5. Materials and methods

The following chapter describes the general methodological approach taken in this research, as well as the materials and methods used both in the field and in the laboratory. As previously outlined in chapter 1, the main focus of fieldwork in East Timor was to discover archaeological sites in which preservation of charred plant materials could provide a history of plant use covering the last ca. 10,000 years. A first field season was undertaken in 2004, with sites located and test excavated in two different regions. In 2005 more comprehensive excavations took place at BCUM rockshelter, the only site shown from the previous season to contain significant amounts of charred plant remains.

Despite the fact that other types of evidence were unearthed during excavations of this site (pottery, stone tools, shellfish, bone, etc.), these will not be dealt with here. The reason behind that choice was not methodological but had to do with time available: conducting a thorough investigation of charred plant remains is very time-consuming, both in terms of field and laboratory work, leaving little time for other evidence to be studied in much detail. As such, individual recording of these other materials was only done for fragments at least 5 centimetres in size or larger (with an XYZ location given within the excavation grid). All remaining smaller materials were retrieved through either the wet-sieving or flotation processes, and general counts and numbers are presented in the results section below.

Results from the 2004 fieldwork season in Baguia were poor and have little relevance to the general outcome of this research. They are described here however as they help illuminate the field strategy undertaken and the decisions made as to what assemblages to investigate. The sites investigated in the Baguia region contained little or no charcoal, and work carried out in the laboratory on charred plant assemblages excavated by the author did not include these sites.

Laboratory work involved sorting wood charcoal (which has not been analysed) from other types of plant parts, including seeds, fruit and nut remains, nutshells, and parenchyma. The identification of these plant parts was done to different degrees of confidence using three main microscope techniques. A collection of modern reference material, against which archaeological specimens were compared, was built using both plant specimens collected in the field, and specimens from the RSPAS collection and the Australian National Herbarium, in Canberra.
After the two fieldwork seasons were conducted, it was decided to analyse additional charred plant assemblages recovered from other sites in East Timor. These sites, excavated by Spriggs, O’Connor and Veth in previous years, are all caves and rockshelters and include Telupunu, Lene Hara, Macha Kuru 1 and 2, and Jerimalai. The recovery methods used by the authors during excavation, as well as those used in the laboratory to sort and identify the plant remains, are described. It was also planned to include a general assessment of the charred plant assemblages recovered from Glover’s excavations in the 1960s (Glover 1972, 1986). However, due to time constraints this was not undertaken.

5.1 Choosing the archaeological sites

The sites under analysis in this research are located in three main regions of East Timor: the ones located and test excavated in 2004 (but from which no samples were analysed) are located in Baguia; the BCUM rockshelter, test pitted in 2004 and excavated in 2005, in Baucau; and the five sites excavated by Spriggs, O’Connor and Veth, in the eastern end of the island, between Com and Tutuala. They correspond to three different geological, climatic and vegetation zones.

The reasons behind the choice of these three locations are varied. This project aims at analysing issues of plant management and agriculture in East Timor through time, using direct macrobotanical evidence. As comprehensive charred plant assemblages from previously excavated contexts in Timor did not exist, it was necessary to locate and excavate sites from which a macrobotanical assemblage could be obtained. Hence the first field season aimed at surveying and test excavating new archaeological contexts containing preserved charred plant materials.

The Baguia region was initially chosen for three main reasons. First, there was knowledge of two archaeological sites existing in Baguia, one excavated by Alfred Bühler in 1935 (Sarasin 1936: 14; Glover 1972b: 120) and the other by Glover in 1966 (Glover 1972a: 56). Located in a limestone-uplifted area, on the slopes of Matabia mountain (which rises 2370 m above sea level), it was thought this was a potential area to find caves and rockshelters with evidence of prehistoric human occupation.

Secondly, and with the exception of the sites found by Glover (1986) in Venilale, almost all archaeological work in East Timor had been carried out in coastal or near-coastal areas. The
North coast, with its uplifted coral reef formations around Baucau and limestone formations to the East, has always attracted most attention because of its many small caves and rockshelters. These seem in many cases suitable for human occupation and are still widely used in East Timor, both as animal pens and extensions of human dwellings.

Thirdly, this is an area where Makasae, a non-Austronesian or Papuan language is dominant (Capell 1943/44, 1943/44b and 1944/45). There is as yet no linguistic information on its antiquity and little or no archaeological information in East Timor to correlate that with. However, some authors argue that the Papuan languages spoken in East Timor fit within the Trans New Guinea (TNG) Phylum group of languages. Linguists have tentatively assigned the non-Austronesian languages of East Timor to TNG Phylum on the basis of pronouns (Ross 2005), but a genetic link between them and the TNG languages of the New Guinea mainland is yet to be definitively demonstrated. According to Schapper (pers. comm.) the languages of eastern East Timor (Fataluku, Makasae and Makalero) are not closely related to Bunak (located in central Timor, across both sides of the East-West Timor border) and appear to have arrived in East Timor later than the Austronesians. Pawley has suggested that agriculture may be the prime mover for the spread of this group of languages, both within New Guinea and from there into places such as East Timor (Pawley 2005, 2007).

The Baucau Plateau, on the other hand, is the area where Glover did most of his fieldwork in the 1960s (Glover 1972 and 1986). His research there comprised a series of test pits and excavations both near the coast (where BCUM rockshelter is located), and in the interior, near Venilale (Glover 1972a, 1986). The Baucau raised coral reef plateau extends 20 kilometres inland from the sea, sloping upwards to the base of the central mountain chain and reaching there around 600 metres above sea level (GERTIL 2002). Rockshelters and caves have formed in the vertical faces of the sequential uplifted terraces, especially in the area closer to the coast. As most sites excavated by Glover contained significant amounts of charcoal, this area always seemed like a viable option to conduct further archaeobotanical investigations.

The eastern region of between Com and Tutuala, where the other sites under analysis are located, is the region where António de Almeida, Mendes Correa and Ruy Cinatti carried out archaeological fieldwork in the 1950s (Almeida 1960; Corrêa et al. 1964; Almeida and Zbyszewski 1967). When archaeological work resumed in East Timor, in 2000, Lene Hara cave was one of the first sites to be investigated by ETAP (O’Connor et al. 2002). Since then, many other sites there have been located and excavated, both within the ETAP project and later by O’Connor and other researchers. They range from rockshelters and caves, to sites with rock art

85
and small fortified settlements (O’Connor et al. 2002 and 2002b; O’Connor 2003; Spriggs et al. 2003; Veth et al. 2004; Veth et al. 2005; Lape 2006; O’Connor 2007). As we shall see, BCUM was the only site from those excavated in 2004 and 2005 to contain significant amounts of charred plant remains. For that reason, it was decided to analyse smaller assemblages of plant materials from sites previously excavated in this region. These sites were all excavated within the ETAP or later by O’Connor.

5.2 The 2004 fieldwork season in Baguia

Fieldwork in the Baguia region during 2004 did not reveal good preservation of charred plant materials, and the few results obtained are presented below, together with the materials and methods employed. The sites investigated within this region did not end up as part of the main corpus of this research and will not be referred to in any detail in the results chapter. As previously noted, however, they do help in understanding the overall field strategy employed.

Baguia is a sub district within the Baucau district, located on the southern slope of Mount Matabia (figure 5.1). This region is topographically diversified, mountainous with clusters of houses and small villages scattered along steep hillsides and within high valleys, and an area of lowland rice-paddies, along the Larisula stream draining to the south coast.

Figure 5.1: Map of the Baucau district showing the Baguia region (© GERTiL).
The region of Baguia was extensively surveyed during six weeks. Several small caves and overhangs were visited, many of them visibly unsuitable for human occupation but still used during the Indonesian occupation as refuges. As the local concept of time depth differs greatly from our own, many sites referred to as ‘old’ and ‘sacred’ by local people have only been so for the past 30 years. The history of these – in most cases – more modern sites should in the future be investigated, as they hold important ethnographic information on the recent use of caves and shelters in this area.

Sites where surface finds were recovered and the Racolo rock art site (O’Connor and Oliveira 2007) are indicated in figure 5.2. They will not, however, be described in the text. These are sites where small numbers of chert flakes and/or pottery fragments were found, but no further archaeological assessment was undertaken. Many other caves, overhangs and cliff walls were inspected during the reconnaissance but no surface finds were found.

**Figure 5.2:** Archaeological sites found in 2004 in Baguia with chert flakes and/or pottery fragments on the surface: 1 – Maulora Uasa 2; 2 – Madalia; 3 – Lubodara Uasa; 4 – Borolacolia; 5 – Araleu Uasa; 6 – Uasa Bere; 7 – Umulai Uasa; 8 – Racolo (rock art site) (© GERTiL).

Two small test pits were excavated in this region. The first was dug at Maulora Uasa 2, a small overhang located near Aiafa (Saelari, Kuluguia), not far from Baguia village (plate 5.1). As there are no published pictures from Bühler’s 1935 excavations (Sarasin 1936), it was not possible to
discern if this was the same site he excavated or a previously unrecorded site. However, according to Sarasin’s article describing Bühler’s excavation (Sarasin 1936: 14) and Glover’s description of his own brief visit to Bühler’s site in 1966 (Glover 1972b: 57), it would not seem to correspond to any of the caves and overhangs located and inspected during the 2004 field survey.

Plate 5.1: Pedro Lebre (left) and Francisco (right) at Maulora Uasa 2 rockshelter, Baguia.

Maulora Uasa 2 is a 25 metres long by 6 metres deep overhang, facing east and located at about 440 metres above sea level. It is currently used as a goat pen. A 50 X 50 centimetres test pit was dug on the 29th and 30th of July, using a combination of arbitrary spits and natural layers (plate 5.2). Arbitrary spits were 5 centimetre depth removals. Analysis of excavation profiles did not show sufficient stratigraphic differences to be distinguished during excavation; therefore, the 5 centimetre spits were maintained to a depth of around 40 centimetres.

Plate 5.2: 50 X 50 centimetres test pit excavated at Maulora Uasa 2 rockshelter, Baguia
Small sherds of earthenware and chert flakes were found in all eight spits and the base of the deposit was not reached. Since the aim of this research project is to examine the transition to agriculture from an archaeobotanical perspective, much effort was put into systematically recovering plant remains using bucket (or manual) flotation and wet-sieving with a 1 millimetre mesh sieve (Fairbairn 2005b). All the sediment – around 10 litres per spit – was floated through fine chiffon material and wet sieved with a 1 millimetre mesh screen, in order to recover any charcoal or seeds. A soil sample from each spit was also kept for future pollen and phytolith analyses. Although both the area and depth of the excavation were too small to infer any relevant conclusions regarding human occupation of the site, almost no charcoal was preserved in any of the spits excavated, thus excluding the possibility of conducting any macrobotanical analysis.

Preliminary pollen analysis from spits 3, 4, 5, 6, 7 and 8, and phytolith analysis from spits 5, 6, 7 and 8, were conducted on the soil samples retrieved. Pollen was analysed by Janelle Stevenson and results are shown in table 5.1. Pollen was generally poorly preserved, either completely absent in spits 4, 5 and 7, or reduced to single and inconclusive specimens of grass and shrubs in spits 3, 6 and 8.

<table>
<thead>
<tr>
<th>Spit</th>
<th>Depth in cm</th>
<th>Identified species' units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0-15</td>
<td>1 Poaceae, 1 Chenopodiaceae</td>
</tr>
<tr>
<td>4</td>
<td>15-20</td>
<td>X</td>
</tr>
<tr>
<td>5</td>
<td>20-25</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td>25-30</td>
<td>1 Poaceae, 1 Chenopodiaceae</td>
</tr>
<tr>
<td>7</td>
<td>30-35</td>
<td>X</td>
</tr>
<tr>
<td>8</td>
<td>35-40</td>
<td>2 Acacia sp.</td>
</tr>
</tbody>
</table>

**Table 5.1**: Results from pollen sampling of Maulora Uasa 2 obtained by Janelle Stevenson (20 x magnification).

Phytolith slides were prepared and a preliminary analysis showed evidence of phytoliths in all 4 spits tested. However, as the excavation suggested poor potential for macrobotanical recovery it was decided not to proceed with further testing in this region, and no phytolith identification has been carried out.

During the time spent in Baguia, another small test pit was dug in a solution cave called Madalia (plate 5.3), near Iarbau, some 5 km from Baguia along the road to Uato Carbau. This cave, located 920 metres above see level and facing northeast, would appear to be the same
one that Glover test pitted in 1966 (Glover 1972a: 56). Glover reports having found very little evidence of human occupation but excavated only to 20 centimetres depth, due to encountering a “solid sheet of travertine” (Glover 1972a: 57). This cave has a main gallery at the entrance and several smaller wetter galleries inside, where stalactites are actively forming.

Plate 5.3: Entrance to Madalia cave, Baguia.

Again, a small test pit of 50 X 50 centimetres was located near the front entrance. Because this cave is still geologically active, the test pit was located in an area protected from water flow from inside the cave. Despite this precaution and in spite of the fact that the cave has a small stone wall at the entrance, no single piece of evidence of human occupation was found, and excavation of the sterile sediments was discontinued at a depth of 40 centimetres.

Despite the fact that several rockshelters and caves were found in Baguia during nearly 2 months of field survey, few showed clear evidence of prehistoric human occupation. Moreover, the only two sites test pitted had very poor or no preservation of charred plant remains. As time available for field reconnaissance was reaching its limit and prospective results for a second field season seemed inconclusive, it was decided not to conduct further research in the Baguia region, but to instead widen the survey to a region with better prospects of macrobotanical recovery: the Baucau region.
5.3 The 2004 and 2005 excavations of Bui Ceri Uato Mane rockshelter

Beside those sites recorded during Glover’s reconnaissance in Baucau, O’Connor had located several cave sites and rockshelters in this area during two field seasons in 2002 (Pannell and O’Connor 2005, and O’Connor 2002 field notes), after an earlier initial visit by O’Connor and Spriggs in 2000. Some of these sites were relocated prior to the 2004 Baguia survey and a small excavation was conducted in one of them, the BCUM rockshelter (figure 5.3).

BCUM is located in the Kaisido area of the Baucau district, within the village of Osso Ua/Uaisa. It is a rockshelter 30 metres wide by six metres deep (plates 5.4 and 5.5), facing west, and is about 2.5 kilometres from the present day coast line. It lies only 50 metres to the north of the original Bui Ceri Uato, excavated by Glover between 1966 and 1967 (Glover 1972, 1986), and although it is not mentioned in any of his publications it was presumably located at that time. It was visited again by the ETAP team in 2000 (Spriggs pers. comm.).

![Figure 5.3: Location of BCUM in the Baucau area (© GERTIL).](image-url)
A 50 X 50 centimetres test pit was dug between the 14\textsuperscript{th} and the 15\textsuperscript{th} of August, using the same approach as had been adopted in Baguia, i.e. with five centimetre spits combined with the natural stratigraphy, floating and wet-sieving of all excavated sediment (plates 5.6 and 5.7). Sediment samples were retrieved from every spit, in order to conduct pollen and phytolith analysis. The slides prepared all showed preserved phytoliths when observed under 20 x magnification, and a new column sample was retrieved in 2005, in order to conduct more thorough phytolith analysis. The amount of charred plant remains found at BCUM was also encouraging, and it was decided to conduct more comprehensive excavations at this site the following year.
Plate 5.6: 50 x 50 centimetre test pit excavated at BCUM in 2004.

Plate 5.7: Flotation and wet-sieving at BCUM in 2004.

The second excavation season of BCUM rockshelter took place between June and September 2005. Again, the excavation method adopted was specifically aimed at systematically recovering charred macrobotanical remains, using both flotation and wet-sieving of the total sediment excavated. A two by two metres grid was laid in close proximity to the area test pitted in 2004, divided into four 1 x 1 metre squares: A, B, C and D (figure 5.4 and plate 5.8).

Figure 5.4: Plan of BCUM showing location of the main excavation areas (2004 and 2005).

Excavation proceeded to a depth of about three metres, with the total excavated sediment reaching approximately ten cubic metres. A combination of arbitrary four to five centimetres units (spits) and natural layers was used, with relative depths measured with a dumpy level, in relation to an arbitrarily point 0 datum located nearby.
Every excavated spit was recorded individually, and sediment properties described and attributed a Munsell colour designation. Artefacts five centimetres in size or larger were recorded tridimensionally, given XYZ (north-south, east-west and depth) coordinates, and bagged individually. All other smaller artefacts were recovered mainly through wet-sieving and flotation processes. After flotation was carried out, the remaining sediment (the heavy flot) was wet sieved through a one millimetre mesh-sieve, dried out and sorted by local villagers. It was then bagged by different types (pottery, stone tools, shellfish, bone, etc.), and later analysed in the laboratory. A column of sediment samples was also retrieved from the eastern profile of square D, through five centimetre spits (plate 5.9). These were later matched with the general stratigraphy of the site and used for phytolith analysis.

Following the suggestion (Spriggs et al. 2003) that the cave excavated by Glover in the 1960s, and located just some 50 metres to the south of BCUM, may have represented the extension of an open and more intensively occupied site, it was decided to test excavate in the area outside the BCUM rockshelter. The original strategy involved excavating around Uai Mata Bai, an existing spring close to the Osso Ua/Uaisa village and the shelters. However, permission by the local community was not granted due to fear of disturbing possible recent graves of people killed during the Indonesian occupation. As most of the landscape around the rockshelters is much eroded and has little deposited sediment, two small 1 x 1 metre test pits were excavated immediately outside the northern back entrance of BCUM, in a garden area formed by successive terraces (figure 5.5).
Excavation was conducted by 10 centimetre arbitrarily spits, as no natural stratigraphy was visible (plates 5.10 and 5.11). All sediment was dry-sieved using a one millimetre mesh. Both test pits revealed the presence of pottery sherds and few stone tools, as well as small quantities of charred macrobotanical remains. However, quantities of pottery and lithics were low and not suggestive of sedentary village occupation. As no structures were found, and
sediment accumulated within the garden terraces seemed of a recent age, no further analysis on these test pits or the assemblages was conducted. It was thus not possible to establish whether there had ever been a larger village site in front of Bui Ceri Uato. Or at least if there was, it seems that its remains have been eroded away. Whether the terraces behind BCUM contain the remains of an open occupation site would require further investigation.

Plate 5.10: View of the terraces outside the back entrance of BCUM.

Plate 5.11: One of the 1 x 1 metre test pits outside BCUM under excavation.

5.3.1 Recovering charred plant remains from BCUM

Archaeological charred plant remains were recovered from BCUM rockshelter, directly during the excavation process, and through flotation and wet-sieving. The methods employed, described below, were similar to the ones used during the 2004 field season.

Whenever preserved in situ, charcoal was recovered separately. In spits and layers which showed fire episodes and good preservation of quantities of charred plant material, excavation proceeded with greater caution. All sediment excavated within each individual spit was kept separate, bagged, and transported to the nearby village of Osso Ua, where it was subject to flotation and wet-sieving (plates 5.12 to 5.16).
The process of flotation involved the use of standard plastic buckets, filled with \( \frac{3}{4} \) of sediment and \( \frac{1}{4} \) of water (Fairbairn 2005b). After waiting approximately 10 minutes for the heavier residue to settle in the bottom, the content of buckets with floating material was then slowly poured through a fine 0.05 millimetre chiffon mesh. The light residue thus retained in each chiffon mesh was carefully folded and put to dry in the shade. It was sorted while still in the field, allowing for the separation between charred plant remains and other buoyant materials. The remaining heavier sediment was then wet sieved and sorted, allowing for the recovery of less buoyant macro plant remains. Sediment weights of each excavated spit in the different squares were recorded, before and after flotation, and after removal of the charred plant remains recovered. Weight of total amount of charred plant remains was also recorded.

Plate 5.12: Adding water to sediment samples during flotation.
Plate 5.13: Pouring sediment samples through fine chiffon during flotation.
Plate 5.14: Wet-sieving heavy fraction samples
Plate 5.15: Drying light fraction samples (the flot).
Plate 5.16: Sorting through dried heavy fraction samples.

5.4 Other sites under analysis

As mentioned previously, current research also included the analysis of charred plant remains recovered from excavations previously undertaken by Spriggs, O’Connor and Veth. The sites in question, located at the eastern end of East Timor, are: the Telupunu cave, in the area of Com, excavated by Spriggs in 2002 (Veth et al. 2004:223; Veth et al. 2005:186,187; Spriggs pers. comm.); the Lene Hara cave, near Tutuala, excavated by O’Connor et al. since 2000 (O’Connor et al. 2002); the Macha Kuru 1 and 2 caves, near the village of Poros and adjacent to Lake Iralalaro, also excavated by the ETAP team in 2001 (Spriggs et al. 2003; Veth et al. 2005); and the Jerimalai cave, in Tutuala, excavated by O’Connor in 2005 (O’Connor 2007).

Excavations by the ETAP and later by O’Connor were conducted using a combination of arbitrary two to five centimetre spits and natural layers (O’Connor and Spriggs, pers. comm.). Wet-sieving through a less than two millimetre mesh sieve (O’Connor et al. 2002:47; O’Connor 2007:528), and flotation (O’Connor 2007:529; O’Connor and Spriggs, pers. comm.) were generally used (Macha Kuru was subject to wet-sieving but no flotation). The flotation method employed consisted in filling plastic buckets with sediment and water, and recovering buoyant charred plant material with a tea strainer. At Telupunu, dry-sieving through a two millimetre mesh sieve was undertaken at the site. The heavy residue was returned to the camp site where flotation took place. The light flot (from this and all other sites) was then bagged and brought back to Canberra (Spriggs and O’Connor pers. comm.). Analysis in the laboratory of the charred plant material recovered from these sites was done in a similar way to the BCUM assemblage (using low powered microscope and SEM), and is described below.
5.5 Glover’s excavated charred plant materials

The sites excavated by Glover in East Timor in the 1960s (Glover 1972, 1986) all contained significant amounts of charred plant materials, and identifications of some of these were done by Douglas Yen, P. van Royen and H. St. John from the Bishop Museum in Hawaii (Glover 1986:229-230; and presented in appendix 9 in this study). As they are referred to in this investigation, it was initially decided that reassessment of those assemblages could provide a) confirmation of original identifications, based on comparison with modern reference material and publication of SEM photographs; and b) a general comparison with charred plant materials recovered from the nearby BCUM site.

With that in mind, Glover’s macrobotanical materials were requested from the Australian Museum, in Sydney, where they have been deposited. After a preliminary assessment at the ANU and due mostly to time constraints, it was decided not to include any of those assemblages in this research. The reasons were twofold. First, the fragments identified by Yen, van Royen and St. John (Glover 1986: 229-230) were not among those materials, or otherwise they were not visibly separated from the rest of the charcoal, and thus direct confirmation of previous identifications was not possible. Information on the location of some of the archaeological materials excavated in East Timor is given by Glover (1986:viii) but this does not include the charred plant assemblages. According to Yen (pers. comm.) the charred plant remains he identified from Glover’s excavations were returned to Canberra and are not currently at the Bishop Museum in Hawaii. Secondly, the total amount of charcoal retrieved by Glover was quite significant, and a comprehensive analysis of it comparable to the one conducted for the sites under discussion here, was out of the question. Although there is no indication on how systematic the analysis of Glover’s excavated charred plant remains was, it is expected that future reassessment of those materials will provide additional information on prehistoric plant use.

5.6 Analysis of charred plant assemblages under discussion

The macrobotanical assemblages under analysis, which form the fundamental corpus of the current research, came from six different sites. The strategies used to analyse the plant remains from these sites vary only to the extent that the assemblage from BCUM, excavated by the author, and Telupunu, were too large to be fully undertaken and needed to be sub
sampled. The methods used in analysing and identifying the plant remains are described below.

Given the large amount of plant material retrieved from BCUM, it was decided to concentrate most of the analysis on square D. This square clearly had more charcoal than the others and also seemed to present better stratigraphic integrity. Total charcoal per spit was first weighed and then separated, and later analysed in different size fractions (between one and two millimetres, between two and four millimetres, and larger than four millimetres). This allowed for better microscopic observation of similar-sized fragments, as well as for a comparison of degrees of preservation between types of plant remains through the stratigraphic sequence.

Several spits from different stratigraphic units were analysed with the use of a low powered microscope (10 x 50 magnification), in order to assess whether there were major changes in composition and diversity of preserved plant specimens throughout the sequence. Based on this preliminary assessment, it was decided to analyse the fractions between two and four millimetres and larger than 4 millimetres of all excavated spits in square D. Fractions between one and two millimetres in spits which contained pottery were also observed under low powered microscope, in order to investigate whether smaller seeds associated with cereal crops were present.

Fragments were initially separated into different categories (e.g. seeds, fruit/nut shells, parenchyma, wood charcoal, etc.), with the use of low-powered (10 x 50 magnification) and stereoscopic (100 x 1000 magnification) microscopes, and kept in separate glass vials. These were then grouped into similar types within each category and compared with the modern reference material, using SEM. Wood charcoal was separated but not analysed, as its analysis involves a different methodological approach and would have required a more comprehensive collection of modern reference material.

The Telupunu macrobotanical remains came from test pits 1 and 2 and they constitute the second most significant assemblage of charred plant material from all sites analysed. Final publication is still in process (Spriggs pers. comm.) and only two short notices are available for reference (Veth et al. 2004:223; Veth et al. 2005:186,187). All existing radiocarbon dates for Telupunu are from test pit 2. For that reason, it was decided to analyse the charred plant materials from this test pit in greater detail. As to spit 1, only general weights of total amounts recovered through excavation or flotation are given. Since total amounts of charred plant remains were not significant at the remaining four sites (Lene Hara, Macha Kuru 1 and 2, and Jerimalai), the analysis comprised the entire assemblages.
5.7 Building a collection of modern reference specimens

One of the most significant aspects in the process of identifying charred plant materials from archaeological sites is having a comprehensive collection of modern specimens for comparative purposes. Acknowledged scientific binomial identifications of archaeobotanical specimens should always be achieved through matching morphological and anatomical features between these and modern reference materials, with varying degrees of confidence. Comparing archaeological to modern plant assemblages is not a straightforward task for several reasons. First, plant coverage and environmental zones change through time and it is not expected that plant species found in archaeological sites correspond exactly to the ones existing in its current surrounding environments. Secondly, there is significant variation within both wild species and cultivars, according to their phenotypical characteristics and local evolutions. And thirdly, preservation of morphological and anatomical features in archaeological specimens is generally poor and does not always permit a perfect matching (e.g. to a species level) with modern materials.

In this context, the more comprehensive the reference collection of modern charred plant remains is, the better the chance of matching the archaeological specimens with it. Bearing that in mind, it was decided to build a reference collection of modern plants based both on specimens gathered in the field and from herbarium specimens. As most archaeological specimens under analysis were fragments of fruits, nuts, seeds and tubers, vouchers of such modern plant types were collected. The first stage involved collecting specimens from around BCUM (cf. Paz 2001:57). While in the field, a list with around 75 names both in Tetun and Uaima’a was compiled by Sr. Augusto Belo, the head of Osso Ua/Uaisa village. These are edible or otherwise economically useful plants currently known to villagers living around BCUM. Of these, only 30 contained edible seeds or nuts and were matched with their correspondent scientific, English or Portuguese names, and individual specimens of these were collected¹. As this part of the reference collection was far from the known number of plants currently in use around the excavated site, and assuming that the range of species used in prehistory was wider than that collected in the field, it had to be complemented.

¹ Lyn Craven and Frank Zich, at the Australian National Herbarium, later confirmed the identification of species collected in the field. The protocol for collecting plant specimens was the one used by the Australian National Herbarium (Craven pers. comm.).
Plate 5.17: Collecting modern plant specimens from around BCUM.

The only systematic ethnobotanical research within the field area was published by Metzner (1977), referred to in detail in chapter 4. Metzner’s survey lists many more species than those I was able to collect in 2005, so the modern reference collection was complemented with specimens existing in the Department of Archaeology and Natural History at the ANU, and with nuts and seeds from the Australian National Herbarium in Canberra. A few important edible species of presumed New Guinea origins were also added, despite the fact that they are not referenced by Metzner as growing in the area investigated. They are, however, known to exist elsewhere in East Timor. Some species which may have been important in the past are not part of the collection, either because they were not recognised during fieldwork or because the herbarium specimens examined or available did not contain fruits or seeds. Andrew Fairbairn provided further reference specimens, already charred, and modern fragments of both Dioscorea alata and Colocasia esculenta were provided by Emilie Dotte. Victor Paz also made some SEM images available from his own reference collection.

As the list provided by Metzner (1977) is extensive and includes several species that we know were introduced after the 16th century, a selection of material from this list had to be made. This list includes most species that do not fall into that category (i.e. post-16th century), provided that they were available in the Herbarium collection. Images from selected publications or from the Internet were used whenever specimens could not be obtained. SEM images from a few other species not listed by Metzner (1977), but relevant as food staples in Island Southeast Asia and/or Melanesia, were also acquired. These are not presented in the main reference material corpus, but instead will be referred to wherever necessary. It should also be noted that the decision to analyse charred plant assemblages from other sites in East Timor was made after completing all fieldwork. Since there is no available ethnobotanical record for the eastern part of the island, the modern collection used for comparison with
those assemblages is the same as the one used for BCUM and may not be best suited for maximising positive identifications as there are likely omissions in it.

Most modern specimens of fruits, nuts and seeds were charred in a muffle furnace with a general matrix composed of wooden ash (following Paz 2001), at an average temperature of 250º, for c. 1.5 to 2 hours. They were then described using low powered (10 x 50 magnification), stereoscope (100 x 1000 magnification) and SEM microscopes.

5.8 Identification criteria of the charred plant materials analysed

One of the major challenges faced by archaeobotanists around the world is the use of standard criteria for the identification of archaeological plant materials. The two standard criteria for identifying plants and plant parts are morphology (the form and shape) and anatomy (the structure). Positive identification of plants found in archaeological sites, preserved through charring or any other process, is ultimately dependent upon matching them to modern materials according to these criteria.

Unfortunately, archaeological plant materials are in general poorly preserved and perfect morphological and anatomical matches are rare. A determination system which expresses different levels of confidence and criteria of classification are thus needed, to provide some consistency in the identification process. Both the determination system and the classification criteria used should always be published, in order to allow comparisons between identifications across the discipline. Despite this being the norm in the reference literature elsewhere, it is not yet standard practice in this part of the world.

The archaeological charred plant materials under discussion here were identified according to the two main criteria referred to above. Entire seeds and fruits were generally identified based on general morphology and external anatomical features, whenever these were preserved. Small fragments of fruits and seeds, nutshells and parenchyma were also identified based on preserved anatomical features.

Identification of archaeological specimens included their comparison with modern reference material, images and/or illustrations, local or regional floral citations, taxonomic details of species, and consideration of the geographical area under analysis (Paz 2005). The determination system and the different levels of confidence adopted (listed in appendix 19)
are the ones outlined by Paz for the identification of different charred plant materials (Paz 2005:71). As to preservation and distortion of archaeological seed remains, the criteria adopted were the ones created by Hubbard and al Azm (1990), also used by Paz (2001). These are given in table 5.3 in appendix 20.

Finally, presence versus absence of plant remains in all archaeological contexts was recorded. As noted by Gunn, the use of this criterion avoids the problem of knowing how large a sample should be in order to be representative, as “plant species quantities do not necessarily represent how much a population was utilising, consuming, or exchanging” (Gunn 1997:237). Despite it having been adopted here, this criterion does not preclude the fact that the presence or absence of different quantities and different types of macrobotanical remains in archaeological contexts may be subject to various interpretations. Whatever the emphasis on quantifying plant parts from archaeological sites, though, it still remains that the best practice for a positive identification of these should be achieved through accurate botanical and taxonomic descriptions and the use of SEM.

5.9 Extraction of samples for phytolith analysis

As mentioned above, general analysis of samples collected from the 2004 excavations at BCUM indicated no preservation of pollen, and it was decided not to pursue this line of investigation. However, good indications for phytolith preservation were obtained from these same sediment samples (Oliveira 2006). In 2005, after excavations at that site were completed, a new column sample of sediment was collected from the eastern profile of square D and then matched with the general stratigraphy of the site.

Extraction of phytoliths was carried out under the supervision of Matiu Prebble. The protocol for extraction of phytoliths from the 2004 samples followed a modified version of that described by Parr (2002), using a Perkin-Elmer Multiwave Microwave Sample Preparation System. The settings with which the in-built computer in the microwave sample preparation system was programmed are given in table 5.4 (Prebble pers. comm.). When finished, a portion of each sample was removed with a transfer pipette and microscope slides were mounted using Naphrax (a mounting medium to glue slide covers).

<table>
<thead>
<tr>
<th>Microwave settings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eight minutes ramp up to a maximum of 120° C</td>
</tr>
<tr>
<td>2</td>
<td>Eight minutes digestion at 120° C</td>
</tr>
</tbody>
</table>
Table 5.4: Settings with which the in-built computer in the microwave sample preparation system was programmed

Extraction of phytoliths from the 2005 samples was also carried out under the supervision of Matiu Prebble, following the heavy liquid flotation protocol as defined by Lentfer and Boyd (1999), Parr (2002) and Prebble (pers. comm.). The steps involved are described in table 5.5 and analysis of phytoliths was carried out by Carol Lentfer. A summary of Lentfer’s preliminary results of the analysis is presented in chapter 9 and the full report is given in appendix 33.

<table>
<thead>
<tr>
<th>Steps used in the heavy liquid flotation protocol (2005 samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Samples crushed and placed in dryer overnight at 40°C</td>
</tr>
<tr>
<td>2. Approximately 0.25 g of dry sediment from each sample placed in centrifuge tubes</td>
</tr>
<tr>
<td>3. Gradually add 15 ml of 30% H2O2 to centrifuge tube (removal of organic matter)</td>
</tr>
<tr>
<td>4. Place centrifuge tubes in 70°C hot water bath and stir periodically until reaction stops</td>
</tr>
<tr>
<td>5. Top up with distilled water and continue adding 30% H2O2</td>
</tr>
<tr>
<td>6. Repeat last two steps until reaction stops completely (may take several days)</td>
</tr>
<tr>
<td>7. Top up with distilled water and centrifuge at 3000 rpm for 2 minutes and decant</td>
</tr>
<tr>
<td>8. Repeat last two steps and decant</td>
</tr>
<tr>
<td>9. Add 15 ml of 30% HC1 and stir (removal of carbonates)</td>
</tr>
<tr>
<td>10. Place centrifuge tubes in 70°C hot water bath and stir and add further 15 ml of 30% HC1</td>
</tr>
<tr>
<td>11. Periodically stir in water bath until reaction stops</td>
</tr>
<tr>
<td>12. Top up with distilled water centrifuge at 3000 rpm for 2 minutes and decant</td>
</tr>
<tr>
<td>13. Wash with distilled water and decant</td>
</tr>
<tr>
<td>14. Repeat last two steps</td>
</tr>
<tr>
<td>15. Add 10 ml of heavy liquid at 2.35 sg* (heavy liquid flotation)</td>
</tr>
<tr>
<td>16. Stir and centrifuge at 3000 rpm for 5 minutes</td>
</tr>
<tr>
<td>17. Transfer the supernatant to a clean centrifuge tube</td>
</tr>
<tr>
<td>18. Wash with distilled water and decant</td>
</tr>
<tr>
<td>19. Top up centrifuge tubes with distilled water</td>
</tr>
<tr>
<td>20. Stir and centrifuge for 10 minutes at 3000 rpm and decant</td>
</tr>
<tr>
<td>21. Remove some of the sample with a transfer pipette and microscope slide using Naphrax</td>
</tr>
</tbody>
</table>

Table 5.5: Heavy liquid flotation protocol (adapted from Lentfer and Boyd 1999, Parr 2002 and following Prebble pers. comm.). * Specific gravity.

5.10 Radiocarbon Dating

Direct AMS dating of identified charred plant specimens recovered from archaeological sites is arguably one of the most reliable ways of investigating past plant management practices. As well as other archaeological materials, charcoal can be subjected to bioturbation and other
post-depositional processes, which may affect its final position within the stratigraphic sequence. As such, identified charred plant materials aged by association with other dated organics in the same archaeological layers are less securely aged than those directly dated by AMS.

The dating process used in this study was dependent on several circumstances. AMS and conventional dates were specifically obtained for the purpose of dating both the charred plant assemblage and the archaeological sequence at BCUM. The AMS method of dating is still quite expensive, with each AMS determination costing almost twice as much as a conventional one. For that reason, only 8 AMS dates were obtained to date directly small fruit and seed fragments from the site. This was done at the Australian Nuclear Science and Technology Organisation (ANSTO), through a grant provided by that institution. Since the expected time for results to be returned from ANSTO is usually quite long, samples were sent when the identification process was still in its initial stages. Thus, although fractions of those samples were kept and later identified through SEM, they were sent before identification was attempted and not after, as they should have been. The remaining determinations from BCUM (1 AMS and 7 conventional) were obtained from unidentified assemblages of wood charcoal, and were used to date the archaeological sequence. These were undertaken as a result of successive grants from the Centre for Archaeological Research (CAR) at the ANU.

As to the remaining sites, all dates from Telupunu came from test pit two. They are all AMS determinations, obtained either on unidentified charcoal or mineralised Celtis sp. seeds (Spriggs pers. comm.). Two additional AMS determinations for Telupunu were obtained in the course of this research, to date directly two identified charred plant remains from that site. O’Connor provided all the dates for Lene Hara, Macha Kuru 1 and 2, and Jerimalai (O’Connor et al. 2002 and 2002b; Spriggs et al. 2003; O’Connor 2007; O’Connor pers. comm. for unpublished determinations). These dates were obtained on different species of shellfish, shell beads, mineralised Celtis sp., unidentified wood charcoal, and animal bone. Tables with all dates and the materials used in the dating process are provided in appendices 3 to 6.

5.11 A short note on Scanning Electron Microscopy

All SEM work was carried out at the ANU Electron Microscopy Unit (EMU), under the supervision of Geoffrey Hunter and Cheng Huang. All archaeological specimens were initially dried for 48 hours in a furnace. After drying, both archaeological and modern charred materials were fractioned and prepared using 12.6 millimetre stubs, double-sided conductive
tape and nail varnish. All samples were again kept in a furnace for a couple of days, after which they were gold-coated. Gold coating and the technical use of the SEM were carried out following EMU’s technical specifications (Hunter pers. comm.).