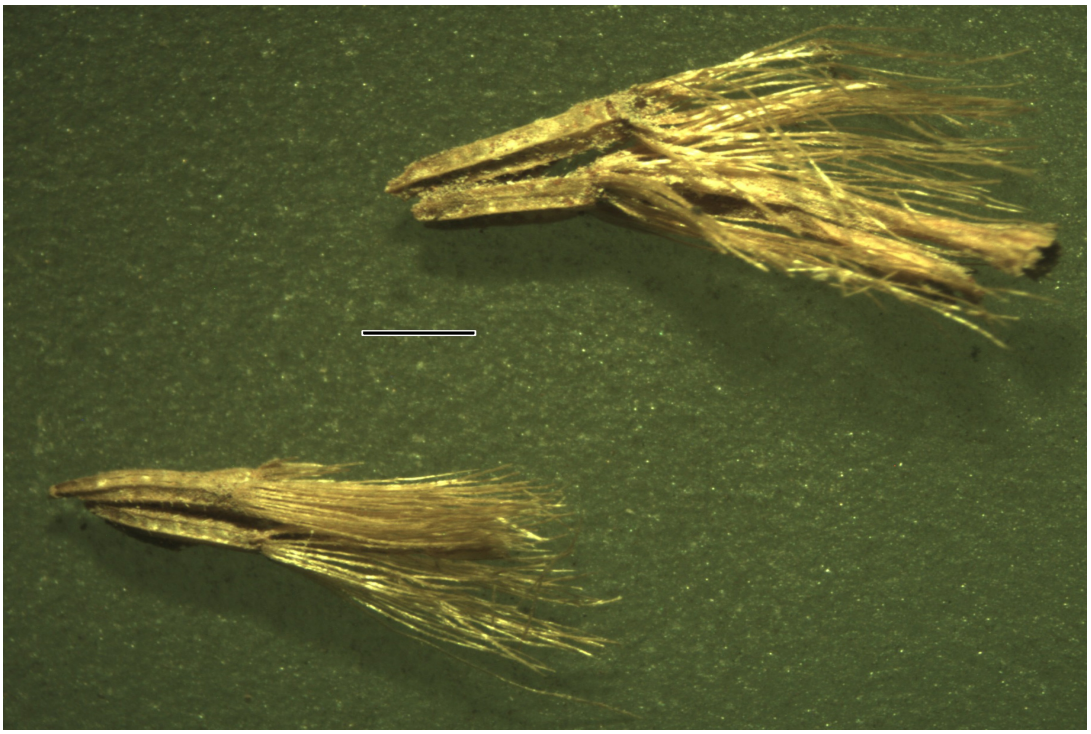

Figure B.75. Type EQ - *Chromolaena;* sample φ1315, Lapa dos Bichos.



Figure B.76. Type ER*;* sample φ1237, Lapa dos Bichos.



Figure B.77. Type ES - *Macroptilium;* sample φ260, Lapa dos Bichos.

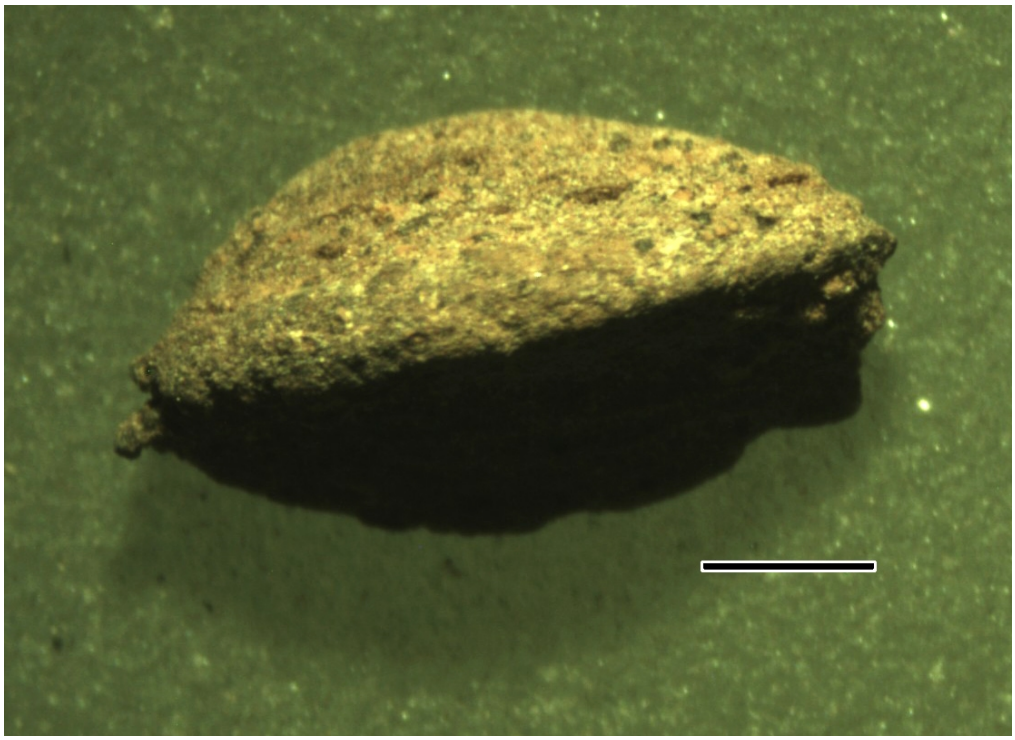

Figure B.78. Type EV*;* sample φ1458, Lapa dos Bichos.



Figure B.79. Type EW - *Ficus;* sample φ394, Lapa dos Bichos.

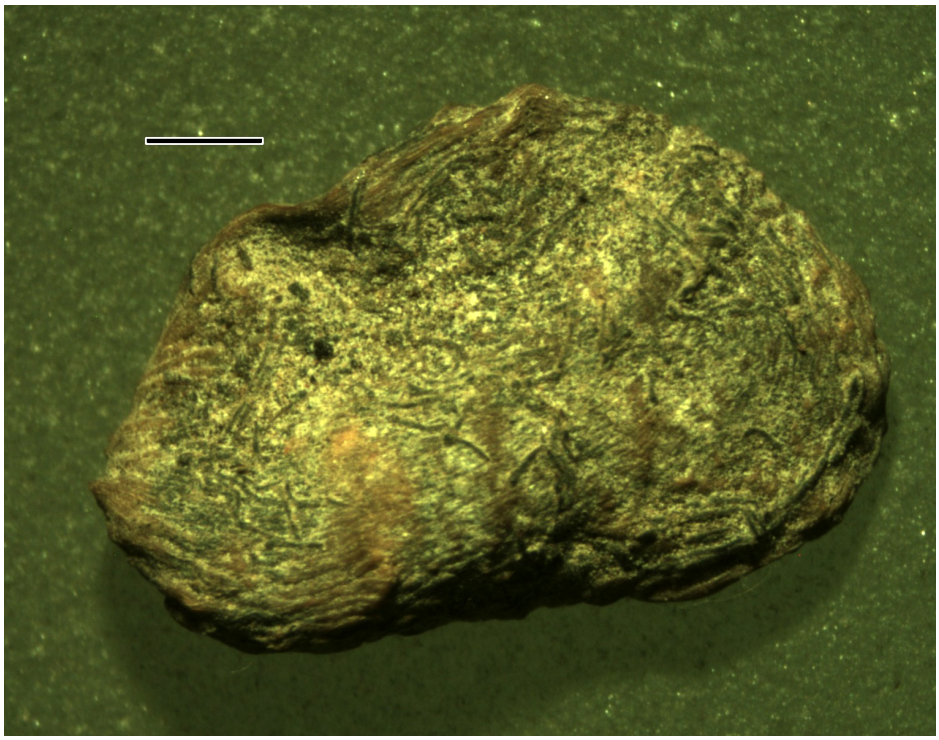

Figure B.80. Type EX - *Alibertia edulis;* sample φ1180, Lapa dos Bichos.



Figure B.81. Type EY*;* sample φ1325, Lapa dos Bichos.

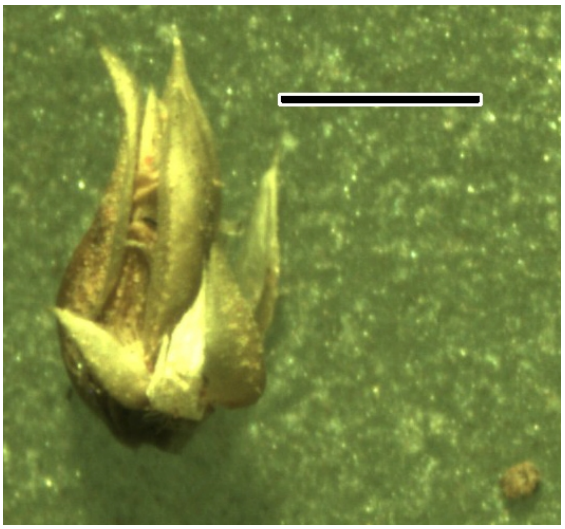

Figure B.82. Type FB - Poaceae*;* sample φ326, Lapa dos Bichos.

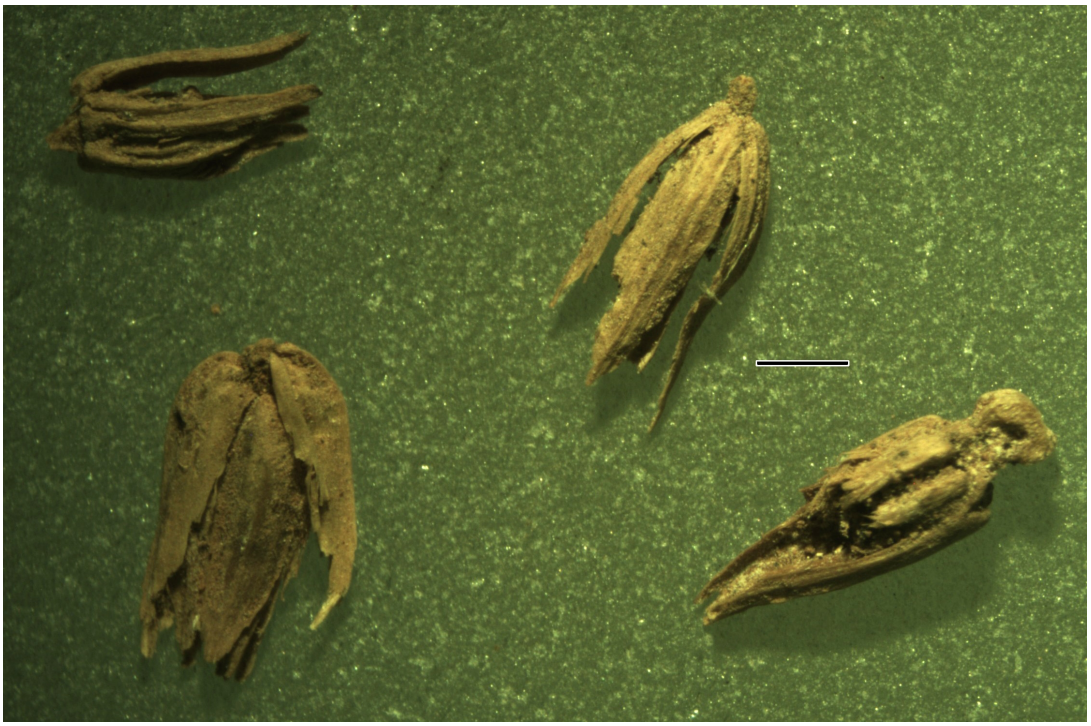

Figure B.83. Type FE*;* sample φ204, Lapa dos Bichos.



Figure B.84. Type FH - *Cavanillesia;* sample φ598, Lapa dos Bichos.



Figure B.85. Type FJ - *Phaseolus vulgaris;* sample φ332, Lapa dos Bichos.

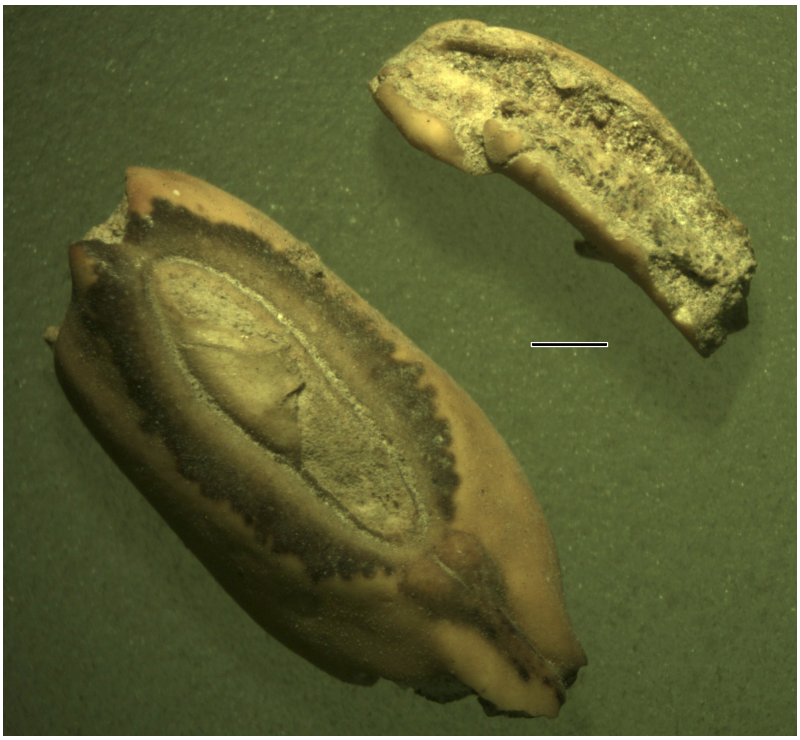

Figure B.86. Type FL - Fabaceae*;* sample φ1645, Lapa dos Bichos.



Figure B.87. Type FM - Fabaceae*;* sample φ276, Lapa dos Bichos.



Figure B.88. Type FQ; sample φ299, Lapa dos Bichos.

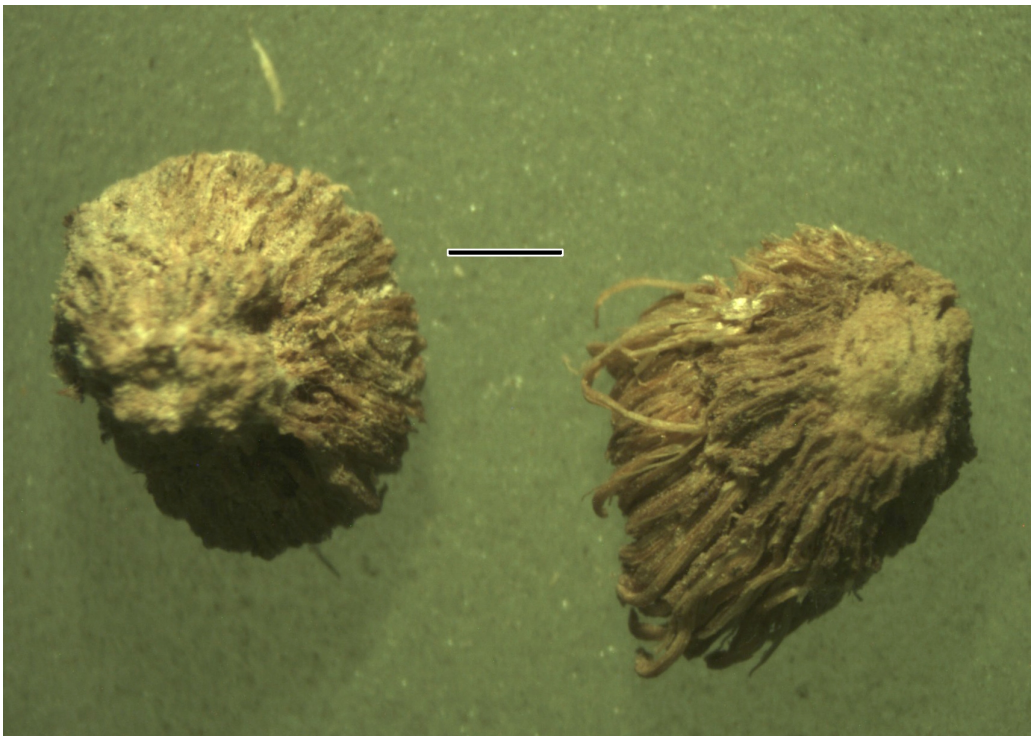

Figure B.89. Type FR; sample φ1619, Lapa dos Bichos.

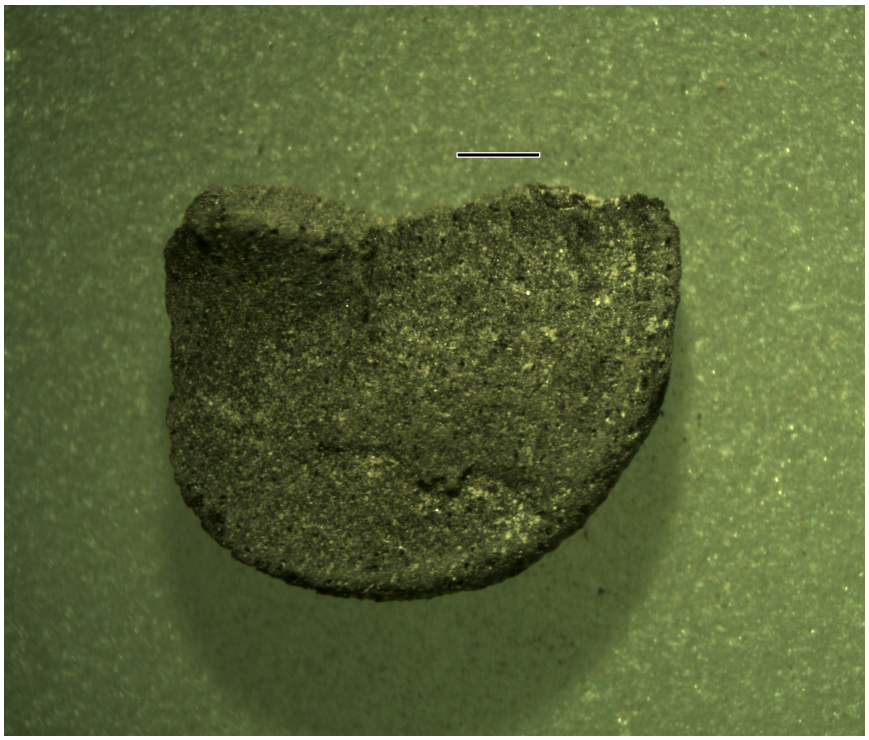

Figure B.90. Type FS; sample φ494, Lapa dos Bichos.

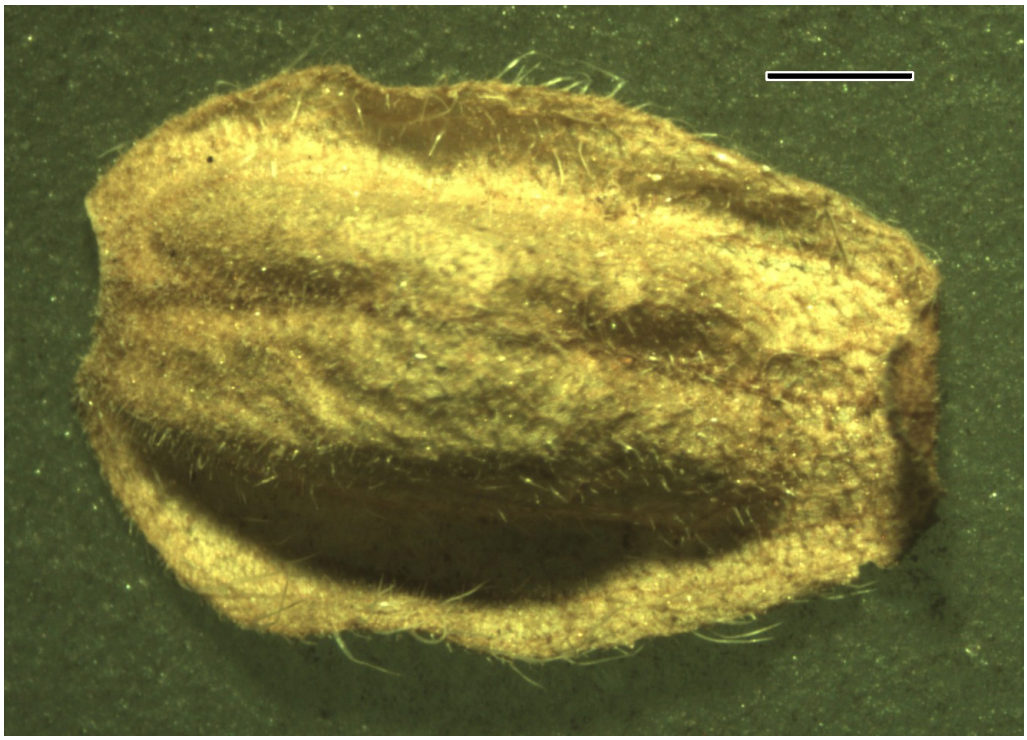

Figure B.91. Type FV; sample φ1494, Lapa dos Bichos.



Figure B.92. Type FW - *Lasiacis;* sample φ1626, Lapa dos Bichos.

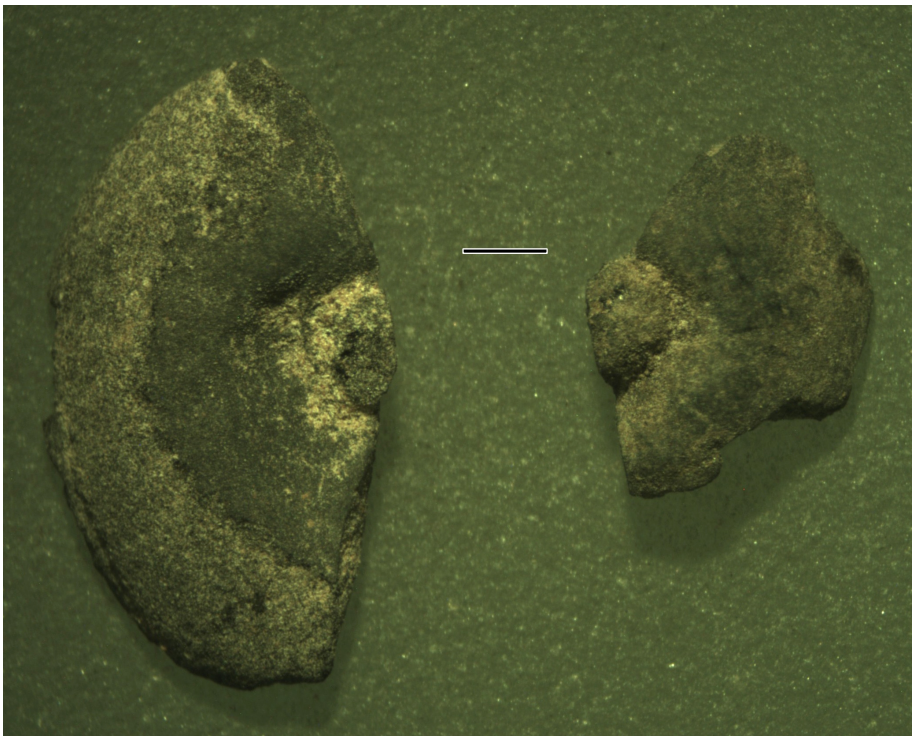

Figure B.93. Type FY*;* sample φ1232, Lapa dos Bichos.

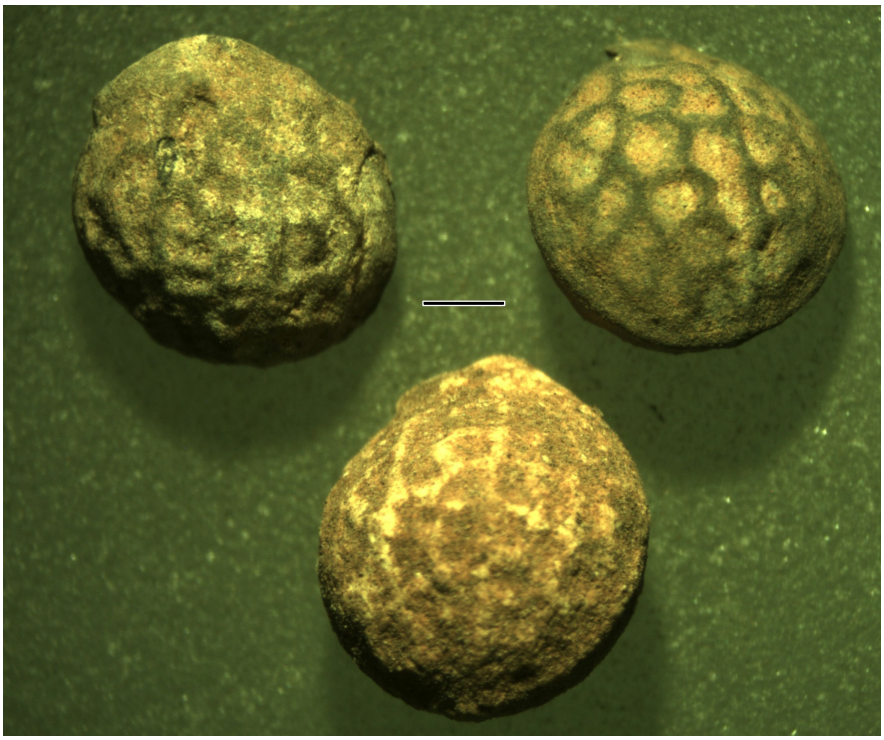

Figure B.94. Type FZ*;* sample φ346, Lapa dos Bichos.



Figure B.95. Type GA*;* sample φ457, Lapa dos Bichos (material to support sample to left of sample).



Figure B.96. Type GD - Aracaceae*;* sample φ458, Lapa dos Bichos.

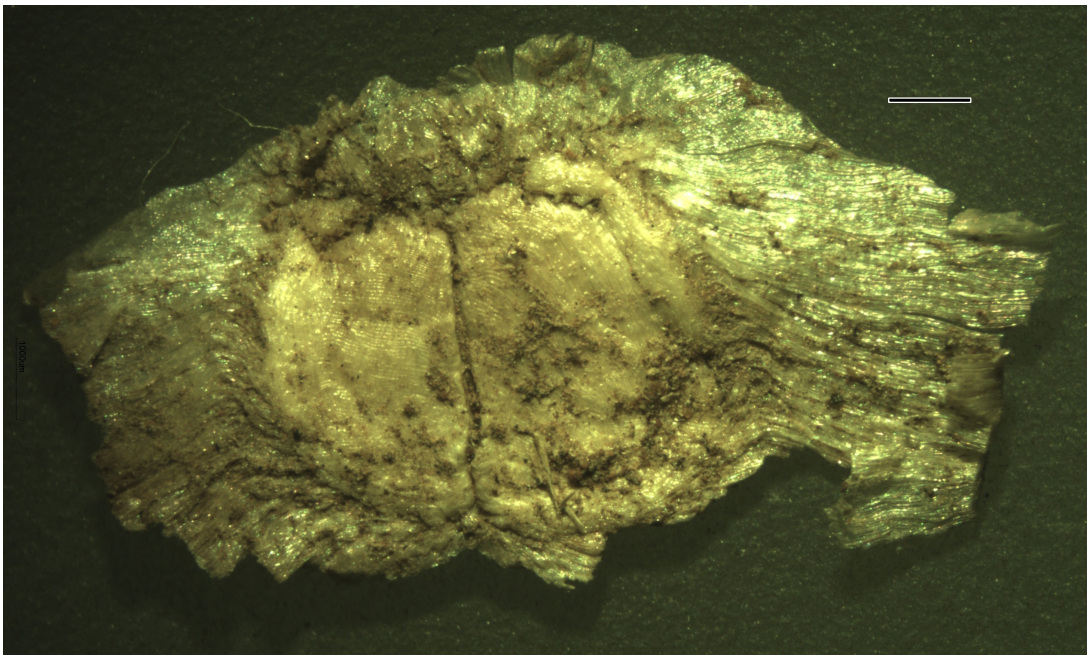

Figure B.97. Type GP - Bigonaceae*;* sample φ1037, Lapa dos Bichos.

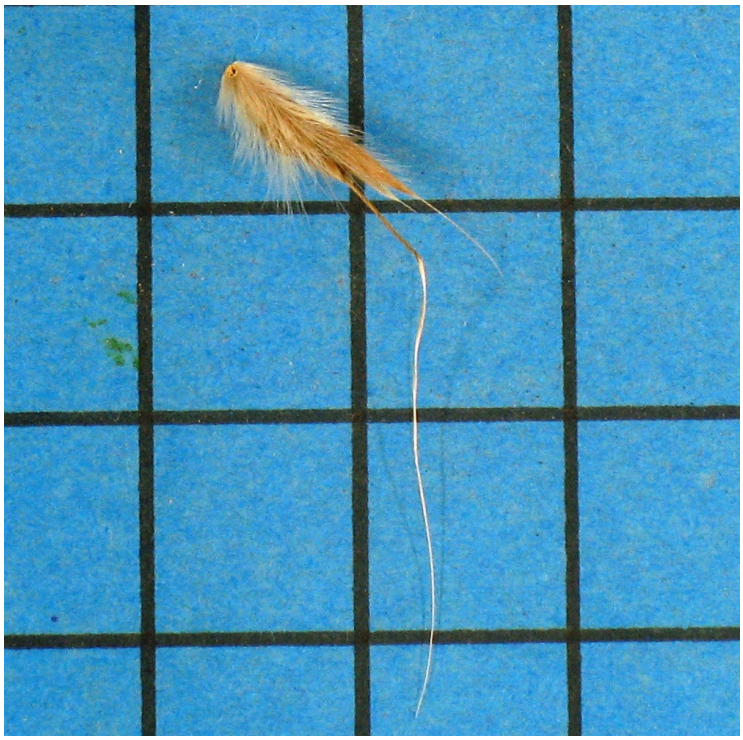

Figure B.98. Type GS - *Andropogon angustatus;* sample φ1083, Lapa dos Bichos.

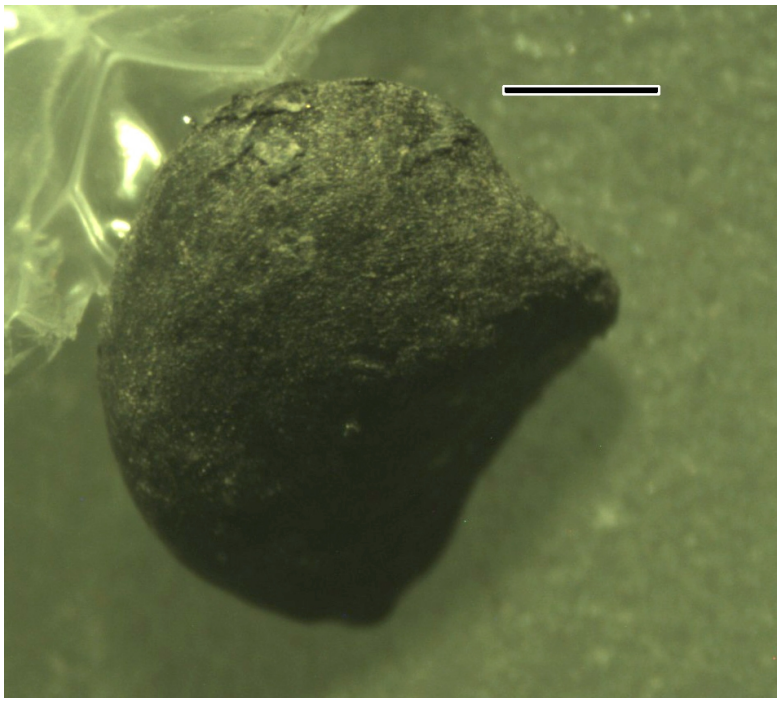

Figure B.99. Type HD - *Albertia* cf.*;* sample φ1215, Lapa dos Bichos (material to support sample to upper left of sample).



Figure B.100. Type HE*;* sample φ1649, Lapa dos Bichos.

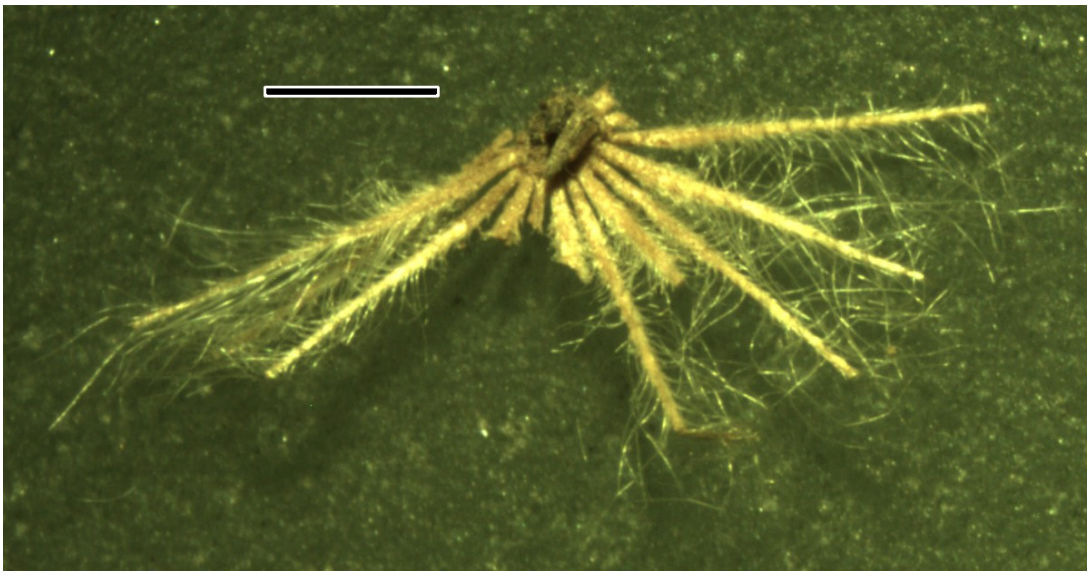

Figure B.101. Type HJ - *Trichogonia;* sample φ1129, Lapa dos Bichos.

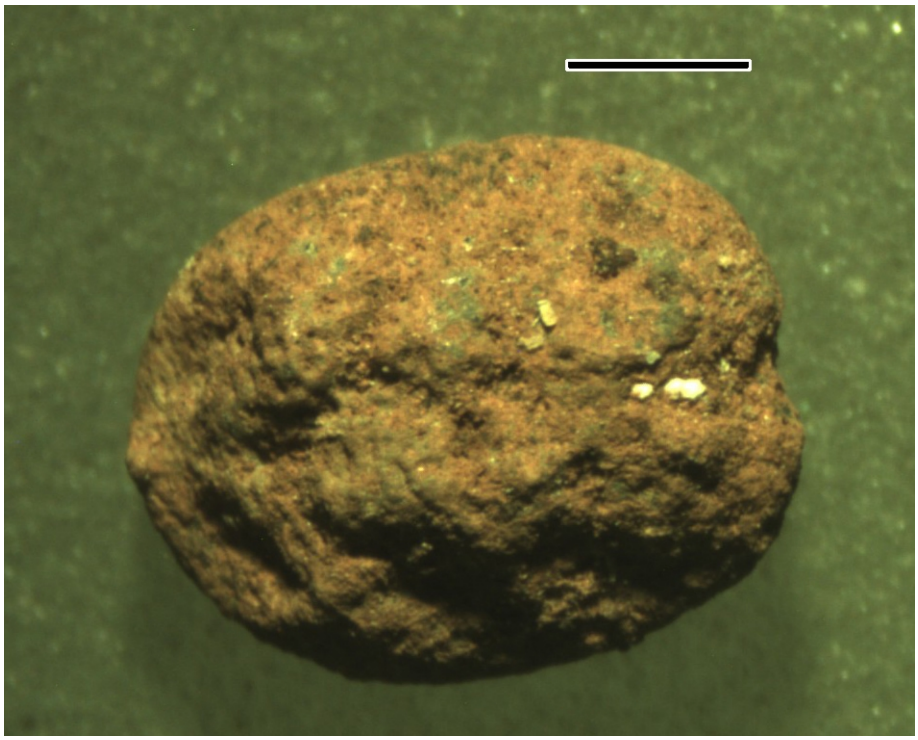

Figure B.102. Type HL*;* sample φ1103, Lapa dos Bichos.

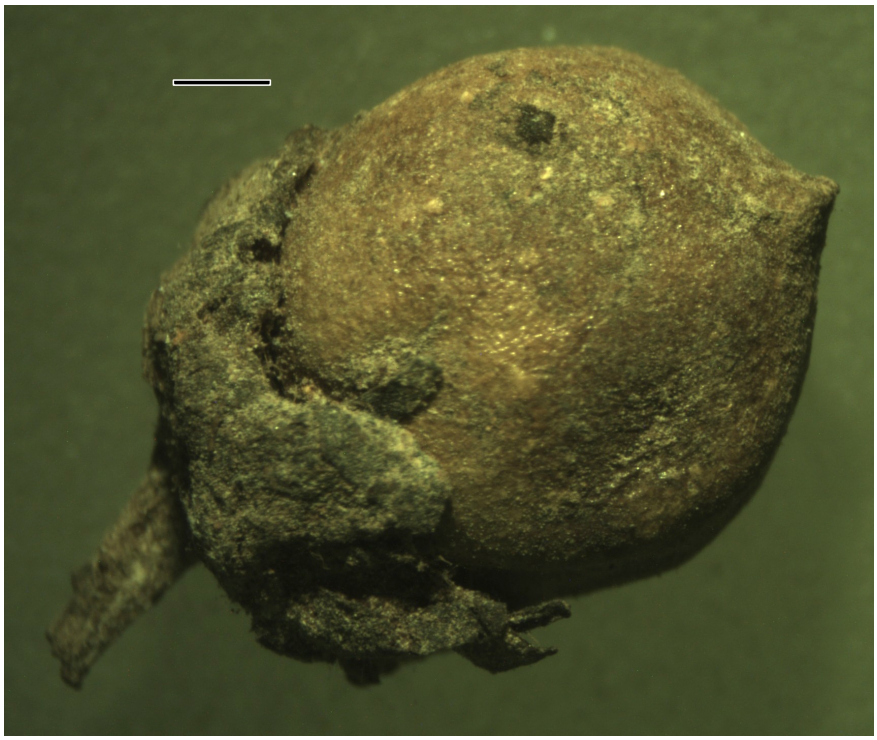

Figure B.103. Type HM; sample φ1734, Lapa dos Bichos.

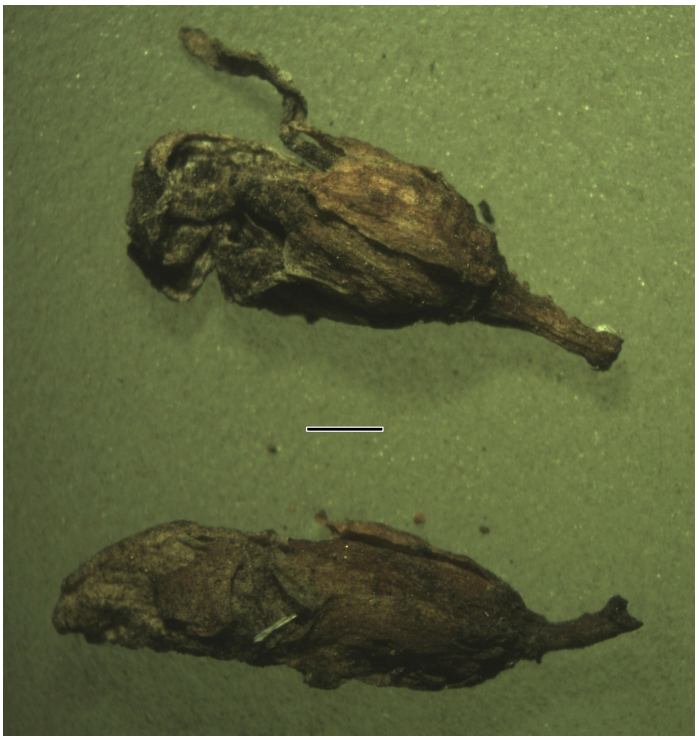

Figure B.104. Type HQ; sample φ2127, Lapa dos Bichos.

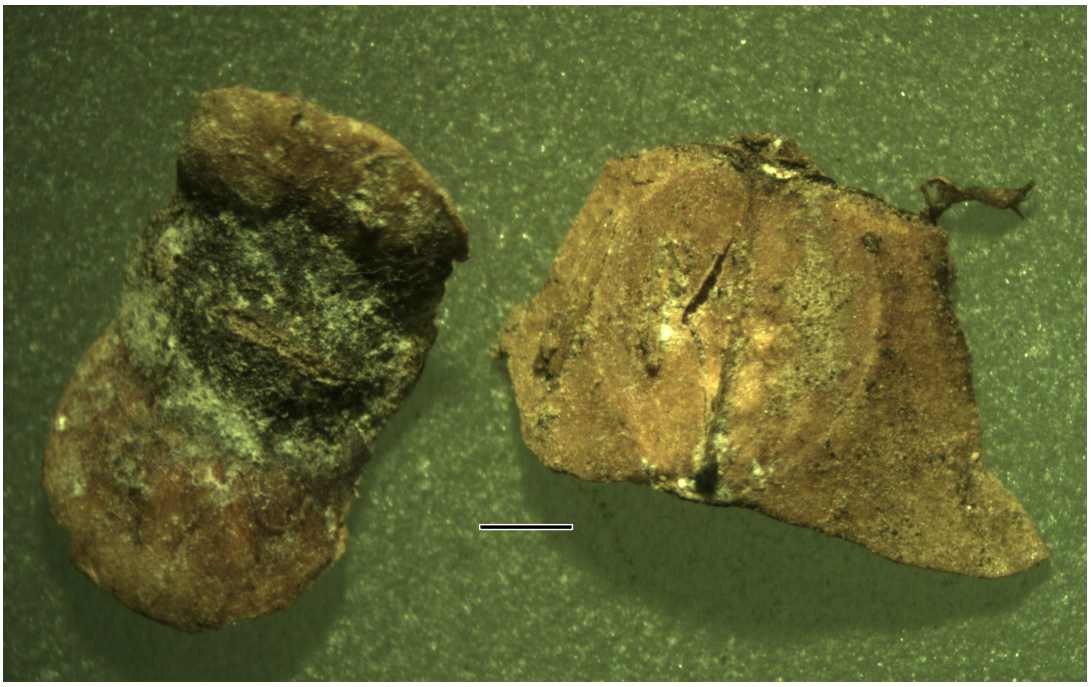

Figure B.105. Type IJ - *Gouania;* sample 7788.16, Lapa Pintada.



Figure B.106. Type IP; sample φ2157, Lapa dos Bichos.

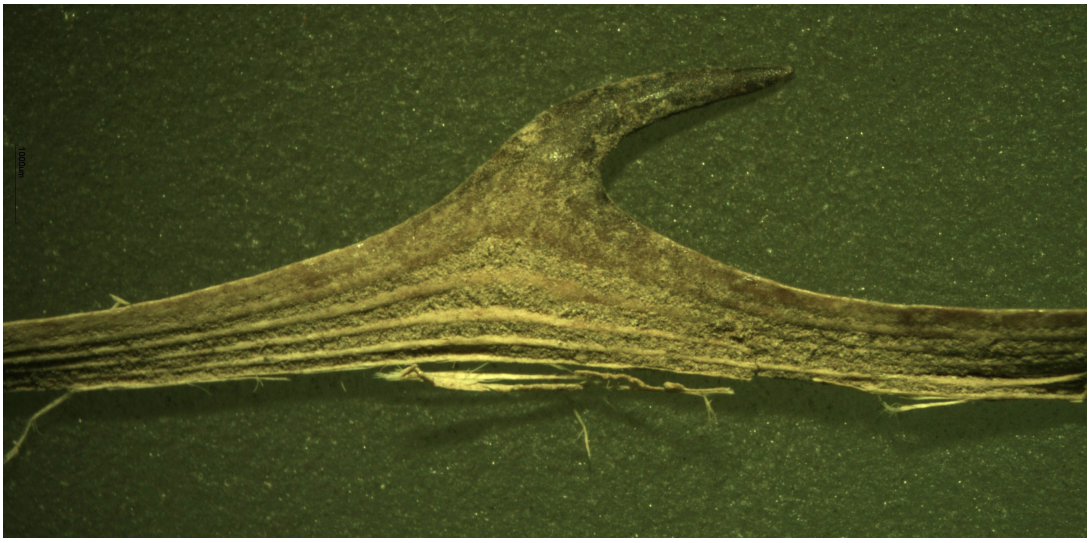

Figure B.107. Type IT - Bromeliaceae; sample φ1333, Lapa dos Bichos.

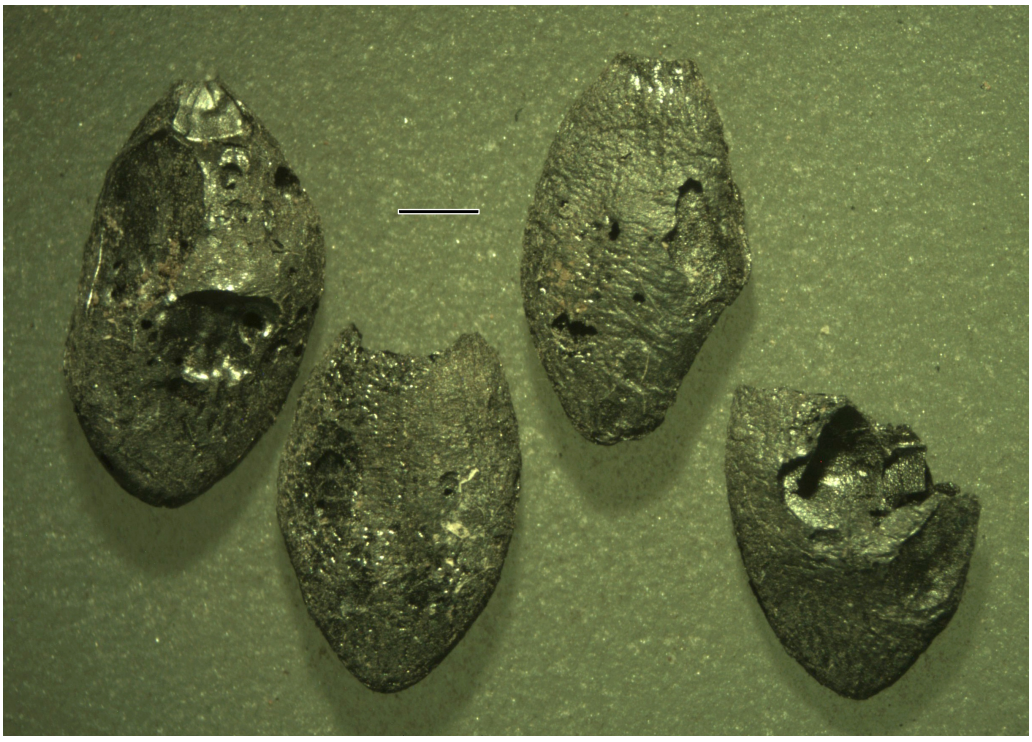

Figure B.108. Type IV; sample φ1255, Lapa dos Bichos.

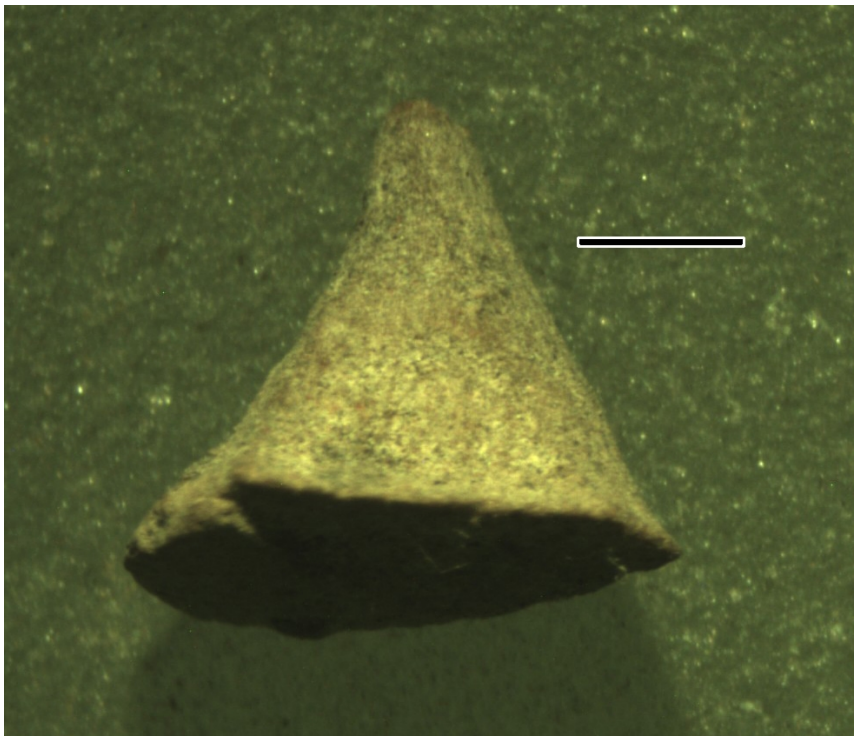

Figure B.109. Type JH - *Chorisia pubilfora* cf.*;* sample φ1217, Lapa dos Bichos.

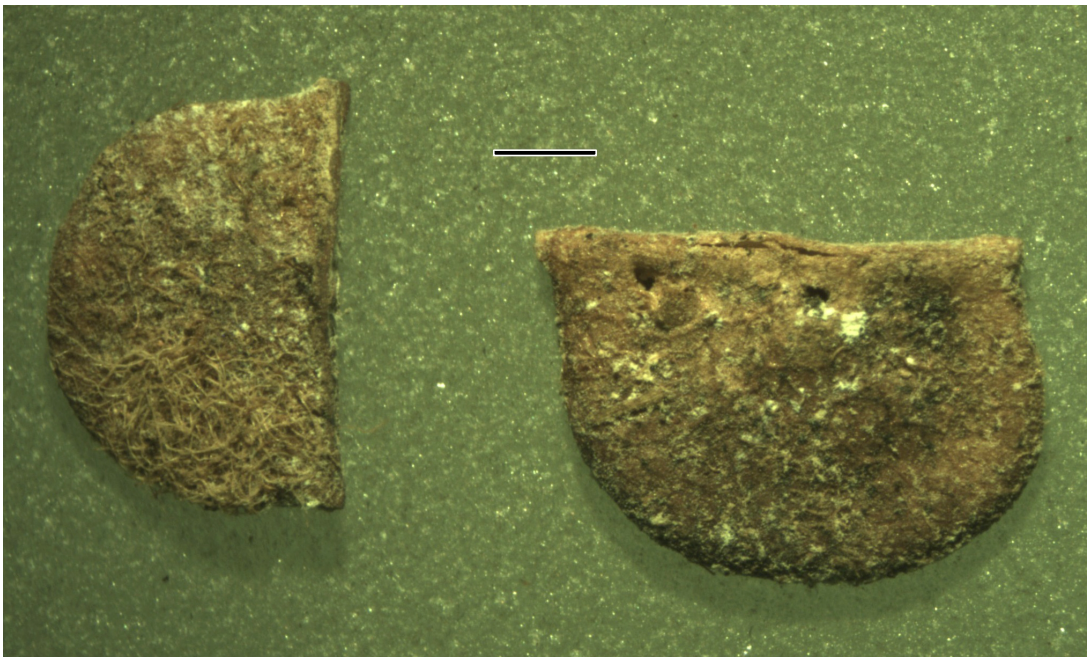

Figure B.110. Type JJ - *Desmodium incanum* cf.*;* sample 7778.15, Lapa Pintada.

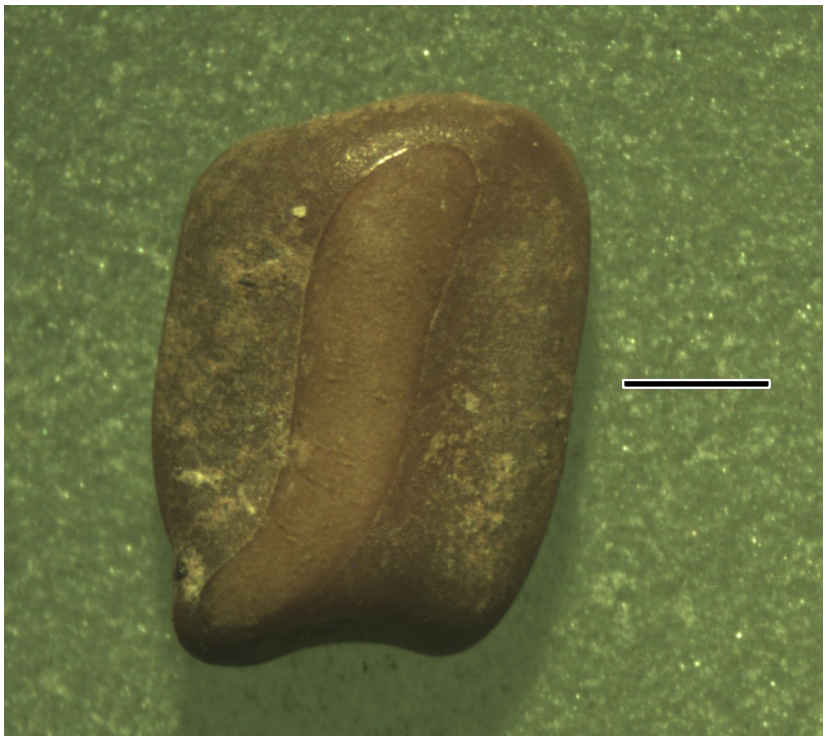

Figure B.111. Type JK; sample 7803.06, Lapa Pintada.

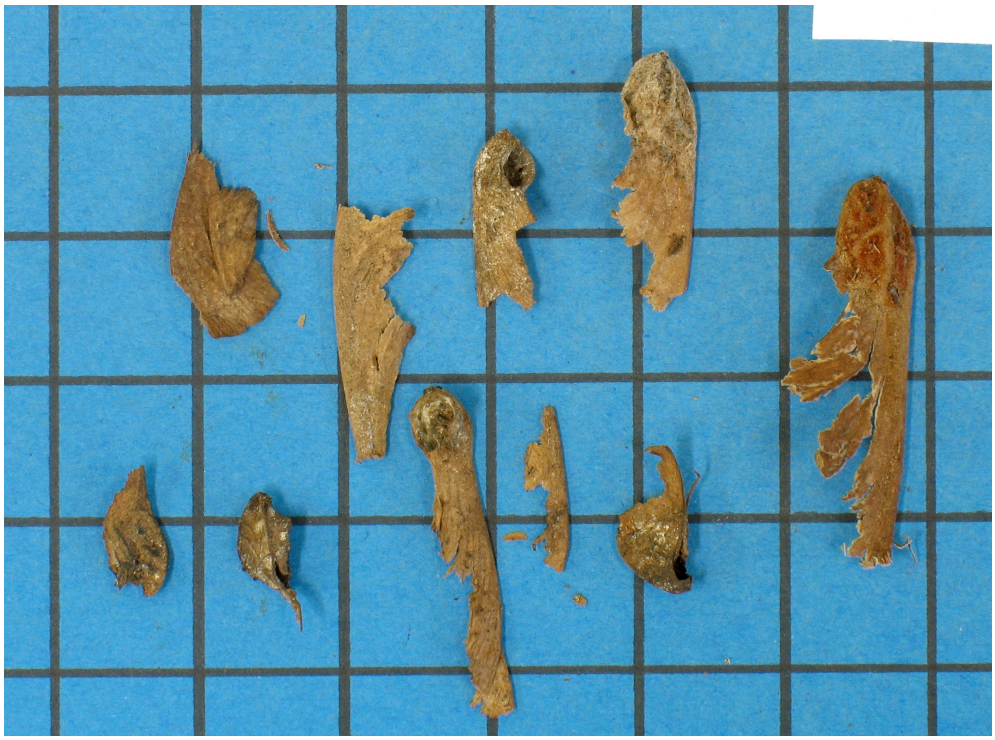

Figure B.112. Type JL - *Machaerium;* sample 7762.22, Lapa Pintada.

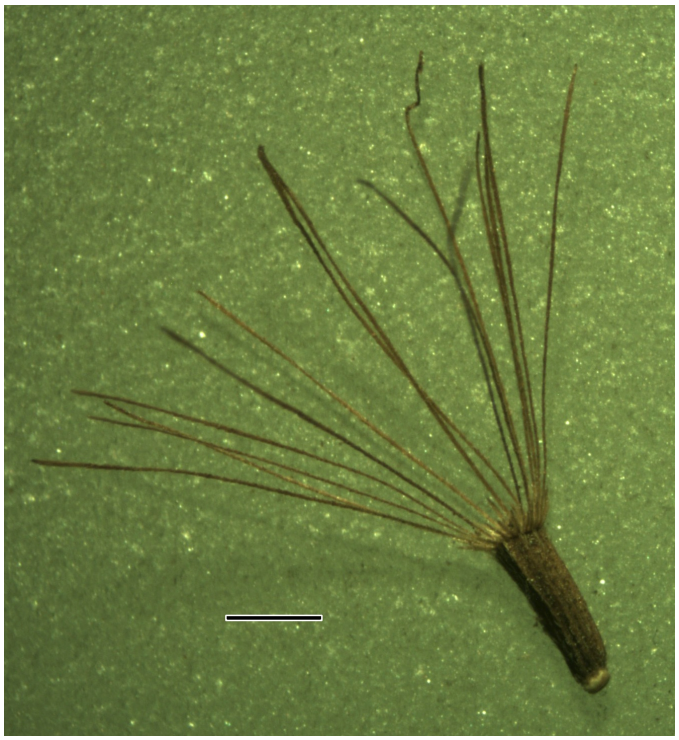

Figure B.113. Type JM - Vernonieae*;* sample 7769.05, Lapa Pintada.

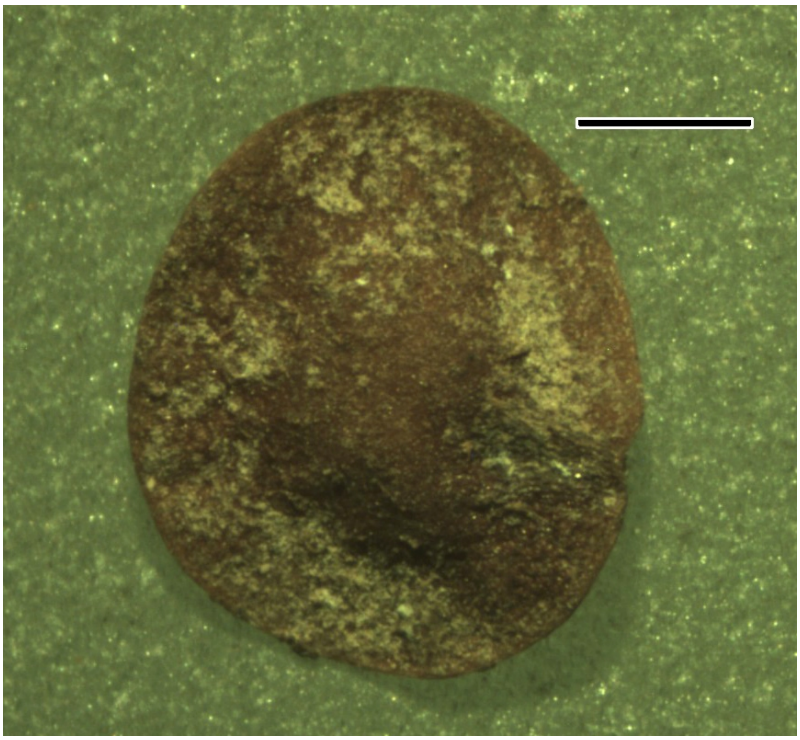

Figure B.114. Type JN*;* sample 7762.17, Lapa Pintada.

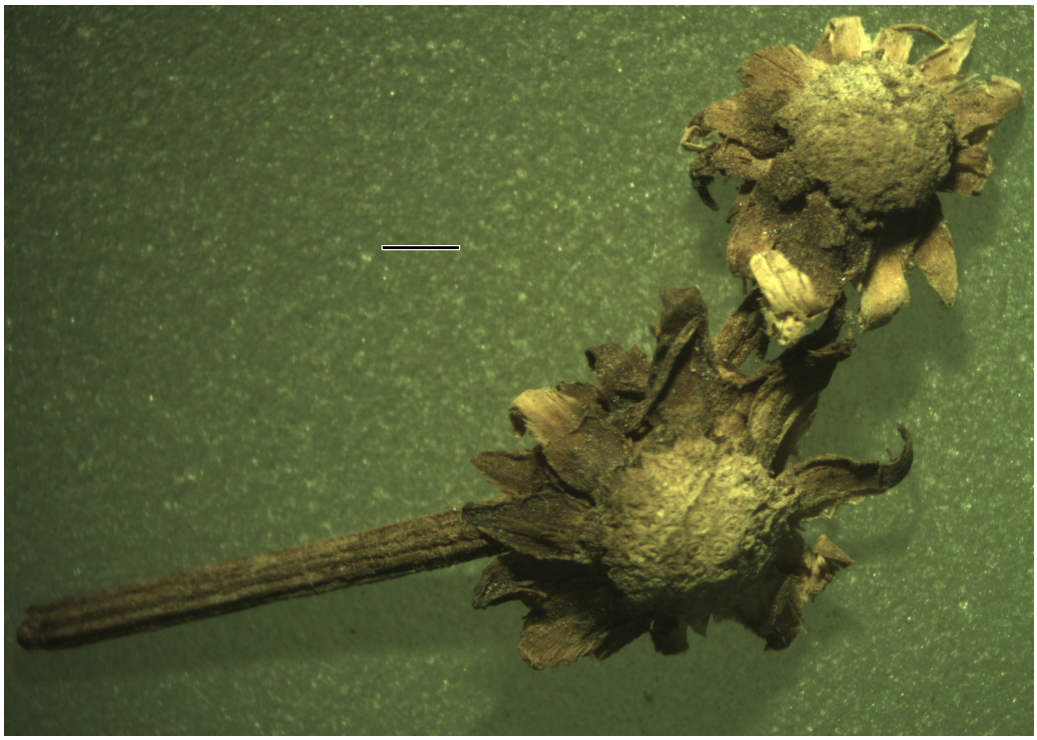

Figure B.115. Type JO - Asteraceae*;* sample 7761.03, Lapa Pintada.



Figure B.116. Type JP - *Acrocomia aculeata;* sample 7837.12, Lapa Pintada.

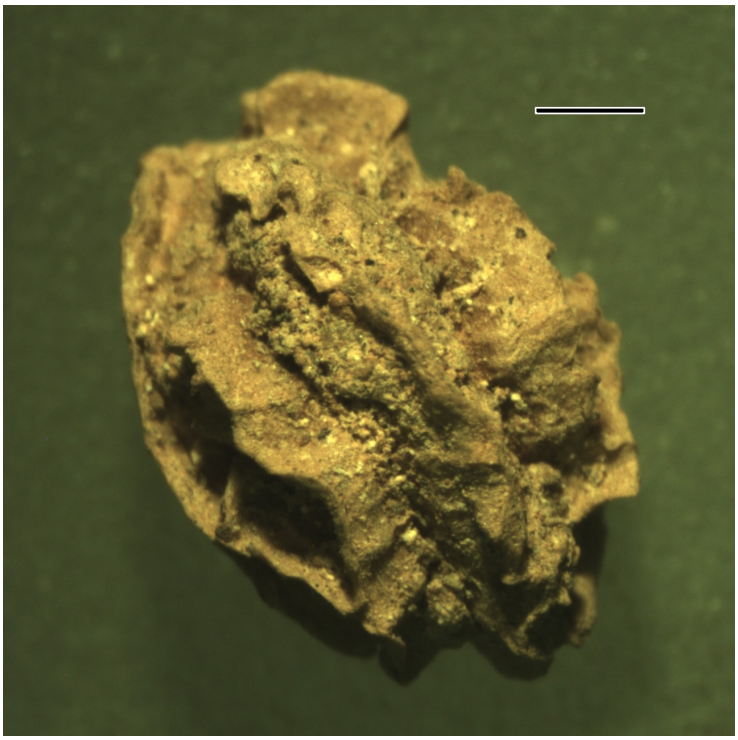

Figure B.117. Type JQ - *Carica;* sample 7917.06, Lapa Pintada.



Figure B.118. Type JR - Fabaceae*;* sample 7931-01, Lapa Pintada.

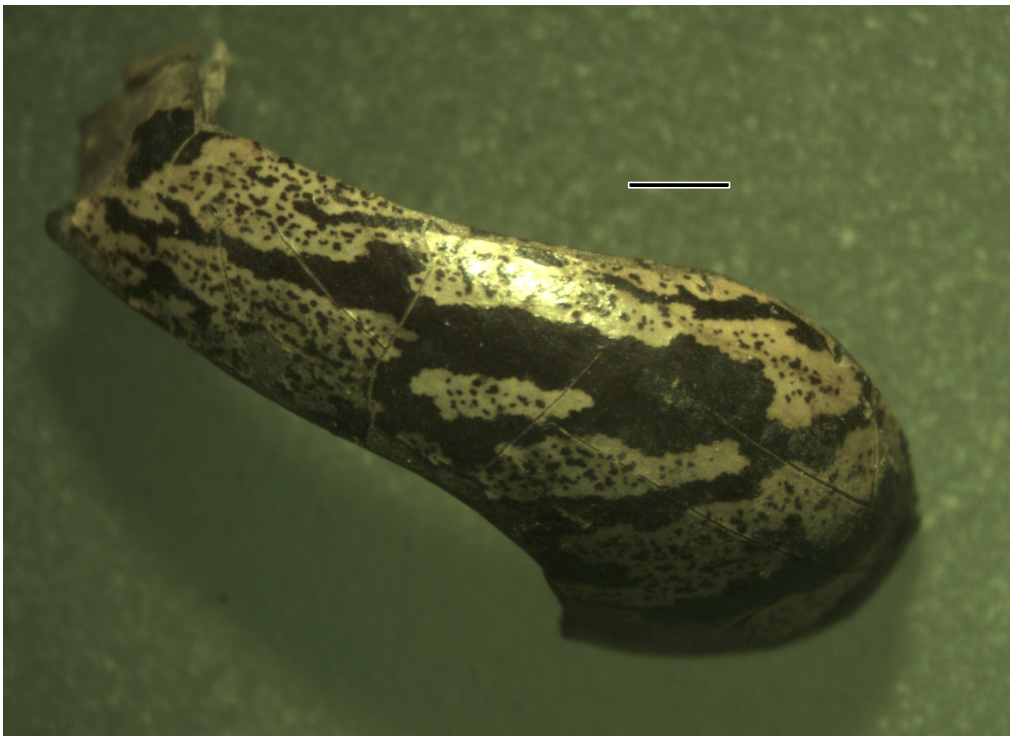

Figure B.119. Type JS*;* sample 7801.03, Lapa Pintada.



Figure B.120. Type JU - Fabaceae*;* sample 7772.02, Lapa Pintada.



Figure B.121. Type KB*;* sample φ1431, Lapa dos Bichos.



Figure B.122. Type KD*;* sample φ1126, Lapa dos Bichos.

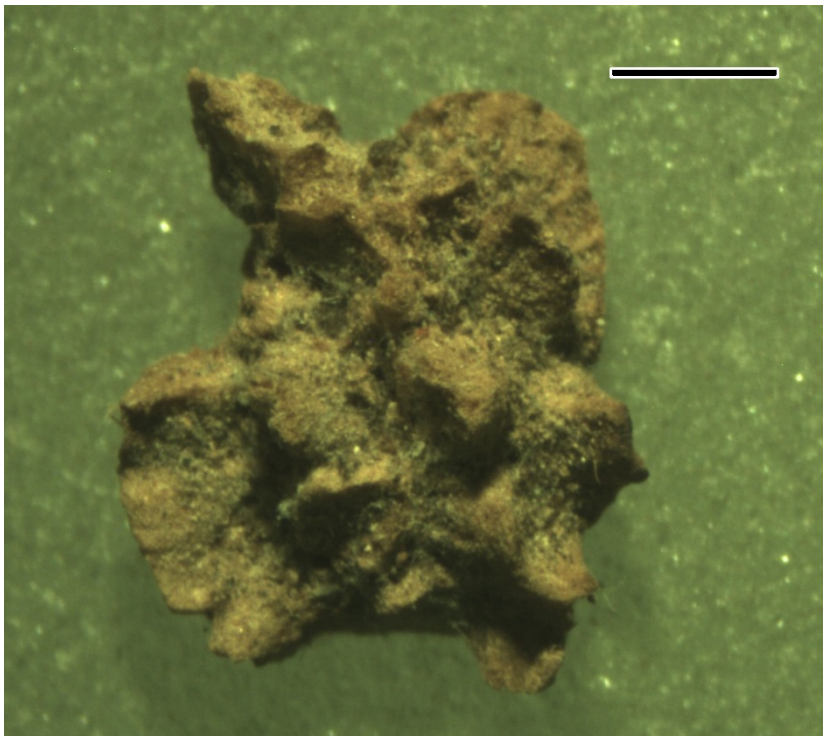

Figure B.123. Type KE*;* sample 7778.10, Lapa Pintada.



Figure B.124. Type KF*;* sample φ1327, Lapa dos Bichos.

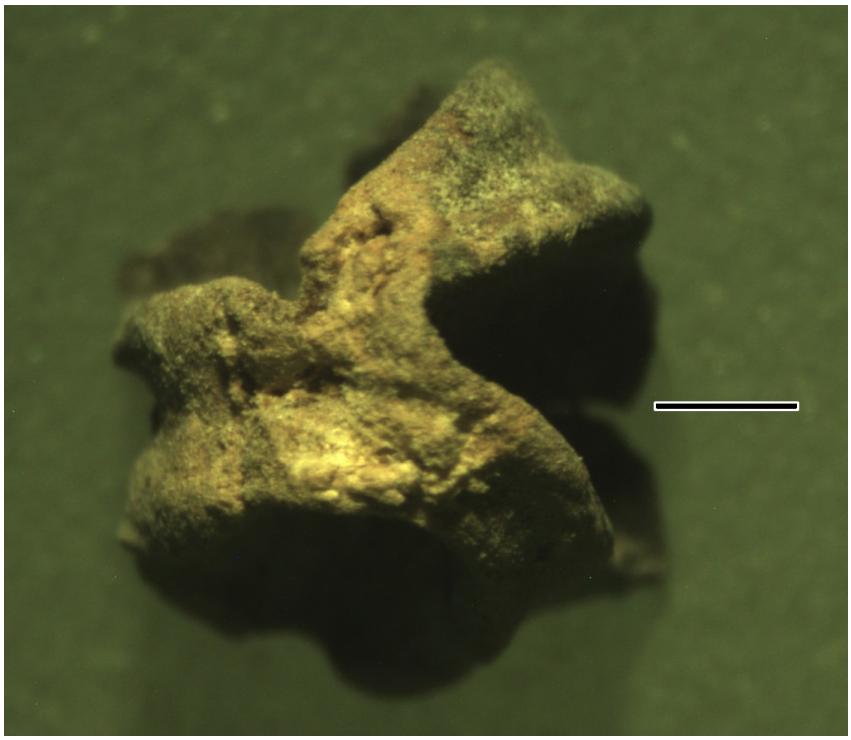

Figure B.125. Type KN*;* sample φ1752, Lapa dos Bichos.



Figure B.126. Type KT*;* sample φ2097, Lapa dos Bichos (material to support sample to left of sample).

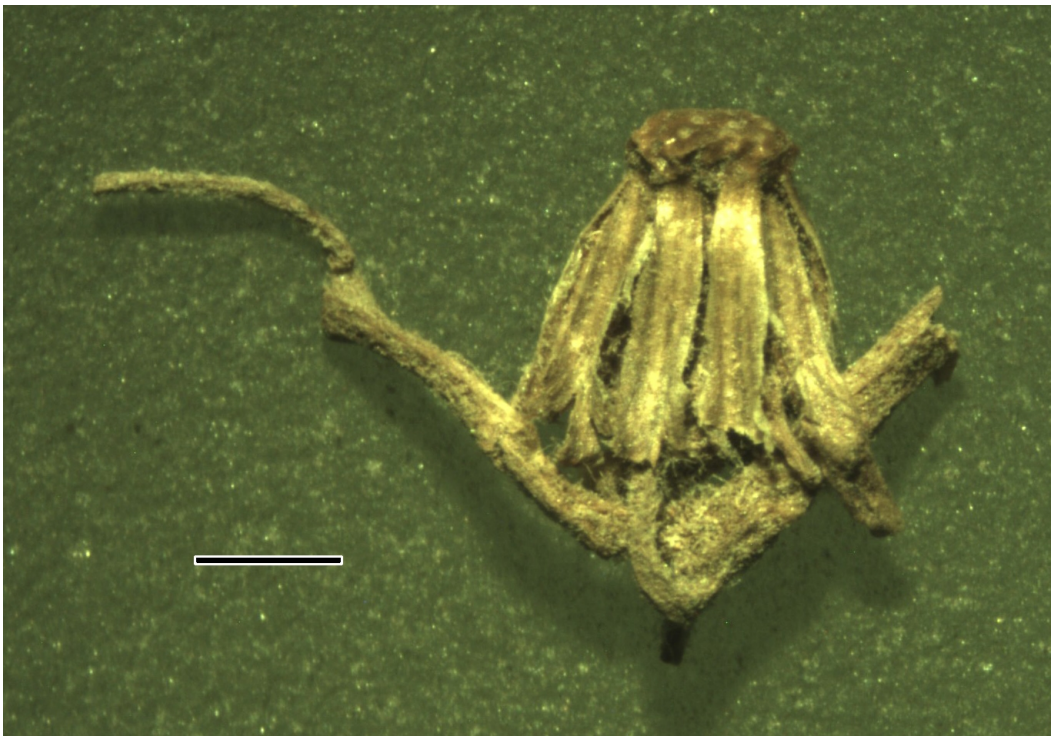

Figure B.127. Type LZ - Asteraceae*;* sample φ1202, Lapa dos Bichos.

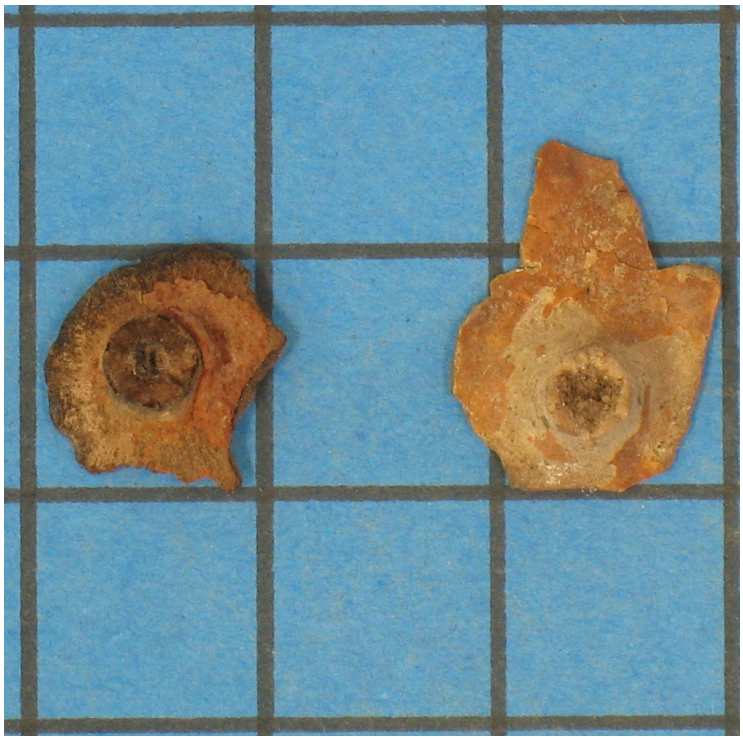

Figure B.128. Type NA - *Zanthoxylum;* sample φ632, Lapa dos Bichos.



Figure B.129. Type NC*;* sample φ652, Lapa dos Bichos.



Figure B.130. Type ND - *Anadenanthera;* sample φ640, Lapa dos Bichos.

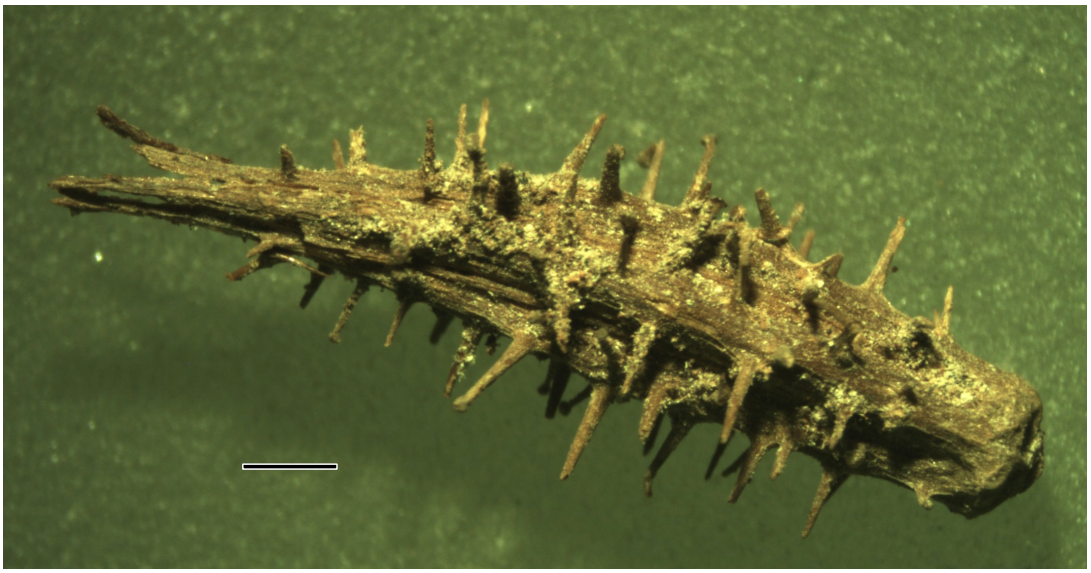

Figure B.131. Type NE - *Plumbago;* sample φ647, Lapa dos Bichos.



Figure B.132. Type NF - Fabaceae*;* sample φ666, Lapa dos Bichos.

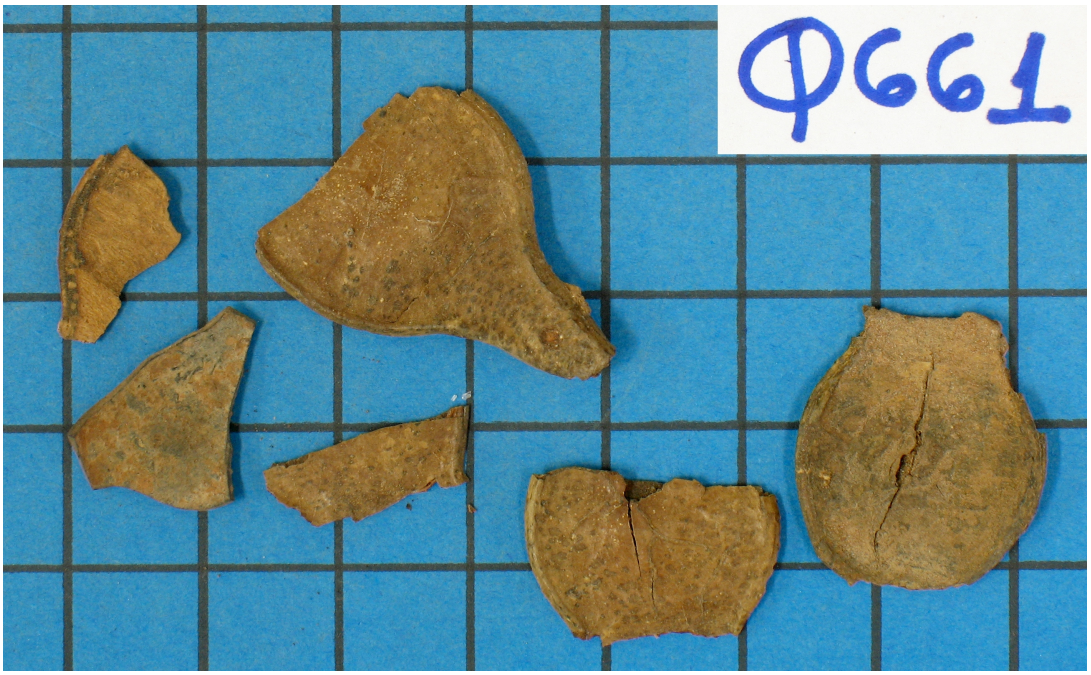

Figure B.133. Type NG - *Anadenanthera;* sample φ661, Lapa dos Bichos.



Figure B.134. Type NM - Fabaceae*;* sample φ662, Lapa dos Bichos.



Figure B.135. Type NP - Fabaceae*;* sample φ665, Lapa dos Bichos.

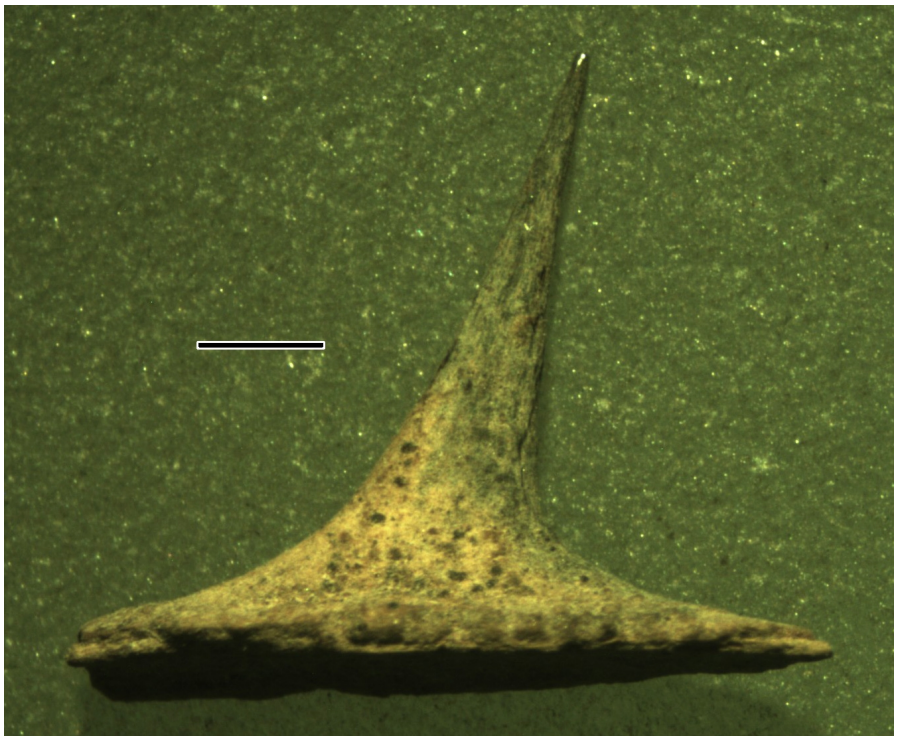

Figure B.136. Type NZ - *Zanthoxylum;* sample φ1191, Lapa dos Bichos.



Figure B.137. Type SPM*;* sample 7166-01, Lapa Pintada.



Figure B.138. Type STP - *Lasiacis;* sample 7822.05, Lapa Pintada.



Figure B.139. Type STV; sample 7776.17, Lapa Pintada.



Figure B.140. Type SVF - Euphorbicaceae; sample 7923-03, Lapa Pintada.



Figure B.141. Type SVH - *Phaseolus lunatus;* sample φ2131, Lapa dos Bichos.



Figure B.142. Type SVI - Eupatorieae*;* sample φ1311, Lapa dos Bichos.



Figure B.143. Type SVJ - Vernonieae*;* sample φ1096, Lapa dos Bichos.

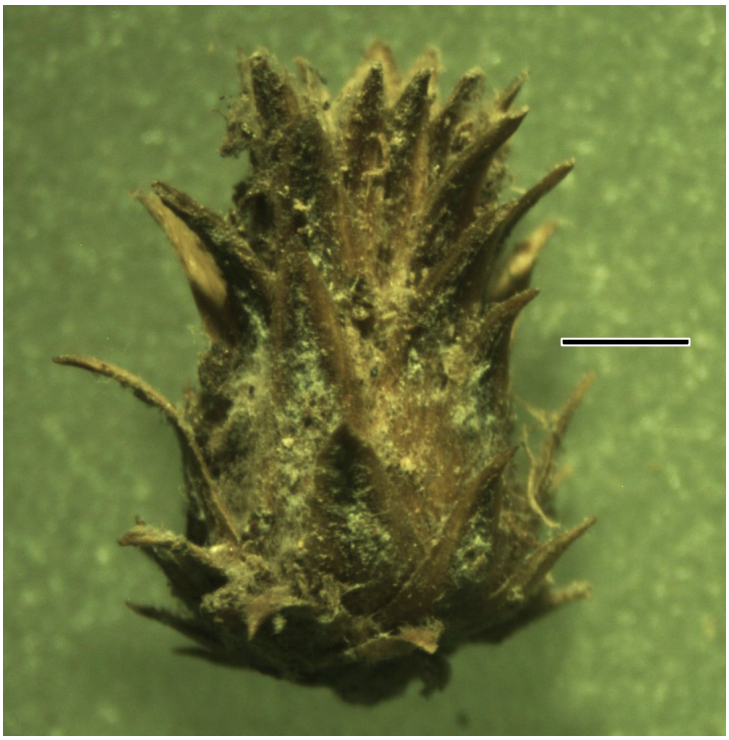

Figure B.144. Type SVK*;* sample 7769.08, Lapa Pintada.

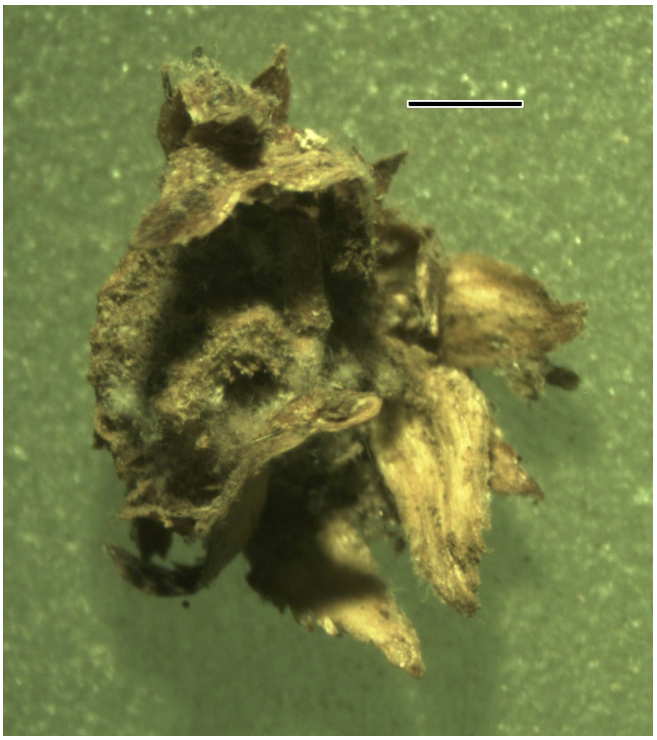

Figure B.145. Type SVL*;* sample 7769.07, Lapa Pintada.



Figure B.146. Type SVM - Vernonieae*;* sample 7778.07, Lapa Pintada.



Figure B.147. Type SVN - Vernonieae cf.; sample 7778.08, Lapa Pintada.

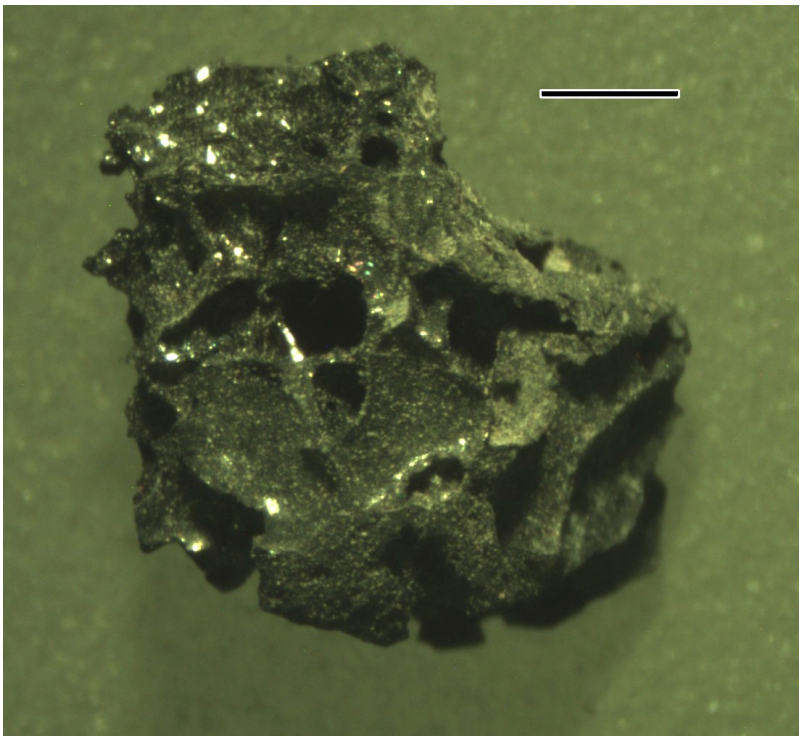

Figure B.148. Type VL; sample φ1722, Lapa dos Bichos.

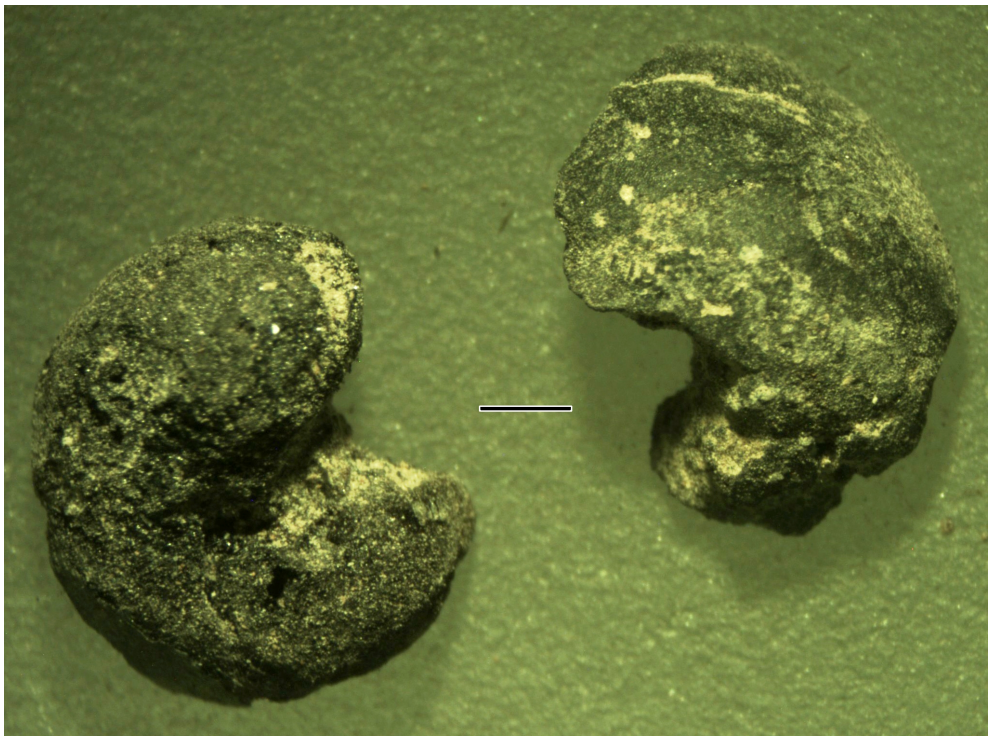

Figure B.149. Type WH - Fabaceae*;* sample φ1783, Lapa dos Bichos.

Appendix C. Plant identification notes for archaeological typology

Botanical identifications of archaeological plant remains are necessary such that it is possible to distinguish edible and useful plants, categories that can be essential to interpretations. The identification of archaeological specimens begins with general directions toward family or genus.

Plants were identified on the basis of comparison with specimens in herbariums, materials collected from modern markets, and digital plant databases. Herbarium visited include Jardim Botânico de Brasília (Brasilia, Distrito Federal), EMBRAPA Centro Nacional de Pesquisa de Recursos Genéticos e Biotecnologia (CENARGEN) (Brasilia, Distrito Federal), Universidade Federal de Brasília (Brasilia, Distrito Federal), Universidade Federal de Goiás (Goiana, Goiás), Museu de História Natural e Jardim Botanico da Universidade Federal de Minas Gerais (Belo Horizonte, Minas Gerais), INPA (Manaus, Amazonia), Museu Antropológico da Universidade Federal de Goiás (Goiana, Goiás), and Missouri Botanical Garden. The botanists and technicians at these locations were invaluable in assisting with plant identification. Specialists in vegetation and germplasm preservation at EMBRAPA CENARGEN and EMBRAPA Cerrados (Planaltina, Distrito Federal) were also consulted.

This appendix outlines some of the identifications that have been made for some types of archaeological samples (types given in bold) as well

as directions that have been followed for other types (listed in italics). Even where the leads have proved to be dead ends, they have led to a greater appreciation for the diversity of plant seeds. Notes are more complete as of identifications made in 2009. All errors are mine.

AA - *Zea mays*
Zea mays as identified by comparison with modern specimens.

AB - *Hymenaea*
Seed identified to the genus *Hymenaea*.

Comparitive material and identification confirmation came from the herbarium staff at the Jardim Botanico de Brasília.

Additional comparative material for Hymenaea was purchased in markets.

AC - *Hymenaea*
Fruit case identified to the genus *Hymenaea*. Comparitive material and identification assistance came from the herbarium staff at the Jardim Botanico de Brasília. Additional comparative material for Hymenaea was purchased in markets.

AD - *Lagenaria*
Lagenaria seeds from modern markets and reference to possible morphological variations from Heiser 1973.

Ron Liesner suggested *Selysia*, however the seed is too heart shaped (accessions 2923335, 3651998, 3311526, 3607935, 3854147, and 3292739). *Lagenaria siceraria,* accession 5257311, has seeds morphologically similar to the archaeological specimens.

AE - *Spondias tuberosa*
Spondias tuberosa. Identified by Antonieta Salomão, CENARGEN, who has collected seeds from this specie which were are being conserved as germplasm.

AF - *Manihot esculenta* cf.
Manihot CENARGEN (Antonieta Salomão and Luciano Bianchetti both thought the appearance was most like *M. esculenta*).

Looks like a Euphorbiaceae Gordon McPherson, Missouri Botanical Garden).

A significant number of exicatas of *Manihot esculenta* at the Missouri Botanical Garden have seed capsules and seeds. The size and shape of the seed capsules match the archaeological specimens.

AG - *Annona*
Annona. Identified by botanists at the Jardim Botanico de Brasília.

Annona seeds have a distinctive seed shape and seed covering. This seed coating covers an internal structure of many rays (or striations). Comparison based on a sample of *Annona montana,* accession 05060142, from Missouri Botanical Garden.

AH - *Passiflora*
Passiflora edulis. Identified by Antonieta Salomão, CENARGEN who has collected seeds from this specie which were are being conserved as germplasm.

AI - *Arachis hypogaea*
Arachis hypogaea as identified in reference to modern specimens.

AJ - *Gossypium barbadense*
The identification of type of cotton as *Gossypium barbadense* was made by EMBRAPA Cerrados professionals, the local name is algodão-rim-de-boi which alludes to the seeds appearance as if fused together. In the MO Botanical Garden I surveyed all *G. barbadense* collections with seeds. Only one of these had seeds that appear to be conjoined, accession number 2813326, on which the seeds were contained in an immature boil. Otherwise the *G. barbadense* seeds are individual and appear to have fiber all around them and where the fiber had been removed there were no attachment scars that would indicate prior seed fusion. (Consulted samples showing no conjoined seeds were accession numbers 2340198, 3609851, 1607592, 1809288, 2174380, 3145596, 5158712, 1611944.) It is possible that the fused seeds indicate a specific variety.

AK - *Caryocar brasiliensis*
Caryocar brasiliensis. Embrapa cerrados

AL - *Syagrus oleracea*
Syagrus oleracea. Jardim Botânico Brasília

AM - *Syagrus oleracea*
Syagrus oleracea. Jardim Botânico Brasília

AN - *Cnidoscolous pubescens*
Identified as *Cnidoscolous pubescens* on the basis of seeds from a modern specimen I collected.

AO - *Cnidoscolous pubescens*
Identified as *Cnidoscolous pubescens* in comparison with a modern specimen I collected and from images in *Árvores Brasileiras.*

Euphorbiaceae doesn't normally have the ridge seen on the archaeological specimen (Gordon McPherson, Missouri Botanical Garden).

A search of *Cnidoscolous pubescens* exicatas at the Missouri Botanical Garden turned up none with mature fruit.

AP - *Spondias mombin*
Spondias mombin CENARGEN

AQ - *Cucurbita*
Cucurbita. Commercial seed.

AR - *Largenaria*
Largenaria. Commercial fruit.

AT - *Cecropia*
Piperaceae. CENARGEN

From comparative material at the Missouri Botanical Garden it appears that the *Piper* seeds are superior and need the core of the fruit to stay together, e.g. *Piper longispercum*.

A very similar looking fruit that is very common in the tropics is *Cecropia* of the Cecropiaceae faimly, suggested by Ron Liesner. The *Cecropia* do not have a strong structural center, and thus are more like the archaeological specimens.

AU - Malpigiaceae
Malpighiaceae. CENARGEN

Ron Liesner, Missouri Botanical Garden, suggested to start by looking Bignonaceae and *Aspidosperma.* The seed of Apocynaceae (*Aspidosperma*) is extremely round whereas the archaeological specimens appear to have a lobed wing. Bignonaceae seems wrong because there are no specimens with obvious attachments between wing and seed that would easily rupture.

The wings on Malpigiaceae fruit are more consistent with the form of the archaeological specimens.

AV - *Lonchocarpus*
Lonchocarpus CENARGEN

In searching some random taxa of *Lonchocarpus* at the Missouri Botanical Garden I did not find a match for the archaeological specimen.

AW
Simaroubaceae, *Simarouba* EMBRAPA cerrados.

Fabaceae CENARGEN.

While consulting exicatas of *Manihot esculenta* at the Missouri Botanical Garden, I found seeds that appeared to be immature but cut along a cross section, on accession 04850356, that appear very similar to the cross sections of archaeological samples φ550 and φ25.

AX - *Terminalia argentea* cf.
Terminalia argentea CENARGEN.

Ron Liesner, Missouri Botanical Garden, suggested Combretaceae.

Within the exicata of the Missouri Botanical Garden there are a couple of *Terminalia* with fruits similar to *Terminalia argentea* and thus this type can be identified to genus with a probable species match.

AY - *Bixa orellana*
Seed of *Bixa orellana*. Seed identified by comparison from a São Paulo market sample.

Seeds also compared positively with specimen photograph on GRIN/PLANTS.

Identification verified at Missouri Botanical Garden herbarium in comparison with accessions 3899541and 3863645 containing seeds and 2785626 where seeds were within fruits.

AZ - *Ruprechtia*
*Ruprechtia (*Polygonaceae) is a perfect match for the structure and typology of the archaeological specimens, the seeds are also of the same size. An examination of multiple specimens from the Missouri Botanical Garden demonstrated that some of *Ruprechtia* have conjoined calyx and others do not. *R. salicifolia, R. tangara, R. tenurflora, R. viraur, R. albida,* and *R. apertia* do not have conjoined calyx and thus do not match the archeological specimens. *R. triflora* is conjoined half way up seed and has some fuzz on the calyx. *R. apertala* is conjoined half way. *R. ramiflora* is an almost perfect match and has a conjoined calyx. Other Polygonaceae do not have the same size or structure, *Triplais americana* for example has wings that begin above the seed and calyx is fuzzy (accession 3928687).

Poacaeae ou Cyperaceae CENARGEN.

Not Poaceae or Cyperaceae because the seed structure is three part, fused bract like covering is slightly prelude, Gerrit Davidse Missouri Botanical Garden.

BA - *Myracrodruon urundeuva*
Myracrodruon urundeuva. EMBRAPA cerrados had modern seed specimens.

BB
Seeds with characteristics of *Zea mays*.

BC - *Zea mays*
Zea mays seed identified in comparison with modern grains.

BD
Ron Liesner, Missouri Botanical Garden, suggested to start by looking Chrysobalinaceae, specifically *Chrysobalanus icaco*. *Chrysobalanus icaco* is a fleshy fruit with pit. Herbarium specimens demonstrate that drying the fruit appears to leave ridges and not an oval shape as in the archaeological type. It was not possible to see the shape of mature pits.

There might be a *Ficus* similar to BD.

BE - *Machaerium*
Machaerium CENARGEN (further suggestion of either acultifolium or villosum as the specie).

The seeds of *Machaerium* from Missouri Botanical Garden exicatas have the correct morphology to match the archaeological specimen.

BF

Malpigiaceae was suggested by some of the CENARGEN botanists, however Antonieta noted that the Malpigiaceae are tripartite while the archaeological specimen broke into two halves.

Ron Liesner, Missouri Botanical Garden, suggested that possibilities could be Flacouritiaceae, or Icacinaceae, but for the latter he thinks the ridges are too deep. For Flacouritiaceae the fruit of *Aporusa microstacny* has segments but not woody.

BH - *Thevetia peruviana*

Thevetia peruviana CENARGEN.

The Missouri Botanical Garden accession number 3245042 of *Thevetia peruviana* has seeds that are clearly equal to the archaeological specimen.

BI

Flower bud that hasn't opened. In Solonaceae the fuzz is called pubescence, however it does not rule out Malvaceae, Ron Liesner, Missouri Botanical Garden.

BJ

Identified initially as *Gossypium hirsutum* due to the fiber type and distinct seeds, no *Gossypium* with fragmentary seeds have been identified in herbarium collections. This type is unidentified.

BK - *Guazuma ulmifolia*

Guazuma ulmifolia EMBRAPA cerrados.

Specimens of *Guazuma ulmifolia* at the Missouri Botanical Garden have the same fruit characteristics, accessions 4038065 and 2694578.

BL - *Bixa orellana*

Fruit case of *Bixa orellana*. Identified by comparison with fruit in *Árvores Brasileiras.* PLANTS.

Identification verified at Missouri Botanical Garden herbarium in comparison with accession 2785626 and others.

BN - *Salacia*

Botanists at EMBRAPA cerrados suggested *Salacia*.

At CENARGEN *Salacia campestris* was proposed.

The seeds of *Salacia juruana,* accession 3635445 of the Missouri Botanical Garden, are very similar to BN but a little smaller. Many other *Salacia* have larger fruit and seeds, but the surfaces are hard to observe since the seeds were cut crosswise along with the fruit. There were no specimens of S*alicia campestris. Salicia elliptica* fruit on accession 4231627 are of a size approximately equal to type BN.

Leonia in the Violaceae have similar seeds.

BO

Maybe Vochysiaceae CENARGEN.

BP - *Zea mays*

These are burnt grains of *Zea mays.*

BR
Euphorbiaceae CENARGEN.

Is more like Rubiaceae than Euphorbiaceae (Gordon McPherson, Missouri Botanical Garden).

BS - Arecaceae
Arecaceae EMBRAPA cerrados.

Ron Liesner suggested Sapotaceae. I couldn't find any Sapotaceae of similar size or fomat.

BT - *Schinopsis brasiliensis*
Schinopsis brasiliensis was proposed by professionals at EMBRAPA Cerrados (November 2007).

Consultation of *Schinopsis brasiliensis* samples at MO allowed for the acquisition of one seed from the Cayola 931 collection, accession 5884529. Ron Liesner, Missouri Botanical Garden assisted. This seed appears to be a match, but needs to be compared in Brazil after the seed coating has been completely removed. Unlike the winged seeds of the Fabaceae family which have a more even profile, the *Schinopsis brasiliensis* (Anacardiaceae) thins from attachment toward the wing.

BU - *Annona*
Annona. EMBRAPA cerrados

Annona seeds have an internal structure of many rays (or striations). On a sample of *Annona montana,* accession 05060142. The shape of the seed is consistent with the archaeological material and the endocarp has a slightly different format than the seed covering

BW - Euphorbiaceae
Euporbiaceae. CENARGEN

BX - *Macairea radula*
Identified as a gall at EMBRAPA cerrados.

Species identification of *Macairea radula* made at CENARGEN by Bruno Machado T. Walter.

BY
Not a grass spikelet, Gerrit Davidse Missouri Botanical Garden.

The archaeological sample looks somewhat like *Eleocharis* (Cyperaceae).

CA
I suspect that this is a Fabaceae pod.

Ron Liesner, Missouri Botanical Garden, suggested that it could be an inflated fruit with calyx attached.

CD - *Mucuna sloanei*
Mucuna sloanei CENARGEN (olho de boi)

CG - Malpigiaceae
Caryocaraceae proposed at CENARGEN.

Byrsonima has seeds extremely similar to the archaeological specimen type CG.

CK - Syagrus
Syagrus, portion related to reproduction. This portion of Arecaceae is similar on the *Attalea*, but the shape is distinctly different.

CL - Malpigiaceae
My suspicion is that this is a Malpigiaceae.

The sample *Amorimia amazonia* from Missouri Botanical Garden the correct size and has the correct morphology.

Ron Liesner, Missouri Botanical Garden, it could be Sapindaceae.

CO
This may be a portion of a Euphorbiaceae.

CQ - Fabaceae
Fabaceae CENARGEN

CU
Possibly Fabaceae CENARGEN

CW
Ron Liesner, Missouri Botanical Garden, suggested to start by looking at Bombicaceae and Gossypium. A cursory search did not turn up seeds small enough.

Malvastrum americanum has inflorescences with fibrous hairs, but the size is too large.

CX
Has some characteristics similar to Vitaceae.

DA
Maybe Sapindaceae CENARGEN.

Ron Liesner, Missouri Botanical Garden, suggested Nyctaginaceae, specifically *Boerhavia.* The plants from the *Boerhavia* are too small.

Qualea parviflora (Vochysiaceae), accession 5956227, has a central divider in the fruit that is similar to type DA.

DC - Solanaceae
Solanaceae. Seeds of *Solanum, Datura,* and *Capsicum* are difficult to distinguish from herbarium specimens.

The celled surface texture of *Capsicum* seeds are the same as those of the archaeological specimens according to Luciano de Bem Bianchetti, CENARGEN, however this characteristic is found in other genera of the Solanaceae. Luciano suggested using the position of the embryo for a better identification.

DE - *Byrsonima*
Identified as *Byrsonima*. The seed surface has surface characteristics consistent with Myrtaceae.

DH - Arecaceae
Arecaceae JBB.

This is an immature fruit of Arecaceae.

DJ - Gnaphalieae
Identified as Asteraceae at CENARGEN. Identified as member of the Gnaphalieae tribe, possibly *Achryocline* at the Missouri Botanical Garden with assistance from John Pruski.

DO - *Myrciaria*
This archaeological material is identified as jaboticaba, *Myrciaria.*

DS
If the wing of the archaeological specimen was round, Ron Liesner suggested the possibility of Bignonaceae.

DU - *Amburana cearensis* cf.
Amburana cearensis CENARGEN.

From specimens at the Missouri Botanical Garden, *Amburana cearensis* fruit matches the archaeological specimen in shape and height. There is one specimen with mature seeds, accession 1628870. *A. acaeana* has similar pods but no mature seeds for comparison.

DV - Euphorbiaceae
Euphorbiaceae CENARGEN, definitively not *Manihot.*

Could be a Euphorbiaceae, (Gordon McPherson, Missouri Botanical Garden).

DW
I suspect Struthanthus orbicularis is a possibility due to the images from STRI. Fruits I saw at the Missouri Botanical Garden had dried flat and smashed. I do not know if the fruits were mature, none were open.

Ron Leisner suggested that it could be a Malvaceae (similar to the pod of okra).

DX
Palicourea marcgravia Embrapa cerrados

EB - Arecaceae
Arecaceae. Talvez babaçu, *Orbignya phalerata*, Embrapa cerrados.

Ron Liesner suggested Sapotaceae. Sapotaceae fruit apear to be much smoother, no woody texture, and fewer internal divisions.

EC - Eupatorieae
Asteraceae. Flower bracts. Eupatorieae tribe. Within the collection, *Chromolaena odorata* has similarly veined bracts. *Chromolaena laevigata* has similarly veined bracts and increasing sizes. The archaeological material has veined bracts of increasing sizes. Missouri Botanical Garden. Assistance from John Pruski.

EG - *Scleria*
I thought this could be Cyperaceae or Arecaceae.

Scleria, one distinctive characteristic is the three ridges on the hypogynium, Gerrit Davidse Missouri Botanical Garden. Used as a bead. *Scleria macrophylla* has achenes of a size that perfectly match the beads. *Scleria eggersiana* is slightly smaller but has the same shape.

The possibility of *Eleocharis* has been eliminated as the seeds are too small to produce the seeds used for the beads.

EJ
Is not Poaceae or Cyperaceae (Gerrit Davidse Missouri Botanical Garden)

EK - *Bixa*
Bixa CENARGEN

EN - Fabaceae
Fabaceae CENARGEN

EO - *Mesosetum*
Mesosetum of the Paniceae tribe, Poaceae, Gerrit Davidse Missouri Botanical Garden.

EQ - *Chromolaena*
Asteraceae. Seed. Style has fused lobes. The style looks like *Chromolaena odorata, access*ion 5622649, of the Eupatorieae tribe. Missouri Botanical Garden herbarium. Assistance from John Pruski.

ER
Could be a Euphorbiaceae, (Gordon McPherson, Missouri Botanical Garden).

ES - *Macroptilium*
Fabaceae, *Macroptilium lathyroides* CENARGEN

Macroptilium lathyroides has seeds much more rounded in profile than the archaeological specimen. *M. erythroloma* appeared to be a good match, while *M. atropurpurem* has similarly winged seeds with greater morphological variability.

EV
I think this could be a Polygonaceae seed or an imature Violaceae fruit (such as *Rinorea sylvatica* as pictured by STRI).

EW - *Ficus*
I thought it could be Malvaceae due to the fused sepals, superior ovary and fruit appearance of fused schizocarp.

Ron Liesner suggested cutting one open to find out if the seeds are consistent with Malvaceae. He also suggested Myrtaceae, but I believe they have inferior ovary position.

Ficus caballina has striations equal to those on the archaeological fruit and morphology of the connection is correct, however the sizes do not match.

EX - *Alibertia edulis*

This archaeological specimen was identified as *Alibertia edulis* in comparison with STRI images.

In the Missouri Botanical Garden collections the seeds of *Alibertia edulis* are hard to see due to inclusion with fruit, however my impression was that that archaeological specimens are slightly larger.

EY

Archaeological specimen shows strong veination in what appear to be fused sepals or a calyx tube. The Lamiaceae and Lythraceae family have been suggested, Ron Liesner, Missouri Botanical Garden.

Lamiaceae is probable as *Hyptis sidifolia* has an equal structure on flowers with branching from notes and strong veination. Structure in other Lamiaceae like *Lepichinia graveoleus*is branching from stem nodes.

Tarasa capitata (Malvacaeae) appears to have flower clusters however the sepals are not strongly enough veined for this archaeological type.

FB - Poaceae

Poaceae CENARGEN.

Possible Poaceae floret, Gerrit Davidse Missouri Botanical Garden.

FE

From the one sample φ204, the item pictured in the lower left could possibly be a grass floret. The remaining three are not Poaceae and the connection does not look quite right for Amaranth, Gerrit Davidse Missouri Botanical Garden

FH - *Cavanillesia*

I think it could be *Cavanillesia arborea.*

Similar fruit are pictured in ARVORES and for GRIN specimen TARS 1737 (*Cavanillesia platanifolia)*.

At the Missouri Botanical Garden there are no samples of *Cavanillesia arborea*, maybe the name has changed. Other *Cavanillesia* have fruit with similar morphological characteristics, therefore the genera identification is probably good.

FJ - *Phaseolus vulgaris*

Phaseolus vulgaris identification in comparison with modern seeds.

FL - Fabaceae

Identified as Fabaceae

FM - Fabaceae
Identified as Fabaceae

FQ
Flower buds or bracts, alternate.

FR
I thought this could be Rubiaceae. There is no support for this from specimens at the Missouri Botanical Garden.

FS
Possible Fabaceae, seed split in two halves and has correct shape. The external texture of the seed is very distinctive and should in identification.

FV
Possible Asteraceae bract.

FW - *Lasiacis*
Lasiacis, identified by Gerrit Davidse Missouri Botanical Garden, he commented that this is one of the largest grass seeds in the area.

FY
Ron Liesner suggested the possibilities of a cup calyx from the Lauraceae family or an imature Eschweilera in the Lecythidaceae family.

FZ
Similar to pictures of *Passiflora* and *Byrsonima.* At Missouri Botanical garden *Zanthoxylum sprucei*, accession 05075060, is similar but probably not a match because it breaks easily into two halves.

GA
Has four locus and thus could be a *Cordia* (Boraginaceae), Ron Liesner.

GD - Aracaceae

I have identified this as Aracaceae

GP - Bigonaceae
Ron Liesner suggested Bignonaceae for the translucent wings or *Gouania lupidoies* in the Raminaceae.

Bignonaceae herbarium samples at the Missouri Botanical Garden were consulted. *Arrabidaea cinnamomea*, accession 2822474, and *Arrabidaea candigera*, accession 3813974, have seeds very similar to the archeological specimen, however the wing is translucent and does not encompass the seed entirely. *Cybistax antisyphyllitica* is a better match for the wings, but the seed is too heart shaped. *Jacaranda* may have the best matching seeds as seen in J*acaranda hesperia* accession 2598540.

GS - *Andropogon angustatus*
Andropogon angustatus of the Andropogoneae tribe, Poaceae. The awn is very specific, Gerrit Davidse Missouri Botanical Garden.

HD - *Albertia* cf.
Seeds with morphological characteristics very similar to type EX, especially curvature and surface texture.

HE
The Paniceae tribe doesn't seem quite right due to the strong veination, Gerrit Davidse Missouri Botanical Garden.

HJ - *Trichogonia*
Asteraceae. Tribe Trichogonia. Has a papus plumos. Suggested taxa are *Trichogonia* and *Tridox procumbens.* From observations at the herbarium, The papus of *Tridox procumens* falls apart when separated from the ovary and the ring in the center was hollow, accessions 4295603 and 4295531. The papus stays together as a group in *Trichogonia salviaefolia* accession 2698195 and *Trichogonia rhadinocarpa* accession 2939544, when separated from the ovary. Thus the archaeological specimen is likely *Trichogonia*. Missouri Botanical Garden. Assistance from John Pruski.

HL
I thought this could be Euphorbiaceae.

Could be a Euphorbiaceae, has location for attachment of a caruncle (Gordon McPherson, Missouri Botanical Garden).

HM
Ron Liesner, Missouri Botanical Garden, suggested that Lauraceae would not have the projection and that it might be a *Solanum*.

HQ
Ron Liesner, Missouri Botanical Garden, suggested Fabaceae for this flower.

IJ - *Gouania*
Rhaminaceae. Ron Liesner, Missouri Botanical Garden, specifically suggested consultation of *Gouania lupidoies.* Examination of accession 1182710 revealed that the interior side of a single section is angled, consistent with the wing angle. In *Gouania mollis*, accession 1752078, it is possible to see that the fruits are originally tripartate. The archaeological specimen is a portion of a tripartate fruit, however the interior side is not an extension of the wing. This geometry matches the archaeological specimen.

Dodonaea of the Sapindaceae was examined and excluded. *Dodonaea viscocia*, accession 3513426, breaks into three parts. Three wings appearing to secure a single, roundish seed, but it is possible that each wing secured a seed. In either case, the wing separates easily from the seed as it is a capsule.

IP
Ron Liesner, Missouri Botanical Garden, suggested Agave in the Liliaceae. While the spines look right, upon close examination the Agave spine can separate from the frond.

IT - Bromeliaceae
The spines on the frond φ1333 are consistent in structure with *Ananas*. However they could possibly belong to other members of the family.

IV
It could be Curcurbitaceae, Ron Liesner.

JH - *Chorisia pubilfora* cf.
Anderson at Cenargen proposed *Chorisia pubiflora* (Bombacaceae) and demonstrated the similarity between the modern specimens and the archaeological sample.

I did not find spines on material at the Missouri Botanical Garden.

JJ - *Desmodium incanum* cf.
Identified from Tropical Forages images.

At the Missouri Botanical Gardens there are many other taxa of *Desmodium* with very similar seeds, and thus it is possible that the specie could be different, however *D. incanum* appears to be the best morphological match.

JK
I thought this could be Fabaceae.

The funicle appears to be a projection, according to Ron Liesner this may assist in identification, he also suggested looking at of *Ludvigia* (Onagraceae). In my opinion, the seed is way too big for the *Ludvigia.*

JL - *Machaerium*
The seeds of *Machaerium* from Missouri Botanical Garden exicatas have the correct morphology to match the archaeological specimen.

JM - Vernonieae
Seed has a double papus. Vernonieae tribe, Asteraceae family. The seed is similar to type SVJ but with a shorter outer papus. Missouri Botanical Garden. Assistance from John Pruski.

JN
Both Bignonaceae and Apocynaceae (*Aspidosperma*) were consulted following Ron Liesner's suggestion. The archaeological seed seems too small and to have too rigid of a 'wing' for both families.

JO - Asteraceae
Asteraceae with deflected branching. Missouri Botanical Garden. Assistance from John Pruski.

JP - *Acrocomia aculeata*
I identified this as *Acrocomia aculeata* with the assistance of a agronomist in Montes Claros and ARVORES.

JQ - *Carica*
I identified this as *Carica* as per the seeds from modern *Carica papaya*.

Ron Liesner suggested that this could also belong to a genus that recently split out from *Carica*.

JR - Fabaceae
I identified this as Fabaceae.

JS
ARVORES has similar seeds for *Hevea brasiliensis* and *Cnidoscolus phyllacanthus.*

Marbled seeds are common, but not restricted to the Euphorbiaceae (Gordon McPherson, Missouri Botanical Garden).

JU - Fabaceae
Seed has characteristics of the Mimosoideae and of the Lupininae, thus it is likely to be some Fabaceae.

KB
Can not be a shoot because it is thicker than the stem. They are probably flower buds. φ1431 has a broken calyx tube and stipules are alternate. Ron Liesner suggested considering Schefflera in the Araliaceae. φ1620 could be the same thing due to the alternate stipules.

KD
Looks similar to Apiaceae – *Foeniculum vulgare.* Other plants with similarly shaped seeds are the thistles and taro.

KE
Could be a calyx. Ron Liesner suggested starting by looking at *Endlicheria* (Lauraceae).

Original guess of mine was *Carica.*

KF
Sugestions were *Ficus* (Moraceae) and stipule of *Cecropia* (Urticaceae). In a cursory search of material at the Missouri Botanical Gardens I did not find that either were similar.

KN
Ron Liesner, Missouri Botanical Garden, suggested *Eschweilera* (Lecythidaceae) and *Endlicheria* (Lauraceae). *Eschweilera c*ould be possible if the archaeological specimen is the central piece that holds seeds in place, however I saw none of these in the collections.

KT
Ron Liesner, Missouri Botanical Garden, suggested examining fruit where 2 hook together. It is not Sapotaceae but might be Apocinaceae.

LZ - Asteraceae
I identified this as Asteraceae.

NA - *Zanthoxylum*
Zanthoxylum CENARGEN Anderson (possibly *Z. rhoifolium*)

NC
Ron Liesner suggested Bignoniaceae, *Crescentia*.

ND - *Anadenanthera*
Anadenanthera CENARGEN Anderson

I did not see spines on the specimens at the Missouri Botanical Garden as collections did not include larger branches.

NE - *Plumbago*
Plumbaginaceae, *Plumbago* calyx CENARGEN

From specimens at the Missouri Botanical Garden there is no question that *Plumbago* is a very good match for this specimen.

NF - Fabaceae
Fabaceae, Ron Liesner.

NG - *Anadenanthera*
Anadenanthera CENARGEN Anderson

Fabaceae, Ron Liesner.

NM - Fabaceae

NP - Fabaceae

NZ - *Zanthoxylum*
Ron Liesner, Missouri Botanical Garden, suggested *Zanthoxylum*. *Zanthoxylum quinduense* (Rutaceae) has spines like those of this type as seen in accessions 05007872, 04977966, 2474175, and others. Many other *Zanthoxylum* also have spines that are appropriate.

SPM
Unlikely to be a gall because they do not normally have such a narrow restriction, Ron Liesner.

STP - *Lasiacis*
Upper floret of *Lasiacis,* Poaceae, Gerrit Davidse Missouri Botanical Garden.

STV
Salacia cauliflora has a peduncle that is woody and similar in form to the archaeological specimen. The specific accession is 3582065. Indubitably there are other plants with similar peduncles.

SVF - Euphorbicaceae

SVH - *Phaseolus lunatus*

SVI - Eupatorieae
Asteraceae. Seed of the Eupatorieae tribe. Missouri Botanical Garden. Assistance from John Pruski.

SVJ - Vernonieae
Asteraceae. Seed of Vernonieae tribe. Has a double papus. Lepidaploa remotifolora, accession n 5579875, was used as a reference. The inner papus fall off easily leaving outer papus, as in the archaeological specimen. Missouri Botanical Garden. Assistance from John Pruski.

SVK
John Pruski, Missouri Botanical Garden suggested that possibilities are Vernonieae of the Asteraceae, Zyridaceae, or Cyperaceae. Within the Vernonieae, *Cyathillium* was suggested as the likely genus as it has pinate bracts. Consultation with *Cyathillium cinereum* show similar pirate structure but fewer rings of bracts. Gerrit Davidse of the Missouri Botanical Garden indicated that only the specimen from UFMG 7778.12 pictured in the lower left hand corner would probably be from a sedge.

SVL
Probably Asteraceae. Missouri Botanical Garden. Assistance from John Pruski.

SVM - Vernonieae
Asteraceae. Vernonieae tribe. Missouri Botanical Garden. Assistance from John Pruski.

SVN - Vernonieae cf.
Asteraceae. Possibly Vernonieae tribe. Missouri Botanical Garden. Assistance from John Pruski.

VL
Texture of the burnt seed is very similar to that of Fabaceae, especially *Phaseolus vulgaris* that I have burnt.

WH - Fabaceae
I identified this specimen as Fabaceae.

General categories included within the typology
A variety of plant materials were distinguished and stored independently following sorting of the archaeological collections. The items in these categories were not included in the analysis discussed in chapter 6 nor were these categories included in the count of unique archaeological types of plant remains.

FO
Leaves

NN
Unidentified fruit rinds with no major, distinguishing characteristics.

PA
Cordage and knots from plant fibers.

PB
Masses of dis-articulated plant fibers.

PC
Artifacts made from palm fruit.

PD
Artifacts which appear to have been smoked.

PE
Artifact with a fine comb like modification that was made from a specific seed, as yet unidentified.

PF
Artifacts made from plant material.

PG
Artifacts probably made on shell and bone.

RA
Roots

RC
Grass plants

RL
Woody materials

RP
Leaf fronds and small sticks.

SVG
Twisted leaves, fronds, and bark which were seemingly manipulated by a person.

Z
Unidentified seed fragments thought not to contain characteristics sufficient for identification purposes

Appendix D. Summary of reference collections

One element of this research was collecting initial plant reference specimens in Brazil. The majority of collections were made in modern markets and from the plants around office buildings at the headquarters of the Empresa Brasileira de Pesquisa Agropecuária Cerrados unit (EMBRAPA cerrados) and the Empresa Brasileira de Pesquisa Agropecuária Recursos Genéticos e Biotecnologia (CENARGEN). The reference collections are stored in the archaeological laboratories of the Museu de Arqueológia e Ethnologia da Universidade de São Paulo.

Table D.1. List of reference collections.

Reference Number	Common Name	Genus	species	Family	Non-native	Collection Location	State	Year
100	Jatobá	*Hymenaea*		Caesalpiniaceae			DF	2006
101	Jatobá	*Hymenaea*		Caesalpiniaceae			DF	2006
102	Jatobá	*Hymenaea*	*courbaril*	Caesalpiniaceae		Clube da semente	DF	2006
103	Jatobá	*Hymenaea*		Caesalpiniaceae			DF	2006
104	Maracujá	*Passiflora*		Passifloraceae			MG	2006
105	Cajá	*Spondias*	*mombin*	Anacardiaceae			MG	2006
106	Caju	*Anacardium*		Anacardiaceae		Market, São Paulo	SP	2007
107	Cabeça de negro	*Annona*	*crassiflora*	Annonaceae			DF	2006
108	Goiaba	*Psidium*		Myrtaceae		Street in São Paulo	SP	2007
109	Maracujá	*Passiflora*		Passifloraceae			GO	2008
110	Lobeira	*Solanum*	*lycocarpum*	Solonaceae			GO	2008
111	Maracujá	*Passiflora*		Passifloraceae			DF	2006
112	Baru	*Dipteryx*	*alata*	Fabaceae		Clube da semente	DF	2006
113	Jatobá	*Hymenaea*		Caesalpiniaceae			GO	2008
114	Ingá	*Inga*		Mimosaceae			GO	2008
115	Fruta do conde	*Rollinia*	*mucosa*	Annonaceae		Private property	BA	2008
116	Umbu	*Spondias*	*tuberosa*	Anacardiaceae		Private property	BA	2007
117	Umbu	*Spondias*	*tuberosa*	Anacardiaceae		Private property	BA	2007
118	Pitanga	*Eugenia*	*uniflora*	Myrtaceae			SC	2007
119	Araticum	*Annona*		Annonaceae		Market, São Paulo	SP	2007
120	Araticum	*Annona*		Annonaceae		Market, São Paulo	SP	2007
121	Caju	*Anacardium*		Anacardiaceae		Market, São Paulo	SP	2007
122		*Manihot*	*dichotoma*	Euphorbiaceae		CENARGEN	DF	2007
123		*Manihot*	*dichotoma*	Euphorbiaceae		CENARGEN	DF	2007
124	Baru	*Dipteryx*	*alata*	Fabaceae		EMBRAPA cerrados	DF	2007
125	Pequi	*Caryocar*	*brasiliense*	Caryocaraceae		EMBRAPA cerrados	DF	2007
126	Xixa	*Sterculia*	*striata*	Malvaceae		EMBRAPA cerrados	DF	2007

Continued on next page.

Table D.1 - continued from previous page.

Reference Number	Common Name	Genus	species	Family	Non-native	Collection Location	State	Year
127	Pera do cerrado	*Eugenia*	*klotzschinana*	Myrtaceae		EMBRAPA cerrados	DF	2007
128	Cereja do rio grande	*Eugenia*	*involucrata*	Myrtaceae			MG	2007
129	Cabaça	*Largenaria*		Cucurbitaceae		Market, Brasília	DF	2007
130	Cabaça	*Largenaria*		Cucurbitaceae		Market, Brasília	DF	2007
131	Mutamba	*Guazuma*	*ulmifolia*	Sterculiaceae		EMBRAPA cerrados	DF	2007
132	Guabiroba	*Campomanesia*		Myrtaceae			MG	2007
133	Grumixama	*Eugenia*		Myrtaceae			MG	2007
134	Araça	*Psidium*		Myrtaceae			MG	2007
135	Jabuticaba	*Myrciaria*		Myrtaceae		Roadside vendor	MG	2007
136	Jenepapo	*Genipa*	*americana*	Rubiaceae			MG	2007
137	Cagaita	*Eugenia*	*dysenterica*	Myrtaceae			MG	2007
138	Mangaba	*Hancornia*	*speciosa*	Apocynaceae			DF	2007
139	Mama-cadela	*Byrsonima*	*gaudichaudii*	Moraceae			MG	2007
140	Maramelada	*Cordiera*		Rubiaceae			MG	2007
141	Araticum	*Annona*		Annonaceae		Market, São Paulo	SP	2007
142	Simaruba	*Simarouba*	*amara*	Simaroubaceae			DF	2007
143	Pimenta de macaco	*Xylopia*	*aromatica*	Annonaceae		EMBRAPA cerrados	DF	2007
144	Umburana de cheiro	*Amburana*	*cearensis*	Fabaceae		Roadside vendor	BA	2007
145	Aroeira	*Myracrodruon*	*urundeuva*	Anacardiaceae		EMBRAPA cerrados	DF	2007
146	Bacupari	*Salacia*	*campestris*	Celastraceae			DF	2007
147	Jabuticaba	*Myrciaria*		Myrtaceae		Roadside vendor	MG	2007
148	Lobeira	*Solanum*	*lycocarpum*	Solonaceae			MG	2007
149	Bacupari			Celastraceae			DF	2007
150	Murici	*Byrsonima*		Malpighiaceae			MG	2007
151	Ingá	*Inga*		Fabaceae			DF	2007
152	Maria preta	*Vitex*		Lamiaceae			BA	2007
153	Campau	*Physalis*		Solonaceae			SP	2007

Continued on next page.

Table D.1 - continued from previous page.

Reference Number	Common Name	Genus	species	Family	Non-native	Collection Location	State	Year
154	Imburana	*Amburana*	*cearensis*	Fabaceae		Market, São Paulo	SP	2007
155	Acerola	*Malpighia*	*emarginata*	Malpighiaceae	X	Market, Diamantina	MG	2007
156	Jacarandá	*Machaerium*		Fabaceae			SP	2007
157	Ipê	*Tabebuia*		Bignoniaceae			SP	2007
158	Sucupira	*Pterodon*	*emarginatus*	Fabaceae			SP	2007
159	Pitanga	*Eugenia*		Myrtaceae			SP	2007
160	Barriguda	*Chorisia*	*pubiflora*	Bombacaceae			DF	2007
161	Chapéu de napleão	*Thevetia*	*peruviana*	Apocynaceae		Market, São Paulo	SP	2007
162	Malva branca	*Sida*	*cordifolia*	Malvaceae		Market, São Paulo	SP	2007
163	Jambolão	*Syzygium*	*cumini*	Myrtaceae	X	Market, São Paulo	SP	2008
164	Jambolão	*Syzygium*	*cumini*	Myrtaceae	X	Market, São Paulo	SP	2007
165	Pimenta rosa	*Schinus*	*terebinthifolius*	Anacardiaceae		Market, São Paulo	SP	2007
166	Urucum	*Bixa*	*orellana*	Bixaceae		Market, São Paulo	SP	2007
167	Olho de boi	*Mucuna*		Fabaceae		Market, São Paulo	SP	2007
168	Olho de boi	*Mucuna*		Fabaceae		unknown		
169	Olho de cabra	*Ormosia*	*arborea*	Fabaceae		Market, São Paulo	SP	2007
170	Mamona	*Ricinus*	*communis*	Euphorbiaceae	X		SP	2007
171	Jatobá	*Hymenaea*		Caesalpiniaceae			MG	2007
172	Muçuna	*Mucuna*		Fabaceae			BA	2008
173		*Aspidosperma*		Apocynaceae			DF	2006
174	Araribá	*Centrolobium*	*tomentosum*	Fabaceae		unknown		
175	Pequi	*Caryocar*	*brasiliense*	Caryocaraceae		Private property	GO	2008
176	Mutamba	*Guazuma*	*ulmifolia*	Sterculiaceae			GO	2008
177	Baru	*Dipteryx*	*alata*	Fabaceae		unknown		
178	Marmelada	*Alibertia*	*edulis*	Rubiaceae			GO	2008
179	Macaúba	*Acrocomia*	*aculeata*	Palmae			GO	2008
180	Bacuri	*Schealea*	*phalerata*	Palmae			GO	2008

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Table D.1 - continued from previous page.

Reference Number	Common Name	Genus	species	Family	Non-native	Collection Location	State	Year
181	Cabaça	*Largenaria*		Cucurbitaceae			DF	2007
182	Guariroba	*Syagrus*	*oleracea*	Palmae			GO	2008
183		*Terminalia*		Combretaceae			MG	2006
184	Jequitibá	*Cariniana*		Lecythidaceae			MG	2006
185	Cansanção	*Cnidoscolus*	*pubescens*	Euphorbiaceae			MG	2006
186	Cansanção	*Cnidoscolus*	*pubescens*	Euphorbiaceae			MG	2006
187	Coco-babão	*Syagrus*		Palmae			DF	2006
188				Malpighiaceae			MG	2006
189	Funcho	*Foeniculum*	*vulgare*	Apiaceae	X	Market, São Paulo	SP	2007
190	Pimenta do reino	*Piper*	*nigrum*	Piperaceae	X	Market, São Paulo	SP	2007
191	Castanha da India	*Aesculus*	*hippocastanum*	Sapindaceae	X	Market, São Paulo	SP	2007
192	Erva doce	*Pimpinella*	*anisum*	Apiaceae	X	Market, São Paulo	SP	2007
192	Pimenta de Jamaica	*Pimenta*	*dioica*	Myrtaceae	X	Market, São Paulo	SP	2007
194	Fecula de sene					Market, São Paulo	SP	2007
195	Coco do cachorro					Private property	GO	2008
196	Pindaíba	*Xylopia*		Annonaceae		Market, São Paulo	SP	2007
197	Macela	*Achyrocline*	*satureioides*	Asteraceae			DF	2007
198							MG	2007
199							MG	2007
200							MG	2006
201	Milho (moderno)	*Zea*	*Mays*	Poaceae			MG	2007
202		*Castanea*		Fagaceae	X	unknow n		
203	Caju	*Anacardium*		Anacardiaceae		unknow n		
204	Embaúva	*Cecropia*		Cecropiaceae			MG	2006
205				Palmae			MG	2007
206	Mandioca do cerrado			Euphorbiaceae		Private property	GO	2007
207				Myrtaceae			SP	2008

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Table D.1 - continued from previous page.

Reference Number	Common Name	Genus	species	Family	Non-native	Collection Location	State	Year
208		*Luffa*	*operculata*	Cucurbitaceae		Market, São Paulo	SP	2009
209	Guaraná	*Paullinia*	*cupana*	Sapindaceae		Market, São Paulo	SP	2009
210	Algodão	*Gossypium*	*hirsutum*	Malvaceae		Market, São Paulo	SP	2009
211	Açai	*Euterpe*	*oleraceae*	Arecaceae		Market, São Paulo	SP	2009
212	Emburana	*Amburana*	*cearensis*	Fabaceae		Market, São Paulo	SP	2009
213	Jatobá	*Hymenaea*		Annonaceae		Market, São Paulo	SP	2009
214	Pimenta de macaco	*Xylopia*	*aromatica*	Annonaceae		Market, São Paulo	SP	2009
215	Bucha	*Luffa*	*aegyptiaca*	Cucurbitaceae		Market, São Paulo	SP	2009
216	Cabaça ornamental	*Lagenaria*	*siceraria*	Cucurbitaceae		Market, São Paulo	SP	2009
217	Melão caipira	*Cucumis*	*melo*	Cucurbitaceae	X	Market, São Paulo	SP	2009
218	Olho de boi	*Mucuna*	*sp*	Fabaceae		Market, São Paulo	SP	2009
219	Zimbro	*Juniperus*	*sp*	Cupressaceae		Market, São Paulo	SP	2009
220				Cucurbitaceae		Private property	MG	2008
221				Fabaceae		Private property	MG	2008
222	Abóbora goianinha	*Cucurbita*	*moshata*	Cucurbitaceae		Commercial seed	MG	2008
223	Moranga coroa	*Cucurbita*	*maxima*	Cucurbitaceae		Commercial seed	MG	2008
224	Morango ew ingado verde	*Cucurbita*	*pepo*	Cucurbitaceae		Commercial seed	MG	2008
225	Abobrinha de tronco caserta	*Cucurbita*	*pepo*	Cucurbitaceae		Commercial seed	MG	2008
226	Pepino aodai	*Cucumis*	*rativus*	Cucurbitaceae	X	Commercial seed	MG	2008
227	Pimentão quadrado vermelho	*Capsicum*	*annuum*	Solonaceae		Commercial seed	MG	2008
228	Jiló morro grande verde escuro	*Solanium*	*gilo*	Solonaceae		Commercial seed	MG	2008
229	Jiló jinguá	*Solanium*	*gilo*	Solonaceae		Commercial seed	MG	2008
230	Tomate cereja	*Lycopersicon*	*lycopersicum*	Solanaceae		Commercial seed	MG	2008
231	Feijáo-vagem	*Phaseolus*	*vulgaris*	Fabaceae		Commercial seed	MG	2008
232	Mamão formosa	*Carica*	*papaya*	Caricaceae		Commercial seed	MG	2008
233	Mamão papaia	*Carica*	*papaya*	Caricaceae		Commercial seed	MG	2008
234				Solonaceae		Private property	MG	2008

Continued on next page.

Table D.1 - continued from previous page.

Reference Number	Common Name	Genus	species	Family	Non-native	Collection Location	State	Year
235						Private property	MG	2008
236						Private property	MG	2008
237				Bombicaceae		Private property	MG	2008
238						Private property	MG	2008
239				Bromeliaceae		Private property	MG	2008
240						Private property	MG	2008
241				Fabaceae		Private property	MG	2008
242	(mature seed of #235)					Private property	MG	2008
243	Fava bareza	*Vicia*	*faba*	Fabaceae	X	Market, São Paulo	SP	2009
244	Feijão moyachi	*Vigna*	*radiata*	Fabaceae	X	Market, São Paulo	SP	2009
245	Feijão de corda	*Vigna*	*unguiculata*	Fabaceae	X	Market, São Paulo	SP	2009
246	Feijão andu	*Cajanus*	*cajan*	Fabaceae	X	Market, São Paulo	SP	2009
247	Feijão bolinha	*Phaseolus*	*vulgaris*	Fabaceae		Market, São Paulo	SP	2009
248	Fava vermelha	*Phaseolus*	*lunatus*	Fabaceae		Market, São Paulo	SP	2009
249	Tremoço grão	*Lupinus*	*albus*	Fabaceae	X	Market, São Paulo	SP	2009
250	Orelha-de-macaco	*Enterolobium*	*contortiriliquum*	Mimosaceae		Street in Bauru	SP	2008
251	Melão cabocolo/ cará	*Sicana*	*odorifera*	Cucurbitaceae		Market, Belo Horizonte	MG	2009
252	Jenipapo	*Genipa*	*americana*	Rubiaceae		Market, Belo Horizonte	MG	2009
253	Jenipapo	*Genipa*	*americana*	Rubiaceae		Market, Belo Horizonte	MG	2009
254	Cacau	*Theobroma*	*cacao*	Malvaceae		Market, Belo Horizonte	MG	2009
255	Tamarindo				X	Market, Belo Horizonte	MG	2009
256	Tamarindo				X	Market, Belo Horizonte	MG	2009
257	Maxixe	*Cucumis*	*anguria*	Cucurbitaceae	X	Market, São Paulo	SP	2009

Appendix E. Inventory of paleoethnobotanical samples from Lapa dos Bichos and Lapa Pintada

The raw data for all of the plant remains analyzed from Lapa dos Bichos and Lapa Pintada are included within this appendix. All sample numbers are unique and begin with either 'φ' or 'UFMG'. The morphological types assigned to the plant remains indicate morphological similarity between items. The identified morphological types have been described in Appendix C and photographs of the same are given in Appendix B.

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1	AP	1.192	1	x	n	8928	O2	1	
φ	2	AE	0.689	1	x	n	8929	O2	2	
φ	3	Z	0.046	5	x		8890	H16	2	
φ	4	YW	0.062	1	x	n	8890	H16	2	
φ	5	AB	0.080	1	x	y	8890	H16	2	
φ	6	AX	0.167	2	x	n	8890	H16	2	
φ	7	AP	1.372	3	x	n	8890	H16	2	
φ	8	AN	1.954	10	x		8890	H16	2	
φ	9	AE	3.443	5	x	ny	8890	H16	2	
φ	10	AS	0.110	1	x	n	8910	I16	2	
φ	11	AP	0.463	1	x	n	8910	I16	2	
φ	12	CC	1.156	1	x	n	8910	I16	2	
φ	13	AE	1.584	1	x	n	8910	I16	2	
φ	14	CT	0.010	1	x	y	8884	H15	2	
φ	15	AL	0.155	1	.		8884	H15	2	
φ	16	AA	0.240	2	x	n	8884	H15	2	
φ	18	AN	0.643	5			8884	H15	2	
φ	19	AC	0.693	1	x	n	8884	H15	2	
φ	20	AE	4.140	5	.		8884	H15	2	
φ	21	AP	15.166	15	x	n	8884	H15	2	
φ	22	BF	0.069	1	x	n	8905	I15	2	
φ	23	BG	0.115	1	x	n	8905	I15	2	
φ	24	AX	0.119	1	x	n	8905	I15	2	
φ	25	AW	0.122	1	x	n	8905	I15	2	
φ	26	AA	0.137	1	x	y	8905	I15	2	
φ	27	BS	0.166	1	x	n	8905	I15	2	
φ	28	AL	0.243	3	.		8905	I15	2	
φ	29	AC	0.292	4	x	n	8905	I15	2	
φ	30	AB	0.696	3	x	y	8905	I15	2	
φ	31	AP	0.700	1	x	n	8905	I15	2	
φ	32	AN	0.910	6	x		8905	I15	2	
φ	33	AE	2.642	2	x	n	8905	I15	2	
φ	34	AX	0.077	1	x	n	8858	G14	2	
φ	35	BF	0.106	1	x	n	8858	G14	2	
φ	36	BV	0.280	2	x	n	8858	G14	2	
φ	37	AE	0.617	1	x	n	8858	G14	2	
φ	38	AB	1.589	4	x	y	8858	G14	2	
φ	39	AP	24.266	24	x	n	8858	G14	2	
φ	40	Z	0.008	1	x	n	8879	H14	2	
φ	41	AH	0.021	1	x	n	8879	H14	2	
φ	42	AZ	0.027	1	x	n	8879	H14	2	
φ	43	DU	0.159	1	x	n	8879	H14	2	
φ	44	BC	0.207	1	x	n	8879	H14	2	
φ	45	AE	0.219	1	x	y	8879	H14	2	
φ	46	AR	0.373	3	x	y	8879	H14	2	
φ	47	AC	0.400	4	x		8879	H14	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	48	AN	0.943	5	x	n	8879	H14	2	
φ	49	AB	0.983	6	x	y	8879	H14	2	
φ	50	FX	0.116	1	x	y	8869	G16	2	
φ	51	AL	1.792	10	x	n	8879	H14	2	
φ	52	BR	2.878	1	x	y	8879	H14	2	
φ	53	AW	0.121	1	x	n	8869	G16	2	
φ	54	AP	5.609	6	x	n	8879	H14	2	
φ	55	AH	0.026	1	x	n	8900	I14	2	
φ	56	AQ	0.027	1	x	n	8900	I14	2	
φ	57	DD	0.037	2	x	n	8900	I14	2	
φ	58	AW	0.085	3	x	n	8900	I14	2	
φ	59	JZ	0.090	1	x	n	8900	I14	2	
φ	60	AS	0.116	1	x	n	8900	I14	2	
φ	61	FT	0.122	1	x	y	8900	I14	2	
φ	62	BG	0.128	1	x		8900	I14	2	
φ	63	AG	0.133	1	x	n	8900	I14	2	
φ	64	AV	0.135	1	x	n	8900	I14	2	
φ	65	AF	0.161	1	x	n	8900	I14	2	
φ	66	AL	0.192	1	x	n	8900	I14	2	
φ	67	BW	0.194	3	x	y	8900	I14	2	
φ	68	AC	0.323	4	x	n	8900	I14	2	
φ	69	AN	0.397	3	x	n	8900	I14	2	
φ	70	AR	0.402	2	x	n	8900	I14	2	
φ	71	AB	0.406	1	x	y	8900	I14	2	
φ	72	BQ	0.573	1	x	y	8900	I14	2	
φ	73	AA	2.030	6	x	n	8900	I14	2	
φ	74	DA	0.043	1	x		8875	H13	2	
φ	75	DS	0.072	1	x	n	8875	H13	2	
φ	76	BG	0.090	1	x	y	8875	H13	2	
φ	77	DX	0.145	1	x	y	8875	H13	2	
φ	78	AD	0.236	3	x	n	8875	H13	2	
φ	79	BT	0.245	1	x	n	8875	H13	2	
φ	80	AN	0.308	3	x	n	8875	H13	2	
φ	81	DU	0.342	1	x	n	8875	H13	2	
φ	82	AG	0.420	1	x	n	8875	H13	2	
φ	83	BD	0.677	2	x	n	8875	H13	2	
φ	84	DH	0.894	2	x	n	8875	H13	2	
φ	85	AE	1.008	1	x	n	8875	H13	2	
φ	86	AP	1.602	1	x	n	8875	H13	2	
φ	87	BO	1.673	1	x	y	8875	H13	2	
φ	88	AL	1.980	1	x	n	8875	H13	2	
φ	89	AA	4.727	15	x	n	8875	H13	2	
φ	90	AB	5.920	7	x	ny	8875	H13	2	
φ	91	AC	10.922	34	x		8875	H13	2	
φ	92	AR	0.101	1	x	n	8863	G15	2	
φ	93	AA	0.397	4	x	n	8863	G15	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	94	AB	0.510	1	x	y	8863	G15	2	
φ	95	AC	1.023	2	x	n	8863	G15	2	
φ	96	AE	1.211	2	x	n	8863	G15	2	
φ	97	AN	2.458	14	x	n	8863	G15	2	
φ	98	AP	2.481	3	x	n	8863	G15	2	
φ	99	BZ	0.036	1	x	n	8869	G16	2	
φ	100	AD	0.219	5	x	n	8869	G16	2	
φ	101	AC	0.319	2	x	n	8869	G16	2	
φ	102	KZ	0.330	1	x	n	8869	G16	2	
φ	103	AR	0.494	1	x	n	8869	G16	2	
φ	104	AE	5.184	6	x	n	8869	G16	2	
φ	105	AN	5.945	27	x	n	8869	G16	2	
φ	106	AP	6.445	7	x	n	8869	G16	2	
φ	107	EF	0.039	1	x		8853	G13	2	
φ	108	BZ	0.070	1	x		8853	G13	2	
φ	109	AD	0.100	1	x	n	8853	G13	2	
φ	110	AI	0.141	1	x	n	8853	G13	2	
φ	111	AF	0.154	2	x	n	8853	G13	2	
φ	112	BD	0.209	1	x	n	8853	G13	2	
φ	113	BE	0.223	2	x	n	8853	G13	2	
φ	114	AL	0.373	2	x	n	8853	G13	2	
φ	115	AN	1.255	10	x	n	8853	G13	2	
φ	116	AA	1.925	7	x	n	8853	G13	2	
φ	117	AE	2.167	2	x	n	8853	G13	2	
φ	118	AC	2.510	14	x	ny	8853	G13	2	
φ	119	AP	3.203	4	x	n	8853	G13	2	
φ	120	AQ	0.036	1	x	n	8895	I13	2	
φ	121	AD	0.140	1	x	n	8895	I13	2	
φ	122	DH	0.232	1	x	n	8895	I13	2	
φ	123	AV	0.233	1	x	n	8895	I13	2	
φ	124	AX	0.325	3	x	n	8895	I13	2	
φ	125	DK	0.404	1	x	n	8895	I13	2	
φ	126	BG	0.563	4	x	n	8895	I13	2	
φ	127	AP	0.721	1	x	n	8895	I13	2	
φ	128	BK	1.203	1	x	n	8895	I13	2	
φ	129	AR	1.323	5	x	n	8895	I13	2	
φ	130	AN	1.431	8	x	n	8895	I13	2	
φ	131	AL	1.670	4	x	n	8895	I13	2	
φ	132	AA	3.743	17	x	n	8895	I13	2	
φ	133	AB	4.967	3	x	y	8895	I13	2	
φ	134	AC	8.690	28	x	ny	8895	I13	2	
φ	135	AE	11.559	8	x		8895	I13	2	
φ	136	BA	0.140	10	x		8914	O11	1	
φ	137	AX	0.101	1	x	n	8915	O11	2	
φ	138	CN	0.156	1	x	n	8915	O11	2	
φ	139	CH	0.450	1	x	n	8915	O11	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	140	AP	1.311	2	x	n	8915	O11	2	
φ	141	BG	0.059	1	x	n	8917	O11	3	
φ	142	BX	0.358	1	x	n	8917	O11	3	
φ	143	AE	0.453	1	x	n	8917	O11	3	
φ	144	AA	0.023	1	x	n	8919	O11	4	
φ	145	AE	0.298	1	x	y	8919	O11	4	
φ	146	AC	4.680	2	x	n	8919	O11	4	
φ	147	AB	0.228	1	x	y	8921	O11	5	
φ	148	AC	1.455	5	x	n	8921	O11	5	
φ	149	DH	0.083	1	.		8924	O11	6	
φ	150	EG	0.009	1	x	n	8866	G15	3	
φ	151	CV	0.085	1	x	n	8866	G15	3	
φ	152	AA	0.408	3	x	n	8866	G15	3	
φ	153	AE	1.545	1	x	n	8866	G15	3	
φ	154	AQ	0.039	1	x	n	8871	G16	3	
φ	155	AE	1.060	1	x	n	8887	H15	3	
φ	156	AR	0.744	1	x	n	8871	G16	3	
φ	157	AN	0.966	4	x	n	8871	G16	3	
φ	158	AA	0.088	1	x	y	8892	H16	3	
φ	159	BQ	0.103	1	x	y	8892	H16	3	
φ	160	BP	0.107	2	x	y	8892	H16	3	
φ	161	LA	0.158	1	x	y	8892	H16	3	
φ	162	AN	0.261	2	x	n	8892	H16	3	
φ	163	AB	0.875	1	x	y	8892	H16	3	
φ	164	AR	0.101	3	x	n	8912	I16	3	
φ	165	AA	0.161	1	x	y	8912	I16	3	
φ	166	AC	0.227	2	x	y	8912	I16	3	
φ	167	AB	0.305	1	x	y	8912	I16	3	
φ	168	AN	0.516	2	x	n	8912	I16	3	
φ	169	AN	0.364	2	x	n	8860	G14	3	
φ	170	AZ	0.022	1	x	n	8881	H14	3	
φ	171	AD	0.195	2	x	n	8881	H14	3	
φ	172	DR	0.337	1	x	n	8881	H14	3	
φ	173	AR	0.354	3	x	n	8881	H14	3	
φ	174	AL	0.846	3	x	n	8881	H14	3	
φ	175	AN	1.677	4	x	n	8881	H14	3	
φ	176	AA	1.726	19	x	ny	8881	H14	3	
φ	177	AE	2.057	3	x	n	8881	H14	3	
φ	178	AC	3.123	9	x	ny	8881	H14	3	
φ	179	BD	0.062	1	x	n	8902	I14	3	
φ	180	AX	0.100	1	x	n	8902	I14	3	
φ	181	DG	0.346	1	x		8902	I14	3	
φ	182	AJ	0.349		x	n	8902	I14	3	
φ	183	AB	0.382	1	x	y	8902	I14	3	
φ	184	AE	4.102	4	x	ny	8902	I14	3	
φ	185	KX	0.106	1	x	y	8907	I15	3	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	186	AE	0.482	1	x	n	8907	I15	3	
φ	187	AA	0.647	10	x	n	8907	I15	3	
φ	188	AD	0.137	2	x	n	8887	H15	3	
φ	189	AR	0.142	1	x	n	8887	H15	3	
φ	190	AA	0.506	6	x	n	8887	H15	3	
φ	191	AE	0.348	1	x	y	8871	G16	3	
φ	192	AA	0.258	6	x	n	8855	G13	3	
φ	193	RA	1.065	3	x	n	8855	G13	3	
φ	194	AX	0.090	1	x	n	8877	H13	3	
φ	195	AL	0.141	2	x	y	8877	H13	3	
φ	196	AC	0.164	2	x	y	8877	H13	3	
φ	197	AA	0.259	5	x	n	8877	H13	3	
φ	198	AE	1.768	1	x	n	8877	H13	3	
φ	199	AZ	0.019	1	x	n	8897	I13	3	
φ	200	AD	0.067	1	x	n	8897	I13	3	
φ	201	AE	0.253	1	x	y	8897	I13	3	
φ	202	AN	0.313	3	x	n	8897	I13	3	
φ	203	DT	0.333	1	x	n	8897	I13	3	
φ	204	DU	0.005	7	x	n	8886	H15	2	
φ	205	BB	0.010	1	x	n	8886	H15	2	
φ	206	AC	0.509	16	x	y	8958			58
φ	207	Z	0.014	1	x	n	8886	H15	2	
φ	208	AC	0.090	2	x	y	8886	H15	2	
φ	209	AL	0.115	4	x	n	8886	H15	2	
φ	210	CG	0.195	1	x	n	8886	H15	2	
φ	211	DH	0.154	1	x	n	8865	G15	2	
φ	212	AL	0.280	1	x	n	8865	G15	2	
φ	213	AN	0.172	2	x	n	8923	O11	5	
φ	214	AN	0.459	5	x	ny	8873	G16	3	
φ	215	AA	66.000		x	n	8941			42
φ	216	AB	13.650	10	x	n	8941			42
φ	217	AC	34.048	145	x	n	8941			42
φ	218	AD	0.678	9	x	n	8941			42
φ	219	AE	14.815	7	x	n	8941			42
φ	220	AF	9.532	160	x	n	8941			42
φ	221	AH	0.020	1	x	n	8941			42
φ	222	AI	0.231	5	x	n	8941			42
φ	223	AJ	1.919	3	x	n	8941			42
φ	224	AK	0.423	1	x	n	8941			42
φ	225	AL	23.685	186	x	n	8941			42
φ	226	AN	17.181	505	x	ny	8941			42
φ	227	AT	0.245	8	x	n	8941			42
φ	228	AU	0.022	8	x	n	8941			42
φ	229	AV	0.322	2	x	n	8941			42
φ	230	AZ	2.041	107	x	n	8941			42
φ	231	BA	0.800		x	n	8941			42

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	232	BB	0.064	3	x		8941			42
φ	233	BC	0.226	2	x	n	8941			42
φ	234	BD	11.584	129	x		8941			42
φ	235	BE	0.235	3	x	n	8941			42
φ	236	BG	0.134	1	x	n	8941			42
φ	237	BH	4.102	2	x	n	8941			42
φ	238	BJ	0.933	1	x	n	8941			42
φ	239	AB	0.706	1	x	y	8941			42
φ	240	BN	1.537	2	x	n	8941			42
φ	241	BB	0.035	2	x	y	8941			42
φ	242	BU	0.101	1	x	y	8941			42
φ	243	BY	0.755	140	x	n	8941			42
φ	244	CB	0.194	1	x	n	8941			42
φ	245	CD	0.193	1	x		8941			42
φ	246	CI	0.183	24	x	n	8941			42
φ	247	CQ	0.058	1	x	n	8941			42
φ	248	AV	0.079	1	x	n	8941			42
φ	249	BB	0.360	9	x	n	8941			42
φ	250	DA	0.043	1	x	n	8941			42
φ	251	DH	0.459	5	x	n	8941			42
φ	252	DJ	0.046	1	x	n	8941			42
φ	253	DQ	0.007	1	x	n	8941			42
φ	254	DS	0.052	1	x	n	8941			42
φ	255	DZ	0.002	1	x	n	8941			42
φ	256	CL	0.003	1	x	n	8941			42
φ	257	EK	0.188	15	x	y	8941			42
φ	258	BY	0.054	40	x	n	8941			42
φ	259	EN	0.004	1	x	y	8941			42
φ	260	ES	0.007	1	x	n	8941			42
φ	261	EX	1.314	50	x	n	8941			42
φ	263	FZ	0.009	1	x	n	8941			42
φ	264	AA	0.039	8	x	n	8942			43
φ	265	AD	0.010	1	x	n	8942			43
φ	266	AF	0.199	5	x	n	8942			43
φ	267	AN	0.372	15	x	ny	8942			43
φ	268	AR	0.048	1	x	n	8942			43
φ	269	AT	0.192	1	x	n	8942			43
φ	270	AU	0.001	1	x	n	8942			43
φ	271	AZ	0.362	14	x	n	8942			43
φ	272	BA	0.020	1	x	n	8942			43
φ	273	BY	0.011	1	x	n	8942			43
φ	274	CK	0.021	1	x	n	8942			43
φ	275	BY	0.001	1	x	n	8942			43
φ	276	FM	0.515	1	x	n	8942			43
φ	277	FU	0.030	1	x	n	8942			43
φ	278	RA	0.892	1	x	n	8942			43

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	279	AC	0.904	4	x	n	8943			44
φ	280	AL	0.488	4	x	n	8943			44
φ	281	AN	1.517	34	x	n	8943			44
φ	282	AU	0.004	1	.		8943			44
φ	283	AB	0.699	8	x	y	8943			44
φ	284	BD	0.238	8	x	n	8943			44
φ	285	AN	0.287	1	x	n	8921	O11	5	
φ	286	AA	4.394		x	n	8945			46
φ	287	AB	1.270	4	x	y	8945			46
φ	288	AC	1.101	29	x		8945			46
φ	289	AH	0.010	2	x		8945			46
φ	290	AL	0.078	3	x		8945			46
φ	291	AN	1.317	63	x	ny	8945			46
φ	292	AT	0.055	1	x	n	8945			46
φ	293	AU	0.004	1	x	n	8945			46
φ	294	AX	0.222	11	x	y	8945			46
φ	295	BY	0.009	2	x	n	8945			46
φ	296	DS	0.054	1	x	n	8945			46
φ	297	AB	0.232	1	x	y	8945			46
φ	298	CN	0.072	1	x	y	8945			46
φ	299	FQ	0.014	1	x	n	8945			46
φ	300	Z	0.287	1	x	n	8945			46
φ	301	AA	0.106		x	n	8955			55
φ	302	AB	2.322	3	x	ny	8955			55
φ	303	AC	0.615	8	x	ny	8955			55
φ	304	AD	0.021	1	x	n	8955			55
φ	305	AF	0.075	7	x	ny	8955			55
φ	306	AL	0.189	7	x		8955			55
φ	307	AN	0.684	16	x	ny	8955			55
φ	308	AQ	0.084	3	x	n	8955			55
φ	309	AR	0.227	24	x	ny	8955			55
φ	310	AZ	0.224	19	x	ny	8955			55
φ	311	BA	0.053	10	x	ny	8955			55
φ	312	BF	0.029	1	x		8955			55
φ	313	BY	0.008	2	x	n	8955			55
φ	314	Z	0.111	1	x	y	8955			55
φ	315	RL	0.020	1	x	n	8955			55
φ	316	FF	0.023	1	x	y	8955			55
φ	317	DU	0.151	1	x	y	8955			55
φ	318	CW	0.002	2	x	n	8955			55
φ	319	EI	0.007	4	x	n	8955			55
φ	320	EL	0.007	1	x	y	8955			55
φ	321	Z	0.013	1	x	n	8955			55
φ	322	EP	0.020	1	x	y	8955			55
φ	323	Z	0.023	1	x	n	8955			55
φ	324	GM	0.008	1	x	y	8955			55

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	325	FA	0.000	1	x	n	8955			55
φ	326	FB	0.000	1	x	n	8955			55
φ	327	CW	0.000	1	x	n	8955			55
φ	328	BY	0.000	1	x	n	8955			55
φ	329	GH	0.115	3	x	y	8955			55
φ	330	AB	1.528	3	x	y	8959			58
φ	331	AE	0.401	1	x	y	8959			58
φ	332	FJ	0.208	1	x	y	8959			58
φ	333	AA	0.928		x	n	8958			58
φ	334	AD	0.032	1	x	n	8958			58
φ	335	AF	0.229	13	x	ny	8958			58
φ	336	AH	0.026	1	x		8958			58
φ	337	AL	1.311	32	x		8958			58
φ	338	AQ	0.058	3	x	n	8958			58
φ	339	AR	0.048	13	x	ny	8958			58
φ	340	AZ	0.172	19	x	ny	8958			58
φ	341	BD	0.046	1	x		8958			58
φ	342	AB	0.638	2	x	y	8958			58
φ	343	ER	0.010	1	x	n	8958			58
φ	344	CG	0.223	2	x	y	8958			58
φ	345	DA	0.054	2	x	n	8958			58
φ	346	FZ	0.472	41	x	n	8958			58
φ	347	BP	0.013	1	x	y	8958			58
φ	348	GI	0.086	1	x	y	8958			58
φ	349	GL	0.305	1	x		8958			58
φ	350	GN	0.094	1	x		8958			58
φ	351	HB	0.022	1	x	n	8958			58
φ	352	AF	0.006	1	x	y	8954			54
φ	353	AH	0.027	1	x		8954			54
φ	354	AN	0.568	15	x	ny	8954			54
φ	355	AP	0.154	1	x	n	8954			54
φ	356	AQ	0.015	1	x	n	8954			54
φ	357	AT	1.666	30	x	n	8954			54
φ	358	AU	0.001	1	x	n	8954			54
φ	359	AX	0.701	7	x	n	8954			54
φ	360	AZ	1.198	105	x	ny	8954			54
φ	361	BA	0.812		x		8954			54
φ	362	DB	0.008	1	x	n	8954			54
φ	363	CN	0.162	1	x	n	8954			54
φ	364	GH	0.027	1	x	y	8954			54
φ	365	AA	0.011	3	x	n	8949			49
φ	366	AC	0.008	1	x	y	8949			49
φ	367	AE	0.198	2	x		8949			49
φ	368	AF	0.224	5	x	n	8949			49
φ	369	AL	0.094	2	x		8949			49
φ	370	AN	0.218	5	x	ny	8949			49

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	371	Z	0.006	1	x	n	8949			49
φ	372	AZ	0.051	2	x	n	8949			49
φ	373	BD	0.137	5	x		8949			49
φ	374	BY	0.010	3	x	n	8949			49
φ	375	CI	0.013	1	x	n	8949			49
φ	376	AA	0.093		x	n	8948			48
φ	377	AC	0.075	3	x		8948			48
φ	378	AD	0.213	5	x	n	8948			48
φ	379	AF	0.659	26	x	ny	8948			48
φ	380	AL	0.210	9	x	ny	8948			48
φ	381	AN	3.224	101	x	ny	8948			48
φ	382	AQ	0.265	11	x	n	8948			48
φ	383	AU	0.033	16	x	n	8948			48
φ	384	AX	0.093	1	x	n	8948			48
φ	385	AZ	0.286	17	x	n	8948			48
φ	386	BA	0.210	31	x		8948			48
φ	387	BD	0.168	2	x		8948			48
φ	388	BE	0.110	1	x	n	8948			48
φ	389	BY	0.125	19	x	n	8948			48
φ	390	CJ	0.009	2	x	n	8948			48
φ	391	DS	0.051	1	x	n	8948			48
φ	392	BY	0.011	4	x	n	8948			48
φ	393	ET	0.007	2	x	n	8948			48
φ	394	EW	0.428	3	x	n	8948			48
φ	395	AF	0.274	1	x		8948			48
φ	396	GB	0.012	1	x	n	8948			48
φ	397	GE	0.430	1	x	n	8948			48
φ	398	GH	0.037	2	x	n	8948			48
φ	399	RA	3.255	3	x	n	8948			48
φ	400	AC	0.017	1	x	y	8961			60
φ	401	AL	0.021	1	x	y	8961			60
φ	402	AT	0.008	2	x	n	8961			60
φ	403	BA	0.009	2	x		8961			60
φ	404	BJ	0.003	1	x	n	8961			60
φ	405	Z	0.022	1	x	y	8961			60
φ	406	AA	0.047	9	x	y	8957			57
φ	407	AD	0.020	1	x	n	8957			57
φ	408	AN	1.025	34	x	ny	8957			57
φ	409	AQ	0.041	5	x	n	8957			57
φ	410	AR	0.047	3	x	y	8957			57
φ	411	BL	0.421	1	x	n	8957			57
φ	412	AA	0.041	3	x	n	8952			52
φ	413	AC	1.253	21	x	ny	8952			52
φ	414	AE	2.440	4	x	ny	8952			52
φ	415	AL	0.036	1	x	n	8952			52
φ	416	AN	0.944	23	x	ny	8952			52

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	417	AR	0.325	2	x	n	8952			52
φ	418	AV	1.503	18	x	n	8952			52
φ	419	AZ	0.130	10	x	ny	8952			52
φ	420	BA	0.074	10	x		8952			52
φ	421	BF	0.041	1	x	n	8952			52
φ	422	CM	0.180	2	x	n	8952			52
φ	423	EK	0.086	7	x	y	8952			52
φ	424	FJ	0.026	1	x	y	8952			52
φ	425	FZ	0.084	8	x	n	8952			52
φ	426	GH	0.180	3	x	n	8952			52
φ	427	RA	2.064	2	x	n	8952			52
φ	428	AA	20.170		x	n	8951			51
φ	429	AC	1.968	16	x	ny	8951			51
φ	430	AE	6.840	5	x		8951			51
φ	431	AH	0.065	4	x		8951			51
φ	432	AJ	1.586	11	x	ny	8951			51
φ	433	AL	7.030	71	x	ny	8951			51
φ	434	AN	17.035	436	x	ny	8951			51
φ	435	AR	0.875	7	x	n	8951			51
φ	436	AX	0.084	1	x	n	8951			51
φ	437	AZ	0.958	49	x		8951			51
φ	438	BD	2.929	51	x		8951			51
φ	439	BE	1.027	8	x	n	8951			51
φ	440	BY	0.067	9	x	n	8951			51
φ	441	EG	0.011	1	x	n	8951			51
φ	442	AA	1.076		x	n	8962			61
φ	443	AC	0.062	3	x	y	8962			61
φ	444	AD	0.004	1	x	n	8962			61
φ	445	AE	0.151	1	x	n	8962			61
φ	446	AF	0.162	9	x	n	8962			61
φ	447	AG	0.191	1	x	n	8962			61
φ	448	AH	0.012	1	x		8962			61
φ	449	AL	0.026	5	x	ny	8962			61
φ	450	AN	29.221	357	x	ny	8962			61
φ	451	AR	0.162	11	x	ny	8962			61
φ	452	AZ	0.109	16	x	ny	8962			61
φ	453	BA	0.000	1	x		8962			61
φ	454	BY	0.001	1	x	n	8962			61
φ	455	BY	0.001	1	x	n	8962			61
φ	456	FN	0.029	1	x	y	8962			61
φ	457	GA	0.032	1	x	y	8962			61
φ	458	GD	0.191	2	x		8962			61
φ	459	GF	0.137	3	x	n	8962			61
φ	460	AA	0.026	1	x	n	8963			62
φ	461	AE	3.599	2	x	n	8963			62
φ	462	AF	0.060	2	x	n	8963			62

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	463	AL	1.695	7	x	n	8963			62
φ	464	AN	1.361	33	x	n	8963			62
φ	465	AZ	0.019	2	x	ny	8963			62
φ	466	DA	0.019	1	x	n	8963			62
φ	467	AC	1.482	21	x	y	8953			53
φ	468	AD	0.320	9	x	n	8953			53
φ	469	AE	7.701	7	x	ny	8953			53
φ	470	AF	0.349	16	x	ny	8953			53
φ	471	AL	5.075	138	x	ny	8953			53
φ	472	AN	6.400	187	x	ny	8953			53
φ	473	AP	0.743	1	x	n	8953			53
φ	474	AR	0.314	12	x	ny	8953			53
φ	475	AS	0.210	1	x	n	8953			53
φ	476	AT	0.076	2	x	n	8953			53
φ	477	AU	0.010	6	x	n	8953			53
φ	478	AX	0.570	11	x	yn	8953			53
φ	479	AZ	0.440	42	x	ny	8953			53
φ	480	BA	3.526		x		8953			53
φ	481	BD	0.630	9	x		8953			53
φ	482	BF	0.140	3	x	n	8953			53
φ	483	CA	0.066	1	x	n	8953			53
φ	484	CE	0.761	1	x	n	8953			53
φ	485	CM	0.140	1	x	n	8953			53
φ	486	CO	0.233	1	x	n	8953			53
φ	487	CP	0.030	1	x		8953			53
φ	488	CU	0.031	1	x	n	8953			53
φ	489	DH	0.148	4	x	ny	8953			53
φ	490	DM	0.103	3	x	ny	8953			53
φ	491	DP	0.050	1	x	n	8953			53
φ	492	DV	0.027	1	x		8953			53
φ	493	EB	9.437	1	x	n	8953			53
φ	494	FS	0.023	1	x	y	8953			53
φ	495	AA	42.013		x	n	8966			64
φ	496	AC	2.443	13	.		8966			64
φ	497	AD	0.043	1	x	n	8966			64
φ	498	AE	6.792	6	x	n	8966			64
φ	499	AF	0.010	1	x	n	8966			64
φ	500	AH	0.069	3	x		8966			64
φ	501	AJ	0.280	1	x	ny	8966			64
φ	502	AL	0.766	9	x	n	8966			64
φ	503	AN	6.154	119	x	n	8966			64
φ	504	AR	0.664	4	x	n	8966			64
φ	505	AX	0.075	1	x	n	8966			64
φ	506	AZ	0.240	16	x	n	8966			64
φ	507	BA	0.052	10	x	n	8966			64
φ	508	BD	0.510	12	x		8966			64

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	509	BE	0.300	4	x	n	8966			64
φ	510	BJ	0.090	14	x	n	8966			64
φ	511	BP	0.018	1	x	y	8966			64
φ	512	BY	0.006	2	x	n	8966			64
φ	513	DA	0.088	2	x	n	8966			64
φ	514	GH	0.170	6	x	n	8966			64
φ	515	AA	1.040	4	x	y	8967			65
φ	516	AZ	0.018	1	x	n	8967			65
φ	517	BA	0.013	1	x	n	8967			65
φ	518	AB	0.342	1	x	y	8967			65
φ	519	Z	0.029	1	x	n	8967			65
φ	520	AA	6.059		x	n	8964			63
φ	521	AE	0.938	1	x	n	8964			63
φ	522	AL	0.090	1	x	n	8964			63
φ	523	AU	0.003	1	x	n	8964			63
φ	524	AV	0.073	1	x	n	8964			63
φ	525	AB	0.331	1	x	y	8964			63
φ	526	RA	6.230	3	x	n	8964			63
φ	527	AA	0.047	2	x	n	8956			56
φ	528	AC	0.034	1	x		8956			56
φ	529	AL	0.038	2	x	ny	8956			56
φ	530	AN	0.344	14	x	n	8956			56
φ	531	AR	0.328	9	x	y	8956			56
φ	532	AZ	0.008	1	x	n	8956			56
φ	533	AA	4.104		x	n	8969			67
φ	534	AB	11.163	3	x	n	8969			67
φ	535	AL	0.110	2	x	n	8969			67
φ	536	AN	0.449	11	x	n	8969			67
φ	537	AZ	0.037	2	x	n	8969			67
φ	538	BE	0.143	2	x	n	8969			67
φ	539	BY	0.010	2	x	n	8969			67
φ	540	CB	0.028	1	x	y	8968			66
φ	541	AC	1.455	8	x		8947			47
φ	542	AD	0.168	2	x	n	8947			47
φ	543	AE	1.358	2	x	n	8947			47
φ	544	AF	0.452	16	x	ny	8947			47
φ	545	AI	0.031	2	x	n	8947			47
φ	546	AK	0.098	1	x	n	8947			47
φ	547	AL	2.118	13	x	n	8947			47
φ	548	AN	1.624	73	x	ny	8947			47
φ	549	AR	0.146	2	x	n	8947			47
φ	550	AW	0.035	1	x	n	8947			47
φ	551	AZ	0.218	11	x	n	8947			47
φ	552	BA	0.074	8	x	ny	8947			47
φ	553	BD	0.478	8	x		8947			47
φ	554	BE	0.326	4	x	n	8947			47

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	555	BF	0.040	1	x		8947			47
φ	556	CF	0.219	2	x	n	8947			47
φ	557	CJ	0.002	3	x	n	8947			47
φ	558	DH	0.165	2	x	n	8947			47
φ	559	NE	0.002	1	x	n	8947			47
φ	560	AB	0.187	1	x	y	8897	I13	3	
φ	561	AB	1.042	2	x	y	8897	I13	3	
φ	562	DH	0.085	1	x	n	8897	I13	3	
φ	563	AA	0.040		x	n	8897	I13	3	
φ	564	AA	2.799		x	n	8897	I13	3	
φ	565	BE	0.057	1	x	n	8897	I13	3	
φ	566	BE	0.146	1	x	n	8897	I13	3	
φ	567	AC	8.280	12	x	n	8897	I13	3	
φ	568	AC	0.334	1	x	n	8897	I13	3	
φ	569	AL	0.184	2	x	n	8897	I13	3	
φ	570	AL	1.770	4	x	n	8897	I13	3	
φ	571	CS	0.145	1	x	n	8897	I13	3	
φ	572	AN	1.392	9	x	n	8959			58
φ	573	AN	10.410		x	ny	8958			58
φ	574	AA	3.031		x	ny	8879	H14	2	
φ	575	AA	1.354	1	x	n	8879	H14	2	
φ	576	AA	2.262		x	n	8869	G16	2	
φ	577	AA	0.061	2	x	y	8869	G16	2	
φ	578	AP	0.680	1	x	n	8914	O11	1	
φ	579	AB	0.436	1	x	y	8866	G15	3	
φ	580	AB	0.892	4	x	y	8866	G15	3	
φ	581	AC	0.943	1	x	n	8866	G15	3	
φ	582	AN	1.072	5	x	n	8866	G15	3	
φ	583	AN	1.084	6	x	n	8866	G15	3	
φ	584	AC	0.282	2	x	y	8871	G16	3	
φ	585	AA	0.200	1	x	n	8860	G14	3	
φ	586	AA	3.050		x	n	8860	G14	3	
φ	587	AA	0.070	1	x	n	8902	I14	3	
φ	588	AA	1.387		x	n	8902	I14	3	
φ	589	AA	3.390		x	n	8902	I14	3	
φ	590	AC	0.086	1	x	n	8902	I14	3	
φ	591	AC	1.646		x	ny	8902	I14	3	
φ	592	AC	0.121	1	x	y	8902	I14	3	
φ	593	AC	0.509	1	x	n	8887	H15	3	
φ	594	AC	0.624	5	x	n	8887	H15	3	
φ	595	AN	0.725	3	x	n	8887	H15	3	
φ	596	AN	0.191	1	x	n	8887	H15	3	
φ	597	CK	0.045	1	x	n	8947			47
φ	598	FH	2.386	1	x	n	8942			43
φ	599	AR	8.167		x	n	8941			42
φ	600	AR	11.163		x	n	8941			42

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	601	RA	4.571	2	x	n	8941			42
φ	602	RA	1.941	3	x	n	8941			42
φ	603	AE	3.525	4	x	ny	8900	I14	2	
φ	604	AE	3.065	1	x	n	8942			43
φ	605	AA	0.116		x	n	8887	H15	3	
φ	606	AA	1.115	1	x	n	8869	G16	2	
φ	607	AA	0.943	1	x	n	8912	I16	3	
φ	608	AA	3.758		x	n	8943			44
φ	609	AR	0.211		x	n	8881	H14	3	
φ	610	AA	0.141		x	n	8887	H15	3	
φ	611	AA	0.243		x	n	8912	I16	3	
φ	612	AA	0.257		x	n	8887	H15	3	
φ	613	AA	0.732	1	x	n	8869	G16	2	
φ	614	NT	4.745	1	x	n	8895	I13	2	
φ	615	AA	1.354	1	x	n	8902	I14	3	
φ	616	AA	0.808	1	x	n	8866	G15	3	
φ	617	AA	1.809	3	x	n	8943			44
φ	618	RA	1.065	1	x	n	8954			54
φ	619	RA	0.888	1	x	n	8954			54
φ	620	AR	0.415	21	x	ny	8954			54
φ	621	AD	0.008	1	x	n	8954			54
φ	623	AA	1.533		x	n	8953			53
φ	624	BD	0.149	2	x		8969			67
φ	625	LB	0.219	1	x	y	8968			66
φ	626	AR	0.027	1	x	n	8969			67
φ	627	BJ	0.051	1	x	n	8964			63
φ	628	AC	0.006	1	x	y	8954			54
φ	629	AR	0.045	1	x	y	8961			60
φ	630	NA	0.046	1	x	n	8884	H15	2	
φ	631	NA	0.015	1	x	n	8957			57
φ	632	NA	0.160	2	x	n	8953			53
φ	633	NA	0.222	2	x	n	8941			42
φ	634	NA	0.088	2	x	n	8966			64
φ	635	ND	0.096	1	x		8879	H14	2	
φ	636	ND	0.672	1	x		8875	H13	2	
φ	637	ND	0.640		x	n	8953			53
φ	638	ND	0.371	2	x	n	8941			42
φ	639	ND	0.184	1	x	n	8958			58
φ	640	ND	0.761	1	x		8892	H16	3	
φ	641	ND	0.055	1	x	n	8952			52
φ	642	ND	0.443	1	x		8887	H15	3	
φ	643	ND	0.188	3	x	n	8951			51
φ	644	NE	0.003	1	x	n	8963			62
φ	645	NE	0.052	6	x	n	8941			42
φ	646	NE	0.003	1	x	n	8962			61
φ	647	NE	0.015	1	x	n	8952			52

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	648	NE	0.005	1	x	n	8944			45
φ	649	NE	0.025	4	x	n	8955			55
φ	650	NE	0.023	2	x	n	8948			48
φ	651	NB	0.759	1	x	n	8879	H14	2	
φ	652	NC	0.870	1	x	n	8941			42
φ	653	NC	0.157	1	x	n	8947			47
φ	654	NC	0.989	1	x	n	8871	G16	3	
φ	655	NC	0.296	1	x	n	8964			63
φ	656	NC	0.347	1	x	n	8941			42
φ	657	NC	1.097	2	x	n	8881	H14	3	
φ	658	NF	1.032	8	x	n	8948			48
φ	659	NF	0.239	2	x	n	8966			64
φ	660	NG	0.231	1	x	n	8941			42
φ	661	NG	0.665	6	x	n	8953			53
φ	662	NM	0.261	2	x	n	8948			48
φ	663	NO	0.040	2	x	n	8947			47
φ	664	NJ	0.125	1	x	n	8941			42
φ	665	NP	0.759	6	x	n	8942			43
φ	666	NF	0.287	2	x	n	8941			42
φ	667	NL	2.461		x	n	8941			42
φ	668	NK	0.364	2	x	n	8941			42
φ	669	NI	0.244		x	n	8955			55
φ	670	NR	0.004	1	x	n	8955			55
φ	671	CO	0.093	1	x	n	8953			53
φ	672	AA	2.058		x	n	8944			45
φ	673	AC	0.419	5	x	n	8944			45
φ	674	AD	0.172	1	x	n	8944			45
φ	675	AL	0.758	8	x	n	8944			45
φ	676	AN	2.214	47	x	n	8944			45
φ	677	AY	0.039	5	x	n	8944			45
φ	678	AZ	0.044	2	x	n	8944			45
φ	679	BA	0.010	2	x		8944			45
φ	680	NH	0.075	1	x	n	8941			42
φ	681	BC	0.132	3	x	n	8944			45
φ	682	BD	0.709	5	x	n	8944			45
φ	683	BB	0.002	2	x	n	8944			45
φ	684	CS	0.026	3	.		8944			45
φ	684	GH	0.027	1	x	n	8944			45
φ	686	RA	0.545	1	x	n	8944			45
φ	687	AA	0.908		x	n	8947			47
φ	688	AA	12.612	3	x	n	8947			47
φ	689	RA	6.221	1	x	n	8947			47
φ	690	RA	2.982	5	x	n	8947			47
φ	691	NC	0.859	1	x	n	8887	H15	3	
φ	692	NC	0.408	1	x	n	8900	I14	2	
φ	693	NU	2.566	3	x	n	8855	G13	3	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	694	NW	1.180	4	x	n	8881	H14	3	
φ	695	NT	1.087	1	x	n	8881	H14	3	
φ	696	NN	1.314	3	x	n	8871	G16	3	
φ	697	NN	4.734	1	x	n	8871	G16	3	
φ	698	NX	2.348		x	n	8942			43
φ	699	NW	0.541	1	x	n	8953			53
φ	700	NN	3.437		x	n	8953			53
φ	701	NN	4.829	24	x	n	8881	H14	3	
φ	702	NC	1.415	3	x	n	8951			51
φ	704	NN	9.012		x	n	8951			51
φ	705	NN	4.665	5	x	n	8964			63
φ	706	NN	5.008	5	x	n	8969			67
φ	707	NN	3.078		x	n	8955			55
φ	708	NK	1.076	6	x	n	8947			47
φ	709	NN	1.771	20	x	n	8958			58
φ	710	NN	1.064	26	x	n	8966			64
φ	711	NC	0.099	1	x	n	8952			52
φ	712	NN	7.396	38	x	n	8952			52
φ	713	PB	0.945	1	x	n	8941			42
φ	714	NN	20.619	70	x	n	8941			42
φ	715	Z	0.812	1	x	n	8941			42
φ	717	AO	0.212	1	.		8949			49
φ	718	AO	2.586	7	.		8944			45
φ	719	AO	6.060	35	.		8945			46
φ	720	AO	12.008	33	.		8890	H16	2	
φ	721	AO	16.140	13	.		8910	I16	2	
φ	722	AO	8.368	11	.		8919	O11	4	
φ	723	AO	1.363	1	.		8917	O11	3	
φ	724	AO	1.316	3	.		8921	O11	5	
φ	725	AO	1.092	4	.		8923	O11	5	
φ	726	AO	2.634	3	.		8924	O11	6	
φ	727	AO	0.448	1	.		8926	O11	7	
φ	728	AO	13.545	12	.		8866	G15	3	
φ	729	AO	2.565	3	.		8866	G15	3	
φ	730	AO	2.556	2	.		8866	G15	3	
φ	731	AO	0.760	3	.		8871	G16	3	
φ	732	AO	9.682	11	.		8871	G16	3	
φ	733	AO	0.136	1	.		8892	H16	3	
φ	734	AO	8.837	22	.		8892	H16	3	
φ	735	AO	1.572	4	.		8892	H16	3	
φ	736	AO	20.180	18	.		8912	I16	3	
φ	737	AO	0.274	2	.		8912	I16	3	
φ	738	AO	17.360	17	.		8860	G14	3	
φ	739	AO	2.874	3	.		8860	G14	3	
φ	740	AO	4.171	5	.		8886	H15	2	
φ	741	AO	21.045	38	.		8884	H15	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	742	AO	52.700	55	.		8905	I15	2	
φ	743	AO	19.400	15	.		8858	G14	2	
φ	744	AO	119.300	81	.		8879	H14	2	
φ	745	AO	113.800	102	.		8900	I14	2	
φ	746	AO	77.800	74	.		8875	H13	2	
φ	747	AN	8.632		.		8875	H13	2	
φ	748	AO	6.900	6	.		8959			58
φ	749	AO	23.900	90	.		8958			58
φ	750	AO	10.900	10	.		8948			48
φ	751	AO	8.800	8	.		8955			55
φ	752	AO	4.700	38	.		8962			61
φ	753	AM	83.600	161	.		8951			51
φ	754	AO	20.300	13	.		8943			44
φ	755	AO	1.414	2	.		8968			66
φ	756	AO	5.304	8	.		8954			54
φ	757	AO	4.048	12	.		8963			62
φ	758	AO	0.310	3	.		8956			56
φ	759	AO	4.515	16	.		8967			65
φ	760	AO	8.700	6	.		8969			67
φ	761	AO	16.740	15	.		8957			57
φ	762	AO	37.300	13	.		8964			63
φ	763	AO	122.000	142	.		8952			52
φ	764	AO	0.910	1	.		8865	G15	2	
φ	765	AO	36.300	35	.		8863	G15	2	
φ	766	AO	70.600	86	.		8869	G16	2	
φ	767	AO	8.048	2	.		8942			43
φ	768	AO	21.900	22	.		8947			47
φ	769	AO	20.500	24	.		8853	G13	2	
φ	770	AO	170.300	125	.		8895	I13	2	
φ	771	AO	3.128	7	.		8907	I15	3	
φ	772	AO	7.192	10	.		8902	I14	3	
φ	773	AO	15.600	40	.		8902	I14	3	
φ	774	AO	3.778	4	.		8902	I14	3	
φ	775	AO	0.851	4	.		8881	H14	3	
φ	776	AO	127.000	116	.		8881	H14	3	
φ	777	AO	4.205	3	.		8855	G13	3	
φ	778	AO	7.100	4	.		8877	H13	3	
φ	779	AO	246.900	237	.		8941			42
φ	780	AO	28.600	41	.		8897	I13	3	
φ	781	AO	18.900	13	.		8897	I13	3	
φ	782	AO	15.600	9	.		8887	H15	3	
φ	783	AO	8.200	10	.		8887	H15	3	
φ	783	AO	83.600	161	.		8951			51
φ	784	AO	0.823	3	.		8887	H15	3	
φ	785	AO	11.400	17	.		8887	H15	3	
φ	786	AO	18.330	15	.		8966			64

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	787	AO	94.100	195	.		8953			53
φ	788	AM	37.715		.		8956			56
φ	789	AM	1.051	13	.		8961			60
φ	790	AM	72.900		.		8948			48
φ	791	AM	99.500		.		8944			45
φ	792	AM	34.600		.		8969			67
φ	793	AM	30.000		.		8886	H15	2	
φ	794	AM	14.280		.		8968			66
φ	795	AM	25.900		.		8942			43
φ	796	AM	61.300		.		8964			63
φ	797	AM	97.900		.		8963			62
φ	798	AM	102.700		.		8954			54
φ	799	AM	1.188		.		8865	G15	2	
φ	800	AM	18.272		.		8967			65
φ	801	AM	2.213		.		8950			50
φ	802	AM	4.252		.		8949			49
φ	803	AM	0.748	4	.		8931	O2	3	
φ	804	AM	32.600		.		8877	H13	3	
φ	805	AM	40.800		.		8907	I15	3	
φ	806	AM	9.675		.		8924	O11	6	
φ	806	AM	3.161		.		8873	G16	3	
φ	807	AM	0.422		.		8937	O2	6	
φ	807	AM	0.422		.		8939	O2	7	
φ	808	AM	0.836		.		8914	O11	1	
φ	809	AM	14.468		.		8915	O11	2	
φ	810	AM	28.100		.		8921	O11	5	
φ	811	AM	11.740		.		8923	O11	5	
φ	812	AM	1.337		.		8855	G13	3	
φ	813	AM	15.455		.		8855	G13	3	
φ	814	AM	116.100		.		8917	O11	3	
φ	815	AM	277.500		.		8919	O11	4	
φ	816	AM	3.000		.		8873	G16	3	
φ	817	AM	119.600		.		8945			46
φ	818	AM	63.100		.		8943			44
φ	819	AM	33.724		.		8957			57
φ	820	AM	99.700		.		8947			47
φ	821	AM	71.500		.		8860	G14	3	
φ	822	AM	1.881		.		8860	G14	3	
φ	823	AM	123.000		.		8966			64
φ	824	AM	80.600		.		8952			52
φ	825	AM	134.000		.		8858	G14	2	
φ	826	AM	53.000		.		8871	G16	3	
φ	827	AM	48.000		.		8871	G16	3	
φ	828	AM	10.573		.		8912	I16	3	
φ	829	AM	110.700		.		8912	I16	3	
φ	830	AM	17.157		.		8866	G15	3	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	831	AM	17.290		.		8866	G15	3	
φ	832	AM	50.600		.		8866	G15	3	
φ	833	AM	81.800		.		8892	H16	3	
φ	834	AM	3.153		.		8892	H16	3	
φ	835	AM	9.655		.		8892	H16	3	
φ	836	AM	242.000		.		8890	H16	2	
φ	837	AM	0.544		.		8853	G13	2	
φ	838	AM	211.300		.		8902	I14	3	
φ	839	AM	70.300		.		8902	I14	3	
φ	840	AM	16.094		.		8902	I14	3	
φ	841	AM	782.000		.		8951			51
φ	842	AM	2330.000		x		8953			53
φ	843	AM	206.000		.		8955			55
φ	844	AM	173.500		.		8959			58
φ	845	AM	291.000		.		8958			58
φ	846	AM	149.200		.		8897	I13	3	
φ	847	AM	81.000		.		8897	I13	3	
φ	848	AM	109.200		.		8887	H15	3	
φ	849	AM	46.700		.		8887	H15	3	
φ	850	AM	69.400		.		8887	H15	3	
φ	851	AM	10.372		.		8887	H15	3	
φ	852	AM	104.000		.		8887	H15	3	
φ	853	AM	361.000		.		8863	G15	2	
φ	854	AM	450.000		.		8910	I16	2	
φ	855	AM	650.000		.		8884	H15	2	
φ	856	AM	445.000		x		8962			61
φ	857	AM	850.000		.		8879	H14	2	
φ	858	AM	890.000		.		8905	I15	2	
φ	859	AM	1205.000		.		8869	G16	2	
φ	860	AM	765.000		.		8900	I14	2	
φ	861	AM	1860.000		.		8890	H16	2	
φ	862	AM	935.000		.		8875	H13	2	
φ	863	AM	900.000		.		8895	I13	2	
φ	864	AM	2030.000		x		8941			42
φ	865	AM	9.257		.		8881	H14	3	
φ	866	AM	63.000		.		8881	H14	3	
φ	867	AE	0.322	1	.		8920	O11	4	
φ	868	AE	1.050	1	.		8885	H15	2	
φ	869	AP	0.836	1	.		8911	I16	2	
φ	870	AP	2.161	2	.		8885	H15	2	
φ	871	AP	1.004	1	.		8864	G15	2	
φ	872	AP	4.740	3	.		8859	G14	2	
φ	873	AL	0.060	2	.		8896	I13	2	
φ	874	AM	0.091	2	.		8906	I15	2	
φ	875	AM	2.774	16	.		8859	G14	2	
φ	876	AM	4.084	10	.		8911	I16	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	877	AM	1.291	8	.		8922	O11	5	
φ	878	AM	0.167	1	.		8867	G15	3	
φ	879	AM	0.829	3	.		8882	H14	3	
φ	880	AM	0.329	2	.		8893	H16	3	
φ	881	AM	0.058	2	.		8946			46
φ	882	AM	1.712	5	.		8872	G16	3	
φ	883	AM	0.486	6	.		8913	I16	3	
φ	884	AM	0.573	3	.		8898	I13	3	
φ	885	AM	0.856	2	.		8876	H13	2	
φ	886	AM	6.002	20	.		8891	H16	2	
φ	887	AM	0.186	2	.		8880	H14	2	
φ	888	AM	1.303	5	.		8885	H15	2	
φ	889	AM	1.909	12	.		8854	G13	2	
φ	890	AM	1.974	10	.		8916	O11	2	
φ	891	AM	7.420	26	.		8870	G16	2	
φ	892	AM	2.953	15	.		8918	O11	3	
φ	893	AM	6.960	14	.		8864	G15	2	
φ	894	AM	1.707	8	.		8867	G15	3	
φ	895	AM	0.051	1	.		8867	G15	3	
φ	896	AM	2.622	15	.		8920	O11	4	
φ	897	RP	0.386		.		8867	G15	3	
φ	898	RP	0.147		.		8908	I15	3	
φ	899	RP	1.283		.		8867	G15	3	
φ	900	RP	1.197		.		8903	I14	3	
φ	901	RP	0.306		.		8867	G15	3	
φ	902	RP	0.444		.		8913	I16	3	
φ	903	RP	2.626		.		8872	G16	3	
φ	904	AN	0.042	1	.		8896	I13	2	
φ	905	AN	0.026	1	.		8880	H14	2	
φ	906	AN	0.208	4	.		8901	I14	2	
φ	907	AN	0.092	3	.		8867	G15	3	
φ	908	AN	0.052	1	.		8867	G15	3	
φ	910	AN	0.051	1	.		8882	H14	3	
φ	911	AN	0.239	2	.		8872	G16	3	
φ	912	AN	0.078	1	.		8893	H16	3	
φ	913	AO	0.608	3	.		8920	O11	4	
φ	914	AO	0.183	1	.		8925	O11	6	
φ	915	AO	1.053	4	.		8882	H14	3	
φ	916	AO	1.202	2	.		8913	I16	3	
φ	917	AO	0.578	1	.		8872	G16	3	
φ	918	AO	1.178	2	.		8867	G15	3	
φ	919	AO	2.033	1	.		8903	I14	3	
φ	920	AO	3.990	3	.		8903	I14	3	
φ	921	AO	1.765	1	.		8901	I14	2	
φ	922	AO	4.753	3	.		8906	I15	2	
φ	923	AO	5.234	4	.		8911	I16	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	924	AO	1.835	3	.		8880	H14	2	
φ	925	AO	3.597	4	.		8885	H15	2	
φ	926	AO	1.059	3	.		8896	I13	2	
φ	927	AO	0.629	2	.		8864	G15	2	
φ	928	RP	0.072		.		8893	H16	3	
φ	929	RP	0.229		.		8898	I13	3	
φ	930	RP	0.153		.		8856	G13	3	
φ	931	RP	0.719		.		8888	H15	3	
φ	932	RP	0.088		.		8932	O2	3	
φ	933	RP	3.352		.		8918	O11	3	
φ	934	RP	0.268		.		8903	I14	3	
φ	935	RP	0.741		.		8882	H14	3	
φ	936	RP	4.661		.		8916	O11	2	
φ	937	RP	5.802		.		8896	I13	2	
φ	938	RP	9.448		.		8891	H16	2	
φ	939	RP	9.799		.		8870	G16	2	
φ	940	RP	7.198		.		8911	I16	2	
φ	941	RP	1.884		.		8859	G14	2	
φ	942	RP	3.755		.		8880	H14	2	
φ	943	RP	3.933		.		8876	H13	2	
φ	944	RP	3.957		.		8901	I14	2	
φ	944	RP	3.956		.		8901	I14	2	
φ	945	RP	2.812		.		8854	G13	2	
φ	946	RP	2.494		.		8864	G15	2	
φ	947	RP	0.064		.		8938	O2	6	
φ	948	RP	0.296		.		8930	O2	2	
φ	949	RP	0.023		.		8925	O11	6	
φ	950	RP	0.098		.		8920	O11	4	
φ	951	RP	4.613		.		8906	I15	2	
φ	952	RP	0.570		.		8922	O11	5	
φ	953	RP	6.487		.		8885	H15	2	
φ	954	AT	1.275	14	x	n	8911	I16	2	
φ	955	BA	0.099	17	x		8880	H14	2	
φ	956	BA	0.009	1	x		8859	G14	2	
φ	957	AA	0.014	1	x	y	8867	G15	3	
φ	958	BA	0.087	9	x		8901	I14	2	
φ	959	AT	0.047	2	x	n	8876	H13	2	
φ	960	BA	0.023	1	x		8864	G15	2	
φ	961	BA	0.251	30	x		8911	I16	2	
φ	962	AZ	0.177	7	x		8906	I15	2	
φ	963	BA	0.095	7	x		8885	H15	2	
φ	964	AA	0.038	3	x	n	8946			46
φ	965	AX	0.078	2	x	n	8859	G14	2	
φ	966	AZ	0.072	3	x		8885	H15	2	
φ	967	AT	0.618	10	x	n	8896	I13	2	
φ	968	AZ	0.022	1	x		8859	G14	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	969	AT	1.067	16	x	n	8906	I15	2	
φ	970	AX	0.195	3	x	n	8896	I13	2	
φ	971	AT	0.790	31	x	n	8916	O11	2	
φ	972	BA	0.292	33	x		8891	H16	2	
φ	973	ND	0.292	2	x	n	8891	H16	2	
φ	974	BA	0.010	6	x		8876	H13	2	
φ	975	ND	0.031	1	x	n	8901	I14	2	
φ	976	AZ	0.006	1	x	n	8908	I15	3	
φ	977	AU	0.011	1	x		8936	O2	5	
φ	978	ND	0.062	1	x	n	8896	I13	2	
φ	979	AU	0.014	1	x		8906	I15	2	
φ	980	AZ	0.035	1	x	n	8901	I14	2	
φ	981	BA	0.107	12	x		8896	I13	2	
φ	982	AZ	0.042	2	x	n	8896	I13	2	
φ	983	BA	0.029	2	x		8913	I16	3	
φ	984	AZ	0.019	1	x	n	8876	H13	2	
φ	985	BA	0.061	6	x		8870	G16	2	
φ	986	BA	0.476	36	x		8906	I15	2	
φ	987	AL	0.023	1	x	n	8906	I15	2	
φ	988	AT	0.381	7	x	n	8901	I14	2	
φ	989	AT	0.090	2	x	n	8891	H16	2	
φ	990	NG	0.050	1	x	n	8903	I14	3	
φ	991	AX	0.194	4	x	n	8854	G13	2	
φ	992	AR	0.030	1	x	n	8913	I16	3	
φ	993	AU	0.018	3	x		8930	O2	2	
φ	994	AA	0.063	1	x	y	8903	I14	3	
φ	995	AX	0.065	1	x	n	8876	H13	2	
φ	996	AA	0.064	1	x	n	8856	G13	3	
φ	997	AX	0.302	5	x	n	8918	O11	3	
φ	998	AZ	0.018	1	x	n	8911	I16	2	
φ	999	AD	0.018	1	x	n	8870	G16	2	
φ	1000	AT	0.213	6	x	n	8864	G15	2	
φ	1001	AX	0.306	6	x	n	8916	O11	2	
φ	1002	AX	0.567	5	x	n	8906	I15	2	
φ	1003	AX	0.240	2	x	n	8925	O11	6	
φ	1004	AU	0.000	2	x	n	8934	O2	4	
φ	1005	ND	0.090	2	x	ny	8867	G15	3	
φ	1006	BA	0.060	3	x		8918	O11	3	
φ	1007	AC	0.214	1	x	n	8867	G15	3	
φ	1008	AC	0.650	1	x	n	8903	I14	3	
φ	1009	AT	0.141	4	x	n	8870	G16	2	
φ	1010	AZ	0.010	1	x	n	8918	O11	3	
φ	1011	AT	0.556	21	x	n	8918	O11	3	
φ	1012	BA	0.011	3	x		8854	G13	2	
φ	1013	AZ	0.006	1	x	n	8891	H16	2	
φ	1014	AR	0.165	1	x	n	8859	G14	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1015	AF	0.091	1	x	n	8901	I14	2	
φ	1016	AA	0.067	1	x		8882	H14	3	
φ	1017	AX	0.154	3	x	n	8911	I16	2	
φ	1018	AX	0.176	3	x	n	8885	H15	2	
φ	1019	AT	0.238	10	x	n	8880	H14	2	
φ	1020	AT	1.033	15	x	n	8885	H15	2	
φ	1021	AD	0.080	1	x	n	8867	G15	3	
φ	1022	AD	0.014	1	x	n	8891	H16	2	
φ	1023	AF	0.037	2	x	n	8906	I15	2	
φ	1024	AX	0.183	2	x	n	8891	H16	2	
φ	1025	AA	0.449	2	x		8876	H13	2	
φ	1026	BE	0.208	1	x		8885	H15	2	
φ	1027	AC	0.095	1	x	n	8901	I14	2	
φ	1028	AX	0.445	4	x	n	8901	I14	2	
φ	1029	AA	0.161	1	x	n	8867	G15	3	
φ	1030	AC	0.307	1	x		8876	H13	2	
φ	1031	AA	0.146	3	x	n	8903	I14	3	
φ	1032	AX	0.364	4	x	n	8880	H14	2	
φ	1033	AA	0.049	2	x	n	8898	I13	3	
φ	1034	NQ	0.154	1	x	n	8870	G16	2	
φ	1035	NN	0.019	2	x	n	8893	H16	3	
φ	1036	DR	0.044	1	x	n	8891	H16	2	
φ	1037	GP	0.003	1	x	n	8876	H13	2	
φ	1038	JF	0.210	5	x	n	8920	O11	4	
φ	1039	GT	0.016	1	x	n	8906	I15	2	
φ	1040	RL	0.012	1	x	n	8906	I15	2	
φ	1041	Z	0.194	1	x	n	8922	O11	5	
φ	1042	GQ	0.397	1	x	n	8880	H14	2	
φ	1043	BZ	0.108	1	x	n	8901	I14	2	
φ	1044	JD	0.090	1	x	y	8872	G16	3	
φ	1045	GA	0.075	1	x	n	8864	G15	2	
φ	1046	IZ	0.092	1	x	n	8913	I16	3	
φ	1047	AX	0.042	1	x	n	8859	G14	2	
φ	1048	IF	0.106	1	x	n	8903	I14	3	
φ	1049	HH	0.016	1	x	n	8918	O11	3	
φ	1049	HH	0.015	1	x	n	8918	O11	3	
φ	1050	AS	0.089	1	x	n	8916	O11	2	
φ	1052	GR	0.084	1	x		8859	G14	2	
φ	1053	CN	0.246	1	x	n	8911	I16	2	
φ	1054	IU	0.110	1	.		8870	G16	2	
φ	1055	CM	0.064	1	x	n	8854	G13	2	
φ	1056	IY	0.076	1	x	n	8920	O11	4	
φ	1057	AP	0.284	1	x	n	8872	G16	3	
φ	1058	BD	0.015	2	x	y	8920	O11	4	
φ	1059	IO	0.028	2	x	y	8859	G14	2	
φ	1060	HZ	0.129	1	x	n	8864	G15	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1061	Z	0.053	2	x	n	8955			55
φ	1062	JE	0.285	1	x	n	8870	G16	2	
φ	1064	HU	0.041	1	x	n	8918	O11	3	
φ	1065	IE	0.054	1	x	n	8859	G14	2	
φ	1066	HV	0.090	1	x	n	8870	G16	2	
φ	1067	Z	0.176	5	.		8891	H16	2	
φ	1068	Z	1.834	6	.		8867	G15	3	
φ	1069	HL	0.005	1	x	n	8864	G15	2	
φ	1070	GW	0.008	1	x	n	8870	G16	2	
φ	1071	HT	0.004	1	x	n	8859	G14	2	
φ	1072	ID	0.004	1	x	n	8859	G14	2	
φ	1073	HY	0.003	1	x	n	8859	G14	2	
φ	1074	FF	0.009	1	x	n	8859	G14	2	
φ	1075	IG	0.004	1	x	n	8916	O11	2	
φ	1076	AX	0.021	1	x	n	8916	O11	2	
φ	1077	IQ	0.012	1	x		8870	G16	2	
φ	1078	FF	0.035	1	x	n	8911	I16	2	
φ	1079	DD	0.013	1	x	n	8891	H16	2	
φ	1080	HI	0.009	1	x	n	8916	O11	2	
φ	1080	IH	0.009	1	.		8916	O11	2	
φ	1081	HP	0.008	1	x	n	8859	G14	2	
φ	1082	DC	0.002	1	x	n	8901	I14	2	
φ	1083	GS	0.003	1	x	n	8922	O11	5	
φ	1084	FZ	0.009	1	x	n	8893	H16	3	
φ	1085	HS	0.038	1	x	n	8901	I14	2	
φ	1087	GZ	0.018	1	x	n	8864	G15	2	
φ	1088	IK	0.018	1	x	n	8888	H15	3	
φ	1089	AH	0.024	1	x	n	8922	O11	5	
φ	1090	IA	0.011	1	x	n	8859	G14	2	
φ	1091	BA	0.005	1	x	n	8867	G15	3	
φ	1092	IV	0.003	1	x	y	8893	H16	3	
φ	1093	IL	0.008	1	x	n	8854	G13	2	
φ	1094	EL	0.005	1	x		8936	O2	5	
φ	1095	IA	0.004	1	x	n	8859	G14	2	
φ	1096	SVJ	0.000	1	x	n	8891	H16	2	
φ	1098	IC	0.021	3	x	n	8859	G14	2	
φ	1099	JA	0.004	1	x	n	8918	O11	3	
φ	1100	HG	0.005	1	x	n	8906	I15	2	
φ	1101	GY	0.045	1	x	n	8854	G13	2	
φ	1103	HL	0.004	1	x	n	8854	G13	2	
φ	1104	BA	0.004	1	x	n	8901	I14	2	
φ	1105	Z	0.006	1	x	n	8906	I15	2	
φ	1106	Z	0.009	1	x	n	8854	G13	2	
φ	1107	DD	0.011	1	x	n	8864	G15	2	
φ	1108	HI	0.005	1	x	n	8859	G14	2	
φ	1109	IS	0.010	1	x	y	8893	H16	3	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1110	AB	0.288	1	x	y	8951			51
φ	1111	PC	6.201	1	x	n	8947			47
φ	1112	KF	0.000	1	x	n	8955			55
φ	1113	CW	0.000	1	x	n	8967			65
φ	1114	KC	0.022	1	x	n	8944			45
φ	1115	Z	0.000	1	x	n	8955			55
φ	1116	NS	0.085	1	x	n	8943			44
φ	1117	LC	0.012	2	x	y	8955			55
φ	1118	EI	0.000	1	x	n	8945			46
φ	1119	EG	0.010	1	x	n	8945			46
φ	1120	AZ	0.006	1	x	y	8955			55
φ	1121	LD	0.005	1	x	y	8955			55
φ	1122	CZ	0.001	1	x	y	8955			55
φ	1123	Z	0.000	1	x	n	8967			65
φ	1124	FZ	0.046	2	x	n	8967			65
φ	1125	Z	0.003		x	n	8967			65
φ	1126	KD	0.009	1	x	n	8945			46
φ	1127	Z	0.004		x	n	8945			46
φ	1128	CW	0.000	1	x	n	8945			46
φ	1129	HJ	0.002	1	x	n	8955			55
φ	1130	LE	0.011	1	x	y	8955			55
φ	1131	FD	0.009	1	x	y	8945			46
φ	1132	NM	0.014	2	x	n	8955			55
φ	1133	LF	0.010	1	x	n	8955			55
φ	1134	AA	0.003	1	x	y	8955			55
φ	1135	LG	0.003	1	x	n	8955			55
φ	1136	KF	0.007	1	x	n	8955			55
φ	1137	LH	0.008	1	x	n	8955			55
φ	1138	LI	0.003	1	x	n	8955			55
φ	1139	AZ	0.018	3	x	y	8955			55
φ	1140	YX	0.005	1	x	n	8955			55
φ	1141	YY	0.000	1	x	n	8945			46
φ	1142	LJ	0.010	1	x	y	8955			55
φ	1143	Z	0.000		x	n	8945			46
φ	1144	KG	0.004	1	x	n	8945			46
φ	1145	KL	0.005	1	x	y	8945			46
φ	1146	FW	0.010	1	x	y	8955			55
φ	1147	BJ	0.009	1	x	n	8945			46
φ	1148	AZ	0.009	1	x	y	8945			46
φ	1149	FZ	0.006	1	x	n	8955			55
φ	1150	DC	0.001	1	x	n	8955			55
φ	1151	AX	0.045	2	x	y	8945			46
φ	1152	AA	0.002	1	x	n	8947			47
φ	1153	AX	0.015	1	x	y	8947			47
φ	1154	BI	0.005	1	x	n	8944			45
φ	1155	EA	0.011	1	x	n	8947			47

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1156	BY	0.008	2	x	n	8947			47
φ	1157	NA	0.005	1	x	n	8961			60
φ	1158	LK	0.010	1	x	n	8947			47
φ	1159	NV	0.004	2	x	ny	8947			47
φ	1160	LL	0.014	1	x	y	8962			61
φ	1161	CL	0.003	2	x	n	8962			61
φ	1162	GM	0.007	1	x	y	8962			61
φ	1163	FW	0.011	1	x	y	8944			45
φ	1164	FF	0.019	2	x	n	8962			61
φ	1165	LM	0.030	1	x	y	8961			60
φ	1166	HF	0.050	1	x	n	8961			60
φ	1167	YZ	0.002	1	x	n	8962			61
φ	1168	ZA	0.003	1	x	n	8962			61
φ	1169	KM	0.002	1	x	y	8962			61
φ	1170	DC	0.011	6	x	n	8962			61
φ	1171	EA	0.022	1	x	n	8962			61
φ	1172	LN	0.007	1	x	y	8961			60
φ	1174	LO	0.004	1	x	n	8947			47
φ	1175	LP	0.003	1	x	n	8947			47
φ	1176	CZ	0.001	1	x	y	8962			61
φ	1177	LQ	0.003	1	x	n	8947			47
φ	1178	LR	0.005	1	x	n	8962			61
φ	1179	LS	0.011	1	x	n	8961			60
φ	1180	EX	0.034	1	x	n	8947			47
φ	1181	CS	0.017	1	x	y	8962			61
φ	1182	HA	0.008	1	x	y	8962			61
φ	1183	LT	0.071	1	x	n	8948			48
φ	1184	HC	0.005	1	x	n	8944			45
φ	1185	CS	0.002	1	x	n	8947			47
φ	1186	HN	0.059	2	x	n	8962			61
φ	1187	NK	0.016	1	x	n	8947			47
φ	1188	NK	0.045	1	x	n	8947			47
φ	1189	NK	0.035	5	x	n	8947			47
φ	1190	LU	0.002	1	x	y	8962			61
φ	1191	NZ	0.006	1	x	n	8947			47
φ	1192	AU	0.003	2	x	n	8947			47
φ	1193	NZ	0.007	1	x	n	8962			61
φ	1194	LV	0.005	1	x	y	8962			61
φ	1195	CX	0.036	3	x	n	8962			61
φ	1196	GG	0.009	1	x	y	8961			60
φ	1197	HD	0.018	1	x	n	8947			47
φ	1198	EK	0.013	1	x	y	8947			47
φ	1199	LW	0.009	1	x	y	8958			58
φ	1200	LX	0.002	1	x	n	8944			45
φ	1201	LY	0.024	1	x	n	8947			47
φ	1202	LZ	0.001	1	x	n	8947			47

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1203	MA	0.000	1	x	n	8947			47
φ	1204	MB	0.009	1	x	n	8958			58
φ	1205	DI	0.008	1	x	y	8958			58
φ	1206	DC	0.003	1	x	n	8944			45
φ	1207	MC	0.002	1	x	y	8958			58
φ	1208	MD	0.005	1	x	n	8958			58
φ	1209	CG	0.051	7	x	y	8958			58
φ	1210	ME	0.014	1	x	n	8947			47
φ	1211	FA	0.002	1	x	n	8947			47
φ	1212	DZ	0.003	1	x	n	8947			47
φ	1213	JG	0.003	1	x	n	8962			61
φ	1214	AL	0.003	1	x	y	8962			61
φ	1215	HD	0.005	1	x	y	8947			47
φ	1216	MF	0.005	1	x	n	8958			58
φ	1217	JH	0.006	1	x	n	8947			47
φ	1218	AA	0.003	1	x	n	8944			45
φ	1219	FF	0.004	1	x	n	8962			61
φ	1220	AL	0.014	1	x	n	8958			58
φ	1221	MG	0.017	1	x	n	8962			61
φ	1222	MH	0.006	1	x	y	8947			47
φ	1223	FZ	0.034	1	x	n	8962			61
φ	1224	MI	0.008	1	x	y	8962			61
φ	1225	FF	0.012	1	x	n	8962			61
φ	1226	Z	0.009	1	x	n	8962			61
φ	1227	Z	0.007	1	x	n	8962			61
φ	1228	GV	0.009	1	x	y	8962			61
φ	1229	FZ	0.024	1	x	n	8962			61
φ	1230	BI	0.001	1	x	n	8962			61
φ	1231	MJ	0.021	1	x	y	8962			61
φ	1232	FY	0.023	2	x	y	8962			61
φ	1233	FP	0.016	1	x	n	8947			47
φ	1234	JH	0.020	3	x	n	8962			61
φ	1235	BB	0.003	1	x	n	8944			45
φ	1236	MK	0.006	1	x	n	8962			61
φ	1237	ER	0.049	2	x	n	8962			61
φ	1238	ML	0.005	1	x	n	8947			47
φ	1239	MM	0.017	1	x	y	8958			58
φ	1240	MN	0.002	1	x	n	8944			45
φ	1241	JG	0.042	5	x	n	8947			47
φ	1242	MO	0.003	1	x	y	8958			58
φ	1243	MP	0.002	5	x	n	8947			47
φ	1244	EI	0.000	1	x	n	8944			45
φ	1245	MQ	0.000	1	x	n	8958			58
φ	1246	FF	0.011	1	x	n	8958			58
φ	1247	MR	0.005	1	x	y	8958			58
φ	1248	JI	0.006	1	x	n	8958			58

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1249	MS	0.000	1	x	y	8958			58
φ	1250	MT	0.005	1	x	n	8958			58
φ	1251	CT	0.006	1	x	y	8958			58
φ	1252	PA	0.008	1	x	n	8958			58
φ	1253	MU	0.002	1	x	y	8958			58
φ	1254	DL	0.005	1	x	n	8958			58
φ	1255	IV	0.053	11	x	y	8958			58
φ	1256	KG	0.020	8	x	n	8958			58
φ	1257	MV	0.005	4	x	n	8958			58
φ	1258	KA	0.008	1	x	y	8947			47
φ	1259	AL	0.020	1	x	n	8958			58
φ	1260	MW	0.002	1	x	y	8958			58
φ	1261	MX	0.023	1	x	y	8958			58
φ	1262	CM	0.032	1	x	y	8958			58
φ	1263	FF	0.003	1	x	n	8958			58
φ	1264	FF	0.003	1	x	n	8958			58
φ	1265	BB	0.000	1	x	n	8944			45
φ	1266	HC	0.009	1	x	n	8947			47
φ	1267	IX	0.000	1	x	y	8958			58
φ	1268	MY	0.000	1	x	n	8958			58
φ	1269	BP	0.024	1	x	y	8958			58
φ	1270	MZ	0.004	1	x	y	8958			58
φ	1271	EA	0.007	1	x	y	8958			58
φ	1272	Z	0.000	1	x	n	8958			58
φ	1273	OA	0.020	1	x	y	8958			58
φ	1274	OB	0.002	1	x	n	8958			58
φ	1275	Z	0.000	1	x	n	8947			47
φ	1276	GY	0.012	1	x	n	8958			58
φ	1277	ED	0.002	1	x	y	8958			58
φ	1278	OC	0.000	1	x	y	8958			58
φ	1279	OD	0.018	1	x	n	8958			58
φ	1280	OE	0.000	1	x	y	8958			58
φ	1281	NZ	0.000	1	x	n	8958			58
φ	1282	BB	0.013	1	x	y	8958			58
φ	1283	FC	0.003	1	x	n	8958			58
φ	1284	OF	0.021	1	x	y	8958			58
φ	1285	FD	0.003	1	x	y	8958			58
φ	1286	EI	0.002	2	x	n	8958			58
φ	1287	HN	0.006	1	x	n	8958			58
φ	1288	BA	0.030	7	x	y	8958			58
φ	1289	FF	0.048	4	x	n	8958			58
φ	1290	OG	0.004	1	x		8958			58
φ	1291	KJ	0.035	1	x	y	8958			58
φ	1292	AD	0.003	1	x	y	8958			58
φ	1293	FG	0.001	1	x	y	8958			58
φ	1294	AD	0.009	1	x	y	8958			58

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1295	CG	0.027	1	x	y	8958			58
φ	1296	IB	0.043	1	x	n	8958			58
φ	1297	OH	0.005	1	x	y	8958			58
φ	1298	OI	0.002	1	x	n	8958			58
φ	1299	BD	0.026	1	x	y	8958			58
φ	1300	FF	0.011	1	x	n	8958			58
φ	1301	OJ	0.002	1	x	y	8958			58
φ	1302	OK	0.001	1	x	y	8958			58
φ	1303	Z	0.009	1	x	n	8958			58
φ	1304	OL	0.000	1	x	y	8958			58
φ	1305	CL	0.000	1	x	n	8958			58
φ	1306	OM	0.005	1	x	n	8958			58
φ	1307	JC	0.341	1	x	n	8951			51
φ	1308	DW	0.011	1	x	n	8948			48
φ	1309	ON	0.039	1	x	y	8948			48
φ	1310	AY	0.031	1	x	n	8949			49
φ	1311	SVI	0.000	1	x	n	8948			48
φ	1313	CW	0.000	2	x	n	8942			43
φ	1314	OP	0.035	1	x	n	8948			48
φ	1315	EQ	0.000	2	x	n	8948			48
φ	1316	EO	0.001	1	x	n	8948			48
φ	1317	EJ	0.010	4	x	n	8948			48
φ	1318	JH	0.010	1	x	n	8948			48
φ	1319	FA	0.003	1	x	n	8948			48
φ	1320	DC	0.001	1	x	n	8948			48
φ	1321	OQ	0.001	1	x	n	8948			48
φ	1322	EC	0.000	1	x	n	8948			48
φ	1323	EC	0.000	2	x	n	8948			48
φ	1324	OR	0.008	1	x	n	8948			48
φ	1325	EY	0.004	1	x	n	8948			48
φ	1326	OS	0.005	1	x	y	8948			48
φ	1327	KF	0.005	1	x	n	8948			48
φ	1328	GJ	0.003	1	x	n	8948			48
φ	1329	BB	0.002	1	x	n	8949			49
φ	1330	OT	0.006	1	x	n	8949			49
φ	1331	Z	0.000	1	x	n	8949			49
φ	1332	OU	0.003	1	x	n	8949			49
φ	1333	IT	0.005	1	x	n	8948			48
φ	1334	BI	0.000	1	x	n	8948			48
φ	1335	EY	0.002	1	x	n	8942			43
φ	1336	ZB	0.000	1	x	n	8969			67
φ	1337	KF	0.012		x	n	8948			48
φ	1338	EI	0.041	6	x	n	8948			48
φ	1339	ZC	0.003	1	x	n	8948			48
φ	1340	OV	0.003	1	x	y	8948			48
φ	1341	EJ	0.000	1	x	n	8948			48

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1342	EZ	0.000	1	x	n	8948			48
φ	1343	OW	0.008	1	x	n	8948			48
φ	1344	OX	0.008	1	x	n	8948			48
φ	1345	OY	0.004	1	x	n	8951			51
φ	1346	GJ	0.004	1	x	n	8948			48
φ	1347	NZ	0.003	1	x	n	8948			48
φ	1348	AY	0.012	1	x	y	8951			51
φ	1349	JB	0.007	1	x	n	8951			51
φ	1350	EA	0.005	1	x	y	8957			57
φ	1351	BA	0.045	5	x		8951			51
φ	1352	OZ	0.003	1	x	n	8951			51
φ	1353	BB	0.013	10	x	y	8951			51
φ	1354	EX	0.030	1	x	n	8951			51
φ	1355	QA	0.005	1	x	n	8948			48
φ	1356	QB	0.018	2	x	y	8948			48
φ	1357	QC	0.011	1	x	y	8951			51
φ	1358	QD	0.002	1	x	n	8951			51
φ	1359	BB	0.015	1	x	n	8951			51
φ	1360	EG		1	x	n	8954			54
φ	1361	EG		1	x	n	8941			42
φ	1362	EG		1	x	n	8962			61
φ	1363	EG		1	x	n	8948			48
φ	1364	PE		1	x	n	8963			62
φ	1365	PF		2	x	n	8951			51
φ	1366	QE	0.872	1	x	n	8957			57
φ	1367	CW	0.000	1	x	n	8949			49
φ	1368	QF	0.014	1	x	y	8951			51
φ	1369	QG	0.004	1	x	y	8957			57
φ	1370	ZD	0.004	1	x	n	8951			51
φ	1371	Z	0.003	1	x	n	8957			57
φ	1372	QH	0.033	1	x	n	8951			51
φ	1373	BW	0.019	1	x	n	8951			51
φ	1374	FF	0.005	1	x	y	8951			51
φ	1375	QI	0.004	1	x	y	8951			51
φ	1376	QJ	0.041	1	x	n	8951			51
φ	1377	QK	0.017	5	x	y	8951			51
φ	1378	FJ	0.014	2	x	y	8951			51
φ	1379	HT	0.001	2	x	y	8951			51
φ	1380	QL	0.020	1	x	y	8951			51
φ	1381	CS	0.007	2	x	n	8951			51
φ	1382	KH	0.005	1	x	n	8951			51
φ	1383	EC	0.000	1	x	n	8951			51
φ	1384	CI	0.004	1	x	n	8951			51
φ	1385	FF	0.037	1	x	n	8957			57
φ	1386	FY	0.024	1	x	y	8951			51
φ	1387	DC	0.009	3	x	n	8951			51

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1388	QM	0.000	1	x	y	8951			51
φ	1389	QN	0.000	1	x	y	8951			51
φ	1390	BB	0.020	2	x	y	8951			51
φ	1391	QO	0.085	2	x	y	8951			51
φ	1392	QP	0.012	1	x	n	8951			51
φ	1393	QQ	0.009	1	x	y	8951			51
φ	1394	QR	0.057	1	x	n	8951			51
φ	1395	BB	0.006	1	x	y	8951			51
φ	1396	DY	0.279	1	x	n	8951			51
φ	1397	BD	0.064	1	x	n	8951			51
φ	1398	QS	0.013	1	x	y	8951			51
φ	1399	NF	0.093	1	x	n	8951			51
φ	1400	QT	0.618	1	x	n	8951			51
φ	1401	QU	0.011	1	x	y	8951			51
φ	1402	QV	0.005	1	x		8951			51
φ	1403	BB	0.019	2	x	n	8951			51
φ	1404	QW	0.005	1	x	y	8951			51
φ	1405	QX	0.004	3	x	y	8951			51
φ	1406	JB	0.013	1	x	n	8951			51
φ	1407	QY	0.065	1	x	n	8951			51
φ	1408	DH	0.020	1	x	n	8951			51
φ	1409	QZ	0.023	1	x	n	8951			51
φ	1410	RB	0.006	1	x	n	8951			51
φ	1411	BB	0.022	1	x	y	8951			51
φ	1412	AL	0.015	1	x	y	8951			51
φ	1413	BB	0.003	1	x	n	8951			51
φ	1414	EK	0.014	1	x	y	8951			51
φ	1415	GH	0.056	1	x		8951			51
φ	1416	PH	0.054	1	x	y	8951			51
φ	1417	PI	0.003	1	x	n	8951			51
φ	1418	PJ	0.138	1	x	n	8951			51
φ	1419	NF	0.039	1	x	n	8951			51
φ	1420	GM	0.061	1	x	y	8951			51
φ	1421	BK	0.025	1	x	y	8951			51
φ	1422	BB	0.021	1	x	n	8941			42
φ	1423	PK	0.023	1	x	n	8951			51
φ	1424	PL	0.010	1	x	n	8951			51
φ	1425	PM	0.021	1	x	y	8951			51
φ	1426	PN	0.026	1	x	n	8951			51
φ	1427	PO	0.013	1	x	n	8951			51
φ	1428	PQ	0.008	1	x	n	8951			51
φ	1429	PS	0.010	1	x	n	8951			51
φ	1430	GK	0.000	1	x	n	8951			51
φ	1431	KB	0.041	1	x	n	8942			43
φ	1432	NG	0.136	1	x	n	8951			51
φ	1433	KF	0.005	1	x	n	8951			51

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1434	CW	0.000	1	x	n	8951			51
φ	1435	PT	0.109	1	x	n	8951			51
φ	1436	PU	0.000	1	x	n	8951			51
φ	1437	CW	0.000	1	x	n	8951			51
φ	1438	PV	0.002	1	x	n	8951			51
φ	1439	PA	0.017	1	x	n	8951			51
φ	1440	EZ	0.000	1	x	n	8942			43
φ	1441	PW	0.036	1	x	y	8951			51
φ	1442	Z	0.645	1	x	n	8951			51
φ	1443	KI	0.118	1	x	n	8951			51
φ	1444	PX	0.006	1	x	y	8953			53
φ	1445	PY	0.006	1	x	y	8953			53
φ	1446	FY	0.010	1	x	y	8954			54
φ	1447	PZ	0.003	1	x	y	8954			54
φ	1448	CG	0.018	1	x	n	8953			53
φ	1449	EU	0.039	1	x	n	8953			53
φ	1450	AZ	0.009	2	x	y	8953			53
φ	1451	RD	0.002	1	x	n	8941			42
φ	1452	RE	0.000	1	x	n	8953			53
φ	1453	EC	0.000	2	x	n	8954			54
φ	1454	RF	0.008	1	x	n	8953			53
φ	1455	DC	0.000	1	x	n	8953			53
φ	1456	RG	0.017	1	x	n	8954			54
φ	1457	PA	0.011	1	x	n	8953			53
φ	1458	EV	0.007	1	x	n	8953			53
φ	1459	AL	0.006	1	x	n	8953			53
φ	1460	CS	0.065	3	x	y	8953			53
φ	1461	RH	0.006	1	x	n	8953			53
φ	1462	HK	0.003	1	x	n	8953			53
φ	1463	JG	0.006	1	x	n	8951			51
φ	1464	RI	0.005	1	x	y	8953			53
φ	1465	RJ	0.006	1	x	y	8953			53
φ	1466	FK	0.019	1	x	y	8953			53
φ	1467	FF	0.007	1	x	y	8953			53
φ	1468	RK	0.009	1	x	y	8953			53
φ	1469	CL	0.001	1	x	n	8954			54
φ	1470	RM	0.021	1	x	y	8953			53
φ	1471	RN	0.013	1	x	n	8953			53
φ	1472	RO	0.017	1	x	n	8953			53
φ	1473	RQ	0.010	1	x	y	8953			53
φ	1474	AH	0.056	1	x	n	8953			53
φ	1475	RR	0.043	1	x	y	8953			53
φ	1476	HB	0.012	1	x	n	8953			53
φ	1477	EL	0.008	1	x	y	8954			54
φ	1478	Z	0.002	1	x	n	8953			53
φ	1479	BY	0.002	1	x	n	8954			54

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1480	RS	0.002	1	x	y	8953			53
φ	1481	EI	0.017	8	x	n	8953			53
φ	1482	AX	0.024	1	x	n	8953			53
φ	1483	RT	0.004	1	x	y	8953			53
φ	1484	NE	0.004	1	x	n	8969			67
φ	1485	ND	0.022	1	x	n	8969			67
φ	1486	FA	0.001	1	x	n	8953			53
φ	1487	ZE	0.000	1	x	n	8953			53
φ	1488	BY	0.006	7	.		8953			53
φ	1489	EA	0.019	1	x	n	8953			53
φ	1490	CG	0.259	1	x	n	8956			56
φ	1491	RU	0.001	1	x	n	8953			53
φ	1492	RV	0.010	1	x	y	8953			53
φ	1493	RW	0.003	1	x	n	8953			53
φ	1494	FV	0.000	1	x	n	8954			54
φ	1495	Z			.		8959			58
φ	1496	CW	0.005	10	x	n	8953			53
φ	1497	RX	0.020	1	x	y	8956			56
φ	1498	Z	0.009	1	x	n	8956			56
φ	1499	RY	0.015	2	x	n	8953			53
φ	1500	RZ	0.004	1	x	y	8953			53
φ	1501	PP	0.001	1	x	y	8956			56
φ	1502	SA	0.034	1	x	y	8956			56
φ	1503	ZF	0.001	1	x	n	8953			53
φ	1504	SB	0.004	1	x	y	8953			53
φ	1505	Z	0.159	1	x	n	8873	G16	3	
φ	1506	SC	0.009	1	x	n	8954			54
φ	1507	AD	0.014	1	x	n	8953			53
φ	1508	SD	0.003	1	x	n	8953			53
φ	1509	CK	0.013	1	x	n	8953			53
φ	1511	SE	0.008	1	x	n	8953			53
φ	1512	SVG	0.010	1	x	n	8951			51
φ	1513	SVG	0.009	1	x	n	8951			51
φ	1514	BY	0.003	2	x	n	8954			54
φ	1515	SF	0.003	1	x	n	8953			53
φ	1516	SG	0.001	1	x	y	8953			53
φ	1517	JG	0.009	4	x	n	8953			53
φ	1518	PA	0.035	1	x	n	8951			51
φ	1519	ZG	0.004	1	x	n	8953			53
φ	1520	SH	0.001	1	x	n	8953			53
φ	1521	FF	0.007	1	x	n	8953			53
φ	1522	JB	0.069	7	x	n	8953			53
φ	1523	NZ	0.016	1	x	n	8953			53
φ	1524	ZH	0.003	1	x	y	8953			53
φ	1525	SI	0.001	1	x	n	8953			53
φ	1526	SJ	0.003	1	x	y	8953			53

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1527	SK	0.033	1	x	y	8953			53
φ	1528	AL	0.032	3	x		8953			53
φ	1529	SM	0.001	1	x	n	8953			53
φ	1530	SL	0.018	1	x	n	8953			53
φ	1531	AX	0.067	1	x	n	8953			53
φ	1532	SN	0.018	1	x	y	8953			53
φ	1533	NZ	0.003	1	x	n	8953			53
φ	1534	FC	0.010	1	x	n	8953			53
φ	1535	SO	0.004	2	x	n	8957			57
φ	1536	Z	0.003	1	x	n	8957			57
φ	1537	ND	0.009	1	x	n	8953			53
φ	1538	KF	0.002	1	x	n	8953			53
φ	1539	SP	0.006	1	x	n	8953			53
φ	1540	SQ	0.003	1	x	y	8953			53
φ	1541	SR	0.011	1	x	n	8953			53
φ	1542	Z	0.038	1	x	y	8953			53
φ	1543	SS	0.003	1	x	y	8953			53
φ	1544	ST	0.038	1	x	n	8953			53
φ	1545	SU	0.006	1	x	y	8953			53
φ	1546	Z	0.010	1	x	y	8953			53
φ	1547	FF	0.008	1	x	n	8953			53
φ	1548	SV	0.007	1	x	n	8953			53
φ	1549	SW	0.005	1	x	y	8953			53
φ	1550	IR	0.005	1	x	n	8953			53
φ	1552	ZI	0.000	1	x	n	8953			53
φ	1553	SX	0.004	1	x	y	8953			53
φ	1554	SY	0.002	1	x	n	8953			53
φ	1555	SZ	0.006	1	x	n	8953			53
φ	1556	TA	0.024	1	x	y	8953			53
φ	1557	TB	0.005	1	x	n	8953			53
φ	1558	TC	0.002	1	x	n	8953			53
φ	1559	Z	0.006	2	x	n	8953			53
φ	1560	KJ	0.055	1	x	n	8953			53
φ	1561	BB	0.004	1	x	n	8969			67
φ	1562	ZJ	0.006	1	x	n	8953			53
φ	1563	TD	0.014	1	x	y	8953			53
φ	1564	Z	0.005	1	x	n	8953			53
φ	1565	BA	0.012	2	x	n	8969			67
φ	1566	EY	0.000	1	x	n	8953			53
φ	1567	PA	0.043	1	x	n	8951			51
φ	1568	TE	0.009	1	x	y	8953			53
φ	1569	TF	0.000	1	x	n	8953			53
φ	1570	EJ	0.002	1	x	n	8969			67
φ	1571	ER	0.010	1	x	n	8873	G16	3	
φ	1572	TG	0.002	1	x	n	8953			53
φ	1573	TH	0.007	1	x	y	8953			53

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1574	TI	0.002	1	x	n	8953			53
φ	1575	AC	0.014	1	x	y	8957			57
φ	1576	Z	0.051	1	x	n	8957			57
φ	1577	BA	0.007	1	x	n	8956			56
φ	1578	TJ	0.027	1	x	n	8956			56
φ	1579	KG	0.005	1	x	n	8969			67
φ	1580	EH	0.023	2	x	n	8969			67
φ	1581	JG	0.009	1	x	n	8957			57
φ	1582	GH	0.411	13	x	y	8941			42
φ	1583	GJ	0.007	1	x	n	8941			42
φ	1584	TK	0.030	4	x	y	8941			42
φ	1585	TL	0.009	1	x	n	8941			42
φ	1586	TM	0.045	2	x	n	8941			42
φ	1587	ZK	0.005	1	x	n	8941			42
φ	1588	AY	0.024	1	x	y	8941			42
φ	1589	TN	0.009	1	x	n	8941			42
φ	1590	TO	0.012	1	x	n	8941			42
φ	1591	TP	0.041	1	x	y	8941			42
φ	1592	BB	0.014	1	x	y	8941			42
φ	1593	TQ	0.008	1	x	y	8941			42
φ	1594	TR	0.005	1	x	y	8941			42
φ	1595	CW	0.001	1	x	n	8941			42
φ	1596	FI	0.006	1	x	n	8941			42
φ	1597	ZL	0.114	12	x	n	8941			42
φ	1598	ND	0.010	1	x	n	8941			42
φ	1599	CS	0.029	4	x	n	8941			42
φ	1600	ZM	0.002	1	x	n	8941			42
φ	1601	TS	0.012	1	x	n	8941			42
φ	1602	TT	0.011	1	x	n	8941			42
φ	1603	EI	0.005	2	x	n	8941			42
φ	1604	KC	0.007	1	x	n	8941			42
φ	1605	SVO	0.012	1	x	n	8941			42
φ	1606	TU	0.002	1	x	n	8941			42
φ	1607	EI	0.002	1	x	n	8941			42
φ	1608	ZN	0.002	1	x	n	8941			42
φ	1609	ZO	0.008	1	x	n	8941			42
φ	1610	TV	0.005	1	x	n	8941			42
φ	1611	TW	0.031	1	x	n	8941			42
φ	1612	TX	0.035	1	x	y	8941			42
φ	1613	TY	0.013	1	x	n	8941			42
φ	1614	TZ	0.013	1	x	n	8941			42
φ	1615	UA	0.044	1	x	n	8941			42
φ	1616	UB	0.004	1	x	y	8941			42
φ	1617	UC	0.004	1	x	y	8941			42
φ	1618	AA	0.011	1	x	n	8941			42
φ	1619	FR	0.013	2	x	n	8941			42

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1620	KB	0.022	1	x	n	8941			42
φ	1621	UD	0.004	1	x	y	8941			42
φ	1622	UE	0.005	1	x	n	8941			42
φ	1623	DC	0.002	1	x	n	8941			42
φ	1624	UF	0.008	1	x	n	8941			42
φ	1625	BB	0.003	1	x	n	8941			42
φ	1626	FW	0.010	1	x	y	8941			42
φ	1627	BB	0.006	1	x	y	8941			42
φ	1628	UG	0.014	1	x	y	8941			42
φ	1629	UH	0.009	1	x	n	8941			42
φ	1630	II	0.011	1	x	n	8941			42
φ	1631	BA	0.009	1	x		8941			42
φ	1632	BB	0.007	1	x	n	8941			42
φ	1633	HD	0.012	1	x	y	8941			42
φ	1634	HC	0.015	3	x	n	8941			42
φ	1635	II	0.017	1	x	n	8941			42
φ	1636	KA	0.006	1	x	n	8941			42
φ	1637	KA	0.000	1	x	y	8941			42
φ	1638	AQ	0.000	1	x	n	8941			42
φ	1639	AZ	0.000	1	x	n	8941			42
φ	1640	BB	0.118	20	x	n	8941			42
φ	1641	EZ	0.001	1	x	n	8941			42
φ	1642	HD	0.048	2	x	n	8941			42
φ	1643	PA	0.856	1	x	n	8964			63
φ	1644	UI	0.015	1	x	n	8941			42
φ	1645	FL	0.034	2	x	n	8941			42
φ	1646	UJ	0.219	15	x		8941			42
φ	1647	EH	0.023	1	x	n	8941			42
φ	1648	BB	0.010	3	x	n	8941			42
φ	1649	HE	0.009	1	x	n	8941			42
φ	1650	CW	0.000	2	x	n	8941			42
φ	1651	KF	0.007	1	x	n	8941			42
φ	1652	ZP	0.004	1	x	n	8941			42
φ	1653	ZQ	0.003	1	x	n	8941			42
φ	1654	FA	0.000	1	x	n	8941			42
φ	1655	UK	0.008	1	x	n	8941			42
φ	1656	AY	0.054	7	x	ny	8941			42
φ	1658	EC	0.000	1	x	n	8941			42
φ	1659	UL	0.014	1	x	y	8941			42
φ	1660	UM	0.002	1	x	n	8941			42
φ	1661	HE	0.007	1	x	n	8941			42
φ	1662	UN	0.010	1	x	y	8941			42
φ	1663	CZ	0.003	1	x	y	8941			42
φ	1664	FA	0.000	1	x	n	8941			42
φ	1665	BD	0.009	1	x	y	8941			42
φ	1666	EC	0.000	1	x	n	8941			42

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1667	BB	0.002	1	x	n	8941			42
φ	1668	UO	0.036	1	x	n	8941			42
φ	1669	HK	0.025	1	x	y	8941			42
φ	1670	JG	0.005	1	x	n	8941			42
φ	1671	UP	0.016	1	x	n	8941			42
φ	1672	EI	0.014	1	x	n	8941			42
φ	1673	UQ	0.000	2	x	y	8941			42
φ	1674	BB	0.005	1	x	n	8941			42
φ	1675	UR	0.051	1	x	y	8941			42
φ	1676	EK	0.000	1	x	y	8941			42
φ	1677	US	0.015	1	x	n	8941			42
φ	1678	JB	0.005	1	x	n	8941			42
φ	1679	BB	0.000	1	x	n	8941			42
φ	1680	UT	0.016	1	x	n	8941			42
φ	1681	BB	0.007	1	x	n	8941			42
φ	1682	PB	7.075	1	x	n	8951			51
φ	1683	UU	0.008	1	x	n	8941			42
φ	1684	FY	0.022	1	x	y	8941			42
φ	1685	UV	0.035	1	x	n	8941			42
φ	1686	UW	0.007	1	x	n	8941			42
φ	1687	UX	0.000	1	x	n	8941			42
φ	1688	UY	0.014	1	x	n	8941			42
φ	1689	EJ	0.003	2	x	n	8941			42
φ	1690	BB	0.014	1	x	n	8941			42
φ	1691	HT	0.003	1	x	y	8941			42
φ	1692	ZR	0.012	1	x	y	8941			42
φ	1693	UZ	0.004	1	x	n	8941			42
φ	1694	Z	0.002	1	x	n	8941			42
φ	1695	Z	0.032	1	x	y	8941			42
φ	1696	VA	0.006	1	x	n	8941			42
φ	1697	VB	0.015	1	x	n	8941			42
φ	1698	VC	0.042	1	x	n	8941			42
φ	1699	VD	0.003	1	x	n	8941			42
φ	1700	AA	0.007	1	x	n	8941			42
φ	1701	BK	0.031	1	x	n	8941			42
φ	1702	VE	0.004	1	x	y	8941			42
φ	1703	VF	0.010	1	x	y	8941			42
φ	1704	BB	0.018	1	x	y	8941			42
φ	1705	VG	0.027	1	x	n	8941			42
φ	1706	DC	0.001	1	x	n	8941			42
φ	1707	DC	0.002	1	x	n	8941			42
φ	1708	BY	0.002	1	x	n	8941			42
φ	1709	VH	0.010	1	x	n	8941			42
φ	1710	BW	0.033	1	x	y	8941			42
φ	1711	VI	0.008	1	x	y	8941			42
φ	1712	NO	0.003	1	x	n	8941			42

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1713	DC	0.002	1	x	n	8941			42
φ	1714	VJ	0.029	1	x	n	8941			42
φ	1715	FF	0.008	1	x	y	8941			42
φ	1716	NZ	0.007	1	x	n	8941			42
φ	1717	VK	0.004	1	x	n	8941			42
φ	1718	JN	0.005	2	x	n	8941			42
φ	1719	EA	0.050	2	x	n	8941			42
φ	1720	Z	0.008	1	x	n	8941			42
φ	1721	UY	0.005	1	x	n	8941			42
φ	1722	VL	0.008	1	x	y	8941			42
φ	1723	BB	0.012	1	x	n	8941			42
φ	1724	PB	0.182	1	x	n	8948			48
φ	1725	JG	0.064	5	x	n	8966			64
φ	1726	PG	0.018	1	x	n	8966			64
φ	1727	EY	0.000	1	x	n	8966			64
φ	1728	VN	0.004	1	x	n	8954			54
φ	1729	BJ	0.105	1	x	n	8966			64
φ	1730	ZS	0.006	1	x	y	8966			64
φ	1731	AA	0.002	2	x	y	8966			64
φ	1732	ND	0.004	1	x	n	8966			64
φ	1733	VM	0.005	1	x	y	8966			64
φ	1734	HM	0.089	1	x	n	8966			64
φ	1735	BA	0.005	1	x	n	8966			64
φ	1736	DI	0.005	2	x	y	8966			64
φ	1737	DC	0.000	2	x	n	8966			64
φ	1738	Z	0.009	1	x	n	8966			64
φ	1739	VO	0.004	1	x	n	8966			64
φ	1740	VP	0.081	1	x	n	8966			64
φ	1741	DC	0.000	1	x	n	8966			64
φ	1742	VQ	0.002	1	x	y	8966			64
φ	1743	VR	0.000	1	x	n	8966			64
φ	1744	DC	0.002	1	x	n	8966			64
φ	1745	VS	0.002	1	x	n	8966			64
φ	1746	VT	0.014	1	x	n	8966			64
φ	1747	NC	0.306	1	x	n	8966			64
φ	1748	VU	0.004	1	x	n	8966			64
φ	1749	KO	0.002	1	x	y	8966			64
φ	1750	BB	0.023	3	x	y	8966			64
φ	1751	VV	0.017	1	x	n	8966			64
φ	1752	KN	0.006	1	x	n	8966			64
φ	1753	JW	0.025	1	x	n	8966			64
φ	1754	HX	0.001	1	x	y	8966			64
φ	1755	KP	0.019	1	x	y	8966			64
φ	1756	VW	0.011	1	x	y	8966			64
φ	1757	DC	0.002	1	x	n	8966			64
φ	1758	VX	0.006	1	x	n	8966			64

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1759	KQ	0.000	1	x	n	8966			64
φ	1760	ZT	0.005	1	x	n	8966			64
φ	1761	VY	0.004	1	x	n	8966			64
φ	1762	HX	0.003	1	x	y	8966			64
φ	1763	GO	0.001	1	x	n	8952			52
φ	1764	FF	0.022	1	x	n	8952			52
φ	1765	CX	0.009	1	x	n	8952			52
φ	1766	ZU	0.033	1	x	n	8952			52
φ	1767	GU	0.003	2	x	n	8952			52
φ	1768	AZ	0.000	1	x	n	8952			52
φ	1769	AZ	0.007	1	x	n	8952			52
φ	1770	VZ	0.020	1	x	n	8966			64
φ	1771	WA	0.013	1	x	n	8952			52
φ	1772	P	0.008	1	x	n	8952			52
φ	1773	WB	0.018	1	x	y	8952			52
φ	1774	FF	0.006	1	x	n	8966			64
φ	1775	WC	0.014	1	x	y	8966			64
φ	1776	WD	0.009	1	x	y	8966			64
φ	1777	KR	0.020	1	x	n	8952			52
φ	1778	BP	0.018	1	x	y	8966			64
φ	1779	WE	0.008	1	x	y	8966			64
φ	1780	WF	0.028	1	x	y	8966			64
φ	1781	WG	0.002	1	x	y	8966			64
φ	1782	ZV	0.002	1	x	n	8966			64
φ	1783	WH	0.028	2	x	y	8966			64
φ	1784	CW	0.000	1	x	n	8952			52
φ	1785	WI	0.008	1	x	n	8952			52
φ	1786	AA	0.008	4	x	n	8966			64
φ	1787	PB	0.121	1	x	n	8948			48
φ	1788	WJ	0.006	1	x	n	8952			52
φ	1789	WK	0.007	1	x	y	8952			52
φ	1790	PB	1.183	1	x	n	8969			67
φ	1791	WL	0.083	1	x	y	8952			52
φ	1792	BD	0.095	2	x	ny	8952			52
φ	1793	PB	1.035	1	x	n	8969			67
φ	1794	PB	0.298	1	x	n	8969			67
φ	1795	PB	0.442	1	x	n	8948			48
φ	1796	CL	0.002	1	x	n	8954			54
φ	1797	WM	0.004	1	x	n	8954			54
φ	1798	BB	0.022	1	x	n	8941			42
φ	1799	ZW	0.000	1	x	n	8954			54
φ	1800	CW	0.000	6	x	n	8954			54
φ	1801	WN	0.014	1	x	n	8966			64
φ	1802	WO	0.031	1	x	y	8941			42
φ	1803	WP	0.042	1	x	n	8963			62
φ	1804	EO	0.000	1	x	n	8954			54

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1805	FF	0.014	1	x	n	8954			54
φ	1806	ZX	0.008	1	x	n	8963			62
φ	1807	WQ	0.007	1	x	n	8954			54
φ	1808	Z	0.046	1	x	n	8963			62
φ	1809	AA	0.011	5	x	n	8966			64
φ	1810	AZ	0.018	1	x	n	8943			44
φ	1811	Z	0.037	1	x	n	8963			62
φ	1812	AF	0.033	2	x	n	8943			44
φ	1813	GW	0.016	1	x	n	8943			44
φ	1814	BB	0.010	1	x	n	8943			44
φ	1815	WR	0.000	1	x	n	8966			64
φ	1816	IT	0.002	1	x	n	8952			52
φ	1817	WS	0.022	1	x	n	8952			52
φ	1818	WT	0.014	1	x	n	8963			62
φ	1819	WU	0.001	1	x	n	8952			52
φ	1820	ZY	0.014	1	x	n	8966			64
φ	1821	EK	0.007	1	x	y	8941			42
φ	1822	PB	1.990	2	x	n	8952			52
φ	1823	WV	0.003	1	x	y	8941			42
φ	1824	AC	0.006	1	x	y	8954			54
φ	1825	ZZ	0.005	1	x	n	8952			52
φ	1826	PB	0.156	1	x	n	8953			53
φ	1827	PB	3.552	1	x	n	8964			63
φ	1828	WW	0.005	1	x	n	8952			52
φ	1829	WX	0.018	8	x	y	8952			52
φ	1830	WY	0.010	3	x	n	8952			52
φ	1831	JH	0.003	1	x	n	8952			52
φ	1832	BY	0.003	1	x	n	8952			52
φ	1833	WZ	0.009	1	x	n	8952			52
φ	1834	GV	0.018	2	x	y	8952			52
φ	1835	XA	0.001	1	x	n	8952			52
φ	1836	XB	0.012	1	x	n	8952			52
φ	1837	CX	0.009	1	x	n	8952			52
φ	1838	ER	0.024	1	x	n	8952			52
φ	1839	XC	0.051	1	x	n	8952			52
φ	1840	XD	0.001	1	x	n	8952			52
φ	1841	HB	0.011	2	x	y	8952			52
φ	1842	AZ	0.004	3	x		8952			52
φ	1843	KS	0.123	1	x	n	8952			52
φ	1844	FZ	0.034	1	x	n	8952			52
φ	1845	PA	0.035	1	x	n	8948			48
φ	1846	XE	0.005	1	x	y	8952			52
φ	1847	KF	0.004	1	x	n	8952			52
φ	1848	PA	0.039	1	x	n	8948			48
φ	1849	XK	0.005	1	x	y	8952			52
φ	1850	FF	0.024	1	x	n	8952			52

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1851	XY	0.002	1	x	n	8954			54
φ	1852	SVG	1.531	1	x	n	8948			48
φ	2412	NN	7.232		x	n	8952			52
φ	1853	BB	0.029	1	x	n	8943			44
φ	1854	EK	0.010	1	x	y	8941			42
φ	1855	XF	0.015	1	x	n	8941			42
φ	1856	Z			.		8886	H15	2	
φ	1857	EI	0.002	1	x	n	8954			54
φ	1858	XG	0.007	1	x	n	8952			52
φ	1859	BY	0.002	1	x	n	8954			54
φ	1860	AP	0.352	8	x	n	8952			52
φ	1862	Z			.		8890	H16	2	
φ	1863	Z			.		8910	I16	2	
φ	1864	Z			.		8884	H15	2	
φ	1865	Z			.		8905	I15	2	
φ	1866	Z			.		8858	G14	2	
φ	1867	Z			.		8879	H14	2	
φ	1868	Z			.		8900	I14	2	
φ	1869	Z			.		8875	H13	2	
φ	1870	Z			.		8863	G15	2	
φ	1871	Z			.		8869	G16	2	
φ	1872	Z			.		8853	G13	2	
φ	1873	Z			.		8895	I13	2	
φ	1874	Z			.		8957			57
φ	1875	Z			.		8952			52
φ	1876	Z			.		8951			51
φ	1877	Z			.		8866	G15	3	
φ	1878	Z			.		8871	G16	3	
φ	1879	Z			.		8892	H16	3	
φ	1880	Z			.		8912	I16	3	
φ	1881	Z			.		8860	G14	3	
φ	1882	Z			.		8881	H14	3	
φ	1883	Z			.		8902	I14	3	
φ	1884	Z			.		8887	H15	3	
φ	1885	Z			.		8855	G13	3	
φ	1886	Z			.		8877	H13	3	
φ	1887	Z			.		8897	I13	3	
φ	1888	Z			.		8962			61
φ	1889	Z			.		8963			62
φ	1890	Z			.		8953			53
φ	1891	Z			.		8966			64
φ	1892	Z			.		8967			65
φ	1893	Z			.		8969			67
φ	1894	Z			.		8947			47
φ	1895	Z			.		8917	O11	3	
φ	1896	Z			.		8919	O11	4	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1897	Z			.		8941			42
φ	1898	Z			.		8942			43
φ	1899	Z			.		8943			44
φ	1900	Z			.		8921	O11	5	
φ	1901	Z			.		8944			45
φ	1902	Z			.		8945			46
φ	1903	Z			.		8955			55
φ	1904	Z			.		8958			58
φ	1905	Z			.		8954			54
φ	1906	Z			.		8949			49
φ	1907	Z			.		8950			50
φ	1908	Z			.		8948			48
φ	1909	Z			.		8961			60
φ	1910	P			.		8941			42
φ	1911	P			.		8942			43
φ	1912	P			.		8943			44
φ	1913	P			.		8944			45
φ	1914	P			.		8945			46
φ	1915	P			.		8949			49
φ	1916	P			.		8948			48
φ	1917	P	8.348		.		8952			52
φ	1918	P	15.000		.		8951			51
φ	1919	P			.		8964			63
φ	1920	P			.		8947			47
φ	1921	RP			.		8929	O2	2	
φ	1922	RP			.		8890	H16	2	
φ	1923	RP			.		8910	I16	2	
φ	1924	RL	1.010	1	.		8910	I16	2	
φ	1925	RP			.		8884	H15	2	
φ	1926	RP			.		8905	I15	2	
φ	1927	RP			.		8858	G14	2	
φ	1928	RP			.		8879	H14	2	
φ	1929	RP			.		8900	I14	2	
φ	1930	RL	7.291	1	.		8900	I14	2	
φ	1931	RL	5.088	1	.		8857	G14	1	
φ	1932	RP			.		8863	G15	2	
φ	1933	RP			.		8875	H13	2	
φ	1934	RP			.		8869	G16	2	
φ	1935	RP			.		8853	G13	2	
φ	1936	RP			.		8853	G13	2	
φ	1937	RP			.		8937	O2	6	
φ	1937	RP			.		8939	O2	7	
φ	1938	RP			.		8914	O11	1	
φ	1939	RP			.		8915	O11	2	
φ	1940	RP			.		8919	O11	4	
φ	1941	RP			.		8942			43

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1942	R			.		8941			42
φ	1943	R			.		8943			44
φ	1944	RP			.		8921	O11	5	
φ	1945	RP			.		8944			45
φ	1946	RP			.		8945			46
φ	1947	RP			.		8955			55
φ	1948	RP			.		8958			58
φ	1949	RP			.		8959			58
φ	1950	RP			.		8954			54
φ	1951	RP			.		8949			49
φ	1952	RP			.		8950			50
φ	1953	R			.		8948			48
φ	1954	R			.		8961			60
φ	1955	RP			.		8926	O11	7	
φ	1956	R	10.196		.		8957			57
φ	1957	R	66.000		.		8952			52
φ	1958	R	94.000		.		8951			51
φ	1959	R	64.000		.		8951			51
φ	1960	RP			.		8866	G15	3	
φ	1961	RP			.		8871	G16	3	
φ	1962	RP			.		8892	H16	3	
φ	1963	RP			.		8860	G14	3	
φ	1964	RP			.		8912	I16	3	
φ	1965	RP			.		8881	H14	3	
φ	1966	RL	13.041		.		8881	H14	3	
φ	1967	RP			.		8902	I14	3	
φ	1968	RP			.		8907	I15	3	
φ	1969	RP			.		8887	H15	3	
φ	1970	RL	3.553	1	.		8887	H15	3	
φ	1971	RP			.		8897	I13	3	
φ	1972	RP			.		8962			61
φ	1973	RP			.		8953			53
φ	1974	RP	60.000		.		8966			64
φ	1975	RP			.		8967			65
φ	1976	R			.		8964			63
φ	1977	R	2.938		.		8956			56
φ	1978	R			.		8969			67
φ	1979	P			.		8969			67
φ	1980	RP			.		8968			66
φ	1981	RP			.		8877	H13	3	
φ	1982	R			.		8947			47
φ	1983	AM	6.838	13	.		4394	P41	2	
φ	1984	AL	0.013	1	.		4394	P41	2	
φ	1985	AE	0.084	1	.		4394	P41	2	
φ	1987	AX	0.349	15	.		4394	P41	2	
φ	1989	Z	0.145	10	.		4394	P41	2	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	1990	BA	0.005	1	.		4394	P41	2	
φ	1992	AZ	0.063	11	.		4394	P41	2	
φ	1993	AM	1.018	3	.		4397	P41	5	
φ	1998	AZ	0.006	2	.		4397	P41	5	
φ	2003	AZ	0.022	3	.		4397	P41	5	
φ	2005	AK	0.000		.		4396	P41	4	
φ	2015	AX	0.019		.		4395	P41	3	
φ	2016	AX	0.040	5	.		4396	P41	4	
φ	2017	AM	0.920	2	.		4396	P41	4	
φ	2019	AO	1.808	14	.		4392	P41	1	
φ	2020	AL	0.539	13	.		4392	P41	1	
φ	2021	AM	40.000		.		4392	P41	1	
φ	2023	AZ	2.748		.		4392	P41	1	
φ	2025	AX	2.425	74	.		4392	P41	1	
φ	2026	BF	0.789	18	.		4392	P41	1	
φ	2027	AH	0.005	1	.		4392	P41	1	
φ	2029	BE	0.066	1	.		4392	P41	1	
φ	2030	BA	0.332	69	.		4392	P41	1	
φ	2057	Z	0.581	21	.		4392	P41	1	
φ	2067	AC	1.412	25	x	ny	3683	C30	4	19
φ	2068	Z	0.364	9	.		3683	C30	4	19
φ	2069	AM	28.400		x	ny	3683	C30	4	19
φ	2070	AR	0.250	25	x	ny	3683	C30	4	19
φ	2071	XH	0.027	1	x	n	3683	C30	4	19
φ	2072	XI	0.018	1	x	n	3683	C30	4	19
φ	2073	XJ	0.012	1	x	n	3683	C30	4	19
φ	2074	XK	0.005	1	x	n	3683	C30	4	19
φ	2075	XL	0.005	1	x	y	3683	C30	4	19
φ	2076	CW	0.000	1	x	n	3683	C30	4	19
φ	2077	AD	0.063	1	x	n	3683	C30	4	19
φ	2078	AZ	0.015	3	.		3683	C30	4	19
φ	2079	AM	0.258	3	x	y	3762	C30	7	20
φ	2080	AM	91.000		x		3661	C30	4	18
φ	2081	Z	0.297	12	.		3661	C30	4	18
φ	2082	AN	1.165	22	x	y	3661	C30	4	18
φ	2083	XM	0.239	2	x	n	3661	C30	4	18
φ	2084	XN	0.176	1	x	n	3661	C30	4	18
φ	2085	AK	0.112	1	x	y	3661	C30	4	18
φ	2086	AC	1.104	30	x	ny	3661	C30	4	18
φ	2087	AA	0.057	4	x	y	3661	C30	4	18
φ	2088	XO	0.100	1	x	n	3661	C30	4	18
φ	2089	XP	0.126	2	x	n	3661	C30	4	18
φ	2090	HO	0.006	1	x	n	3661	C30	4	18
φ	2091	DC	0.004	1	x	n	3661	C30	4	18
φ	2092	XQ	0.006	1	x	n	3661	C30	4	18
φ	2093	ER	0.023	1	x	n	3661	C30	4	18

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	2094	FF	0.008	1	x	n	3661	C30	4	18
φ	2095	XR	0.004	1	x	n	3661	C30	4	18
φ	2096	KA	0.007	1	x	y	3661	C30	4	18
φ	2097	KT	0.007	1	x	n	3661	C30	4	18
φ	2098	XS	0.008	1	x	n	3661	C30	4	18
φ	2099	XT	0.004	1	x		3661	C30	4	18
φ	2100	BY	0.006	1	x	n	3661	C30	4	18
φ	2101	HR	0.085	1	x	n	3661	C30	4	18
φ	2102	AZ	0.028	4	x	y	3661	C30	4	18
φ	2103	XU	0.008	1	x	y	3661	C30	4	18
φ	2104	AR	0.058	9	x	ny	3661	C30	4	18
φ	2105	CL	0.000	1	x	n	3661	C30	4	18
φ	2106	HQ	0.000	1	x	n	3661	C30	4	18
φ	2107	XX	0.002	1	x	y	3661	C30	4	18
φ	2108	SPA	0.003	1	x	n	3661	C30	4	18
φ	2109	XV	0.005	1	x	y	3661	C30	4	18
φ	2110	CX	0.010	1	x	n	3661	C30	4	18
φ	2111	AH	0.029	1	x		3661	C30	4	18
φ	2112	AX	0.018	1	x	n	3661	C30	4	18
φ	2113	XW	0.034	1	x	n	3661	C30	4	18
φ	2114	XZ	0.031	1	x	y	3661	C30	4	18
φ	2115	YA	0.012	1	x	y	3661	C30	4	18
φ	2116	YB	0.006	1	x	n	3661	C30	4	18
φ	2117	Z	0.005		x	n	3661	C30	4	18
φ	2118	CX	0.008	1	x	n	3661	C30	4	18
φ	2119	HR	0.123	1	x	n	3661	C30	4	18
φ	2120	YC	0.017	1	x	n	3661	C30	4	18
φ	2121	BA	0.030	6	x	ny	3661	C30	4	18
φ	2123	YD	0.015	1	x	y	3661	C30	4	18
φ	2124	AR	0.096	1	x	y	8982	K 24	5	34
φ	2125	BA	0.000	1	x		8982	K 24	5	34
φ	2126	AF	6.022	1	x	ny	8982	K 24	5	34
φ	2127	HQ	0.005	2	x	n	8982	K 24	5	34
φ	2128	YE	0.002	1	x	y	8982	K 24	5	34
φ	2129	AX	0.089	1	x	y	8982	K 24	5	34
φ	2130	AE	0.709	1	x	ny	8975	K 24	4	29
φ	2131	SVH	0.084	1	x	y	8975	K 24	4	29
φ	2132	BA	0.033	3	x	y	8975	K 24	4	29
φ	2133	AZ	0.012	1	x	y	8975	K 24	4	29
φ	2134	AX	0.031	3	x	y	8975	K 24	4	29
φ	2135	AC	0.012	1	x	y	8975	K 24	4	29
φ	2136	YF	0.021	1	x	n	8975	K 24	4	29
φ	2137	Z	0.047	5	.		8975	K 24	4	29
φ	2138	YG	0.008	2	x	n	4387	K24	6	
φ	2139	BA	0.011	2	x	n	4387	K24	6	
φ	2140	YH	0.007	1	x	y	8978	K 24	6	39

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	2141	HQ	0.002	1	x	n	8978	K 24	6	39
φ	2142	HQ	0.003	1	x	n	4391	K24	8	
φ	2143	CW	0.001	1	x	n	4391	K24	8	
φ	2144	BA	0.012	1	x	n	4391	K24	8	
φ	2145	AM	0.957	8	x	n	3758	K24	2	
φ	2146	AO	0.223	1	x	n	3758	K24	2	
φ	2147	AN	0.160	4	x	ny	3758	K24	2	
φ	2148	BY	0.001	1	x	n	3758	K24	2	
φ	2149	KF	0.003	1	x	n	3758	K24	2	
φ	2150	HQ	0.003	1	x	n	3758	K24	2	
φ	2151	AX	0.066	1	x	n	3758	K24	2	
φ	2152	BA	0.136	21	x		3758	K24	2	
φ	2153	AZ	0.027	5	x	ny	3758	K24	2	
φ	2154	CW	0.006	10	x	n	3758	K24	2	
φ	2155	AA	0.002	1	x	y	3758	K24	2	
φ	2158	AM	0.247	3	x	n	8977	K 24	6	38
φ	2159	AC	0.026	1	x	y	8977	K 24	6	38
φ	2160	Z	0.019	2	.		8977	K 24	6	38
φ	2161	AX	0.044	1	x	n	8977	K 24	6	38
φ	2162	CL	0.005	2	x	n	8977	K 24	6	38
φ	2163	BA	0.028	5	x	ny	8977	K 24	6	38
φ	2164	YI	0.017	1	x	y	8977	K 24	6	38
φ	2165	CW	0.002	5	x	n	8977	K 24	6	38
φ	2166	Z	0.017	1	x	n	8977	K 24	6	38
φ	2167	BY	0.001	1	x	n	8977	K 24	6	38
φ	2168	AM	0.374	3	x	n	4384	K24	5	
φ	2169	AN	0.062	3	x	y	4384	K24	5	
φ	2170	GP	0.009	2	x	n	4384	K24	5	
φ	2171	CW	0.000	1	x	n	4384	K24	5	
φ	2172	GC	0.000	1	x	n	4384	K24	5	
φ	2173	Z	0.004	2	.		4384	K24	5	
φ	2174	GP	0.001	1	x	n	4384	K24	5	
φ	2175	AR	0.073	8	x	y	8972	K 24	2	24
φ	2176	AN	0.072	3	x	ny	8972	K 24	2	24
φ	2177	AO	0.408	3	x	n	8972	K 24	2	24
φ	2178	AM	5.610		x	ny	8972	K 24	2	24
φ	2179	AA	0.119	31	x	y	8972	K 24	2	24
φ	2180	AX	0.049	1	x	y	8972	K 24	2	24
φ	2181	BA	0.116	24	x		8972	K 24	2	24
φ	2182	AZ	0.166	21	x		8972	K 24	2	24
φ	2183	JH	0.003	1	x	n	8972	K 24	2	24
φ	2184	AC	0.115	3	x	ny	8972	K 24	2	24
φ	2186	YJ	0.215	1	x	y	8972	K 24	2	24
φ	2187	YK	0.011	1	x	y	8972	K 24	2	24
φ	2188	SPB	0.006	1	x	y	8972	K 24	2	24
φ	2189	Z	0.002	1	x	n	8972	K 24	2	24

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	2190	EA	0.082	3	x	n	8972	K 24	2	24
φ	2191	CZ	0.000	1	x	y	8972	K 24	2	24
φ	2192	JN	0.000	1	x	n	8972	K 24	2	24
φ	2193	BA	0.027	5	x		4384	K24	5	
φ	2194	BY	0.000	1	x	n	4384	K24	5	
φ	2195	YL	0.006	1	x	n	4384	K24	5	
φ	2196	AM	0.216	1	x	n	4384	K24	5	
φ	2197	Z	0.034	1	x	y	4384	K24	5	
φ	2198	GW	0.014	2	x	n	4384	K24	5	
φ	2200	AC	0.015	1	x	y	4384	K24	5	
φ	2201	AX	0.064	1	x	n	4384	K24	5	
φ	2202	BY	0.000	1	x	n	4384	K24	5	
φ	2203	BA	0.000	1	x	n	4384	K24	5	
φ	2204	CW	0.002	4	x	n	4384	K24	5	
φ	2205	AM	0.671	5	x	n	8974	K 24	4	28
φ	2206	SPC	0.036	1	x	n	8974	K 24	4	28
φ	2207	GC	0.000	1	x	n	8974	K 24	4	28
φ	2208	BA	0.015	1	x	n	8974	K 24	4	28
φ	2209	AC	0.047	1	x	y	8974	K 24	4	28
φ	2210	AL	0.004	1	x	n	4378	K24	4	
φ	2211	AM	0.481	5	x	ny	4378	K24	4	
φ	2212	AN	0.026	1	x	y	4378	K24	4	
φ	2213	BA	0.021	5	x		4378	K24	4	
φ	2214	AX	0.047	4	x	ny	4378	K24	4	
φ	2215	FZ	0.012	1	x	n	4378	K24	4	
φ	2216	JH	0.003	1	x	n	4378	K24	4	
φ	2217	AC	0.058	3	x	y	4378	K24	4	
φ	2218	HO	0.017	2	x	n	4378	K24	4	
φ	2219	Z	0.011	1	.		4378	K24	4	
φ	2220	AM	0.686	5	x		4377	K24	3	
φ	2221	BF	0.042	1	x	n	4377	K24	3	
φ	2222	BA	0.050	5	x		4377	K24	3	
φ	2223	AX	0.177	13	x		4377	K24	3	
φ	2224	YM	0.063	1	x	n	4377	K24	3	
φ	2226	YN	0.016	1	x	n	4377	K24	3	
φ	2227	AC	0.013	1	x	y	4377	K24	3	
φ	2228	AO	0.247	1	x		4377	K24	3	
φ	2229	AM	2.243	17	x		4377	K24	3	
φ	2230	HN	0.023	1	x	n	4377	K24	3	
φ	2231	BA	0.002	1	x		4377	K24	3	
φ	2232	CW	0.000	1	x	n	4377	K24	3	
φ	2233	Z	0.044	5	.		4377	K24	3	
φ	2234	YO	0.008	1	x	n	4377	K24	3	
φ	2235	FF	0.006	1	x	n	4377	K24	3	
φ	2237	AX	0.028	6	x	n	4377	K24	3	
φ	2238	YP	0.004	1	x	n	4377	K24	3	

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	2239	AM	24.300		.		8973	K 24	2	25
φ	2240	AO	0.309	1	.		8973	K 24	2	25
φ	2241	AC	1.895	29	.		8973	K 24	2	25
φ	2242	AN	0.277	9	.		8973	K 24	2	25
φ	2257	AX	0.787	21	.		8973	K 24	2	25
φ	2259	AA	1.629		.		8973	K 24	2	25
φ	2265	AH	0.022	1	.		8973	K 24	2	25
φ	2285	AZ	1.416		.		8973	K 24	2	25
φ	2286	BA	0.398	71	.		8973	K 24	2	25
φ	2288	BE	0.043	1	.		8973	K 24	2	25
φ	2289	AR	0.262	31	.		8973	K 24	2	25
φ	2297	CS	0.026	2	.		8973	K 24	2	25
φ	2314	AM	1.546	12	.		3759	K24	1	
φ	2315	AN	0.087	2	.		3759	K24	1	
φ	2316	Z	0.034	1	.		3759	K24	1	
φ	2317	AR	0.071	14	.		3759	K24	1	
φ	2321	BA	0.561	66	.		3759	K24	1	
φ	2324	AX	0.652	10	.		3759	K24	1	
φ	2326	AA	0.026	2	.		3759	K24	1	
φ	2327	AZ	0.264	26	.		3759	K24	1	
φ	2330	BY	0.006	7	.		3759	K24	1	
φ	2331	AC	0.103	1	.		3759	K24	1	
φ	2334	AM	11.150	30	.		8971	K 24	2	23
φ	2336	BA	0.213	34	.		8971	K 24	2	23
φ	2337	AX	0.095	2	.		8971	K 24	2	23
φ	2338	BY	0.001	1	.		8971	K 24	2	23
φ	2340	AA	0.127	33	.		8971	K 24	2	23
φ	2341	AZ	0.462	48	.		8971	K 24	2	23
φ	2347	Z	0.036	3	.		8971	K 24	2	23
φ	2348	AC	0.027	1	.		8971	K 24	2	23
φ	2349	YQ	0.034	3	x	y	4390	K24	7	
φ	2350	YR	0.012	1	x	n	4390	K24	7	
φ	2351	GP	0.015	2	x	n	4390	K24	7	
φ	2352	YS	0.002	1	x	n	4390	K24	7	
φ	2353	CW	0.004	5	x	n	4390	K24	7	
φ	2354	YT	0.000	1	x	n	4390	K24	7	
φ	2355	YU	0.000	1	x	n	4390	K24	7	
φ	2356	AR	0.004	1	x	n	4390	K24	7	
φ	2357	Z	0.000	1	x	n	4390	K24	7	
φ	2358	BY	0.000	1	x	n	4390	K24	7	
φ	2359	YV	0.005	1	x	n	4390	K24	7	
φ	2360	DW	0.019	2	x	n	4390	K24	7	
φ	2361	BA	0.014	2	x	n	4390	K24	7	
φ	2362	PA	0.117	1	x	n	8941			42
φ	2363	PA	0.016	1	x	n	8941			42
φ	2364	PA	0.029	1	x	n	8941			42

	Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
φ	2365	PA	0.839	1	x	n	8941			42
φ	2366	PA	0.062	1	x	n	8941			42
φ	2367	PA	0.005	1	x	n	8941			42
φ	2368	PA	0.185	1	x	n	8941			42
φ	2369	PA	0.055	1	x	n	8941			42
φ	2370	PA	0.039	1	x	n	8941			42
φ	2371	PA	0.007	1	x	n	8941			42
φ	2372	SVG	3.551	7	x	n	8941			42
φ	2373	SVG	0.128	1	x	n	8941			42
φ	2374	SVG	0.832	1	x	n	8941			42
φ	2375	PB	0.481	1	x	n	8941			42
φ	2376	PB	0.792	1	x	n	8941			42
φ	2377	PB	0.940	1	x	n	8941			42
φ	2378	PB	0.927	1	x	n	8941			42
φ	2379	PB	0.660	11	x	n	8941			42
φ	2380	PB	0.144	1	x	n	8941			42
φ	2381	PB	0.076	1	x	n	8941			42
φ	2382	PB	0.790	1	x	n	8941			42
φ	2383	PB	0.222	1	x	n	8941			42
φ	2384	PB	0.457	1	x	n	8941			42
φ	2385	PB	2.000	2	x	n	8947			47
φ	2386	PB	1.548	1	x	n	8947			47
φ	2387	PB	0.071	1	x	n	8947			47
φ	2388	PB	0.940	1	x	n	8947			47
φ	2389	PB	0.232	1	x	n	8947			47
φ	2390	PB	0.265	1	x	n	8947			47
φ	2391	PB	1.371	1	x	n	8947			47
φ	2392	PB	0.146	1	x	n	8947			47
φ	2393	PB	0.065	1	x	n	8947			47
φ	2394	PB	0.327	1	x	n	8947			47
φ	2395	PB	0.090	1	x	n	8947			47
φ	2396	PB	0.051	1	x	n	8947			47
φ	2397	PA	0.015	1	x	n	8895	I13	2	
φ	2398	SVG	0.156	1	x	n	8895	I13	2	
φ	2399	PB	0.453	1	x	n	8895	I13	2	
φ	2400	PB	0.065	1	x	n	8895	I13	2	
φ	2401	PB	0.184	1	x	n	8881	H14	3	
φ	2402	PB	0.597	1	x	n	8881	H14	3	
φ	2403	PB	0.047	1	x	n	8875	H13	2	
φ	2404	PB	0.140	1	x	n	8900	I14	2	
φ	2405	PB	0.575	3	x	n	8915	O11	2	
φ	2406	PD	0.202	1	x	n	8869	G16	2	
φ	2408	PG	0.075	1	x	n	8955			55
φ	2409	PG	0.213	2	x	n	8955			55
φ	2410	NY	0.505	1	x	n	8941			42
φ	2411	PB	1.689		.		8912	I16	3	

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 6221.01	DL	0.004	1	x	n	6221	N115 L114	7A	
UFMG 6221.02	SPD	0.012	1	x	n	6221	N115 L114	7A	
UFMG 6221.03	Z	0.008	1	x	n	6221	N115 L114	7A	
UFMG 6221.04	AL	0.177	6	x		6221	N115 L114	7A	
UFMG 6221.05	Z	0.063	3	.		6221	N115 L114	7A	
UFMG 6221.06	AM	5.900		.		6221	N115 L114	7A	
UFMG 6415.01	AM	9.311	28	x	y	6415	N115 L113	8	
UFMG 6415.02	SPE	0.047	3	x	y	6415	N115 L113	8	
UFMG 6415.03	SPF	0.011	2	x	y	6415	N115 L113	8	
UFMG 6437.01	AM	9.004	35	x	y	6437	N115 L113	9	
UFMG 6437.02	AR	0.217	1	.		6437	N115 L113	9	
UFMG 6437.03	SPJ	0.004	1	x	y	6437	N115 L113	9	
UFMG 6703.01	AC	0.119	1	x	y	6703	N115 L114	10	
UFMG 6703.02	JV	0.015	7	x	n	6703	N115 L114	10	
UFMG 6703.03	SPG	0.008	1	x	n	6703	N115 L114	10	
UFMG 6703.04	JJ	0.003	1	x	n	6703	N115 L114	10	
UFMG 6703.05	Z	0.062	2	.		6703	N115 L114	10	
UFMG 6703.06	ND	0.823	1	x	n	6703	N115 L114	10	
UFMG 6703.07	AM	1.400		.		6703	N115 L114	10	
UFMG 6706.01	AL	0.015	1	x	y	6706	N115 L113	10	
UFMG 6706.02	AM	11.156	38	x	y	6706	N115 L113	10	
UFMG 6706.03	GY	0.016	1	x	y	6706	N115 L113	10	
UFMG 6726.01	AM	12.497	67	x	y	6726	N115 L113	11	
UFMG 6726.02	AL	0.022	1	x	n	6726	N115 L113	11	
UFMG 6726.03	SPH		5	x	y	6726	N115 L113	11	
UFMG 6726.04	SPI	0.009	2			6726	N115 L113	11	
UFMG 6726.05	AZ		3	x	y	6726	N115 L113	11	
UFMG 6736.01	GK	0.000	1			6736	N115 L114	12	
UFMG 6736.02	AM	0.600		.		6736	N115 L114	12	
UFMG 7054-01	SPJ	0.287	1	x	n	7054	N112 L104	0	
UFMG 7054-02	SPK	0.204	1	x	n	7054	N112 L104	0	
UFMG 7054-03	JP	21.882	3	x	n	7054	N112 L104	0	
UFMG 7054-04	AM	17.234	8	.		7054	N112 L104	0	
UFMG 7054-05	RL	2.608	2	.		7054	N112 L104	0	
UFMG 7055-01	SPL	0.483	1	x	n	7055	N112 L104	1	
UFMG 7055-02	AM	48.700	39	.		7055	N112 L104	1	
UFMG 7055-03	RL	7.235	12	.		7055	N112 L104	1	
UFMG 7059	PA	0.064		x	n	7059	N112 L104	1	
UFMG 7060-01	JL	0.051	1	x	n	7060	N112 L104	2	
UFMG 7060-02	AM	18.672	15	.		7060	N112 L104	2	
UFMG 7060-03	RL	3.822	11	.		7060	N112 L104	2	
UFMG 7061-01	AM	12.555	9	.		7061	N112 L104	2	1
UFMG 7061-02	RL	0.799	6	.		7061	N112 L104	2	1
UFMG 7062-01	PD	1.132	1	x	n	7062	N112 L104	3	
UFMG 7062-02	AM	19.328	19	.		7062	N112 L104	3	
UFMG 7062-03	RL	3.166	31	.		7062	N112 L104	3	

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7065-01	AM	3.366	2	.		7065	N112 L104	4	
UFMG 7065-02	RL	8.689	11	.		7065	N112 L104	4	
UFMG 7067-01	AM	5.294	4	.		7067	N112 L104	5	
UFMG 7067-02	RL	1.577	2	.		7067	N112 L104	5	
UFMG 7068-01	AM	2.160	1	.		7068	N112 L104	6	
UFMG 7068-02	RL	2.080	3	.		7068	N112 L104	6	
UFMG 7069-01	AM	4.219	2	.		7069	N112 L104	7	
UFMG 7164-01	AM	17.100	10	.		7164	N121 L114	0	
UFMG 7164-02	RL	1.565	4	.		7164	N121 L114	0	
UFMG 7165-01	AM	128.600	71	.		7165	N121 L114	1	
UFMG 7165-02	RL	65.200		.		7165	N121 L114	1	
UFMG 7166-01	SPM	0.724	1	x	n	7166	N121 L114	2	
UFMG 7166-02	AM	71.800	38	.		7166	N121 L114	2	
UFMG 7166-03	RL	234.500		.		7166	N121 L114	2	
UFMG 7167-01	AK	8.981	2	x	n	7167	N121 L114	3	
UFMG 7167-02	KU	1.494	7	x	n	7167	N121 L114	3	
UFMG 7167-03	SPN	0.824	1	x	n	7167	N121 L114	3	
UFMG 7167-04	AM	22.761	9	.		7167	N121 L114	3	
UFMG 7167-05	RL	30.700		.		7167	N121 L114	3	
UFMG 7168-01	AK	4.936	1	x	n	7168	N121 L114	3	fogueira
UFMG 7168-02	AM	25.515	13	.		7168	N121 L114	3	fogueira
UFMG 7168-03	RL	36.300		.		7168	N121 L114	3	fogueira
UFMG 7751-01	AJ	1.192	1	x	n	7751	N115 L113	2	
UFMG 7761.01	AH	0.015	2	x		7761	N115 L114	3	
UFMG 7761.02	JK	0.011	1	x	n	7761	N115 L114	3	
UFMG 7761.03	JO	0.013	1	x	n	7761	N115 L114	3	
UFMG 7761.04	SPO	0.002	1	x	n	7761	N115 L114	3	
UFMG 7761.05	SPP	0.005	1	x	n	7761	N115 L114	3	
UFMG 7761.06	JJ	0.003	1	x	n	7761	N115 L114	3	
UFMG 7761.07	ND	0.007	1	x	n	7761	N115 L114	3	
UFMG 7761.08	SPQ	0.005	1	x	n	7761	N115 L114	3	
UFMG 7761.09	Z	0.004	1	.		7761	N115 L114	3	
UFMG 7761.10	AM	54.400		.		7761	N115 L114	3	
UFMG 7761.11	AM	0.998		.		7761	N115 L114	3	
UFMG 7762.01	SPR	0.007	1	x	n	7762	N115 L113	3	
UFMG 7762.02	SPS	0.043	1	x	n	7762	N115 L113	3	
UFMG 7762.03	SPT	0.005	1	x	n	7762	N115 L113	3	
UFMG 7762.04	SPU	0.015	3	x	n	7762	N115 L113	3	
UFMG 7762.05	SPV	0.020	1	x	n	7762	N115 L113	3	
UFMG 7762.06	GG	0.006	1	x	n	7762	N115 L113	3	
UFMG 7762.07	BJ	0.000	1	x	n	7762	N115 L113	3	
UFMG 7762.08	ND	0.282	4	x	n	7762	N115 L113	3	
UFMG 7762.09	AL	0.147	13	x	n	7762	N115 L113	3	
UFMG 7762.10	SPW	0.010	1	x	y	7762	N115 L113	3	
UFMG 7762.11	DC	0.002	1	x	n	7762	N115 L113	3	
UFMG 7762.12	HW	0.005	1	x	n	7762	N115 L113	3	

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7762.13	SPX	0.002	1	x	n	7762	N115 L113	3	
UFMG 7762.14	SPY	0.008	1	x	n	7762	N115 L113	3	
UFMG 7762.15	SPZ	0.008	1	x	n	7762	N115 L113	3	
UFMG 7762.16	SQA	0.006	1	x	y	7762	N115 L113	3	
UFMG 7762.17	JN	0.002	1	x		7762	N115 L113	3	
UFMG 7762.18	SQB	0.006	1	x	n	7762	N115 L113	3	
UFMG 7762.19	BA	0.005	1	x		7762	N115 L113	3	
UFMG 7762.20	IJ	0.006	1	x	n	7762	N115 L113	3	
UFMG 7762.21	JL	0.009	2	x	n	7762	N115 L113	3	
UFMG 7762.22	JL	0.142	12	x	n	7762	N115 L113	3	
UFMG 7762.23	SQC	0.004	1	x	n	7762	N115 L113	3	
UFMG 7762.24	SQD	0.001	1	x	n	7762	N115 L113	3	
UFMG 7762.25	HW	0.010	1	x	n	7762	N115 L113	3	
UFMG 7762.26	Z	0.023	2	.		7762	N115 L113	3	
UFMG 7762.27	AM	163.300		.		7762	N115 L113	3	
UFMG 7764-01	AA	0.714	2	x	n	7764	N114 L114	1	
UFMG 7769.01	BA	0.010	1	x		7769	N115 L113	4	
UFMG 7769.02	AH	0.013	2	x		7769	N115 L113	4	
UFMG 7769.03	JY	0.003	1	x	n	7769	N115 L113	4	
UFMG 7769.04	Z	0.017	1	x	n	7769	N115 L113	4	
UFMG 7769.05	JM	0.004	22	x	n	7769	N115 L113	4	
UFMG 7769.06	SQE	0.008	1	x		7769	N115 L113	4	
UFMG 7769.07	SVL	0.003	1	x	n	7769	N115 L113	4	
UFMG 7769.08	SVK	0.012	2	x	n	7769	N115 L113	4	
UFMG 7769.09	KG	0.002	1	x	n	7769	N115 L113	4	
UFMG 7769.10	SQF	0.005	1	x	n	7769	N115 L113	4	
UFMG 7769.11	JJ	0.002	2	x		7769	N115 L113	4	
UFMG 7769.12	ND	0.028	1	x		7769	N115 L113	4	
UFMG 7769.13	SQG	0.003	1	x	y	7769	N115 L113	4	
UFMG 7769.14	Z	0.063	4	.		7769	N115 L113	4	
UFMG 7769.15	Z	0.024	1	.		7769	N115 L113	4	
UFMG 7769.16	AM	50.800		.		7769	N115 L113	4	
UFMG 7769.17	AM	1.721		.		7769	N115 L113	4	
UFMG 7770-01	PA	0.006	1	x	n	7770	N115 L113		
UFMG 7772.01	AA	0.016	1	x	n	7772	N114 L114	1	
UFMG 7772.02	JU	0.005	1	x	n	7772	N114 L114	1	
UFMG 7772.03	AL	0.252	3	x	n	7772	N114 L114	1	
UFMG 7772.04	JL	0.069	1	x	n	7772	N114 L114	1	
UFMG 7772.05	KU	0.358	2	x	n	7772	N114 L114	1	
UFMG 7772.06	AM	253.600		.		7772	N114 L114	1	
UFMG 7772.07	AM	0.738		.		7772	N114 L114	1	
UFMG 7776-01	AA		1	x	n	7776	N115 L114		B
UFMG 7776-02	SQH		1	x	n	7776	N115 L114		B
UFMG 7776-03	AL			x	n	7776	N115 L114		B
UFMG 7776-04	FO	0.407	3	x	n	7776	N115 L114		B
UFMG 7776-05	AA			x	n	7776	N115 L114		B

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7776-06	AC			x	n	7776	N115 L114		B
UFMG 7776-07	AM			x	n	7776	N115 L114		B
UFMG 7776.01	AC	2.544	7	x	n	7776	N115 L114		B
UFMG 7776.02	AA	0.101	13	x	n	7776	N115 L114		B
UFMG 7776.03	EJ	0.004	1	x	n	7776	N115 L114		B
UFMG 7776.04	KV	0.004	1	x	n	7776	N115 L114		B
UFMG 7776.05	SQI	0.015	2	x	n	7776	N115 L114		B
UFMG 7776.06	SQJ	0.027	1	x	n	7776	N115 L114		B
UFMG 7776.07	SQK	0.076	1	x	n	7776	N115 L114		B
UFMG 7776.08	SQL	0.007	1	x		7776	N115 L114		B
UFMG 7776.09	SQM	0.016	1	x		7776	N115 L114		B
UFMG 7776.10	SQN	0.002	1	x	n	7776	N115 L114		B
UFMG 7776.11	JT	0.023	1	x	n	7776	N115 L114		B
UFMG 7776.12	JT	0.518	26	x	n	7776	N115 L114		B
UFMG 7776.13	SQO	0.019	2	x		7776	N115 L114		B
UFMG 7776.14	JT	0.039	1	x	n	7776	N115 L114		B
UFMG 7776.15	SQP	0.053	1	x	y	7776	N115 L114		B
UFMG 7776.16	SQQ	0.007	1	x	n	7776	N115 L114		B
UFMG 7776.17	STV	0.439	1	x	n	7776	N115 L114		B
UFMG 7776.18	ND	1.487	22	x		7776	N115 L114		B
UFMG 7776.19	AC	0.916	6	x		7776	N115 L114		B
UFMG 7776.20	AL	5.425	34	x	n	7776	N115 L114		B
UFMG 7776.21	AC	2.212	3	x	n	7776	N115 L114		B
UFMG 7776.22	AC	0.314	9	x		7776	N115 L114		B
UFMG 7776.23	AL	0.486	6	x	n	7776	N115 L114		B
UFMG 7776.24	AM	2.106		.		7776	N115 L114		B
UFMG 7776.25	AM	162.400		.		7776	N115 L114		B
UFMG 7777.01	AC	0.066	1	x	y	7777	N115 L114		B/C
UFMG 7777.02	SQS	0.171	1	x	y	7777	N115 L114		B/C
UFMG 7777.03	SQT	0.009	1	x	y	7777	N115 L114		B/C
UFMG 7777.04	SQU	0.009	1	x	y	7777	N115 L114		B/C
UFMG 7777.05	SQV	0.135	1	x	y	7777	N115 L114		B/C
UFMG 7777.06	SQW	0.028	1	x	y	7777	N115 L114		B/C
UFMG 7777.07	SQX	0.005	1	x	y	7777	N115 L114		B/C
UFMG 7777.08	KW	0.004	1	x	n	7777	N115 L114		B/C
UFMG 7777.09	SQY	0.004	1	x	y	7777	N115 L114		B/C
UFMG 7777.10	AL	0.318	2	x	n	7777	N115 L114		B/C
UFMG 7777.11	SQZ	0.020	1	x	y	7777	N115 L114		B/C
UFMG 7777.12	Z	0.022	3	.		7777	N115 L114		B/C
UFMG 7777.13	AA	0.034	3	x	y	7777	N115 L114		B/C
UFMG 7777.14	SRA	0.018	1	x	y	7777	N115 L114		B/C
UFMG 7777.15	HX	0.002	1	x	n	7777	N115 L114		B/C
UFMG 7777.16	SRC	0.007	1	x	n	7777	N115 L114		B/C
UFMG 7777.17	SRD	0.005	1	x	n	7777	N115 L114		B/C
UFMG 7777.18	SRE	0.003	1	x	y	7777	N115 L114		B/C
UFMG 7777.19	JN	0.002	1	x	n	7777	N115 L114		B/C

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7777.20	AC	0.113	1	x	y	7777	N115 L114		B/C
UFMG 7777.21	AL	0.283	20	x	ny	7777	N115 L114		B/C
UFMG 7777.22	ND	0.110	2	x	n	7777	N115 L114		B/C
UFMG 7777.23	Z	0.019	4	.		7777	N115 L114		B/C
UFMG 7777.24	AM	85.100		.		7777	N115 L114		B/C
UFMG 7778.01	AA	0.135	1	x	n	7778	N115 L113	5	
UFMG 7778.02	AR	0.031	1	x	y	7778	N115 L113	5	
UFMG 7778.03	BA	0.012	1	x		7778	N115 L113	5	
UFMG 7778.04	SRB	0.009	1	x	n	7778	N115 L113	5	
UFMG 7778.05	ND	0.050	3	x		7778	N115 L113	5	
UFMG 7778.06	DT	0.007	1	x	n	7778	N115 L113	5	
UFMG 7778.07	SVM	0.005	1	x	n	7778	N115 L113	5	
UFMG 7778.08	SVN	0.032	2	x	n	7778	N115 L113	5	
UFMG 7778.09	HW	0.007	1	x	n	7778	N115 L113	5	
UFMG 7778.10	KE	0.004	1	x	n	7778	N115 L113	5	
UFMG 7778.11	SRF	0.004	1	x	n	7778	N115 L113	5	
UFMG 7778.12	SVK	0.010	4	x	n	7778	N115 L113	5	
UFMG 7778.13	SRG	0.003	1	x	n	7778	N115 L113	5	
UFMG 7778.14	JL	0.158	12	x	n	7778	N115 L113	5	
UFMG 7778.15	JJ	0.006	2	x	n	7778	N115 L113	5	
UFMG 7778.16	AH	0.024	2	x	y	7778	N115 L113	5	
UFMG 7778.17	SRH	0.000	1	x	n	7778	N115 L113	5	
UFMG 7778.18	BK	0.013	1	x	n	7778	N115 L113	5	
UFMG 7778.19	SRI	0.080	1	x	n	7778	N115 L113	5	
UFMG 7778.20	SRJ	0.005	1	x	y	7778	N115 L113	5	
UFMG 7778.21	SRK	0.015	1	x	n	7778	N115 L113	5	
UFMG 7778.22	HQ	0.009	1	x	n	7778	N115 L113	5	
UFMG 7778.23	SRL	0.026	1	x	n	7778	N115 L113	5	
UFMG 7778.24	SRM	0.010	1	x	y	7778	N115 L113	5	
UFMG 7778.25	Z	0.034	2	.		7778	N115 L113	5	
UFMG 7778.26	AL	0.071	4	x	n	7778	N115 L113	5	
UFMG 7778.27	P	0.103	1	x	n	7778	N115 L113	5	
UFMG 7778.29	AM	80.000		.		7778	N115 L113	5	
UFMG 7778.30	AM	1.624		.		7778	N115 L113	5	
UFMG 7779.01	AL	0.278	6	x	ny	7779	N115 L114	4	
UFMG 7779.02	AA	0.013	2	x	y	7779	N115 L114	4	
UFMG 7779.03	AC	0.088	2	x	y	7779	N115 L114	4	
UFMG 7779.04	SRN	0.169	1	x	y	7779	N115 L114	4	
UFMG 7779.05	SRO	0.166	1	x	y	7779	N115 L114	4	
UFMG 7779.06	SRP	0.060	1	x	n	7779	N115 L114	4	
UFMG 7779.07	SRQ	0.015	1	x	y	7779	N115 L114	4	
UFMG 7779.08	SRR	0.008	1	x	n	7779	N115 L114	4	
UFMG 7779.09	SRS	0.041	1	x	y	7779	N115 L114	4	
UFMG 7779.10	AC	0.100	3	x	y	7779	N115 L114	4	
UFMG 7779.11	Z	0.008	1	x	n	7779	N115 L114	4	
UFMG 7779.12	EK	0.024	1	x	y	7779	N115 L114	4	

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7779.13	AM	0.070	2	x	y	7779	N115 L114	4	
UFMG 7779.14	SRT	0.007	1	x	n	7779	N115 L114	4	
UFMG 7779.15	SRU	0.018	1	x	y	7779	N115 L114	4	
UFMG 7779.16	SRV	0.015	1	x	y	7779	N115 L114	4	
UFMG 7779.17	Z	0.031	4	.		7779	N115 L114	4	
UFMG 7779.18	AM	87.900		.		7779	N115 L114	4	
UFMG 7779.19	AM	0.218		.		7779	N115 L114	4	
UFMG 7780-01	PA	0.077	1	x	ny	7780	N115 L114		A
UFMG 7788.01	AH	0.055	3	x		7788	N115 L113	6	
UFMG 7788.02	SRW	0.009	1	x	y	7788	N115 L113	6	
UFMG 7788.03	SRX	0.005	1	x	n	7788	N115 L113	6	
UFMG 7788.04	SRY	0.004	1	x	n	7788	N115 L113	6	
UFMG 7788.05	JL	0.007	1	x	n	7788	N115 L113	6	
UFMG 7788.06	SRZ	0.013	1	x	n	7788	N115 L113	6	
UFMG 7788.07	DC	0.005	1	x	n	7788	N115 L113	6	
UFMG 7788.09	SSA	0.012	1	x	n	7788	N115 L113	6	
UFMG 7788.10	Z	0.002	1	.		7788	N115 L113	6	
UFMG 7788.11	AL	1.732	20	x	n	7788	N115 L113	6	
UFMG 7788.12	SVK	0.006	1	x	n	7788	N115 L113	6	
UFMG 7788.13	AA	0.309	2	x	n	7788	N115 L113	6	
UFMG 7788.14	DO	0.210	4	x	n	7788	N115 L113	6	
UFMG 7788.15	JL	0.480	15	x	n	7788	N115 L113	6	
UFMG 7788.16	IJ	0.011	2	x	n	7788	N115 L113	6	
UFMG 7788.17	SVK	0.008	2	x	n	7788	N115 L113	6	
UFMG 7788.18	EJ	0.000	1	x	n	7788	N115 L113	6	
UFMG 7788.19	SSB	0.004	1	x	n	7788	N115 L113	6	
UFMG 7788.20	GP	0.003	1	x		7788	N115 L113	6	
UFMG 7788.21	FO	0.003	1	x	n	7788	N115 L113	6	
UFMG 7788.22	SSC	0.002	1	x	n	7788	N115 L113	6	
UFMG 7788.23	JJ	0.010	4	x	n	7788	N115 L113	6	
UFMG 7788.24	DC	0.001	1	x	n	7788	N115 L113	6	
UFMG 7788.25	ND	0.155	1	x	n	7788	N115 L113	6	
UFMG 7788.26	P	0.125	9	x	n	7788	N115 L113	6	
UFMG 7788.27	AM	52.400		.		7788	N115 L113	6	
UFMG 7788.28	AM	0.095		.		7788	N115 L113	6	
UFMG 7789-01	FJ	0.145	1	x	n	7789	N115 L113	6	
UFMG 7789-02	AM	11.600	1	x	n	7789	N115 L113	6	
UFMG 7789-03	RL	1.435	1	x	n	7789	N115 L113	6	
UFMG 7789-04	P	1.700	1	x	n	7789	N115 L113	6	
UFMG 7793.01	SSD	0.003	1	x	n	7793	N115 L113	7	
UFMG 7793.02	JL	0.109	5	x	n	7793	N115 L113	7	
UFMG 7793.03	ND	0.153	1	x	y	7793	N115 L113	7	
UFMG 7793.04	P	0.087	8	x	n	7793	N115 L113	7	
UFMG 7793.05	AL	0.016	1	x	y	7793	N115 L113	7	
UFMG 7793.06	AL	0.070	2	x	n	7793	N115 L113	7	
UFMG 7793.07	AM	39.000		.		7793	N115 L113	7	

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7793.08	AM	0.024		.		7793	N115 L113	7	
UFMG 7795-01	PA	0.573	1	x	n	7795	N115 L113		C
UFMG 7795-02	AL	0.333	1	x	n	7795	N115 L113		C
UFMG 7795-03	AC	0.822	2	x	n	7795	N115 L113		C
UFMG 7795-04	BL	1.071	1	x	n	7795	N115 L113		C
UFMG 7795-05	AA	0.964	1	x	n	7795	N115 L113		C
UFMG 7795-06	RL	1.136	2	x	n	7795	N115 L113		C
UFMG 7795-07	AA	0.540	1	x	n	7795	N115 L113		C
UFMG 7795-08	PA	3.667	1	x	n	7795	N115 L113		C
UFMG 7795-09	FJ	0.317	1	x	n	7795	N115 L113		C
UFMG 7795-10	RL	0.051	1	.		7795	N115 L113		C
UFMG 7798.01	JP	0.551	2	x	n	7798	N115 L114	5	
UFMG 7798.02	AL	0.137	4	x	ny	7798	N115 L114	5	
UFMG 7798.03	SSE	0.010	1	x	y	7798	N115 L114	5	
UFMG 7798.04	DO	0.013	1	x	n	7798	N115 L114	5	
UFMG 7798.05	SSF	0.020	1	x	y	7798	N115 L114	5	
UFMG 7798.06	AC	0.045	3	x	y	7798	N115 L114	5	
UFMG 7798.07	SSG	0.046	1	x	y	7798	N115 L114	5	
UFMG 7798.08	Z	0.075	6	.		7798	N115 L114	5	
UFMG 7798.09	ND	0.182	2	x	ny	7798	N115 L114	5	
UFMG 7798.10	AL	0.358	4	x	ny	7798	N115 L114	5	
UFMG 7798.11	EE	0.036	1	x	n	7798	N115 L114	5	
UFMG 7798.12	SSH	0.019	1		y	7798	N115 L114	5	
UFMG 7798.13	AA	0.010	1	x	y	7798	N115 L114	5	
UFMG 7798.14	AC	0.962	11	x	y	7798	N115 L114	5	
UFMG 7798.15	P	0.112	1	x	n	7798	N115 L114	5	
UFMG 7798.16	AM	129.900		.		7798	N115 L114	5	
UFMG 7798.17	AM	1.902		.		7798	N115 L114	5	
UFMG 7799-01	ND	0.517	1	x		7799	N115 L114		B
UFMG 7799-02	Z	1.120	1	x		7799	N115 L114		B
UFMG 7799-03	AA	1.035	1	x	n	7799	N115 L114		B
UFMG 7799-04	AL	0.781	1	x	n	7799	N115 L114		B
UFMG 7799-05	AB	1.226	1	x	n	7799	N115 L114		B
UFMG 7799-06	AB	2.387	1	x	n	7799	N115 L114		B
UFMG 7799-07	AM	8.798	1	x	n	7799	N115 L114		B
UFMG 7799-08	RL	1.193	1	x	n	7799	N115 L114		B
UFMG 7799-09	RL	0.304	6	.		7799	N115 L114		B
UFMG 7801.01	AH	0.040	1	x		7801	N115 L113		C
UFMG 7801.02	DO	0.468	13	x	n	7801	N115 L113		C
UFMG 7801.03	JS	0.010	1	x	n	7801	N115 L113		C
UFMG 7801.04	SSI	0.035	1	x	y	7801	N115 L113		C
UFMG 7801.05	BJ	0.021	2	x	n	7801	N115 L113		C
UFMG 7801.06	SSJ	0.131	1	x	n	7801	N115 L113		C
UFMG 7801.07	SSK	0.001	1	x	n	7801	N115 L113		C
UFMG 7801.08	SSL	0.008	1	x	n	7801	N115 L113		C
UFMG 7801.09	DC	0.004	1	x	n	7801	N115 L113		C

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7801.10	JL	0.020	7	x	n	7801	N115 L113		C
UFMG 7801.11	SSM	0.026	1	x	n	7801	N115 L113		C
UFMG 7801.12	SSN	0.013	1	x	n	7801	N115 L113		C
UFMG 7801.13	SSO	0.004	1	x	y	7801	N115 L113		C
UFMG 7801.14	SSP	0.025	1	x	y	7801	N115 L113		C
UFMG 7801.15	SSQ	0.000	1	x	n	7801	N115 L113		C
UFMG 7801.16	AL	0.034	3	x	n	7801	N115 L113		C
UFMG 7801.17	Z	0.033	3	.		7801	N115 L113		C
UFMG 7801.18	AD	0.050	2	x	n	7801	N115 L113		C
UFMG 7801.19	AR	0.029	1	x	n	7801	N115 L113		C
UFMG 7801.20	AZ	0.019	1	x	n	7801	N115 L113		C
UFMG 7801.21	AC	0.373	4	x	n	7801	N115 L113		C
UFMG 7801.22	BJ	0.027	1	x	n	7801	N115 L113		C
UFMG 7801.23	AA	0.017	2	x	n	7801	N115 L113		C
UFMG 7801.24	SSR	0.059	3	x	n	7801	N115 L113		C
UFMG 7801.25	DF	0.021	2	x	n	7801	N115 L113		C
UFMG 7801.26	SSS	0.000	1	x	n	7801	N115 L113		C
UFMG 7801.27	SST	0.007	1	x	n	7801	N115 L113		C
UFMG 7801.28	JJ	0.004	1	x		7801	N115 L113		C
UFMG 7801.29	JN	0.000	1	x		7801	N115 L113		C
UFMG 7801.30	SSU	0.005	1	x	n	7801	N115 L113		C
UFMG 7801.31	SN	0.020	1	x	n	7801	N115 L113		C
UFMG 7801.32	GG	0.007	1	x	n	7801	N115 L113		C
UFMG 7801.33	HX	0.004	1	x	n	7801	N115 L113		C
UFMG 7801.34	SSV	0.003	1	x	n	7801	N115 L113		C
UFMG 7801.35	SSW	0.004	1	x	n	7801	N115 L113		C
UFMG 7801.36	SSX	0.006	1	x	n	7801	N115 L113		C
UFMG 7801.37	SSY	0.326	27	x	n	7801	N115 L113		C
UFMG 7801.38	JL	0.004	1	x		7801	N115 L113		C
UFMG 7801.39	SSZ	0.002	1	x	n	7801	N115 L113		C
UFMG 7801.40	STA	0.092	2	x	n	7801	N115 L113		C
UFMG 7801.41	STB	0.000	1	x	n	7801	N115 L113		C
UFMG 7801.42	JX	0.012	1	x	n	7801	N115 L113		C
UFMG 7801.43	STC	0.004	1	x	n	7801	N115 L113		C
UFMG 7801.44	STD	0.019	1	x	n	7801	N115 L113		C
UFMG 7801.45	Z	0.028	3	.		7801	N115 L113		C
UFMG 7801.46	AL	7.177	167	x	n	7801	N115 L113		C
UFMG 7801.47	ND	0.936	21	x		7801	N115 L113		C
UFMG 7801.48	STE	0.099	1	x	n	7801	N115 L113		C
UFMG 7801.49	P	0.049	2	x	n	7801	N115 L113		C
UFMG 7801.50	P	0.046	2	x	n	7801	N115 L113		C
UFMG 7801.51	AC	0.905	7	x		7801	N115 L113		C
UFMG 7801.52	AC	0.315	2	x		7801	N115 L113		C
UFMG 7801.53	STF	0.005	1	x	n	7801	N115 L113		C
UFMG 7801.54	AA	0.017	1	x	n	7801	N115 L113		C
UFMG 7801.55	AM	520.000		.		7801	N115 L113		C

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7801.56	AM	4.759		.		7801	N115 L113		C
UFMG 7803-01	RL	1.600	1	x	n	7803	N115 L113		C
UFMG 7803-02	AA	0.539	2	x	n	7803	N115 L113		C
UFMG 7803-03	AR	0.106	1	x	n	7803	N115 L113		C
UFMG 7803-04	DH	0.380	1	x	n	7803	N115 L113		C
UFMG 7803-05	AL	0.368	1	x	n	7803	N115 L113		C
UFMG 7803-06	PA	0.062	1	x	n	7803	N115 L113		C
UFMG 7803-07	RL	3.753	1	x	n	7803	N115 L113		C
UFMG 7803-08	RL	1.571	1	x	n	7803	N115 L113		C
UFMG 7803-09	RL	1.569	1	x	n	7803	N115 L113		C
UFMG 7803-10	RL	0.165	1	x	n	7803	N115 L113		C
UFMG 7803-11	RL	0.369	1	x	n	7803	N115 L113		C
UFMG 7803-12	RL	0.775	1	x	n	7803	N115 L113		C
UFMG 7803-13	RL	0.613	4	x	n	7803	N115 L113		C
UFMG 7803.01	AH	0.038	1	x		7803	N115 L113		C
UFMG 7803.02	STG	0.035	1	x	y	7803	N115 L113		C
UFMG 7803.03	STH	0.007	1	x	n	7803	N115 L113		C
UFMG 7803.04	STI	0.053	1	x	n	7803	N115 L113		C
UFMG 7803.05	STJ	0.018	1	x	n	7803	N115 L113		C
UFMG 7803.06	JK	0.014	1	x		7803	N115 L113		C
UFMG 7803.07	FZ	0.010	2	x	n	7803	N115 L113		C
UFMG 7803.08	STK	0.008	1	x	n	7803	N115 L113		C
UFMG 7803.10	HV	0.004	1	x	n	7803	N115 L113		C
UFMG 7803.11	STL	0.013	2	x		7803	N115 L113		C
UFMG 7803.12	STM	0.217	1	x		7803	N115 L113		C
UFMG 7803.13	JL	0.004	1	x	n	7803	N115 L113		C
UFMG 7803.14	STN	0.008	1	x	n	7803	N115 L113		C
UFMG 7803.15	AL	0.096	1	x	n	7803	N115 L113		C
UFMG 7803.16	Z	0.060	6	.		7803	N115 L113		C
UFMG 7803.17	DF	0.033	2	x	n	7803	N115 L113		C
UFMG 7803.18	AL	0.875	14	x	n	7803	N115 L113		C
UFMG 7803.19	JL	0.030	2	x		7803	N115 L113		C
UFMG 7803.20	AM	263.400		.		7803	N115 L113		C
UFMG 7803.21	AM	4.662		.		7803	N115 L113		C
UFMG 7815-01	AM	329.000		.		7815	N115 L113		A
UFMG 7815-02	AL	4.421		.		7815	N115 L113		A
UFMG 7815-03	BL	0.412	1	.		7815	N115 L113		A
UFMG 7815-05	DO	1.407	4	.		7815	N115 L113		A
UFMG 7815-07	AC	0.557		.		7815	N115 L113		A
UFMG 7815-08	AA	0.345		.		7815	N115 L113		A
UFMG 7815-09	PA	0.019	1	.		7815	N115 L113		A
UFMG 7815-10	AH	0.033	1	.		7815	N115 L113		A
UFMG 7815-12	AF	0.092	3	.		7815	N115 L113		A
UFMG 7815-15	AZ	0.008	3	.		7815	N115 L113		A
UFMG 7815-16	BA	0.001	1	.		7815	N115 L113		A
UFMG 7815-24	Z	0.505		.		7815	N115 L113		A

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7819-01	AC	2.018		.		7819	N115 L113		fogueira 2
UFMG 7819-02	AJ	0.059	1	.		7819	N115 L113		fogueira 2
UFMG 7819-06	AA	0.007	1	.		7819	N115 L113		fogueira 2
UFMG 7819-07	EG	0.007	1	x		7819	N115 L113		fogueira 2
UFMG 7819-09	AM	249.300		.		7819	N115 L113		fogueira 2
UFMG 7819-10	DO	0.270	1	.		7819	N115 L113		fogueira 2
UFMG 7819-13	AB	1.064	1	.		7819	N115 L113		fogueira 2
UFMG 7819-19	Z	0.043	2	.		7819	N115 L113		fogueira 2
UFMG 7819-20	AM	0.454	3	.		7819	N115 L113		fogueira 2
UFMG 7819-21	AL	1.060	4	.		7819	N115 L113		fogueira 2
UFMG 7822.01	AH	0.023	1	x	y	7822	N115 L113		A
UFMG 7822.02	SSC	0.017	1	x	n	7822	N115 L113		A
UFMG 7822.03	STO	0.010	1	x	y	7822	N115 L113		A
UFMG 7822.04	DL	0.026	2	x	n	7822	N115 L113		A
UFMG 7822.05	STP	0.004	1	x	y	7822	N115 L113		A
UFMG 7822.06	AA	0.011	1	x	n	7822	N115 L113		A
UFMG 7822.07	AF	0.005	1	x	y	7822	N115 L113		A
UFMG 7822.08	STQ	0.027	1	x	y	7822	N115 L113		A
UFMG 7822.09	STR	0.002	1	x	y	7822	N115 L113		A
UFMG 7822.10	Z	0.002	1	x	y	7822	N115 L113		A
UFMG 7822.11	AC	0.983	4	x	y	7822	N115 L113		A
UFMG 7822.12	ND	0.887	6	x		7822	N115 L113		A
UFMG 7822.13	AL	1.429	12	x	ny	7822	N115 L113		A
UFMG 7822.14	AM	0.200		.		7822	N115 L113		A
UFMG 7822.15	AM	114.800		.		7822	N115 L113		A
UFMG 7824.01	AL	0.062	2	x	n	7824	N115 L113		
UFMG 7824.02	CK	0.018	1	x	n	7824	N115 L113		
UFMG 7824.03	STS	0.027	1	x	y	7824	N115 L113		
UFMG 7824.05	AL	0.052	6	x	n	7824	N115 L113		
UFMG 7824.06	AC	0.462	1	x	y	7824	N115 L113		
UFMG 7824.07	STE	0.558	1	x	y	7824	N115 L113		
UFMG 7824.08	AA	0.088	1	x	n	7824	N115 L113		
UFMG 7824.09	AR	0.004	1	x	n	7824	N115 L113		
UFMG 7824.10	JL	0.038	1	x	n	7824	N115 L113		
UFMG 7824.11	STT	0.050	1	x	y	7824	N115 L113		
UFMG 7824.12	AM	0.020		.		7824	N115 L113		
UFMG 7824.13	AM	31.100		.		7824	N115 L113		
UFMG 7825.01	AH	0.032	1	x		7825	N115 L113		D
UFMG 7825.02	STU	0.019	1	x	y	7825	N115 L113		D
UFMG 7825.03	Z	0.005	2	.		7825	N115 L113		D
UFMG 7825.04	AL	0.362	1	x	n	7825	N115 L113		D
UFMG 7825.05	AF	0.025	1	x	n	7825	N115 L113		D
UFMG 7825.06	AL	2.754	46	.		7825	N115 L113		D
UFMG 7825.07	AC	1.679	9	x	ny	7825	N115 L113		D
UFMG 7825.08	AR	0.086	1	x	n	7825	N115 L113		D
UFMG 7825.09	STV	0.358	2	x	y	7825	N115 L113		D

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7825.10	STW	0.081	1	x	n	7825	N115 L113		D
UFMG 7825.11	ND	1.239	6	x		7825	N115 L113		D
UFMG 7825.12	AC	0.114	2	x	y	7825	N115 L113		D
UFMG 7825.13	AM	0.401		.		7825	N115 L113		D
UFMG 7825.14	AM	308.800		.		7825	N115 L113		D
UFMG 7829.01	AC	0.296	2	x	n	7829	N115 L114		B
UFMG 7829.02	AH	0.029	1	x		7829	N115 L114		B
UFMG 7829.03	STX	0.025	1	x	n	7829	N115 L114		B
UFMG 7829.04	AC	0.360	5	x	y	7829	N115 L114		B
UFMG 7829.05	AL	1.072	18	x	n	7829	N115 L114		B
UFMG 7829.06	Z	0.059	5	.		7829	N115 L114		B
UFMG 7829.07	Z	0.212	6	.		7829	N115 L114		B
UFMG 7829.08	P	0.054	2	x	n	7829	N115 L114		B
UFMG 7829.09	AM	129.100		.		7829	N115 L114		B
UFMG 7830-01	AA	1.755	1	x	n	7830	N115 L113		fossa
UFMG 7830.01	AC	0.689	4	x	n	7830	N115 L113		fossa
UFMG 7830.02	AR	0.013	2	x	y	7830	N115 L113		fossa
UFMG 7830.03	JL	0.086	4	x	n	7830	N115 L113		fossa
UFMG 7830.04	ND	0.241	2	x	y	7830	N115 L113		fossa
UFMG 7830.05	DN	0.005	3	x	n	7830	N115 L113		fossa
UFMG 7830.06	AL	2.008	14	x	n	7830	N115 L113		fossa
UFMG 7830.07	STY	0.051	2	x	y	7830	N115 L113		fossa
UFMG 7830.08	AC	0.015	2	x	y	7830	N115 L113		fossa
UFMG 7830.09	AA	0.016	1	x	n	7830	N115 L113		fossa
UFMG 7830.10	STZ	0.014	1	x	y	7830	N115 L113		fossa
UFMG 7830.11	SUA	0.112	2	x	n	7830	N115 L113		fossa
UFMG 7830.12	AF	0.119	1	x	y	7830	N115 L113		fossa
UFMG 7830.13	SUB	0.038	2	x	y	7830	N115 L113		fossa
UFMG 7830.14	SUC	0.177	2	x	y	7830	N115 L113		fossa
UFMG 7830.15	DO	0.161	1	x	n	7830	N115 L113		fossa
UFMG 7830.16	SUD	0.012	1	x	n	7830	N115 L113		fossa
UFMG 7830.17	SUE	0.008	1	x	y	7830	N115 L113		fossa
UFMG 7830.18	SUF	0.163	1	x	n	7830	N115 L113		fossa
UFMG 7830.19	AL	1.106	2	x	n	7830	N115 L113		fossa
UFMG 7830.20	Z	0.097	3	.		7830	N115 L113		fossa
UFMG 7830.21	P	1.724	29	x	n	7830	N115 L113		fossa
UFMG 7830.22	P	0.602	4	x	n	7830	N115 L113		fossa
UFMG 7830.23	AM	0.213		.		7830	N115 L113		fossa
UFMG 7830.24	AM	171.400		.		7830	N115 L113		fossa
UFMG 7833-01	PA	0.090	1	x	n	7833	N115 L113		A
UFMG 7833-02	PA	0.279	1	x	ny	7833	N115 L113		A
UFMG 7833-03	SUG	0.061	1	x	n	7833	N115 L113		A
UFMG 7833-04	AM	2.586	1	x		7833	N115 L113		A
UFMG 7837-01	RL	2.600	1	x	n	7837	N115 L114		D
UFMG 7837-02	ND	2.248	1	x	n	7837	N115 L114		D
UFMG 7837-03	RL	1.370	1	x	n	7837	N115 L114		D

Unique ID		Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG	7837-04	RC	0.271	1	x	n	7837	N115 L114		D
UFMG	7837-05	RL	2.200	1	x	n	7837	N115 L114		D
UFMG	7837.01	BA	0.015	1	x		7837	N115 L114		D
UFMG	7837.02	AF	0.036	1	x	n	7837	N115 L114		D
UFMG	7837.03	SUH	0.001	1	x	n	7837	N115 L114		D
UFMG	7837.05	SUJ	0.004	1	x	n	7837	N115 L114		D
UFMG	7837.07	Z	0.068	4	.		7837	N115 L114		D
UFMG	7837.08	AC	4.151	5	x	n	7837	N115 L114		D
UFMG	7837.09	ND	0.275	2	x	n	7837	N115 L114		D
UFMG	7837.10	AL	4.851	33	x	n	7837	N115 L114		D
UFMG	7837.11	AL	0.319	4	x	n	7837	N115 L114		D
UFMG	7837.12	JP	1.422	1	x	n	7837	N115 L114		D
UFMG	7837.13	AK	0.114	1	x	n	7837	N115 L114		D
UFMG	7837.14	AF	0.016	1	x	n	7837	N115 L114		D
UFMG	7837.15	AC	0.115	2	x	ny	7837	N115 L114		D
UFMG	7837.16	AH	0.036	1	x		7837	N115 L114		D
UFMG	7837.17	Z	0.048	4	.		7837	N115 L114		D
UFMG	7837.18	P	0.000	2	x	n	7837	N115 L114		D
UFMG	7837.19	P	0.020	2	x	n	7837	N115 L114		D
UFMG	7837.20	AM	2.011		.		7837	N115 L114		D
UFMG	7837.21	AM	457.100		.		7837	N115 L114		D
UFMG	7838-01	RL	1.138	1	x	n	7838	N115 L114		E
UFMG	7838-02	RL	2.265	1	x	n	7838	N115 L114		E
UFMG	7838-03	RL	8.000	1	x	n	7838	N115 L114		E
UFMG	7838-04	RL	3.674	1	x	n	7838	N115 L114		E
UFMG	7838-05	P	3.500	1	x	n	7838	N115 L114		E
UFMG	7838-06	RL	4.200		x	n	7838	N115 L114		E
UFMG	7914-01	AG	0.080	1	x	n	7914	N100 L100	1	
UFMG	7914-02	SUL	1.676	1	x	n	7914	N100 L100	1	
UFMG	7914-03	AM	2.339	8	.		7914	N100 L100	1	
UFMG	7914-04	RL	37.400		.		7914	N100 L100	1	
UFMG	7915-01	AQ	0.035	1	x	n	7915	N100 L100	1	
UFMG	7915-02	AM	13.722	21	.		7915	N100 L100	1	
UFMG	7915-03	ND	3.113	3	.		7915	N100 L100	1	
UFMG	7915-04	RL	26.500		.		7915	N100 L100	1	
UFMG	7915.01	AM	1.715	6	.		7915	N100 L100	1	
UFMG	7915.02	AQ	0.057	5	.		7915	N100 L100	1	
UFMG	7915.03	AF	0.126	15	.		7915	N100 L100	1	
UFMG	7915.04	AM	1.419	2	.		7915	N100 L100	1	
UFMG	7915.05	AD	0.023	1	.		7915	N100 L100	1	
UFMG	7915.06	AQ	0.060	10	.		7915	N100 L100	1	
UFMG	7915.08	AF	0.048	6	.		7915	N100 L100	1	
UFMG	7916.01	AM	26.500	131	x		7916	N100 L100	2	1
UFMG	7916.02	AM	9.400	28	x	y	7916	N100 L100	2	1
UFMG	7916.03	JL	0.496	8	x	n	7916	N100 L100	2	1
UFMG	7916.04	SUM	0.005	1	x	n	7916	N100 L100	2	1

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7916.05	AH	0.021	2	x	n	7916	N100 L100	2	1
UFMG 7916.06	AQ	0.175	10	x	n	7916	N100 L100	2	1
UFMG 7916.07	EY	0.001	1	x	n	7916	N100 L100	2	1
UFMG 7916.08	AI	0.133	2	x	n	7916	N100 L100	2	1
UFMG 7916.09	AF	0.098	25	x	n	7916	N100 L100	2	1
UFMG 7916.10	SUN	0.002	1	x	n	7916	N100 L100	2	1
UFMG 7916.11	JY	0.010	3	x	n	7916	N100 L100	2	1
UFMG 7916.12	SUO	0.013	1	x	n	7916	N100 L100	2	1
UFMG 7916.13	SUP	0.018	1	x	y	7916	N100 L100	2	1
UFMG 7916.14	SUQ	0.028	4	x	n	7916	N100 L100	2	1
UFMG 7916.15	SUR	0.002	1	x	n	7916	N100 L100	2	1
UFMG 7916.17	SUS	0.006	2	x	n	7916	N100 L100	2	1
UFMG 7916.18	SUT	0.010	1	x	n	7916	N100 L100	2	1
UFMG 7916.19	SUU	0.008	2	x	n	7916	N100 L100	2	1
UFMG 7916.20	BK	0.000	1	x	n	7916	N100 L100	2	1
UFMG 7916.21	SUV	0.001	1	x	n	7916	N100 L100	2	1
UFMG 7916.22	SUW	0.009	1	x	n	7916	N100 L100	2	1
UFMG 7916.23	Z	0.194	26	x	n	7916	N100 L100	2	1
UFMG 7916.24	IW	0.027	3	x	n	7916	N100 L100	2	1
UFMG 7917-01	AQ	0.717	19	x	n	7917	N100 L100	2	
UFMG 7917-02	AA	0.097	1	x	n	7917	N100 L100	2	
UFMG 7917-03	AF	0.388	10	x	n	7917	N100 L100	2	
UFMG 7917-04	SUX	0.040	1	x	n	7917	N100 L100	2	
UFMG 7917-05	SUY	0.045	1	x	y	7917	N100 L100	2	
UFMG 7917-06	KX	0.050	1	x	y	7917	N100 L100	2	
UFMG 7917-07	SUZ	0.148	1	x	y	7917	N100 L100	2	
UFMG 7917-08	SVA	0.017	1	x		7917	N100 L100	2	
UFMG 7917-09	AM	18.715	24	.		7917	N100 L100	2	
UFMG 7917-10	RL	57.100		.		7917	N100 L100	2	
UFMG 7917.01	AM	0.826	7	x		7917	N100 L100	2	
UFMG 7917.02	AQ	0.022	3	x	n	7917	N100 L100	2	
UFMG 7917.03	AF	0.662	93	x	n	7917	N100 L100	2	
UFMG 7917.04	SVB	0.008	1	x	n	7917	N100 L100	2	
UFMG 7917.05	AM	0.026	1	x	n	7917	N100 L100	2	
UFMG 7917.06	JQ	0.009	1	x	n	7917	N100 L100	2	
UFMG 7917.07	AF	0.756	82	.		7917	N100 L100	2	
UFMG 7917.08	AQ	0.110	11	x	n	7917	N100 L100	2	
UFMG 7917.09	AI	0.012	1	x	n	7917	N100 L100	2	
UFMG 7917.10	SVC	0.001	1	x	n	7917	N100 L100	2	
UFMG 7917.11	SVD	0.037	1	x	y	7917	N100 L100	2	
UFMG 7917.12	DQ	0.005	1	x	y	7917	N100 L100	2	
UFMG 7917.13	Z	0.133	7	x	n	7917	N100 L100	2	
UFMG 7919-01	SVE	0.025	1	x	n	7919	N100 L100	3	
UFMG 7919-02	Z	0.517	2	x	n	7919	N100 L100	3	
UFMG 7919-03	AM	2.656	8	.		7919	N100 L100	3	
UFMG 7919-04	RL	0.956		.		7919	N100 L100	3	

Unique ID	Type	Weight (g)	Quantity	photo	burnt	PN	Unit	Level	Feature
UFMG 7920.01	AM	37.400		x		7920	N100 L100	3	1
UFMG 7920.02	AM	0.211	5	x		7920	N100 L100	3	1
UFMG 7920.03	DC	0.012	5	x	n	7920	N100 L100	3	1
UFMG 7920.04	AR	0.013	1	x	n	7920	N100 L100	3	1
UFMG 7920.05	KV	0.003	2	x	n	7920	N100 L100	3	1
UFMG 7920.06	KV	0.001	2	x	n	7920	N100 L100	3	1
UFMG 7923-01	AQ	4.068	1	x	n	7923	N100 L100	3	
UFMG 7923-02	AF	0.473	12	x	n	7923	N100 L100	3	
UFMG 7923-03	SVF	0.137	1	x	n	7923	N100 L100	3	
UFMG 7923-04	KX	0.052	1	x	y	7923	N100 L100	3	
UFMG 7923-05	AF	0.077	2	x	n	7923	N100 L100	3	
UFMG 7923-06	AM	35.631	76	.		7923	N100 L100	3	
UFMG 7923-07	RL	3.146		.		7923	N100 L100	3	
UFMG 7926-01	AF	0.033	1	x	n	7926	N100 L100	4	
UFMG 7926-02	AM	14.401	41	.		7926	N100 L100	4	
UFMG 7923-01	RL	0.200		.		7926	N100 L100	4	
UFMG 7926.01	KY	0.002	2	x	n	7926	N100 L100	4	
UFMG 7926.02	AM	7.551		x		7926	N100 L100	4	
UFMG 7926.03	AM	8.405		.		7926	N100 L100	4	
UFMG 7928-01	AM	7.580	30	.		7928	N100 L100	4	
UFMG 7931-01	JR	0.108	3	x	y	7931	N100 L100	5	
UFMG 7931-02	AM	0.652	4	.		7931	N100 L100	5	
UFMG 7931.01	AM	0.793	7	.		7931	N100 L100	5	
UFMG 7931.02	AD	0.010	1	.		7931	N100 L100	5	
UFMG 7932-01	AM	12.078	37	.		7932	N100 L100	5	
UFMG 7932-02	RL	0.127		.		7932	N100 L100	5	
UFMG 7934-01	AM	11.116	44	.		7934	N100 L100	6	
UFMG 7935-01	AM	2.934	13	.		7934	N100 L100	6	
UFMG 7935-02	RL	0.053		.		7935	N100 L100	7	

Appendix F. An initial glimpse of paleoethnobotanical remains from Lapa Grande

The site of Lapa Grande is a rock shelter in a limestone formation in the region of Montes Claros, Minas Gerais, Brazil. With its location along a local river and near the headquarters of a ranch, the large rock shelter of Lapa Grande has been well known and utilized during the historic period. In 2008 Lucas Bueno excavated a one by one meter test pit near the entrance of the rock shelter where there is an accumulation of sediment. The results of the analysis of flotation samples from this test pit for paleoehtnobotanical remains are presented here. The sediments and stratigraphy of the Lapa Grande rock shelter have not been dated. In Table F.1 it is apparent that almost the entire assemblage of plant remains from the site are domesticated plant foods and palm nuts. Bottle gourd, a domesticated industrial plant was found, but cotton was not. This site is provocative due to the difference in its assemblage from that of Lapa Pintada which is located approximately two kilometers away. Remains found in samples from both excavation screens and five liter flotation are compared side by side.

Table F.1. The paleoethnobotanical remains from the site of Lapa Grande are almost exclusively domesticated plant foods and palm nuts.

PN	level	recovered in excavation	recovered in flotation (5 liter sample)
7914	0	palm nuts Annona sp. 1 other type	
7915	1	palm nuts squash 1 thorn/spine	palm nuts squash Manihot sp. bottle gourd
7916	2 (feature)		palm nuts squash Manihot sp. peanut passion fruit mutamba 15 other types
7917	2	palm nuts squash Manihot sp. maize 5 other types	palm nuts squash Manihot sp. peanut Carica sp. (papaya) 4 other types
7919	3	Palm nuts 1 other type	
7920	3 (feature)		palm nuts bottle gourd Solanaceae 1 other type
7923	3	palm nuts squash Manihot sp. Euphorbiaceae 1 other type	
7926	4	palm nuts Manihot sp.	palm nuts 1 other type
7931	5	palm nuts Fabaceae	palm nuts bottle gourd
7932	5	palm nuts	
7934	6	palm nuts	
7935	7	palm nuts	