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Goemulgaw Lagal: Cultural and Natural Histories of the Island of Mabuyag, Torres Strait

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Image on book cover: Pearlshelling station at Panay, Mabuyag, 1890s. Photographer unknown (Cambridge University Museum of Archaeology and Anthropology: N23274.ACH2).

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Midden formation and marine specialisation at Goemu village, Mabuyag, Torres Strait, before and after European contact

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Goemu village site on Mabuyag features one of the largest midden deposits recorded in Torres Strait. Following pioneering mapping and excavations of the site by archaeologists from University College London (UCL) in 1985, we document in detail results of follow-up excavations undertaken at two linear mounded midden deposits by archaeologists from Monash University in 2005. Comprehensive radiocarbon dating indicates Square A mound formed c.350-450 cal BP while Square B mound formed c.950-1,000 cal BP. Both mounds reveal a subsistence focus on dugong and turtle hunting supplemented by fishing and shellfishing from adjacent intertidal reef flats and mangrove forests. Lower densities of dugong bone in Square A probably reflect concomitant deposition of dugong bones in specialised ritual bone mounds. Inclusion of dog teeth, teeth extracted from children post-mortem and high density surface concentrations of bottle glass fragments in Square B indicate ritualised deposition before and after European contact. Other material culture includes pearl shell scrapers and ground clam shell adornments. Charcoal underlying midden deposits suggests pre-village landscape firing while land snails within midden deposits suggest shade trees once occurred across the now fire-induced, anthropogenic grasslands of Goemu. Intensified use of Goemu within the past 500 years parallels intensified village occupation on nearby Pulu islet, thus revealing the complementary social history of settlement sites across Goemulgaw territory.

❑ *village, midden mounds, marine specialisation, Mabuyag, Mabuiag, Torres Strait*

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The long-term history and development of Indigenous societies along the Queensland coast has attracted considerable archaeological attention over the past 30 years (Hiscock, 2008; Lourandos, 1997; McNiven & Hall, 1999). The mainstay of this research is midden deposits dominated by marine shells and supplemented by animal bones and stone artefacts. During the 1970s, 1980s and 1990s, the focus of this research was subtropical southeast Queensland and the development of mixed coastal-terrestrial economies of the past 6,000 years and intensified coastal occupation during the past 1,000 years (e.g. Hall, 1982; McNiven, 1999, 2006a; Morwood, 1987; Ulm, 2006; Ulm & Hall, 1996; Walters, 1989). Over the past 15 years, the emphasis of midden research has moved northwards to the tropical islands of Torres Strait and a focus on the development of highly-specialised maritime societies over a period of at least 7,000 years (e.g. Ash & David, 2008; Carter, 2004; Carter *et al*., 2004; Crouch *et al*., 2007; David & Weisler, 2006; David *et al*., 2008; Ghaleb, 1990; McNiven, 2006b; McNiven *et al*., 2008; Richardson, 2000; Wright, 2011). In this paper, we attempt to further understand the complex and specialised marine focus of Torres Strait Islanders by documenting in detail the results of excavations undertaken at Goemu village midden site on Mabuyag island, central western Torres Strait (Figure 1). We provide one of the most comprehensive analyses of

FIG. 1. Map of Mabuyag (Source: Schlenker mapping, Matthew Coller and Duncan Wright).

midden deposits for a coastal archaeological site in Queensland and reveal rare insights into continuities and changes in ritual and secular dimensions of midden formation before and after contact with Europeans.

GOEMU VILLAGE

ETHNOGRAPHIC CONTEXT

Goemu is one of the major 'old village' sites of Mabuyag (Figures 1-7). At the time of early European contact in the 1870s, the Goemulgal (people of Mabuyag) had a population of at least 300 people (Mullins, 1992). The island and adjacent seas are divided into four major totemic districts and Goemu is the settlement focus of the southeast district and the *kaigas* (shovel-nosed shark), *waru* (turtle) and *umai* (dog) totemic clans (Haddon, 1904: 164, 266, 1935: 56; Davis and Prescott, 1992; Eseli, 1998). Whereas the settlements of Dabangay and Panay on the northeast coast are the centre of the *dhangal* (dugong) and *koedal* (crocodile) clans and dugong hunting rituals, Goemu was the focus of turtle hunting rituals (Haddon, 1904: 183, 333, 1912: 217, 1935: 59) but also hosted mortuary ceremonies (Haddon, 1904: 253, 1912: 289), war dances (Haddon, 1904: 301) and the preparation of heads following headhunting raids (Haddon, 1904: 75, 301, 313-314). Goemu was also the place where the culture warrior hero Kuyam (Kwoiam) once lived (Haddon, 1904: 2, 67, 80, 1935: 58, 381). Apart from houses, structures at Goemu once included a skull-house (*kuiku-iut*), ceremonial *kod* (special men's area) and the *wiwai* turtle hunting shrine (Haddon, 1904: 3, 54, 214, 306-307, 333-336, 1935: 59).

It is likely that Goemu was still occupied in 1870 as during this year a battle took place between the people of Mua and the people of Badu and Mabuyag (including warriors from Goemu) (see Haddon, 1904:

FIG. 2. Goemu looking northeast, 1996 (Photo: Ian J. McNiven).

FIG. 3. Goemu (centre) showing fringing coral reef and mangrove forest to the south, looking north, June 2008 (Photo: Ian J. McNiven).

FIG. 4. Panoramic view of east coast of Mabuyag taken from Kuyam's lookout (hill above Goemu), looking northeast, 1898. Although the quality of the negative is poor, the locations of the three major old village sites of eastern Mabuyag are visible: Bau (north), Mui (middle) and Goemu (south). Buildings are evident at Bau but no buildings are discernable at either Mui or Goemu. Photography by Alfred Haddon (CUMAA: N.23031.ACH2).

314-315; Shnukal, 2008). With the arrival of Christian missionaries on Mabuyag in 1872 (see Shnukal, this volume), use of Goemu decreased dramatically with Alfred Haddon making no mention of occupation of the village during his visits in 1888 and 1898. Furthermore, Haddon's photograph of the *wiwai* turtle shrine at Goemu in 1898 (see Harris & Ghaleb Kirby, this volume) shows considerable vegetation overgrowth which is consistent with an absence of occupation. Archaeological evidence (see below) demonstrates selected continuities in ceremonial and occupational use of Goemu after 1872.

FIG. 5. General view of southern half of Goemu, looking northeast, December 2005. Square B excavations in progress in centre of photo (Photo: Ian J. McNiven).

FIG. 6. General view of northern half of Goemu, looking northeast, December 2005. Square A with white sand backfill is located near the centre of the photo (Photo: Ian J. McNiven).

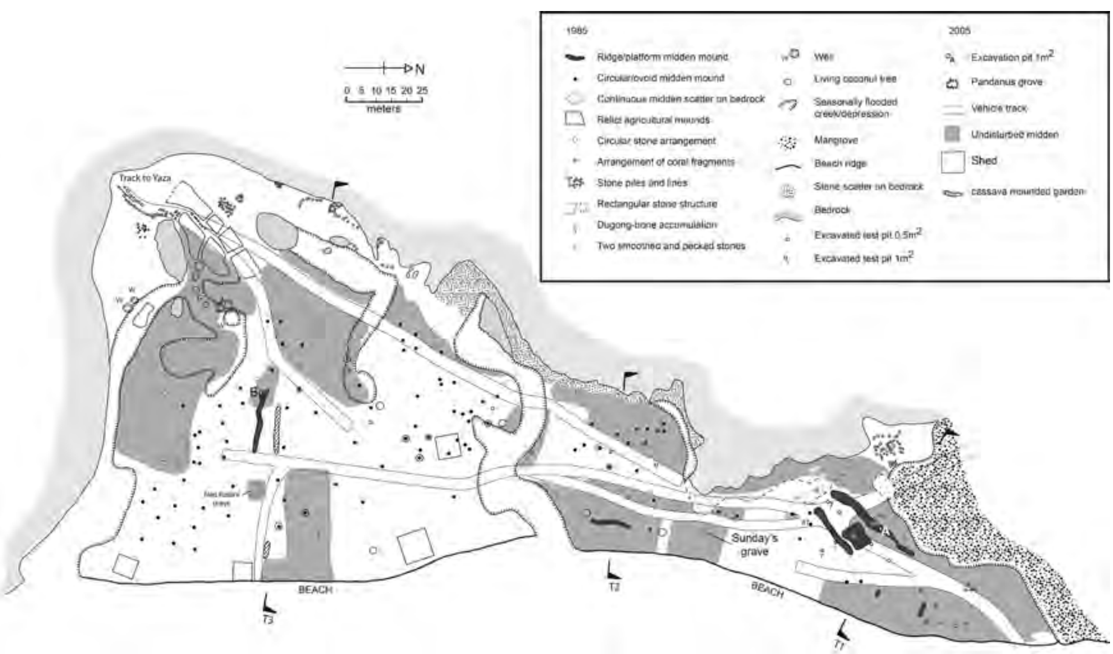


FIG. 7. Plan of Goemu village.

ARCHAEOLOGICAL MAPPING

Archaeological surveys of Mabuyag indicate that the largest and most extensive midden deposits are located at Goemu. These deposits reveal that Goemu was a major settlement place on Mabuyag. A detailed map and vegetation description of Goemu was produced by the University College London team in 1985 (Harris & Ghaleb, 1987). Controlled burning of the thick grass cover by local community members in 1985 provided a rare opportunity to record and map the location of over 100 surface features (e.g. mounded middens and stone arrangements). The village is located on the coast across a 320 m-long, wedge-shaped flat area of shelly sand deposits fronted by the high water mark and backed mostly by rocky hills supporting open woodland with a range of tree types (e.g. Mango Bark, *Canarium australianum*; Beach Tamarind, *Cupaniopsis anacardioides* and Kapok, *Cochlospermum gillivraei*). It has a maximum width of 140 m (in the south) and covers an area of 20,000 m^2 (2 ha) (Harris & Ghaleb, 1987: 12). Vegetation across the village is dominated by anthropogenic grassland (mostly tussock grass, *Cenchrus elymoides* var. *brevisetosus*) with scattered coconut trees and *Pandanus* sp. and almond (*Terminalia catappa*) trees at the southern end of the village (Figures 5-6). An intermittent line of shrubs (e.g. *Pemphis acidula* and *Hibiscus tiliaceus*) occurs adjacent to the high water mark. Mangroves are found within the tidal creek flanking the northern end of Goemu and to the south (Figures 3, 6-7).

Fieldwork at Goemu by a team from Monash University directed by one of us (IM) in 2005 revealed the historical significance of the 1985 UCL site map. Extensive levelling of the site by machinery in 2005 to provide better vehicle access and to accommodate construction of four tin sheds (domestic structures) removed nearly 70% of mounded midden features. Our update of the 2005 map shows the area of disturbance and the location of new features at the site (Figure 7). Clearly, Goemu is an active landscape that continues to be used and modified by the Mabuyag community. In addition to adding to the UCL map, the Monash team produced a series of cross-sections of Goemu (Figure 8).

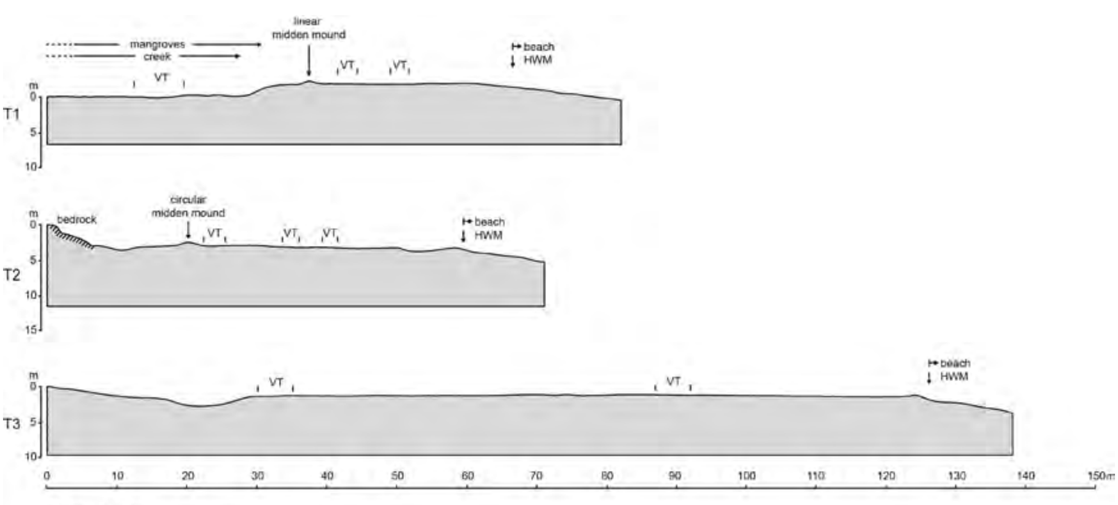


FIG. 8. Transect cross-sections of Goemu (see T1-T3, Fig. 7).

MIDDEN DEPOSITS

Three types of midden deposit which 'superficially consist of bone (primarily dugong), angular chunks of stone, and shell' were identified at Goemu by the UCL team (Ghaleb, 1990: 181-85, 212-13, 226, 267, 303; Harris *et al*., 1985: 44, 48; Harris & Ghaleb, 1987: 10):

1. Level midden. 'Discontinuous surface scatters' forming 'level' midden deposits with considerable sub-surface components.

2. Circular midden mounds. Ninety-five discrete circular or ovoid mounds averaging 1.0-1.5 m in diameter and 30 cm in height occur mostly across the southern half of the village (Figures 7, 9-10). Circular mounds cover c.180 m^2 or around 0.9% of the surface area of Goemu.

3. Linear and platform midden mounds. Seven 'large linear and rectangular accumulations' occur mostly across the far northern part of the village (Figures 7-8). The northern complex consists of a midden 'platform' (8 m x 5-7 m with a mean height of 15 cm) flanked by two linear mounded features – the western linear mound measures 35 m x 3 m (mean height = 28 cm) and the eastern linear mound measures 20 m x 2 m (mean height = 18 cm). Linear mounds

FIG. 9. Circular midden Mound 73, northern end of Goemu, 30 November 2008 (Photo: Ian J. McNiven).

FIG. 10. Circular midden Mounds 75 (centre) and 74 (right), northern end of Goemu, 30 November 2008 (Photo: Ian J. McNiven).

and the platform cover c.170 m^2 and 48 m^2 respectively or around 1.1% of the surface area of Goemu.

SHELL & STONE ARRANGEMENT

A concentration of shells (mostly large *bu*, *Syrinx aruanus*) and rocks covering an area of approximately 3 m x 3 m is located in the southwest section of Goemu on the inland flanks of the village (Figure 11). Ceremonial arrangements of *bu* shells are a feature of the ceremonial *kod* on the nearby sacred islet of Pulu and other islands of western and central Torres Strait (David *et al*., 2005; McNiven *et al*., 2009a) while ceremonial stone arrangements are a common feature of western Torres Strait (David *et al*., 2004). In contrast, mixed arrangements of *bu* shells and large rocks are uncommon across western Torres Strait, with the most famous example being the memorial marker to the warrior culture-hero Kuyam located on the hill top to the southwest of Goemu (Haddon, 1904: 368). While it is possible the Goemu shell and stone arrangement is associated with a grave (see below), it is more likely that it is a ceremonial site.

GRAVES

Two grave sites of known individuals at Goemu have been identified by contemporary Torres Strait Islanders.

Sunday's Grave

The grave of a man named Sunday is located within shoreline sandy deposits at the

FIG. 11. Shell and stone arrangement, Goemu, looking northwest, 12 December 2005 (Photo: Ian J. McNiven).

northern section of Goemu (Cygnet Repu, pers. comm. to Ian McNiven, November 2001) (Figures 7, 12-13). The outline of the grave is marked on the surface by a rectangular alignment of large *bu* (*Syrinx aruanus*) and large *alup* (*Melo* sp.) shells. Across the surface of the inland (western) sections of the grave is a dense scatter of fragmented bottles and ceramic containers (e.g. demijohn). One of the wine bottle neck fragments exhibited an applied molten glass finish which was shaped by tooling to create a rim or lip with a top surface that is angled/ bevelled and a band or collar just below the rim (i.e. 'champagne' type finish) (Figure 13). Such finishes were manufactured from the 1880s through to 1920 (Boow, 1991: 68; Coutts, 1984; Lindsey, 2010). It is possible that the artefacts on the grave represent items associated with Sunday. In this connection, Haddon (1904: 286) recorded that it was a custom on Mabuyag that 'An old dugong-harpoon, canoe, or club, if a special favourite of the deceased, would be broken by his brother and the fragments laid in and upon the grave'.

FIG. 12. Sunday's grave, Goemu, looking east, 18 November 2001 (Photo: Ian J. McNiven).

FIG. 13. Sunday's grave, Goemu, looking east, 18 November 2001 (Photo: Ian J. McNiven).

Grave of Ned Katai

The rectangular-shaped, stone-lined grave of Ned Katai (c.1861-1887) is located at the southern end of Goemu (Figures 7, 14). Unlike Sunday's grave, Ned Katai's grave does not feature a surface scatter of artefacts.

FIG. 14. Grave of Ned Katai (c.1887) with rock border, Goemu, looking northeast, 1 November 2009 (L to R: Terrence Whap, Fr. Banu, David Amber and Garrick Hitchcock) (Photo: Ian J. McNiven).

GEOMORPHOLOGICAL AND SEA LEVEL CONTEXT

Goemu is located across a shelly sand platform that extends from the base of the rocky hill backing the site out to the water's edge and the high water mark (Figures 3-8). These biogenic shelly sands are rich in tiny molluscs (gastropods and bivalves), foraminifera, *Halimeda* and fragments of coral and coralline algae that clearly derive from the adjacent fringing reef (cf. Hart, 2009). They are typical of coarse-grained shelly sands currently found along the beach, particularly the upper beach, fronting Goemu. Sediments along the inland margin of the platform contain a high proportion of rock fragments washed down from adjacent slopes (Figure 9). High concentrations of rock fragments across other parts of the platform are associated with midden deposits and appear mostly to be cooking stones (see below). Mapping of the site, including a series of seven cross-sections, indicates that the shelly sand platform is low-lying, level and elevated <1 m above the high water mark (Figures 7-8). Back (western) sections of the midden located along the base of the rocky hill slope rise up 2 m above the high water mark at the northern end of the site. Archaeological excavations by Harris and Ghaleb Kirby (this volume) in 1985 and by us in 2005 indicate that these beach deposits range in depth from less than 20 cm on the inland margin of the platform adjacent to the rocky hill side to over 2 m deep closer to the current shoreline. The flat shelly sand platform forming the substrate to Goemu village most likely represents prograded beach deposits.

While no detailed studies have been undertaken on the geomorphological history of Mabuyag, it is probable that the shelly platform at Goemu dates mostly to the past 3,000 years based on known sea level changes and sandy deposit formation across the region. For example, Barham's (2000) research found that in relation to the present, western Torres Strait sea levels were around 1.4 m higher c.5,500-6,000 BP and 0.7 m higher c.4,000 BP. Similarly, Woodroffe *et al*. (2000) report that 'sea level was at least 0.8-1.0 m higher than present 5,800 years BP falling gradually until at least 2,300 years BP'. While this pattern of higher sea levels falling to modern levels around 2,000-3,000 years BP matches studies from other parts of north Queensland (Frank, 2008: 680; Larcombe *et al*., 1995), more recent studies argue that sea levels in north Queensland only fell to modern levels within the past 2,000 years (Lewis *et al*., 2008: 77-78) and even within the past 1,000 years (Woodroffe, 2006: 110, 2009: 2487). As such, it is likely that higher levels prior to 3,000-4,000 years ago would have placed the Goemu shoreline at the foot of the inland rocky slope and all of the area taken in by the current village site was within the inter-tidal zone. As sea level dropped to modern levels over the past 3,000 years, the Goemu shoreline moved outwards (i.e. seaward) and in its wake shelly beach deposits accumulated (i.e. prograded) to form the shelly platform upon which Goemu village is located today.

Studies of prograded shelly sand deposits from other parts of Torres Strait are consistent with hypothesised formation of the Goemu shelly platform within the past 3,000 years. For example, Barham (2000: 288-289; see also Barham *et al*., 2004: 40) argues that many flat sandy areas fringing rocky islands 'commenced regionally at around 3,500 BP [3,700 years ago]'. Similarly, Woodroffe *et al*. (2007) report that shelly sands forming Warraber island in central Torres Strait began forming around 2,500-2,700 years ago and continued to grow incrementally to the present. On the island of Mua to the immediate south of Mabuyag, Orr (2008) found that a sandy beach ridge sequence developed over the past 3,000 years in behind a shoreline which advanced seaward over a distance of 200 m. If the Goemu prograded platform formed mostly within the past 3,000-4,000 years then it is clear that this place could only have been available to accommodate a large village site similarly within the past few thousand years.

EXCAVATIONS: 1985 AND 2005

In 1985, the UCL team excavated examples of the three types of midden at Goemu – level middens across the village, a circular midden mound (Mound 87), and the platform-linear midden mound complex at the northern end of the village (Harris & Ghaleb, 1987; Harris & Ghaleb Kirby, this volume; Ghaleb, 1990). A key aim of these excavations was to test whether the mounded midden features differed compositionally from the level midden deposits. In 2005, we excavated the northern linear mound-platform midden complex (Square A) and a linear mounded midden feature at the southern end of the village (Square B). Key aims of our excavations were to obtain more detailed and fine-grained stratigraphic, chronological and compositional information on the development of mounded midden features at the site to augment the UCL findings.

NORTHERN LINEAR MIDDEN MOUND EXCAVATIONS (SQUARE A)

FEATURE DESCRIPTION

The linear midden mound feature is located at the northern end of Goemu village in an area designated Gumu III by the UCL team (Figures 6-7). The feature was mapped by the UCL team in 1985 and measured c.35 m long with a maximum width of c.3 m and height of c.30 cm. It is oriented sub-parallel to, and at least 25 m from, the shoreline and is positioned towards the inland (western sections) of the site on land that slopes gently inland down into a tidal creek with mangroves. Since 1985, a 6 m-wide vehicle track cutting has been made through the southern sections of the feature. This cutting has sectioned the feature down to a depth of c.1 m (Figure 6). The surface of the linear mound exhibits a very high density of cultural materials, particularly dugong bone, rock fragments and marine shells (Figures 15-16). During the wet season, thick grass cover develops across the feature and dies back as the dry season advances.

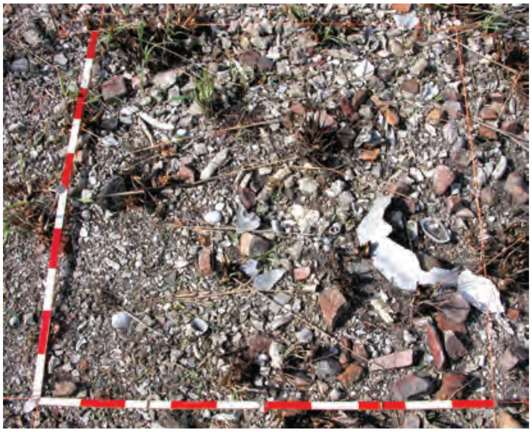


FIG. 15. Surface of XU1 prior to excavation, Square A, Goemu, 27 November 2005. Note remains of baler shell container – centre right (Photo: Ian J. McNiven).

EXCAVATION JUSTIFICATION

Square A was selected for excavation to obtain a sample of cultural materials from the northern platform-linear mound complex at Goemu. This midden mound complex was targeted for excavation by the UCL team in 1985 (see Figure 7 for location of the 1985 excavations). However, a number of issues remained unresolved with these excavations and necessitated a new excavation program to shed further light on the nature of cultural deposits at Goemu. First, cultural materials from the UCL team excavations were only documented and analysed in part. Second, much of the excavated cultural materials were placed back into excavation pits after preliminary in-field analysis and as such are no longer available for re-analysis. Third, as the UCL excavations extended only to 60 cm below the surface, the nature of cultural materials in deeper levels of Goemu remained unknown. Fourth, the UCL team were only able to obtain two reliable radiocarbon dates (on charcoal fragments large enough to be dated by the conventional method, before AMS dating of very small

FIG. 16. Excavation of Square A on linear midden mound, Goemu, 30 November 2005 (From L to R: Alice Bedingfield, Duncan Wright, Beeboy Whop, and Cygnet Repu – a senior site custodian). Looking northeast (Photo: Ian J. McNiven).

samples was feasible) which unavoidably left chrono-stratigraphic details of the deposits incomplete. In short, finer-grained excavation details were required to allow more fine-grained analyses of the development of cultural deposits at Goemu throughout it history of use. This need for new excavation data reflected in many ways new understandings of major changes in western Torres Strait history over the past 1,000 years that had been made over the past 20 years since the UCL excavations (e.g. David & Mura Badulgal Committee, 2006; McNiven, 2006b; McNiven *et al*., 2009a). These new understandings also extended to the nature of ritualised midden mounding at Goemu and the need for fine-grained stratigraphic information on deposit formation (Ghaleb, 1990; McNiven, 2012; McNiven & Wright, 2008). In short, new research questions and data requirements necessitated a new excavation program at Goemu.

EXCAVATION METHODS

Between 26 November and 7 December 2005, we excavated a 1 m x 1 m pit (Square A) on the eastern edge of the 28 cm-high western linear mound of the northern platform-linear mound complex (Figures 6-7, 15-16). The pit is located 30 m inland (west) of the shoreline. Square A was excavated to a maximum depth of 202 cm using 34 excavations units (XUs). XUs 1 to 29 taking in the upper 131 cm of the pit were 1 m x 1 m in area while XUs 30 to 34 taking in the lower 70 cm of the pit were restricted to a 40 cm x 40 cm area in the northeast corner of the pit. A total of 1715.5 kg (1625.5 litres) was excavated (Appendix 1). XU thickness averaged 2.6 cm in midden levels XUs 1-11. The number of depth elevations (to nearest mm) taken at the start and end of each XU was at least nine for XUs 1-29 and four for XUs 30-34. Significant artefacts and charcoal fragments suitable for radiocarbon dating were plotted in 3D and bagged separately for protection. All excavated materials were dry sieved on-site (on the adjacent beach) and then wet sieved (freshwater) off-site, each time through 2.1 mm mesh. Small sediment samples were taken of dry sediments that passed through the sieve for each XU. The pit was backfilled with <2.1 mm sieve materials supplemented by nearby beach sands. Excavated materials were shipped from Mabuyag to Cairns via Horn Island and then trucked to Monash University under an AQIS permit.

STRATIGRAPHY AND SITE FORMATION

Two major and six minor stratigraphic units (SUs) were identified (Figures 17-18, Table 1). The upper 25-30 cm (SU1a) was black loamy sediment with dense midden deposit and considerable amounts of bone (mostly dugong), fragments of rock (most likely cooking stones), marine shells, crustacean exoskeleton, stone artefacts, charcoal and ochre. A low number of small fragments of glass and rusty metal were recovered down to depths of 12 cm and 20 cm respectively. SU1a (XUs 1-11) corresponds in thickness to the mean height of the linear mound feature. SU1b extends down to c.35-40 cm below the surface and is very dark gray to dark gray loamy sediment with lower density midden deposit. SU1c is a c.10 cm thick zone

TABLE 1. Stratigraphic unit descriptions for Square A, Goemu

SU	Description
1	SU1 is sub-divided into SU1a, SU1b and SU1c and comprises the major culture-bearing deposit. The darker coloured sediments of SU1 are in contrast to the lighter coloured sediments of SU2. SU1a comprises black (7.5YR-2.5/1) loam with a clotted texture. It has a thickness range of c.20 to 30 cm with a mean depth of c.25 cm below the surface. The interface with SU1b is undulating and reasonably well-defined. Sediments are partly consolidated and difficult to excavate due to the high density of cultural materials in the form of larger stones, bones and shell. Numerous fibrous roots through SU. Sediment acidity (pH) ranges from 7.9 to 8.3. SU1c comprises dark gray (7.5YR-4/1) loam with a coarse-grained texture. It was differentiated from SU1b by a higher concentration of coarse-grained shelly sand inclusions, especially foraminifera. The unit has a mean thickness range of c.5 to 10 cm with a mean depth of c.50 cm below the surface. The interface with SU2a is gently undulating and ranges from reasonably well-defined to partly diffuse. Cultural materials (stones, bones and shells) are at a much lower density compared to SU1b. Numerous fibrous roots through SU. Sediment acidity (pH) ranges from 8.2 to 8.3.
2	SU2 is subdivided into SU2a, SU2b, SU2c and SU2d, each representing unconsolidated beach-derived sands of different colour and texture. SU2a comprises dark grey (7.5YR-4.1) to gray (7.5YR-5.1) coarse-grained shelly sand intruded by finer-grained darker sediments from SU1c. The unit has a thickness range of c.5 to 10 cm with a mean depth of c.55 cm below the surface. The interface with SU2b is undulating and ranges from reasonably well-defined to partly diffuse. Cultural materials (stones, bones and shells) are sparse. Numerous fibrous roots through SU. Sediment acidity (pH) ranges from 8.3 to 8.7. SU2b comprises gray (7.5YR-5/1) to pink (7.5YR-7/3) mottled coarse-grained shelly sand. The unit has a thickness of c.30 cm with a basal depth range of c.80 to 90 cm below the surface. The gently undulating interface with SU2c is reasonably well-defined. Cultural materials (stones, bones and shells) are sparse. It has scattered fibrous roots with a zone of scattered small nodules of pumice and fragments of charcoal running through the middle of the unit. Another distinctive feature of the unit is a concentration of ash-rich deposit exposed in the east section. In section, the c.30 cm-wide and c.20 cm-deep deposit extends down from the top of SU2a and appears to be an anthropogenic feature consistent with a 'fire-pit'. Some of the ash-rich deposit has infiltrated SU1c through post-depositional mixing. Overall, sediment acidity (pH) of SU2b ranges from 8.0 to 8.7. SU2c comprises evenly-spaced, alternating layers of pinkish white (7.5YR-8.2) and pink (7.5YR-8/3) sediment. All sediments are coarse-grained shelly sands grading to very loose and coarser-grained shelly sands with depth. The base of this unit, at a depth of approximately 160 cm below the surface, was identified in the small extension pit in the northeast corner of the major pit. As such, the unit has a thickness of c.80 cm. While overall the unit exhibits few cultural materials, a linear arrangement of rocks (a feature of cultural origin) was exposed within the upper 15 cm of the unit running between the north and south sections. Overall, sediment acidity (pH) of SU2b ranges from 8.0 to 9.2. SU2d is exposed only in the northeast corner extension pit and comprises the lower 25-35 cm of this pit. The base of this unit was not exposed. The unit comprises pinkish white (7.5YR-8/2) shelly sands that are finer in texture compared to SU2c. Neither cultural materials nor fibrous roots were found in the unit. Sediment acidity (pH) is consistently 9.2.

of dark gray loamy sediment mixed with considerable shelly sand from SU2 and few cultural materials.

The change to SU2 is marked by a change to shelly beach sands with very few cultural remains. SU2a is dark gray to gray in colour and is mixed with darker midden matrix from SU1 above. SU2b is gray to pink, coarse-grained shelly sand with few cultural materials and a zone of charcoal and pumice. An ash-rich zone in the upper sections of SU2b appears to be a cooking pit. SU2c is pinkish white to pink laminated shelly sands with little cultural material except for an alignment of six stones running across the square between the south and north walls at a depth of c.95-100 cm below the surface. The basal 30-35 cm of the pit is fine-grained, pinkish white, shelly sands (SU2d) with no obvious cultural materials. Thus, in short, biogenic shelly sands dominate SUs 2b to 2d taking in the lower two-thirds of Square A between c.60 cm and 200 cm below the surface. With the beginning of major cultural deposition and midden formation c.40 cm below the surface, beach sediments give way to loamy sediments associated with cultural materials such as rocks, shells, bones, stone artefacts etc.

FIG. 17. South section of Square A, Goemu (Photo: Ian J. McNiven).

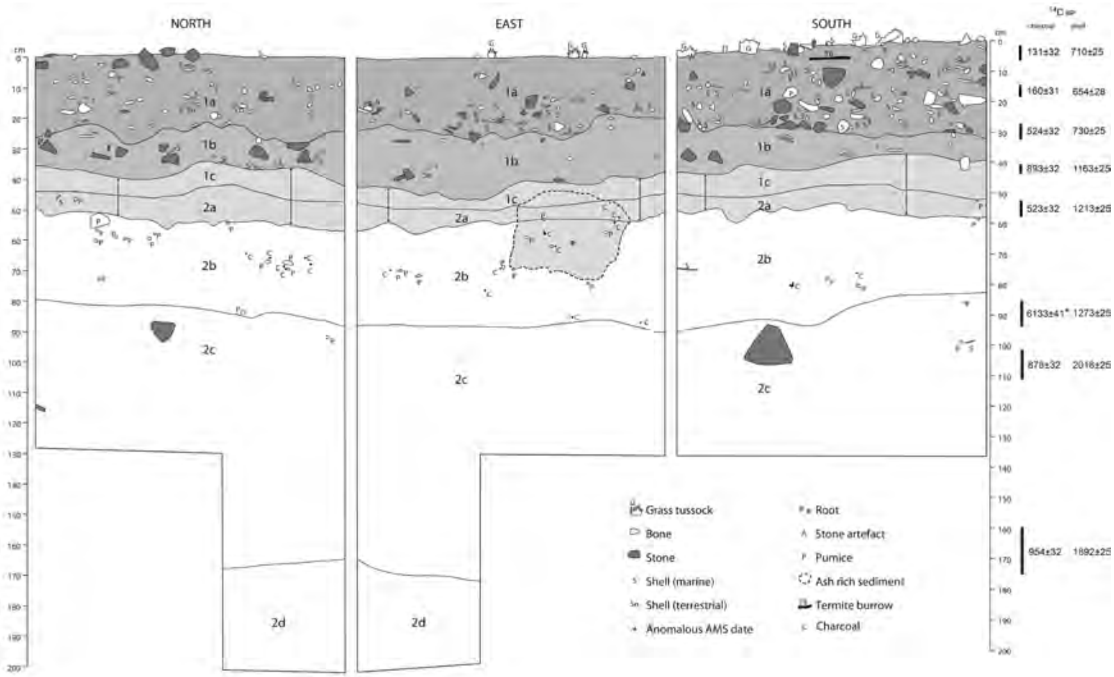


FIG. 18. Stratigraphy of Square A, Goemu

Ashy pit features

Two distinct concentrations of dark gray shelly sands with a relatively high concentration of charcoal fragments were revealed under the main midden deposit spanning SUs 1c, 2a and the upper half of SU2b. The concentrations appear to be pit features with the eastern feature clearly visible in the east section of Square A (Figures 18-19). The larger eastern pit has a maximum width of 37 cm and depth of 20 cm. Ashy sediments from the feature also infiltrate SUs 2a and 1c, probably through post-depositional disturbance. The higher concentration of charcoal in the pits is indicated by the fact that the density of charcoal within the pit (e.g. 4.5 g / 10 litres of deposit, XU20a) is over seven times that within surrounding sediments (e.g. 0.6 g / 10 litres of deposit, XUs 20b and 20c). In addition, the density of rocks (mostly fire-cracked – see below) within the larger eastern pit (e.g. 61 g / 10 litres of deposit, XU20a) is six times that seen for surrounding sediments (e.g. 10 g / 10 litres of deposit, XUs 20b and 20c). As the pits contain relatively low amounts of other cultural materials (e.g. bone, stone artefacts, economic shells) compared to overlying midden deposits, they are interpreted as specialised cooking features (i.e. ground ovens).

Stone alignment

An alignment of six large granite stones was revealed below the main midden layer in XUs 23-25 across the upper sections of SU2c within prograded shelly beach sands (Figures 18, 20). It comprised four isolated stones and two stones remaining embedded in the northern and southern walls of the pit. Five of the stones are in a line while a sixth stone appears to have moved laterally to the east leaving an obvious gap in the linear arrangement. The four isolated stones are consistent in size with a maximum length range of 21-25 cm. The base of the linear arrangement dips over a vertical distance of 8 cm between the northern and southern walls and averages 101 cm below the ground surface. The arrangement is clearly cultural given its form and sedimentary context within biogenic shelly beach sands away from natural rock outcrops. The four loose stones were removed to allow continuation of excavation and returned to their original position during backfilling.

Bioturbation and stratigraphic integrity

Visually obvious stratigraphic mixing of sediments was limited to SUs 1c and 2a. In contrast, minor post-depositional disturbance from plants and animals was recorded throughout the Square A deposit. Fibrous roots were recorded in every XU except XUs 30, 32-34. Larger roots (up to 9 mm in diameter) were rare and restricted to XUs 6 to 13 between 7 cm and 35 cm below the surface. The only animal disturbance observed while excavating was insect burrows. Live ants were observed only in XUs 9 and 10 (16-24 cm below the surface) in SU1a. Small, isolated termite burrows with live termites were observed in two zones – XUs 2-7 (2-12 cm below the surface) in SU1a and XUs 20-21 (67-74 cm below the surface) in SU2b. Termite tunnels devoid of live termites were recorded in XUs 23-29 (90-131cm below the surface) in SU2c. The UCL team similarly found 'some degree of post-depositional disturbance' in nearby Squares E, GH, M, T and Y in the form of 'modern rodent droppings and roots throughout the levels excavated' (Ghaleb, 1990: 226). Despite the pervasiveness of root and insect disturbance within Square A, the impact of such disturbance was small-scale, and in terms of bioturbation the deposit is considered to exhibit high stratigraphic integrity. However, such disturbance had a major impact on the suitability of charcoal for radiocarbon dating (see following).

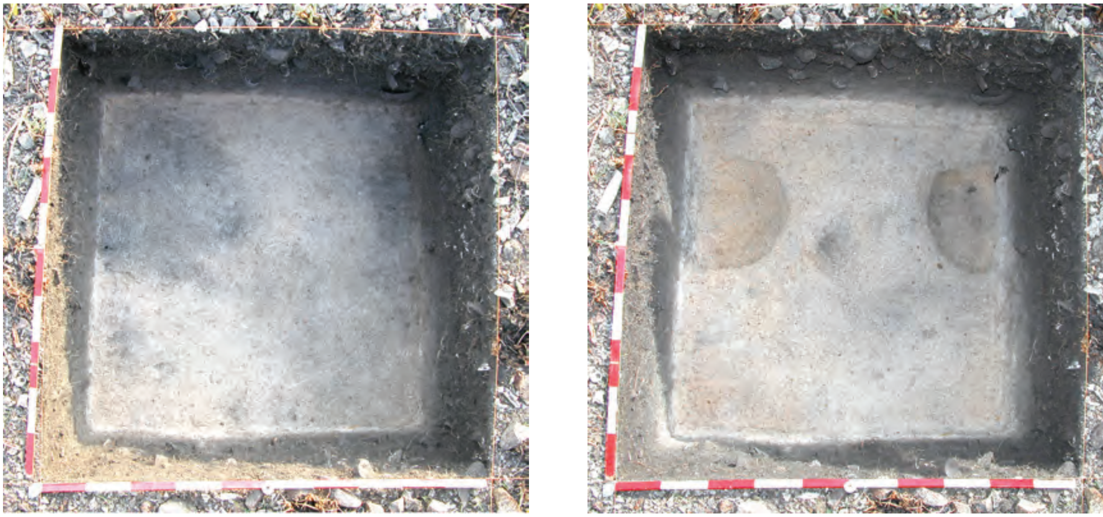


FIG. 19. Two ashy pit features, dating to c.750-800 cal BP, located beneath the main midden deposit, Square A, Goemu. Left: Upper sections of pit features exposed at the end of XU20, 30 November 2005. Right: Base of pit features at the end of XU22a, 1 December 2005. Looking south (Photo: Ian J. McNiven).

FIG. 20. Buried stone alignment, dating to between c.900 and 1,650 cal BP, located on a sloping surface at the end of XU26, Square A, Goemu. Looking east (Photo: Ian J. McNiven).

Land snails

A total of 101.8g of land snails was recovered from Square A. No land snails were found in sediments below 90 cm beneath the ground surface with most (90% by weight) snail shells associated with dense midden deposits in SUs 1a and 1b (XUs 1-16) (Appendix 1 and Figure 21). Of the six species of snails identified, the two most ubiquitous were *Torresitrachia torresiana* and *Trachiopsis strangulata*, followed by more sporadic occurrences of *Allopeas gracile*, *Hadra funiculata*, *Torresiropa spaldingi* and *Gastrocopta pediculus* (Table 2). The habitat preferences for the snail shells indicate that the area of Square A at the northern end of Goemu village once supported vine thicket. The absence of land snails in XUs 24 to 34 which take in most of SUs 2c and 2d probably reflects the lack of both paedogenesis and the development of fine-grained sediments supporting vine thicket and higher moisture which are the preferred habitat for land snails.

Pumice

A significant quantity (3352.9 g) of pumice nodules was retrieved from Square A. Nearly all (>99% by weight) of pumice was found in XUs 1-24 (SUs 1a to 2b) taking in the upper 98 cm of deposit (Appendix 1). Highest densities of pumice were found on the surface (XU1) and underlying the main midden deposit in XUs 19 and 20 in SU2b (Figure 21). The lower metre of deposit taking in SUs 2c and 2d contained little pumice (11.7 g). The paucity of pumice in shelly sands across the lower half of the pit is difficult to explain given that pumice tends to be a natural feature of beach deposits in the region. However, the restriction of cuttlefish fragments (10.4 g) in the lower levels of the pit in XUs 20 to 30 (SUs 2b-2d) is consistent with the beach origin of these lower deposits (Appendix 1).

TABLE 2. Land snails, Square A, Goemu.

XU	*Torresitrachia torresiana*	*Trachiopsis strangulata*	*Allopeas gracile*	*Hadra funiculata*	*Torresitopa spaldingi*	*Gastrocopta pediculus*
1	✓	✓	✓			
2	✓	✓	✓			
3	✓	✓	✓			
4	✓	✓		✓		
5	✓	✓	✓	✓		
6	✓	✓	✓			
7	✓	✓	✓			
8	✓	✓			✓	
9	✓	✓				
10	✓	✓				
11	✓	✓		✓		
12	✓	✓				
13	✓	✓				✓
14	✓	✓				
15	✓	✓	✓			
16a	✓	✓			✓	
16b		✓			✓	
17a	✓	✓	✓	✓		
17b	✓	✓	✓			
18a	✓	✓				
18b	✓	✓	✓			
18c		✓			✓	
19a	✓	✓				
19b	✓	✓	✓			
19c		✓				
20a		✓		✓		
20b	✓	✓				
20c		✓				
21a	✓	✓	✓			
21b		✓			✓	
21c		✓				
22a	✓	✓				
22b	✓	✓				
22c		✓				
23	✓					

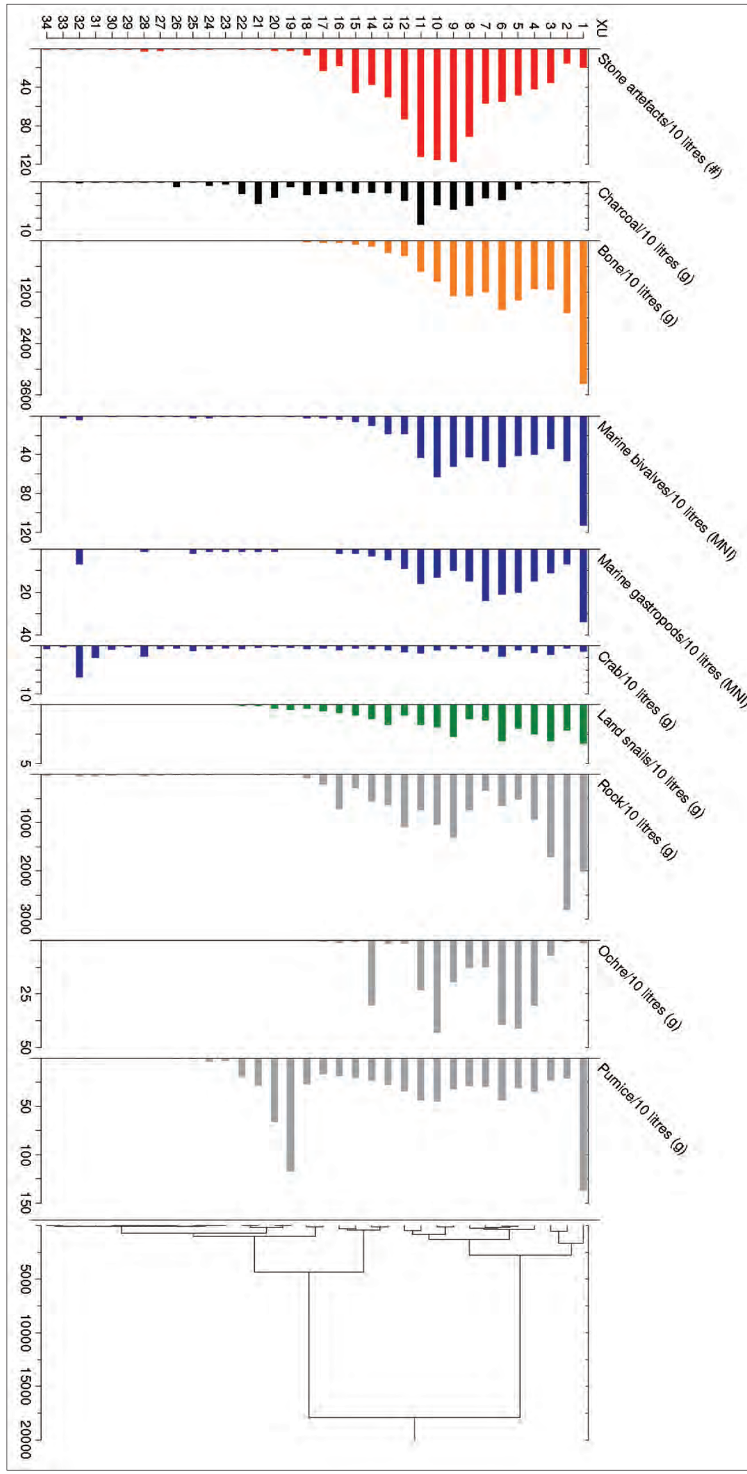


FIG. 21. Vertical changes in cultural and non-cultural materials, Square A, Goemu.

RADIOCARBON DATING

Two series of radiocarbon dating (AMS) using charcoal and marine shell are available for Square A. Dating was undertaken by The University of Waikato Radiocarbon Dating Laboratory in New Zealand. Radiocarbon dates were calibrated into calendar years using the online calibration program Calib 6.0 (Stuiver & Reimer, 1993) and the Southern Hemisphere calibration dataset (ShCal04) (McCormac *et al*., 2004) for charcoal dates and the marine calibration dataset (Marine09) (Reimer *et al*., 2009) for marine shell ages with the new ΔR value of -63±44 years determined recently for Torres Strait (Ulm *et al*., 2009; Sean Ulm pers. comm., 2010).

The first series of eight AMS dates was obtained on single fragments of wood charcoal from eight XUs (Table 3). SU1a, taking in the mounded feature and the main midden deposit, has three 14C ages of 113±32 BP (top), 160±31 BP (middle) and 524±32 BP (base) which all calibrate to within the past 500 years or so. The older date of c.500 years ago matches well with the date of c.550 years ago obtained by the UCL team for the base of the main midden deposit in Square M located 5 m to the southeast (Harris & Ghaleb, 1987: 18; see also Harris & Ghaleb Kirby, this volume). The two dates of c.100 years ago within 12.5 cm of the surface mark the maximum depth of nearly all glass and metal items and are consistent with commencement of European contact with Mabuyag Islanders in the second half of the nineteenth century. These dates suggest that the foundations of the c.30 cm-high mounded midden feature most likely were formed around 500 years ago with much of the upper half of the feature added after European contact.

Underlying ages of 893±32 BP (c.750 years ago) and 523±32 BP (c.500 years ago) for the base of SU1b and SU2a respectively are stratigraphically inverted, a result consistent with the interface (mixed) nature of sediments represented by these levels. Ages of 878±32 BP (c.750 years ago) and 954±32 BP (c.850 years ago) for the upper and lower sections of SU2c indicate that SU2, taking in over 1 m of sediment accumulated rapidly over a century. An age of 6133±41 BP from the base of SU2b is anomalous as it is an order of magnitude older than surrounding AMS dates (see below).

The second series of eight AMS dates was obtained on the filter-feeding marine bivalve *Paphies striata*. The shell dates were obtained from the same XUs as the charcoal dates to allow chrono-stratigraphic comparisons. Each shell date was undertaken on a single complete or near complete valve measuring 2.0-2.6 cm in maximum length. It was assumed that shell valves of this size would have little opportunity to move vertically through the dense midden deposit. As such, it was hoped that a more vertically consistent chronological sequence of dates, and hence a more reliable chronological framework, would be obtained using shell. Results provide a more internally consistent sequence of dates and a slightly different chronological picture to that provided by the charcoal dates (Table 3). First, the three shell ages for the top, middle and base of SU1a are similar and range from 654±28 to 730±25 BP, which calibrate to c.350 to 450 cal BP. These dates suggest that SU1a, corresponding to the mounded midden deposit, formed rapidly over a period of a century or so, and not over a period of 400 years as suggested by the charcoal dates. Second, the lower sections of the midden deposit, taking in SU1c and SU2a, yielded shell ages of 1163±25 and 1213±25 BP, which calibrate to c.750 and c.800 cal BP respectively. This chronology is similar in part to that obtained by the matching charcoal dates. Third, the two shell ages from the upper sections of SU2c and which bracket the stone alignment are 1273±25 and 2018±25 BP or between c.900 and c.1650 cal BP. Fourthly, the base of SU2c produced a shell age of 1892±25 BP which calibrates to c.1,500 cal BP, which is much older than the associated charcoal date of c.850 cal BP.

TABLE 3. AMS radiocarbon dates, Square A, Goemu

Lab. No.	XU	Mean Depth Below Surface (cm)	Sample Type	$\delta^{13}C$‰	Conventional Radiocarbon Age (years BP)	Calibrated Age BP 68.3% (with probabilities)	Calibrated Age BP 95.4% (with probabilities)	Years Ago (cal BP) Circa*
Wk-21514	3	1.5-3.4	Wood charcoal Single fragment 0.01 g	-22.7 ±0.2	131±32	22-72 (0.425) 83-105 (0.161) 112-141 (0.239) 228-250 (0.174)	0-146 (0.807) 222-263 (0.193)	100
Wk-29690	3	1.5-3.4	*Paphies striata* Complete right valve, 1.23 g, 24.1 mm	1.7 ±0.2	710±25	360-473 (1.000)	301-493 (1.000)	400
Wk-21515	7	9.5-12.5	Wood charcoal Single fragment 0.01 g	-9.8 ±0.2	160±31	0-28 (0.215) 59-118 (0.429) 136-147 (0.072) 221-233 (0.079) 237-264 (0.204)	0-153 (0.699) 173-177 (0.005) 208-277 (0.296)	100
Wk-29691	7	9.5-12.5	*Paphies striata* Complete left valve, 1.24 g, 24.6 mm	2.3 ±0.2	654±28	304-414 (1.000)	270-464 (1.000)	350
Wk-21516	11	24.1-28.3	Wood charcoal Single fragment 0.06 g	-25.2 ±0.2	524±32	505-530 (1.000)	496-545 (1.000)	500
Wk-29692	11	24.1-28.3	*Paphies striata* Complete right valve, 1.79 g, 26.2 mm	2.0 ±0.2	730±25	385-490 (1.000)	310-504 (1.000)	450
Wk-21517	15	37.5-41.1	Wood charcoal Single fragment 0.06 g	-26.8 ±0.2	893±32	728-775 (0.874) 778-788 (0.126)	683-801 (0.968) 875-882 (0.010) 887-897 (0.021)	750
Wk-29693	15	37.5-41.1	*Paphies striata* Complete right valve, 1.02 g, 23.0 mm	1.9 ±0.2	1,163±25	701-824 (1.000)	672-888 (1.000)	750
Wk-21518	18c	49.8-54.9	Wood charcoal Single fragment 0.02 g	-25.6 ±0.2	523±32	504-530 (1.000)	496-545 (1.000)	500

TABLE 3. cont.d.

Lab. No.	XU	Mean Depth Below Surface (cm)	Sample Type	$\delta^{13}C$‰	Conventional Radiocarbon Age (years BP)	Calibrated Age BP 68.3% (with probabilities)	Calibrated Age BP 95.4% (with probabilities)	Years Ago (cal BP) Circa*
Wk-29694	18c	49.8-54.9	*Paphies striata* Near complete left valve, 0.95 g, 21.3 mm	1.5 ±0.2	1,213±25	767-886 (1.000)	706-921 (1.000)	800
Wk-21519	23	81.6-90.1	Wood charcoal Single fragment 0.07 g	-25.1 ±0.2	6,133±41	6,808-6,811 (0.008) 6,858-6,873 (0.063) 6,880-7,004 (0.929)	6,792-7,029 (0.893) 7,045-7,069 (0.021) 7,079-7,085 (0.006) 7,106-7,156 (0.080)	6,950
Wk-29695	23	81.6-90.1	*Paphies striata* Complete right valve, 0.60 g, 20.0 mm	2.0 ±0.2	1,273±25	813-931 (1.000)	747-986 (1.000)	900
Wk-21520	25	98.3-104.7	Wood charcoal Single fragment 0.04 g	-27.8 ±0.2	878±32	690-699 (0.099) 721-771 (0.901)	681-794 (1.000)	750
Wk-29696	25	98.3-104.7	*Paphies striata* Complete right valve, 0.62 g, 20.6 mm	1.7 ±0.2	2,018±25	1,579-1,720 (1.000)	1,528-1,794 (1.000)	1,650
Wk-21521	32	156.2-171.2	Wood charcoal Single fragment 0.02 g	26.5 ±0.2	954±32	769-818 (0.523) 834-837 (0.022) 865-904 (0.455)	745-909 (1.000)	850
Wk-29697	32	156.2-171.2	*Paphies striata* Complete left valve, 0.67 g, 19.8 mm	1.8 ±0.2	1,892±25	1,424-1,565 (1.000)	1,373-1,649 (1.000)	1,500

*Median probability of calibrated dates rounded to the nearest 50 years

CULTURAL MATERIALS

Cultural materials include charcoal, vertebrate bone, mollusc shell, crustacean exoskeleton, stone artefacts and shell artefacts, and European contact items made from glass, metal and ceramic (Figures 21-22, Appendix 1).

CHARCOAL

Of the 75.2 g of charcoal recovered from Square A, most (94%) was recovered from XUs 5 to 22 within SUs 1a to 2b across the upper 81 cm of deposit (Figure 21). Vertical changes in charcoal density through SUs 1a to 2b reveal a bimodal distribution. The upper concentration includes nearly all charcoal and is associated with midden deposits across the upper sections of Square A. This charcoal probably derives from hearths. The second concentration is more complex in origin. From the associated anomalous radiocarbon age of 6133±41 BP obtained on charcoal in XU23 it is clear that some charcoal in the lower concentration is also environmental and derives from sediments and time periods far removed from occupation of the site during the past 1,000 years (see Discussion).

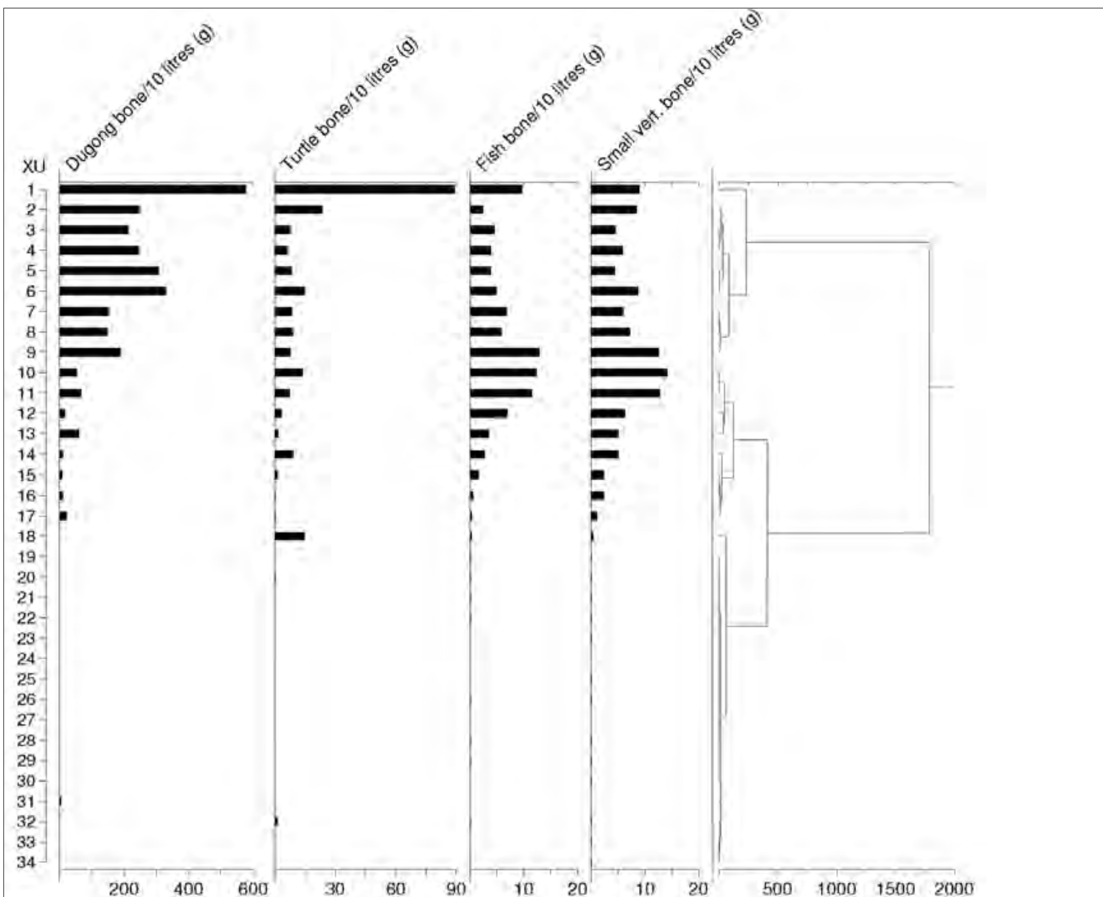


FIG. 22. Vertical changes in bone, Square A, Goemu.

BONE

A total of 46,594.9 g of bone was recovered from Square A (Table 4). While bone was recovered from every XU, nearly all (92%) came from XUs 1-11 (SU1a) representing the main midden deposit (Figure 21). Within XUs 1-11 the mean density of bone was 1.2 kg / 10 litres of deposit. Most (82%, 38,293.0 g) of the bone assemblage was designated 'large vertebrate' which most likely represents dugong given the range and relative abundance of identified taxa and morphology of bones. 'Small vertebrate' bone (401.2 g) comprised only 1% of the bone assemblage and is probably mostly fish bone given the range of identified taxa and morphology of bones. The remaining bone assemblage comprised dugong (15%, 6986.9 g), turtle (1%, 527.0 g), fish (including shark/ ray) (<1%, 380.3 g), snake/lizard (<1%, 6.1 g) and bird (<1%, 0.4 g).

TABLE 4. Bone data, Square A, Goemu.

XU	Large Vertebrate (g)	Turtle (g)	Dugong (g)	Small Vertebrate (g)	Fish (g)	Shark/ Ray (g)	Reptile (g)	Bird (g)	Total (g)
1	2,122.6	71.2	461.4	7.2	7.7	0.4	0	0.1	2,670.6
2	1,537.8	25.7	271.7	9.2	2.7	0.4	0	0	1,847.5
3	2,379.5	20.1	560.1	11.9	11.7	1.4	0.5	0	2,985.2
4	1,961.2	14.1	561.3	13.2	8.8	1.8	0.1	0	2,560.5
5	3,344.5	26.0	956.2	13.9	12.1	1.6	0.5	0.1	4,354.9
6	4,032.5	47.7	1059	28.5	15.7	2.6	2.5	0	5,188.5
7	3,515.5	29.4	530.2	20.6	23.2	3.4	0.1	0.1	4,122.5
8	4,668.9	37.3	614.3	30.2	23.7	3.3	0.1	0	5,377.8
9	5,033.6	36.5	897.8	60.1	60.7	10.4	0.3	0.1	6,099.5
10	3,573.1	57.7	223.9	58.9	50.9	4.8	1.1	0	3,970.4
11	3,268.4	38.6	354.2	67.5	60.2	9.1	0.4	0	3,798.4
12	1,211.0	12.1	59.7	23.3	25.4	3.0	0	0	1,334.5
13	6,93.4	5.4	210.1	17.3	11.7	1.4	0	0	939.3
14	271.5	21.4	23	11.8	6.4	0.8	0	0	334.9
15	264.7	5.3	34.9	9.4	6.1	0.9	0.1	0	321.4
16a	91.1	0.4	19.8	6.8	1.6	0.3	0.1	0	120.1
16b	28.7	0	12.8	0.6	0.2	0	0	0	42.3
17a	65.9	0.5	103.1	4.8	1.3	0.2	0.1	0	175.9
17b	64.9	0	21	1.2	0.4	0.1	0	0	87.6
18a	20.3	0.6	0	1.1	1.3	0.1	0	0	23.4
18b	8.7	72.1	0	0.3	0.1	0.1	0	0	81.3
18c	12.4	0	0	0.4	0.2	0.1	0.1	0	13.2
19a	1.8	0	0	0.1	0.1	0	0	0	2
19b	9.8	0	0	0.4	0.1	0.1	0	0	10.4
19c	10.9	0	0	0.2	0.1	0.1	0.1	0	11.4
20a	10.0	0	0	0.1	0.1	0	0	0	10.2
20b	9.2	0	0	0.3	0.1	0	0	0	9.6

TABLE 4. cont.d.

XU	Large Verte-brate (g)	Turtle (g)	Dugong (g)	Small Verte-brate (g)	Fish (g)	Shark/ Ray (g)	Reptile (g)	Bird (g)	Total (g)
20c	3.5	1.1	0	0.1	0.1	0	0	0	4.8
21a	0.8	0	0	0	0	0	0	0	0.8
21b	5.3	0	0	0.3	0.2	0	0	0	5.8
21c	3.2	0	0	0.2	0.1	0	0	0	3.5
22a	0.3	0	0	0	0.1	0	0	0	0.4
22b	8.8	0	0	0.1	0.1	0	0	0	9
22c	1.2	0	0	0.1	0	0	0	0	1.3
23	2.1	0	0	0.2	0	0	0	0	2.3
24	1.8	0	0	0	0	0	0	0	1.8
25	0.5	0	0	0.2	0	0	0	0	0.7
26	0.8	0	0	0.1	0.1	0	0	0	1
27	1.8	0	0	0	0	0.1	0	0	1.9
28	15.9	0	0	0.1	0.1	0.1	0	0	16.2
29	1.3	0	0	0.1	0.1	0	0	0	1.5
30	0.2	0	0	0.1	0	0	0	0	0.3
31	2.3	0	12.4	0	0	0	0	0	14.7
32	28.4	3.8	0	0.1	0.1	0.1	0	0	32.5
33	2.5	0	0	0.1	0	0	0	0	2.6
34	0.4	0	0	0.1	0	0	0	0	0.5
Tt:	38,293.0	527.0	6,986.9	401.2	333.6	46.7	6.1	0.4	46,594.9

0.1g = ≤0.1g

Dugong

The Square A bone assemblage is dominated by dugong (*Dugong dugon*) (*dhangal* in Mabuyaagi [language of the Goemulgal]). Indeed, dugong probably represents over 95% of the bone assemblage given that most 'large vertebrate' bone probably represents dugong, and identified turtle bone comprises only 1% of the bone assemblage. While nearly all (99.8%) dugong bone was restricted to XUs 1-17 in SU1 within 50 cm of the surface; most bone (85%) and highest concentrations were found in XUs 1-9 within 20 cm of the surface (Figure 22, Table 4). Using right and left ear bones (tympano-periotic complex), the minimum number of individuals (MNI) represented by these bones is nine. The dugong bone assemblage is represented mostly by ribs (62%), followed by vertebrae (17%), skull (16%) and limbs (including scapula) (5%) (Table 5). In a modern reference dugong skeleton, representation (by weight) of bone elements is ribs (45%), vertebrae (27%), skull (20%) and limbs (including scapula) (8%) (Skelly *et al*., 2011). Thus, in Square A, ribs are over-represented while skull and limbs (including scapula) are partly under-represented, and vertebrae considerably under-represented. The over-representation of ribs most likely reflects the desirability of rib meat, particularly ribs cooked over an open fire, as practiced on Mabuyag today. In this connection, while 19% of dugong

TABLE 5. Dugong bone elements, Square A, Goemu.

	Ossicles			Tusks/Teeth		Other Skull		Total Skull		Ribs	
XU	Total (g)	Burnt (g)	MNI	Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)
1	0	0	0	0	0	9.2	0	9.2	0	295.7	101.5
2	50.3	0	2	0	0	0	0	50.3	0	195.4	3.4
3	0	0	0	0	0	172.3	60.8	172.3	60.8	291.9	0
4	0	0	0	0	0	0	0	0	0	444.9	100.6
5	6.5	6.5	1	0	0	10.6	0	17.1	6.5	678.4	135.6
6	1.3	0	1	0	0	267.2	46.9	268.5	46.9	652.2	236.2
7	1.8	0	1	0	0	154.6	0	156.4	0	302.7	69.1
8	0	0	0	0	0	49.2	0	49.2	0	313.8	8.0
9	84.6	0	2	1.2	0	140.0	30.1	225.8	30.1	531.9	132.7
10	10.5	0	1	19.7	0	0	0	30.2	0	172.3	94.1
11	44.1	44.1	1	22.2	3.4	96.5	0	162.8	47.5	171.2	77.2
12	0	0	0	0	0	0	0	0	0	59.7	18.3
13	0	0	0	0	0	0	0	0	0	86.5	22.1
14	0	0	0	5.7	1.5	0	0	5.7	1.5	17.3	17.3
15	0	0	0	0	0	0	0	0	0	13.0	0
16a	0	0	0	0	0	0	0	0	0	19.8	5.8
16b	0	0	0	0	0	0	0	0	0	0	0
17a	0	0	0	0	0	0	0	0	0	103.1	0
17b	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0
Tt:	199.1	50.6	9	48.8	4.9	899.6	137.8	1,147.5	193.3	4,349.8	1,021.9

Limbs (incl. Scapula)		Vertebrae		Total	
Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)
0	0	156.5	21.5	461.4	123.0 (26.7%)
0	0	26.0	0	271.7	3.4 (1.3%)
58.2	0	37.7	0	560.1	60.8 (10.9%)
0	0	116.4	0	561.3	100.6 (17.9%)
99.2	0	161.5	0	956.2	142.1 (14.9%)
0	0	138.3	17.6	1059.0	300.7 (28.4%)
0	0	71.1	0	530.2	69.1 (13.0%)
110.5	14.7	140.8	0	614.3	22.7 (3.7%)
0	0	140.1	26.7	897.8	189.5 (21.1%)
0.5	0	20.9	0	223.9	94.1 (42.0%)
0	0	20.2	0	354.2	124.7 (35.2%)
0	0	0	0	59.7	18.3 (30.7%)
0	0	123.6	0	210.1	22.1 (10.5%)
0	0	0	0	23.0	18.8 (81.7%)
0	0	21.9	0	34.9	0 (0%)
0	0	0	0	19.8	5.8
0	0	12.8	0	12.8	0 (0%)
0	0	0	0	103.1	0 (0%)
0	0	21.0	0	21.0	0 (0%)
0	0	12.4	0	12.4	0 (0%)
268.4	14.7	1,208.8	65.8	6,986.9	1,295.7 (18.5%)

bones (by weight) show signs of burning in Square A, the proportion of burning for different bone elements varies considerably: ribs (24%), skull (17%), limbs (including scapula) (6%) and vertebrae (5%) (Table 5). The concentration of burning on ribs is consistent with cooking over an open fire. The considerable under-representation of vertebrae is probably also explained by modern ethnographic dugong butchering practices on Mabuyag where vertebrae are discarded away from domestic areas soon after butchering (McNiven, pers. obs.).

Turtle

Turtle bone was represented mostly by fragments of osteoderm and limb bones (including phalanges) probably belonging to green sea turtle (*Chelonia mydas*) (*waru* in Mabuyaagi). Nearly all (99%) turtle bone was recovered from XUs 1-18 within 55 cm of the surface in SU1 (Figure 22, Table 4).

Fish (including shark and ray)

Nearly all (97.6% by count) fish bone and shark/ray elements were restricted to XUs 1-17 in SU1 within 50 cm of the surface (Table 4). However, 68.9% (n=3115) of all fish bone and shark-ray elements were recovered from XUs 6-12, while 47% of small vertebrate bone was concentrated in XUs 9-11 across the base of SU1a between 16 cm and 28 cm below the surface (Figure 22). Only 2.4% (n=107) of fish and shark/ray elements were found from XUs 18 to 32 near the base of Square A and it is likely that much of this material represents natural inclusions within biogenic beach sands. In this regard, XUs 19b and 27 had water-rounded (and pitted) shark teeth (cf. Carcharhinidae) suggesting non-cultural origins, while XUs 20c, 28 and 32 had fish bone and shark/ray (Elasmobranchii) vertebrae that were white and well preserved, also pointing to natural deposition.

A total of 4519 fish bone and shark/ray (Elasmobranchii) elements weighing 374.9 g were identified to nearest taxon using an extensive reference collection consisting of around 400 specimens representing 50 families (Weisler, 2001: Appendix 3). As the elements were from small individuals and quite fragmentary, each specimen was examined with the aid of a binocular scope under 10X magnification. To estimate approximate fish size, the diameter (mm) of all measurable vertebrae and widths of lower pharyngeals of parrotfish (Scaridae) and wrasses (Labridae) were taken with digital callipers to two decimal places.

Quantification was by number of identified specimens (NISP) using the standard five-paired cranial bones (dentary, articular, quadrate, premaxillary and maxilla) as well as unique elements including bony denticles and the terminal spine of stingrays (Dasyatidae), vertebrae of sharks/rays, upper and lower pharyngeals (as well as isolated enamel portions) of wrasses and parrotfish, and shark teeth. Table 6 lists the elements used for quantification. The number of identified specimens (NISP) of fish and sharks/rays by XU for Square A is presented in Table 7. The NISP and minimum number of individuals (MNI) for the main cultural layer (SU1, XUs 1-17) is presented in Table 8. Because even small sharks have more than 150 vertebrae, a single shark can have dozens of teeth, and hundreds of bony tubercles may comprise an individual ray, MNI of 1 for these taxa recovered within SU 1 was calculated as: 150 Elasmobranchii vertebrae, <100 ray tubercles and <50 shark teeth. Excluding Elasmobranchii, Dasyatidae and cf. Carcharhinidae from the discussion on quantification shows consistently that wrasses, followed by parrotfish and emperors, are clearly the most abundant taxa. Wrasses are the most common taxon representing 66.5% of MNI and 22.3% of NISP in the assemblage. All other taxa, regardless of quantification measure, are below 10.2%.

To gain an estimate of the size of the most common taxon, the width of the lower pharyngeal of wrasses was measured. With a relatively large sample size of 55 from SU1, the mean width was 19.78±7.2 mm. The widths ranged from 8.52 to 40.02 mm with a median of 20.14 mm. Although a species level identification was not certain, most of the bones identified to wrasse were similar to Labridae *Bodianus* sp. or *Thalassoma* sp. The lower pharyngeal of *Bodianus* in the reference collection has a width of 24.50 mm and is from an individual that weighed 322 g. It is likely, then, that the reconstructed weight of the majority of wrasses contributing bones to the Square A assemblage weighed <300 g, although there were three lower pharyngeal widths >35 mm (all from XU9) that probably had reconstructed live weights significantly greater than 300 g. Of the nine grouper (Serranidae) MNI, one dentary was from an individual >490 g live weight, while one premaxillary was the largest teleost in the assemblage with a reconstructed live weight >2,200 g based on comparisons with the reference collection. Although measurement data are not available for the snappers and emperors, all these bones were from small individuals, likely <300 g live weight as these elements are similar in size to the labrids. Two lower pharyngeals of parrotfish were 7.08 mm and 7.45 mm wide which is consistent with individual fish weighing <300 g (see Fleming, 1986). Thus, the overall weight and length of teleost fish and sharks/rays in the assemblage is characterized by small individual size.

Some 946 bony fish vertebrae averaged 5.07 mm, ranging from 1.53 to 16.85 mm (Figure 23). The Elasmobranchii class consisted of 842 vertebrae with an average width of 4.25 mm and range of 2.28-18.44 mm (Figure 24). One modern reference specimen of

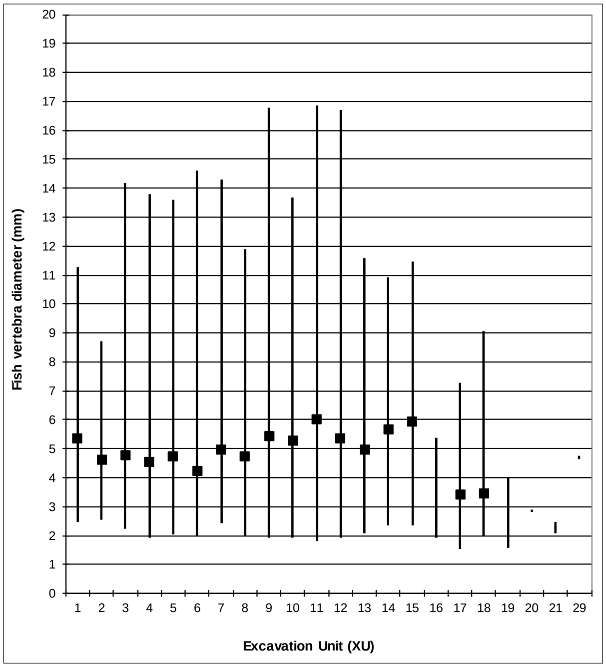


FIG. 23. Range and mean diameter of vertebra centra, bony fish, Square A, Goemu.

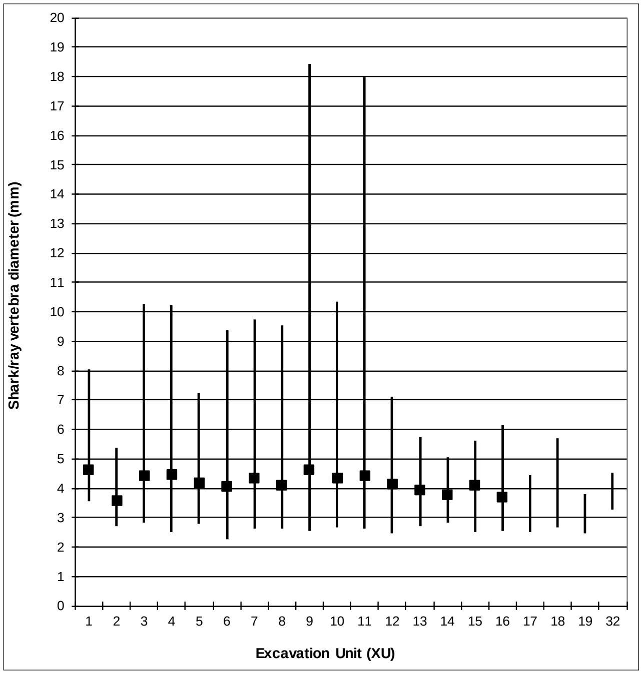


FIG. 24. Range and mean diameter of vertebra centra, sharks/rays, Square A, Goemu.

TABLE 6. Fish taxa, Square A, Goemu.

	Carcharhinidae	Dasyatidae	Elasmobranchii	Labridae	Lethrinidae	L. lethrinus	Lutjanidae	Muraenidae	Scaridae	Serranidae	Tetraodontidae	Total
Articular				5	18		1	1		1		26
Dentary				12	5		2		3	12	4	38
Denticle		58										58
Lower pharyngeal				113					14			127
Maxilla										1		1
Premaxillary				11	22	8			2	14	1	58
Premaxillary-dentary				81	6	3			22	4	1	117
Quadrate				3	2					4		9
Spine		1										1
Tooth	25			2					10			37
Upper pharyngeal				137					33			170
Vertebra			918									918
Total	25	59	918	364	53	11	3	1	84	36	6	1560

TABLE 7. Fish elements, Square A, Goemu.

XU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16a
Elasmobranchii (vertebrae)	9	15	36	35	40	69	74	83	109	104	127	79	45	35	31	13
Dasyatidae *Urogymnus africanus*	2	3	4	7	2	9	2	8	2	8	6	1	2	1	0	0
cf. Carcharhinidae (teeth)	1	0	2	0	2	3	2	1	0	0	1	0	0	0	0	1
Serranidae	0	0	4	0	0	1	5	2	7	7	6	2	1	0	0	0
Lutjanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
Lethrinidae	1	0	0	0	1	7	8	11	10	8	3	6	0	0	0	0
L. lethrinus	0	0	0	0	0	0	0	0	0	0	11	0	16	0	0	0
Labridae	11	5	24	15	20	41	38	22	40	30	49	20	0	11	11	3
Muraenidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Scaridae	4	2	4	10	7	9	5	8	6	9	10	1	0	4	1	3
Tetraodontidae	0	0	0	2	3	0	0	0	0	0	1	0	0	0	0	0
Identified	28	25	74	69	75	140	134	135	174	166	214	109	64	52	43	22
All fish	94	65	181	182	200	342	341	417	497	531	645	342	199	124	129	59

TABLE 8. Identified fish and Elasmobranchii from XUs 1-17 (SU1), Square A, Goemu.

Taxon	Common Name	NISP	%	MNI	%
Elasmobranchii (vertebrae)	Sharks/rays	910	59.2	6	3.4
Dasyatidae *Urogymnus africanus*	Thorny Stingray	57	3.7	1	<1
cf. Carcharhinidae (teeth)	Sharks	15	<1	1	<1
Serranidae	Groupers	36	2.3	9	5.4
Lutjanidae	Snappers	3	<1	1	<1
Lethrinidae (incl. *L. lethrinus*)	Emperors	82	5.3	17	10.2
Labridae	Wrasses	342	22.3	111	66.5
Muraenidae	Moray Eels	1	<1	1	<1
Scaridae	Parrotfish	84	5.5	17	10.2
Tetraodontidae	Puffers	6	<1	3	1.8
Identified		1,536		167	
All fish		4,412			

See text for discussion of quantification of Elasmobranchii, Dasyatidae and cf. Carcharhindae. NISP = number of identified specimens and MNI = minimum number of individuals.

16b	17a	17b	18a	18b	18c	19a	19b	19c	20a	20b	20c	21b	21c	22a	22b	26	27	28	29	32	Totals
0	6	0	0	0	1	0	1	4	0	0	0	0	0	0	0	0	0	1	0	2	919
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	58
0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	4	0	0	22
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
0	2	0	3	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2	0	0	349
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
0	9	3	3	0	2	0	3	5	0	0	0	0	0	0	1	0	1	7	0	2	1,560
5	39	20	24	5	8	6	14	9	3	3	2	10	2	1	3	1	1	9	1	5	4,519

Whaler or Requiem shark (Carcharhinidae *Carcharhinus* sp.) weighed 1750 g, was 735 mm long, and had 157 vertebrae with an average width of 6.05±2.01 mm ranging from 1.58 mm to 9.56 mm. It is likely that most of the Elasmobranchii vertebrae are of small-sized sharks and rays – perhaps nothing longer than a metre or so. The only elasmobranch identified to genus was the Thorny Stingray (Dasyatidae *Urogymnus africanus*) which was identified from the bony tubercles that are found by the hundreds on the dorsal surface of a single individual. Attaining lengths up to 3 m, this taxon does not have a venomous spine and inhabits sandy or mud bottoms and rarely frequent the vicinity of coral reefs (Randall *et al*., 1990: 29-30). It is possible to estimate the total weight of live fish and sharks/rays represented by the SU1 assemblage from Square A by multiplying the MNI of 167 by an average live weight of 300 g yielding 50.1 kg. This is not an exact figure, of course, but it is likely that the true total weight is close to this value. With dugong and turtle representing a huge biomass relative to captured teleosts and elasmobranchs, it is obvious that fin fish were secondary in importance to the diet but, nonetheless, were a significant addition to subsistence.

Reptile (including crocodile)

Most (92%) of the small amount of reptile bone was found in XUs 1-11 within SU1a and the main midden (mound) deposit (Table 4). No reptile bone was found in XUs 20-34 through the lower 60-201 cm (SUs 2b-2d) of Square A. In terms of NISP, the assemblage is represented mostly by skinks (Scincidae) (17), followed by crocodiles (*Crocodylus* sp.) (7), goannas (*Varanus* sp.) (6), and venomous snakes (Elapidae) (4) (Table 9). The skinks are mostly small and are considered to be natural on-site deaths.

TABLE 9. Reptile bones, Square A, Goemu.

XU	Taxon (element)
3	Crocodile (1 caudal vertebra) Goanna (1 caudal vertebra)
4	Skink (1 sacral)
5	Skink (1 vertebra) Goanna (2 vertebrae)
6	Crocodile (1 dorsal vertebra) Skink (1 vertebra) Goanna (1 caudal vertebra)
7	Crocodile (1 distal caudal vertebra)
8	Crocodile (1 distal caudal vertebra) Venomous snake (1 vertebra)
9	Crocodile (1 caudal vertebra) Skink (1 vertebra) Venomous snake (1 vertebra)
10	Crocodile (1 caudal vertebra) Venomous snake (2 vertebrae)
11	Goanna (2 caudal vertebrae)
12	Crocodile (1 anterior caudal vertebra)
15	Skink (2 vertebrae)
16a	Skink (1 vertebra)
17a	Skink (1 vertebra)
18c	Skink (5 dorsals)
19c	Skink (4 vertebrae)

The goannas (medium sized), venomous snakes (mostly small) and crocodiles (very small individuals) are considered food items. It is possible that representation of goannas and crocodiles mostly by caudal (tail) vertebrae indicates a subsistence focus on tail meat.

Bird

The small amount of bird bone (all represented by limb fragments) was confined to XUs 1-9 (SU1a) within 20 cm of the surface (Table 4). Birds are a well-known Torres Strait Islander food item (McNiven & Hitchcock, 2004: 110-111) and the archaeological bird bone in Square A may represent food remains.

SHELLFISH

To be counted for analysis shellfish had to meet the following three analytical criteria. First, each shell (whole or fragment) had to be at least 15 mm long to be considered 'economic' (i.e. to have been collected by people for food). This issue is critical given that the midden matrix was biogenic shelly sands that feature millions of naturally-deposited shells and shell fragments per cubic metre. The size threshold of 15 mm tended to separate out what were clearly naturally-deposited small shells and larger shells deposited by people (see also Attenbrow, 1992: 20; cf. Rowland, 1994). However, a number of taxa which appear to be natural inclusions in the shelly sands also fell within this size threshold (see below). Second, shells must exhibit signs that they were collected 'live'. As such, all shells (whole or fragments) revealing evidence of water-rolled edges, weathered inner surfaces (e.g. pitting), parasite drill holes, and/or marine growth (e.g. coral) on the inner surface were excluded from analysis. Third, of the 'economic' and 'live' specimens, only those diagnostic anatomical elements (DAE) suitable for MNI calculations were separated out for analysis. DAEs had to be >50% complete to avoid double counting errors. The number of DAEs used for each taxon varied from two to three. For bivalves, two DAEs were used – left and right hinges. For gastropods, up to three DAEs were selected from the following – apex, anterior canal, posterior canal, lower columellar plait, operculum and umbilicus. For chitons, two DAE's were used – anterior valve and posterior valve. In all cases, MNI was calculated for each taxon within each XU by taking the highest count of any individual DAE.

Taxa identification was undertaken using the shell reference collection of the Programme for Australian Indigenous Archaeology (Monash University) and reference texts (Lamprell & Healy, 1998; Lamprell & Whitehead, 1992; Wilson *et al*., 1993, 1994). In some cases, shells were sent to John Stanisic (Queensland Museum) for authoritative identification.

Taxa

A total of minimum number of individuals (MNI) of 2691 marine shellfish divided into bivalves (MNI=1989), gastropods (MNI=643), Polyplacophera (Chitons) (MNI=57) and Cephalopods (MNI=2) was identified from Square A (Table 10). These shells are represented by 50 taxa with slightly more bivalve taxa (n=27) compared to gastropod taxa (n=21). However, 86% of shellfish MNI are made up by only four taxa: two bivalves – *Paphies striata* (62%, MNI=1663) and *Chama* sp. (5%, MNI=139), and two gastropods – *Nerita* spp. (15%, MNI=408) and *Monodonta labio* (4%, MNI=116).

The majority (62%, n=31) of taxa can be considered incidental in terms of shellfishing practices with MNI representations of five or less. Indeed, it is probable that many (n=15) of these incidental taxa are non-cultural as they occur only in lower levels of Square A in SU2b (XUs 20-34) which contain few indications of cultural activity (i.e. *Clypeomorus batillariaeformis, Cerithium torresi, Nassarius splendidulus, Cerithium balteatum, Planaxis sulcatus*, Buccinidae, *Cardita muricata, Dosinia mira, Felaniella scalpta,* Mytilidae, *Acrosterigma vlamingi, Antigona chemnitzii, Irus irus, Tawera armata and Acrosterigma cf. gratiosa*) (Table 10). It is also possible that a further six taxa (Haminoeidae, Cerithiidae, *Cerithium salebrosum*, *Fragum* sp., *Gafrarium* sp. and *Divaricella ornata*) similarly are non-cultural as they occur only or mostly in lower levels (XUs 20-34) of Square A. As such, nearly half (21 out of 50) of the MNI shell taxa identified in Square A may not be cultural even though they conform to the 'economic' size and 'live' condition criteria established above. Clearly, cultural context also needs to be considered when assessing the cultural value of shells.

TABLE 10. Shellfish MNI, Square A, Goemu (shaded rows = non-cultural taxa).

Taxon	Tidal Zone	Substrate	MNI	%	1	2	3	4	5	6	7	8	9	10
Minimum number of taxa (total):					9	9	13	9	12	14	13	12	14	13
Minimum number of taxa (cultural):					9	9	13	9	12	14	13	12	13	12
GASTROPODS														
Nerita spp.	UIT	RMT	408	15.2	15	2	14	17	33	45	53	39	30	40
Monodonta labio	UIT	RMT	116	4.3	9	4	7	9	16	13	18	13	9	5
Terebralia sulcata	IT	MM	19	0.7	1		1							2
Cypraea spp.	IT	RCR	17	0.6			1			2	1			
Haminoeidae	IT+ST	SM	15	0.6										
Cerithiidae	IT	SM	15	0.6										
Cerithium salebrosum	ST	S	13	0.5										
Melo sp.	IT+ST	S	11	0.4		1	1	1	2	1		1	2	1
Clypeomorus batillariaeformis	UIT	RCR	5	0.2										
Fissurellidae (Limpet)	IT+ST	RCR	4	0.2								1		
Turbo spp.	IT+ST	RCR	4	0.2			1			1				1
Cerithium torresi	IT+ST	SM	3	0.1										
Trochus sp.	IT+ST	RCR	3	0.1			1		1					
Littoraria sp..	UIT	RMT	2	0.1							1			
Nassarius splendidulus	IT+ST	S	2	0.1										
Strombus luhuanus	IT+ST	CR	1	<0.1					1					
Lataxiena sp.?			1	<0.1									1	
Syrinx aruanus	IT+ST	S	1	<0.1					1					
Cerithium balteatum	IT	S	1	<0.1										
Planaxis sulcatus	IT	R	1	<0.1										
Buccinidae	IT+ST	RCR	1	<0.1										
Subtotal:			643											
BIVALVES														
Paphies striata	IT+ST	S	1,663	61.8	84	47	84	85	121	151	141	161	214	225
Chama sp.	IT+ST	RCR	139	5.2	1		2	2	2	8	5	5	18	28
Tellina spp.	IT	SM	44	1.6		1	1		1	2	4	4	5	4
Pinctada spp.	IT+ST	MSCR	33	1.2	2	1		1	1	3	4	2	3	2
Anadara sp..	IT	SM	18	0.7	2	1	2	2	3	2	2	2	2	
Fragum sp.	IT	S	17	0.6										
Polymesoda erosa	IT	MM	13	0.5	1	1	1			1	2	1	1	
Davila plana	IT	S	12	0.4									1	3
Gafrarium sp.	IT	SM	9	0.3									1	1
Divaricella ornate	IT	S	6	0.2										
Dosinia sp.	IT	S	4	0.2										
Saccostrea sp.	IT+ST	RMT	4	0.2						2	1	1		
Cardita muricata	IT	S	4	0.1										
Dosinia mira	IT+ST	SM	3	0.1										

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
14	11	10	7	9	7	5	4	3	6	7	12	12	14	9	5	5	9	1	4	1	15	5	0
14	10	9	7	7	7	5	3	3	5	3	3	4	6	2	2	1	4	0	1	0	6	1	0
66	24	11	4	2	3	1			2	1		1	2				1				2		
9	3		1																				
8	3	2	1			1																	
		2		3	1						1		1				1				4		
				1						3	2	2	4	1					1	1			
	1						1				2	2	2	2			2				3		
										1		1	2		1	1	2				5		
1																							
														1							4		
					1				1			1											
									1														
											1	1					1						
					1																		
																					1		
											1	1											
														1									
																					1		
																						1	
183	54	33	10	13	7	10	8	4	3	2	3	2	3	1	1	1	7		1		2	2	
21	6	21	12	4	1	2								1									
6		1		2	2	1	1		1	1	2	1	1		1		1				1		
4	3	4		2									1										
		1								1	2	2	5	1		1					2	2	
3	1							1															
6	1	1																					
				1							1	1			1		1		1		1		
										1	1		1	1							1	1	
1								1					1								1		
																1	1	1			1		
									2							1							

TABLE 10. Cont.d.

Taxon	Tidal Zone	Substrate	MNI	%	1	2	3	4	5	6	7	8	9	10
Felaniella scalpta	IT+ST	MCR	3	0.1										
Mytilidae	IT+ST	RCRMS	3	0.1										
Asaphis violascens	IT	S	2	0.1										1
Mactra sp.	IT	S	2	0.1									1	
Acrosterigma vlamingi	IT	S	2	0.1										
Spondylus sp.	IT+ST	CR	1	<0.1										
Tridacna squamosa	IT	CR	1	<0.1						1				
Timoclea marica	IT	S	1	<0.1										
Antigona chemnitzii	IT	S	1	<0.1										
Irus irus	IT	CR	1	<0.1										
Tawera armata	IT+ST	S	1	<0.1										
Mactra sericea			1	<0.1										
Acrosterigma cf. gratiosa	IT	CRS	1	<0.1										
Subtotal			1,989											
POLYPLACOPHERA														
Chitons	IT+ST	R	57	2.1	2	1	2	6	8	6	8	7	4	4
CEPHALOPODS														
Nautilus pompilius	ST	P	2	0.1				1			1			
TOTAL:			2,691	100	117	59	118	125	190	238	241	237	292	317

IT = intertidal, UIT = upper intertidal, ST = subtidal
R = rocks, CR = coral reef, S = sand, MT = mangrove trees, MM = mangrove mud, M = mud, P = pelagic

Thus, of the 50 shell taxa identified, only 29 taxa are considered cultural of which half (n=13) are non-incidental.

Habitats

The 29 cultural taxa were obtained from a range of tidal habitats with different substrates – sand, mud, coral reef, rocks and mangroves trees (Table 10). All of these habitats are located within 1 km of Goemu (Figure 3). The only exception is nautilus shells (Cephalopods) which are pelagic – but the dead shells can be found washed up on local beaches. Of the 13 non-incidental cultural shell taxa, a broad and comprehensive range of habitats was exploited – rocks and mangroves trees (*Nerita* spp. and *Monodonta labio*), rocks (Polyplacophera), mud (*Terebralia sulcata* and *Polymesoda erosa*), rocks and coral reef (*Cypraea* spp. and *Chama* sp.), sand (*Melo* sp., *Paphies striata* and *Davila plana*), sand and mud (*Tellina* spp. and *Anadara* sp.), and sand, mud and coral reefs (*Pinctada* sp.).

Chronological changes

Most (84%) shells were restricted to XUs 1-11 which represent SU1a and the main midden deposit within 28 cm of the surface (Figure 21). Within these levels the number of cultural taxa per XU ranges from 9 to 14 (Table 10). In contrast, the number of cultural taxa per XU in SU2 drops to 0 to 6. Overall, the

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
													1	1								1	
																			1		2		
1																							
	1																						
												1			1								
			1																				
							1																
											1												
											1												
													1										
1																							
													1										
2	2	1	2	2																			
312	99	77	31	30	15	15	11	6	10	10	18	16	26	10	5	5	17	1	4	1	31	7	0

major chronological change is the dramatic increase in shell discard in SU1a where the diversity of taxa collected also increases. In terms of changes in shellfishing practices within SU1a, the focus consistently remained bivalves supplemented by gastropods (Figure 21). However, a number of changes in shellfishing foci are evident moving from SU1b and the lower parts of SU1a into the upper part of SU1a. For example, in terms of non-incidental taxa, most *Chama* sp. (76%), *Terebralia sulcata* (84%) and all *Davila plana* were found in XUs 9-14, whereas most *Anadara* sp. (89%) and *Monodonta labio* (77%) were found in XUs 1-8.

CRUSTACEA

Crustacean remains were in the form of exoskeleton (crabs and crayfish) and shell (barnacles). Crab remains (mostly claws) totalling 154.4 g were found in all levels of Square A (Figure 21, Appendix 1). While many crab remains in the main midden deposit are likely to be food remains, crab remains are a natural component of biogenic shelly sands in Torres Strait and many if not most crab remains in SU2 are considered to be the result of natural deposition. Overall, crab contributed a minor albeit consistent part of local diets over the past 800 years. In marked contrast, crayfish (mouthparts) weighing 0.2 g were identified only from XU3 and clearly represent an insignificant part of local diets registered in Square A. Most of the barnacle shells (57.3 g) found scattered throughout much of Square A are acorn barnacles (Balanomorpha). All are considered to be non-dietary and most likely entered the site attached to turtle shell. Indeed, a reasonable positive association exists between the relative amounts of barnacle shell and turtle bone through Square A (Figure 25).

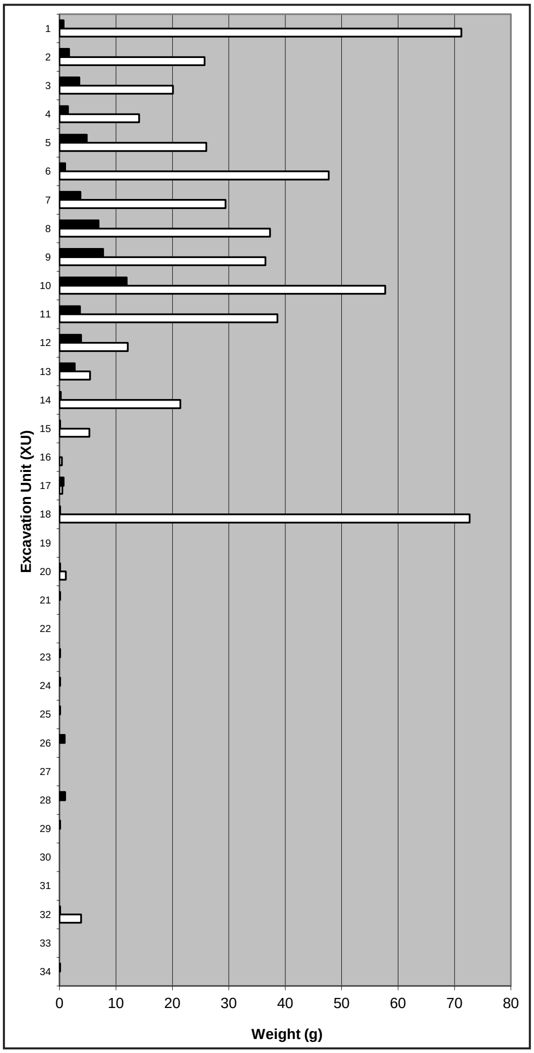


FIG. 25. Vertical changes in barnacles (black bars) and turtle bone (white bars), Square A, Goemu (NB. excludes 'pit' feature represented by XUs 19a, 20a, 21a and 22a).

SEA URCHINS

A small amount (1.4 g) of sea urchin spine fragments was identified in Square A (Appendix 1). Most (79%) were recovered from XUs 8-16 with none found in the upper parts of the main midden deposit in XUs 1-7. While these remains may reveal sea urchins were food items, it is also possible the rough surfaced spines were used as small abrading/drilling tools.

MATERIAL CULTURE

A broad range of material culture items made from stone, shell, bone, ochre, metal, ceramic and glass was recovered from Square A.

Stone artefacts

A total of 984 stone artefacts weighing 1498.83 g was recovered from Square A. Nearly all (n=981) are flaked stone artefacts (flakes, cores and retouched flakes) with the remaining three an igneous hammerstone (1131.3 g) in XU5, a ground stone (possibly an axe fragment) (8.8 g) made from volcanic stone in XU6, and a volcanic bevelled-edged implement (43.8 g) in XU11 (Figure 26). Nearly all (n=959, 98%) flaked

FIG. 26. Large igneous hammerstone, XU5 Square A, Goemu.

stone artefacts are made from quartz with the remainder made from volcanic stone (n=22, 2%) (Table 11). Both raw materials are available locally on Mabuyag and surrounding islets. The mean weight of flaked artefacts is 0.3 g with quartz artefacts (0.2 g) considerably smaller on average than volcanic artefacts (5.1 g). Most (97%) flaked artefacts were recovered from SU1 in XUs 1-17 with highest concentrations in XUs 9-11 in the lower parts of SU1a (Figure 21).

TABLE 11. Flaked stone artefact raw materials, Square A, Goemu.

XU	Total (#)	Total (g)	Quartz (#)	Quartz (g)	Volcanic (#)	Volcanic (g)
1	20	7.75	19	6.20	1	1.55
2	15	1.14	15	1.14	0	0
3	35	3.47	34	3.43	1	0.04
4	43	5.35	41	5.12	2	0.23
5	48	6.34	48	6.34	0	0
6	55	4.97	55	4.97	0	0
7	57	11.83	54	10.74	3	1.09
8	91	21.53	90	10.50	1	11.03
9	117	32.28	112	26.76	5	5.52
10	115	110.98	114	41.33	1	69.65
11	112	35.21	112	35.21	0	0
12	73	18.54	72	17.99	1	0.55
13	50	3.72	50	3.72	0	0
14	37	9.99	37	9.99	0	0
15	46	8.91	46	8.91	0	0
16a	17	1.04	17	1.04	0	0
16b	1	0.4	1	0.40	0	0
17a	14	2.77	14	2.77	0	0
17b	9	0.79	9	0.79	0	0
18a	4	3.12	4	3.12	0	0
18b	2	0.07	2	0.07	0	0
18c	1	0.76	0	0	1	0.76
19a	0	0	0	0	0	0
19b	2	0.07	2	0.07	0	0
19c	0	0	0	0	0	0
20a	0	0	0	0	0	0
20b	2	0.13	2	0.13	0	0
20c	0	0	0	0	0	0
21a	0	0	0	0	0	0
21b	1	0.01	1	0.01	0	0
21c	0	0	0	0	0	0
22a	0	0	0	0	0	0
22b	1	0.05	0	0	1	0.05
22c	0	0	0	0	0	0
23	0	0	0	0	0	0
24	1	0.05	1	0.05	0	0

TABLE 11. cont.d.

XU	Total (#)	Total (g)	Quartz (#)	Quartz (g)	Volcanic (#)	Volcanic (g)
25	1	22.2	0	0	1	22.20
26	1	0.03	0	0	1	0.03
27	2	0.03	2	0.03	0	0
28	3	0.12	1	0.02	2	0.10
29	1	0.05	1	0.05	0	0
30	1	0.2	1	0.20	0	0
31	0	0	0	0	0	0
32	1	0.79	1	0.79	0	0
33	1	0.08	0	0	1	0.08
34	1	0.16	1	0.16	0	0
Total:	981	314.93	959	202.05	22	112.88

Shell artefacts

Five shell artefacts were identified in Square A. First, the remains of a large baler (*Melo* sp.) shell container was exposed on the surface of XU1 with its base extending down into XU3 at a depth of 3 cm (Figure 27). As such, the artefact dates to c.350 cal BP. The container exhibits characteristic removal of the internal structure of the shell (columellar) with remnant chipping on the inside of the apex. Such containers were recorded ethnographically on Mabuyag in the late nineteenth century (Figure 28) and are well-known for the region (Haddon, 1912: 122-123, 1935: 302-303).

Second, the proximal end of a *Strombus luhuanus* shell with a maximum length of 33 mm (15.2 g) was recovered from XU5 and dates to c.350-450 cal BP (Figure 29A). Edges of the sectioned whorls show evidence of having been chipped away with the outer whorl subsequently ground flat. In addition, a hole has been drilled through the apex. The artefact most likely was used as a body adornment given the ethnographically-known tradition of using marine shells (bivalves and gastropods) as body adornments across Torres Strait (Haddon, 1912: 39-56). While no ethnographic information is available on use

FIG. 27. Baler shell container (c.350 cal BP), XU3, Square A, Goemu.

FIG. 28. Turtle butchering with baler shell container located to left, Mabuyag, 1898. Photograph taken by Alfred Haddon, 1898 (CUMAA: N.23008.ACH2).

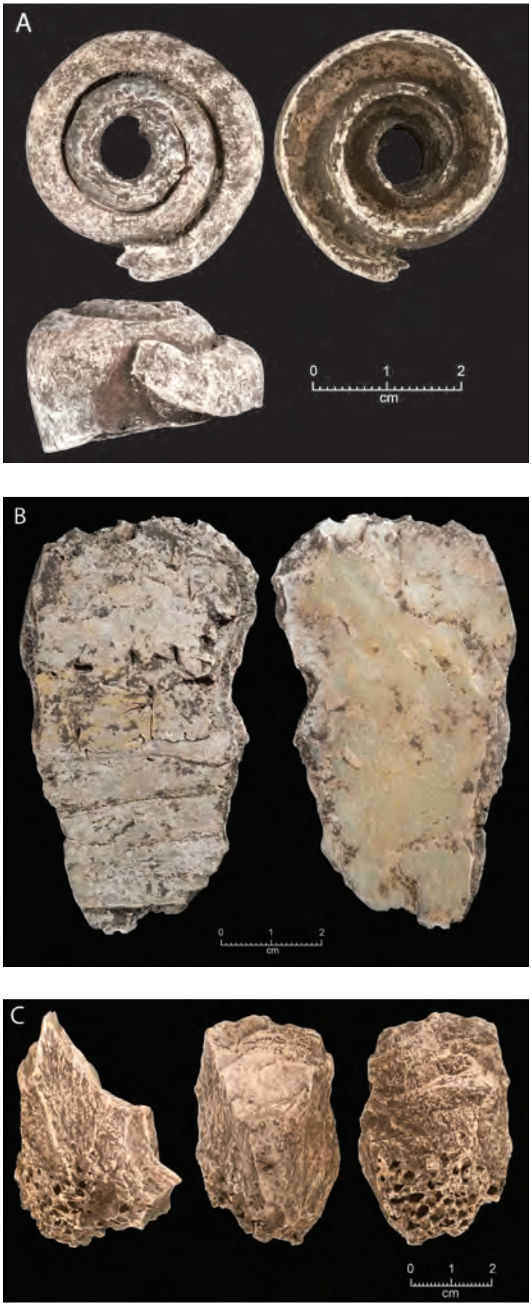


FIG. 29. Shell artefacts from Square A, Goemu, dating c.350-450 cal BP.

A: *Strombus luhuanus* adornment, XU5.

B: *Pinctada* sp. scraper, XU9.

C: *Tridacna* sp. flaked implement, XU7.

of *Strombus* sp. body adornments in Torres Strait, the technique of flaking and grinding the proximal end of marine gastropods into body adornments has been documented for *Conus* sp. shells across the region (Haddon, 1912: 43-44; Moore, 1984: 72, Pl. 36 #311).

Third, a sub-rectangular fragment of flaked pearl shell (*Pinctada* sp.) was recovered from XU9 dating to c.350-450 cal BP (Figure 29B). It has a maximum length, width and thickness of 82 mm, 46 mm and 4 mm respectively and weighs 20.7 g. The fragment exhibits unifacial and bifacial flaking around the margins with systematic denticulate flaking of one end consistent with use as a scraping implement. Pearlshell scrapers are known ethnographically for Torres Strait and specifically for Mabuyag (Haddon, 1912: 65; Moore, 1984: 65, Pl. 30 #248). While serrated pearlshell scrapers were not recorded ethnographically, Haddon (1912: 124-125) recorded turtleshell scrapers with a serrated working edge in the eastern Strait.

Fourth, three flaked fragments of giant clam shell (*Tridacna gigas*) were recovered from XU7 dating to c.350-450 cal BP. The fragments show evidence of conchoidal fracture indicating purposeful flaking and modification by people (Figure 29C). The maximum length and weight of the fragments are: #1 (60 mm, 73.7 g), #2 (40 mm, 9.1 g) and #3 (36 mm, 9.3 g). While fragments #2 and #3 appear to be the by-products of making implements, fragment #1 exhibits bifacial flaking along one margin consistent with preparation of a working edge of an implement. No ethnographic observations have been made of either giant clam shell flaking or giant clam shell implement manufacture in Torres Strait. However, Haddon (1935: 302) reported that clam shell axes were called *daumer-upi-tulik* by the people of Erub in eastern Torres Strait. While no mention is made of clam shell axe manufacture on Erub the associated name suggests such items were made in the recent past (i.e. nineteenth century). In this connection, Haddon (1935: 302) was informed by the Rev. MacFarlane that 'clam-shell axes have given way to "white man" goods'.

Indirect evidence of further shell artefacts in Square A comes from fragments of nautilus shell (*Nautilus pompilius*) recovered from XUs 4 and 7 and dating to c.350-450 cal BP. Nautilus shells are pelagic creatures that usually inhabit ocean depths of more than 60 m (Coleman, 1985: 298). The shells are accessible only after death when they wash up on beaches. Considerable ethnographic information is available on use of nautilus shell in the manufacture of body adornments and inlays on carvings and human skulls from various parts of Torres Strait during the nineteenth century (Haddon, 1912: 36, 40, 1935: 325-326). Headbands made with shaped pieces of nautilus shell were recorded on Mabuyag in the nineteenth century (Haddon, 1912:3 6). As such, it is likely the fragments of nautilus shell recovered from Square A relate to manufacture of decorative items.

Bone artefact

The tip of a bone point was found in XU12 dating to c.450 cal BP (Figure 30). It has a maximum length and width of 12 mm and 8 mm respectively and weighs 0.2 g. The working end of the point is rounded in plan view and lenticular in cross-section. This working end clearly shows evidence of grinding striations on both sides of, and perpendicular to, the working edge. The artefact is made from dense compact bone of a large vertebrate, possibly a section of limb bone. Nineteenth century ethnographic information is available on a range of bone implements/items from across Torres Strait such as arrow barbs (cassowary and wallaby bone imported from New Guinea), ear piercers (fish and flying fox bone), awls (flying fox wing bone) and nose bones (fish bone) (Haddon, 1912: 10, 127, 1935: 43, 72, 91, 100, 294-295). However, the rounded form and size of the Square A bone point tip is more consistent with a larger bone implement not associated with arrow barbs or piercing skin. In this connection, Haddon (1912: 127, 1935: 65) recorded that Torres Strait Islanders husked coconuts with pointed implements imported from New Guinea and made from the 'lower leg bone (tibio-tarsus) of a cassowary'. The bone is 'split longitudinally, and the upper portion cut away and brought to a flat rounded point, the lower articular end being left intact' (Haddon, 1912: 127) (Figure 31). Landtman (1933: 57) similarly recorded cassowary leg bone implements used for husking coconuts by the Kiwai people at the Fly River mouth.

FIG. 30. Tip of bone point dating to c.450 cal BP, Square A XU12, Goemu.

FIG. 31. Cassowary leg bone coconut huskers, Torres Strait (from Haddon, 1912: Fig. 163).

Rocks

A considerable amount of rock (47.8 kg) (excluding six stones forming the stone alignment in XUs 23-25) was excavated from Square A. Nearly all (96%) rocks came from XUs 1-17 (SU1) where the mean density of rocks was 2.7 kg / XU or 0.8 kg / 10 litres of deposit (Figure 21, Appendix 1). The rock assemblage is dominated by angular fragments of local volcanic rock and most appear to be fire-cracked cooking stones ethnographically associated with ground ovens known as *amai* in Mabuyag language or *kapmauri* in Torres Strait creole (Haddon, 1912: 132) (see also Ghaleb, 1990: 370) (Figure 32). Ground ovens are used to cook dugong, turtle and a range of vegetables. However, none of the rocks within SU1 were associated with any form of pit feature that could be interpreted as a ground oven. All the rocks were simply mixed in with midden material. Clearly, the associated ground ovens were located away from Square A elsewhere at Goemu. In contrast, the ashy pit features located beneath the main midden deposit within the upper half of SU2b are seen as in situ ground oven features dating to c.750-800 cal BP (see above).

Ochre

A total of 928.5 g of ochreous rock was identified from Square A. Most (90%) ochre occurred in XUs 1-11 (SU1a) within 28 cm of the surface (Figure 21, Appendix 1). No ochre was found in XUs 23-34 taking in the lower 120 cm of Square A. Ochre is well-documented ethnographically as a pigment source during the nineteenth century and it is likely that most of the ochre recovered from Square A had a similar purpose (McNiven & David, 2004).

FIG. 32. Ground oven (*amai*) with fire heating volcanic rocks to cook a turtle, Bau, Mabuyag, 24 September 2006 (Photo: Ian J. McNiven).

Bottle glass

Seven pieces of glass, all small flakes, were recovered from Square A: XU3 (n=1, 0.1 g), XU5 (n=1, 0.1 g), XU6 (n=1, 0.1 g) and XU7 (n=4, 0.3 g). The flakes range in size from 6 to 12 mm and all are made from green bottle glass except for the XU5 flake which is clear glass. The XU5 flake also exhibits burning impact. None of the flakes reveal evidence of bipolar (anvil) reduction. The XU3 flake and three of XU7 flakes are tertiary (i.e. they exhibit no signs of the original glass surface on the dorsal surface). All remaining flakes are secondary and reveal some sections of the original glass surface (most probably bottle) on the dorsal surface. The glass assemblage clearly reflects systematic flaking of glass objects (mostly bottles) of European origin. As the glass flakes are all small they probably reflect flaking debris from tool manufacture. However, use-wear and residue analyses may identify that some of the flakes were used as small cutting tools. In the nineteenth century, Haddon (1912: 12, 31, 1935: 93, 114, 325) recorded that Torres Strait Islanders used bottle glass to make cutting implements. It is likely that all of the Square A glass flakes similarly date to the nineteenth century given the known history of contact between the Goemulgal and Europeans (see Shnukal, this volume).

Metal

Single, small fragments of rusty metal were recovered from XU3 (0.1 g) and XU9 (1.2 g). The XU3 fragment has a maximum length of 9 mm and is of amorphous shape and from an unknown item. The XU9 fragment has a maximum length of 22 mm and is thin and curved and possibly comes from a metal container. Both items are considered to date to the nineteenth century given the contact history of Mabuyag.

Ceramic

A small stoneware sherd with yellow glaze (1.4 g) was recovered from XU31 located 143-156 cm below the surface with associated AMS dates of c.850 cal BP (charcoal) and c.1,500 cal BP (shell). The sherd appears to be in situ as it exhibits no adhering darker sediments characteristic of SUs 1a to 2a located within 60 cm of the surface. The place of manufacture of the sherd is unknown (see Grave & McNiven, 2013).

SOUTHERN LINEAR MIDDEN MOUND EXCAVATIONS (SQUARE B)

FEATURE DESCRIPTION

The linear midden mound feature is located at the southern end of Goemu village on flat ground in an area designated Gumu I by the UCL team (Figures 5, 7, 33). The feature was mapped by the UCL team in 1985 and measured c.20 m long with a maximum width of c.3 m. Our mapping of the western sections of the feature revealed a maximum mound height of 18 cm (Figures 34-35). In contrast to the Square A linear mound feature, the Square B linear mound feature is oriented perpendicular to the shoreline. The eastern end of the mound is located 45 m from the shoreline. Since 1985, machinery work at

FIG. 33. Square B, Goemu, prior to excavation, looking east, 7 December 2005 (Photo: Ian J. McNiven).

the site has removed some three-quarters of the feature to leave a small western remnant where Square B was positioned. The surface of the remnant feature exhibits a very high density of cultural materials, particularly dugong bone, rock fragments, marine shells and bottle glass fragments. During the wet season thick grass cover envelopes the feature and then dies back as the dry season progresses.

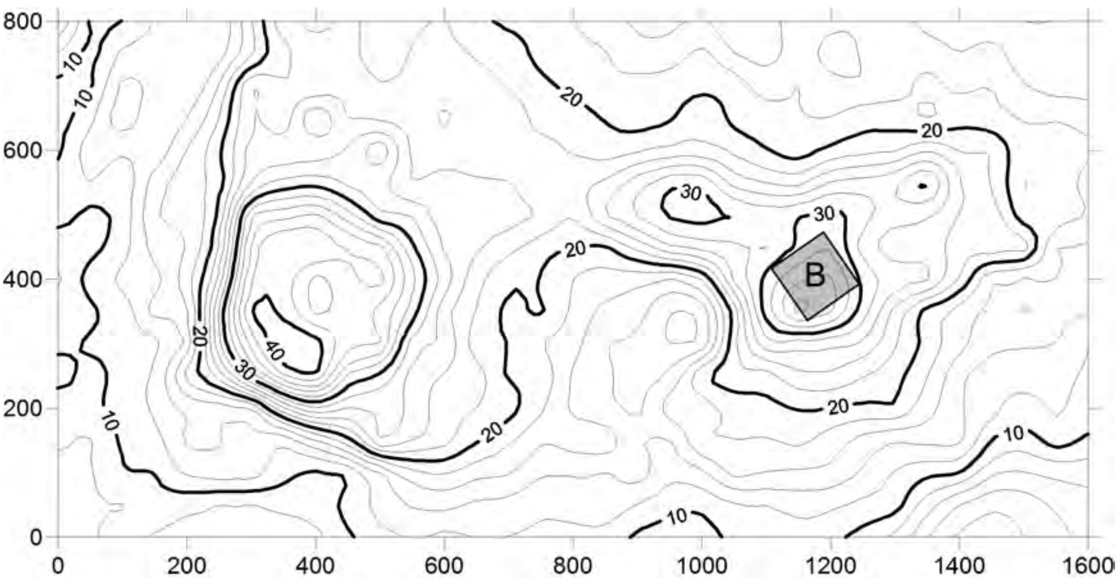


FIG. 34. Contour map of Square B mound, western remnant of linear midden mound feature (right) and circular midden mound (left). Contours and axis scales in cm.

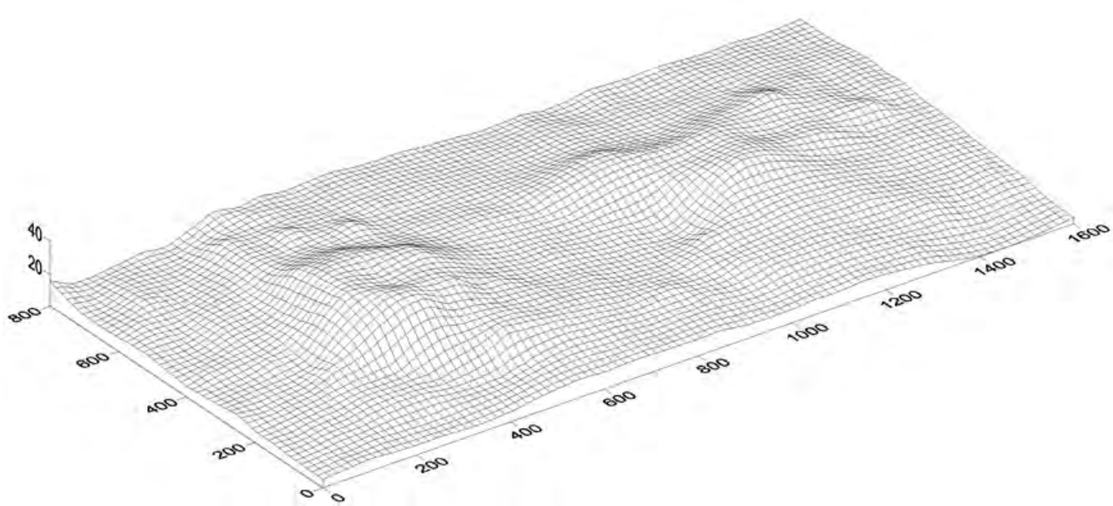


FIG. 35. 3D wireframe surface map of Square B mound, western remnant of linear midden mound feature (right) and circular midden mound (left). Axis scales in cm.

EXCAVATION JUSTIFICATION

Square B was excavated to sample midden deposits in another part of the village. We aimed to determine whether or not the southern sections of the village revealed a similar or different history to that revealed in the northern part of the site. Square B was located specifically on the remnant western end of a linear mound feature in order to sample such a feature and the nature of underlying cultural deposits. Significantly, the UCL team did not undertake detailed analyses of excavated materials from the southern half of Goemu except for shallow excavations at the *wiwai* turtle shrine. Square B was positioned over a dense midden deposit featuring a high concentration of broken bottles that appeared to date mostly to the late nineteenth and possibly early twentieth centuries. In fact, this glass deposit is the highest concentration of bottle glass recorded to date at any site in Torres Strait. As such, a secondary aim of the Square B excavations was to better characterise the nature of this glass assemblage and explore its relationship with the rest of the mounded midden feature.

EXCAVATION METHODS

Between 7 and 18 December 2005, we excavated a 1 m x 1 m pit (Square B) on the remnant western end of the linear mound feature (Figure 36). Square B is located 65 m inland (west) of the shoreline. It was excavated to a maximum depth of 94 cm using

FIG. 36. Members of the Mabuyag community visiting excavations at Square B, Goemu, 14 December 2005 (Photo: Ian J. McNiven).

20 excavation units (XUs). A total of 1149.2 kg (1119.0 litres) was excavated (Appendix 2). XU thickness averaged 2.7 cm in midden levels XUs 1-11. More generally, excavation procedures followed those employed at Square A. Unfortunately, excavated materials from the three basal XUs 18, 19 and 20 and sediment samples from all XUs were lost during transit from Mabuyag to Monash University.

STRATIGRAPHY AND SITE FORMATION

Two major and six minor stratigraphic units (SUs) were identified (Figures 37-38, Table 12). The upper 25 cm (SU1a) was black

FIG. 37. West section of Square B, Goemu (Photo: Ian J. McNiven).

TABLE 12. Stratigraphic unit descriptions for Square B, Goemu.

SU	Description
1	SU1 is sub-divided into SU1a and SU1b and comprises the major culture-bearing deposit. The darker coloured sediments of SU1 are in contrast to the lighter coloured sediments of SU2. SU1a comprises black loam with a clotted texture. It has a thickness of c.20-25 cm. The interface with SU1b is undulating and reasonably well defined. Sediments are partly consolidated and difficult to excavate due to the high density of cultural materials in the form of larger stones, bones and shell. Considerable numbers of bottle glass fragments occur within the upper 6 cm of the deposit. Numerous fibrous roots through SU. SU1b comprises very dark gray loam with a coarse-grained texture due to coarse-grained shelly sand inclusions. The unit has a thickness range of c.8 to 17 cm with a mean depth of c.30 cm below the surface. The interface with SU2a is undulating and diffuse. Sediments are partly consolidated but easy to excavate. Cultural materials (stones, bones and shells) are at a lower density compared to SU1a. Numerous fibrous roots through SU.
2	SU2 is subdivided into SU2a, SU2b, SU2c and SU2d, each representing beach-derived shelly sands of different colour and texture. SU2a comprises dark grey unconsolidated coarse-grained biogenic shelly sand intruded by finer-grained darker sediments from SU1b. The unit has a thickness range of c.5 to 12 cm with a mean basal depth of c.40 cm below the surface. The interface with SU2b is undulating and ranges from reasonably well-defined to partly diffuse. Cultural materials (stones, bones and shells) are sparse. Numerous fibrous roots through SU. SU2b comprises grey to pink mottled and unconsolidated coarse-grained shelly sands. The unit is variable in thickness with a basal depth range of c.60 to 70 cm below the surface. The gently undulating interface with SU2c is well-defined. Cultural materials (stones, bones and shells) are sparse. It has scattered fibrous roots of lower density compared to SU2a. Two pit-like features of darker sediment intrude into the upper 15 cm of the unit in the southwest quadrant of the excavation pit. Sediments in these features are similar to SU2a mixed sediments but less mottled in colouring. SU2c comprises grey, compacted, fine-grained shelly sands with some grey mottling. The unit has a thickness range of c.5 to 10 cm with a basal depth range of c.70 to 80 cm below the surface. The gently undulating interface with SU2d is well defined. The unit is culturally sterile. SU2d comprises grey, unconsolidated, coarse-grained shelly sands with some grey mottling. It comprises the lower 15-20 cm of this pit. The base of this unit was not exposed. Neither cultural materials nor fibrous roots were found in the unit.

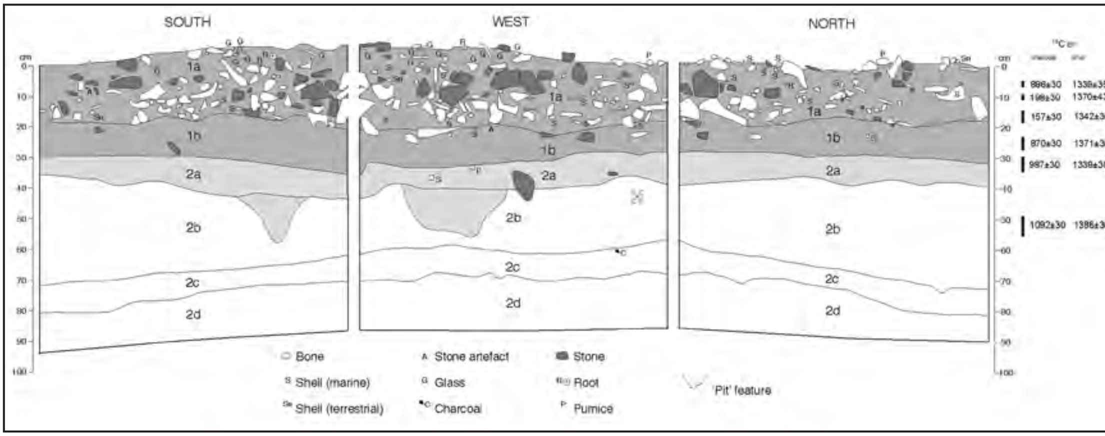


FIG. 38. Stratigraphy of Square B, Goemu.

FIG. 39. Two dark gray ashy pit features dating to c.950-1,000 cal BP located beneath the main midden deposit (top left) as seen at the end of XU15, Square B, Goemu. Looking west, 14 December 2005 (Photo: Ian J. McNiven).

loamy sediment with dense midden deposit and considerable amounts of bone (mostly dugong), fragments of rock (probably cooking stones), marine shells, crustacean exoskeleton, stone artefacts, charcoal and ochre. High concentrations of fragmented bottle glass occur within the upper 6 cm of SU1a. A low number of small fragments of glass and rusty metal were recovered down to a depth of 27 cm. SU1a (XUs 1-10) corresponds in thickness to the height of the mounded midden feature. SU1b underlies SU1a and extends down to c.30 cm below the surface. It is very dark gray loamy sediment with lower density midden deposit. The change from SU1b to SU2 is undulating and diffuse and marked by a change to shelly sands with very few cultural remains. SU2a is dark gray in colour and is mixed with darker midden material from SU1 above. The base of the unit is c.40 cm below the surface. The interface with SU2b is undulating and ranges from reasonably well-defined to partly diffuse. SU2b is gray to pink, mottled and coarse-grained shelly sand with few cultural materials. The unit is variable in thickness with a depth range of approximately 60 to 70 cm below the surface. Two pit features of darker sediment occur within the upper 15 cm of the unit (see below). SU2c comprises grey, compacted, fine-grained shelly sand with some mottling. The base of the unit ranges between c.60 and c.80 cm below the surface. The unit is culturally sterile. The change to the grey, unconsolidated, coarse-grained shelly sands of SU2d is well-defined. This basal unit is culturally sterile. Thus, in summary, biogenic shelly sands dominate SU2 taking in the lower two-thirds of Square B between c.30 and c.90 cm below the surface. Following interpretations made at Square A, the lower shelly sands in Square B are similarly seen to represent prograded beach deposits. In marked contrast, the upper c.30 cm of Square B sees a change to cultural deposition and the formation of midden deposits and loamy sediments.

Pit features

Two distinct concentrations of dark gray shelly sands were identified immediately beneath the main midden deposit in SU2b. Both pit features are clearly visible in the south and west sections (Figures 38-39). The larger western pit has a width of 34 cm and depth of 15 cm while the southern pit has a width of 23 cm and depth of 15 cm. However, only the western pit exhibits a higher concentration of charcoal fragments (e.g. 0.7 g / 10 litres of deposit, XU17b) compared to surrounding sediments (e.g. 0.2 g / 10 litres of deposit, XU17a). Both pits also contain higher concentrations of rocks (mostly fire-cracked) – western pit (e.g. 15.3 kg / 10 litres of deposit, XU17b) and southern pit (e.g. 28.0 kg / 10 litres of deposit, XU17c) compared to surrounding sediments (13.3 kg / 10 litres of deposit, XU17a). As the pits contain relatively negligible amounts of other cultural materials (e.g. bone, stone artefacts, economic shells) compared to overlying and surrounding deposits, they are interpreted as specialised cooking features (i.e. ground ovens).

Bioturbation

Post-depositional disturbance from plants and animals was recorded throughout the Square B deposit. Fibrous roots were recorded in every XU except XUs 15 and 16. Isolated larger roots (up to 1 cm in diameter) were found in XUs 1 to 12 within 35 cm of the surface. A few rotting larger roots were recorded in XUs 17 and 19. Animal disturbance was restricted to insects with a live spider in a burrow in XU4 (5-7 cm below the surface), live ants in XUs 4 to 12, and live termites in XUs 5 to 12. Thus, root and insect disturbance vectors were recorded throughout the main culture-bearing deposits in SUs 1a to 2a within 35 cm of the surface. While the impact of this disturbance is considered to be small-scale, the impact on suitability of charcoal for radiocarbon dating is considerable (see below).

Land snails

A total of 272.7 g of snail shells was recovered from Square B (Table 13). No land snails were found in sediments below a depth of 49 cm with most (92% by weight) associated with the dense midden levels of SU1a (XUs 1-9) (Appendix 2, Figure 40). Of the five species of snails identified, the two most ubiquitous were *Torresitrachia torresiana* and *Trachiopsis strangulata*, followed by *Hadra funiculate* and more sporadic occurrences of *Allopeas gracile* and *Torresiropa spaldingi* (Table 13). As with Square A, these land snails prefer vine thickets and not grasslands as currently found across most of the southern sections of Goemu. Similarly, the concentration of land snails in midden levels of Square B most likely reflects paedogenesis and the development of fine-grained loamy sediments supporting vine thicket vegetation and higher moisture which are the preferred habitat for land snails.

Pumice

A total of 156.1 g of pumice nodules were found in Square B. As with land snails, most pumice (80% by weight) was found in the dense midden levels of SU1a (XUs 1-9) (Appendix 2, Figure 40). As with Square A, the relative paucity of pumice in prograded beach deposits across the lower sections of the pit is curious given pumice washes up on beaches and is a natural component of beach deposits. Square B pumice suggests strongly that the inland deposition of pumice mostly occurred in association with intense human occupation.

RADIOCARBON DATING

Two series of radiocarbon dating (AMS) using charcoal and marine shell are available for Square B. Dating was undertaken by The University of Waikato Radiocarbon Dating

TABLE 13. Land snails, Square B, Goemu.

XU	*Torresitrachia torresiana*	*Trachiopsis strangulata*	*Allopeas gracile*	*Hadra funiculata*	*Torresitopa spaldingi*
1	✓	✓	✓	✓	
2	✓	✓	✓	✓	
3	✓	✓	✓	✓	
4	✓	✓	✓	✓	
5	✓	✓	✓	✓	
6	✓	✓	✓	✓	
7	✓	✓	✓	✓	
8	✓	✓		✓	✓
9	✓	✓		✓	
10	✓	✓		✓	
11	✓	✓		✓	
12	✓	✓		✓	
13	✓	✓			
14a	✓	✓			
14b	✓	✓		✓	
15a		✓			
15b	✓				

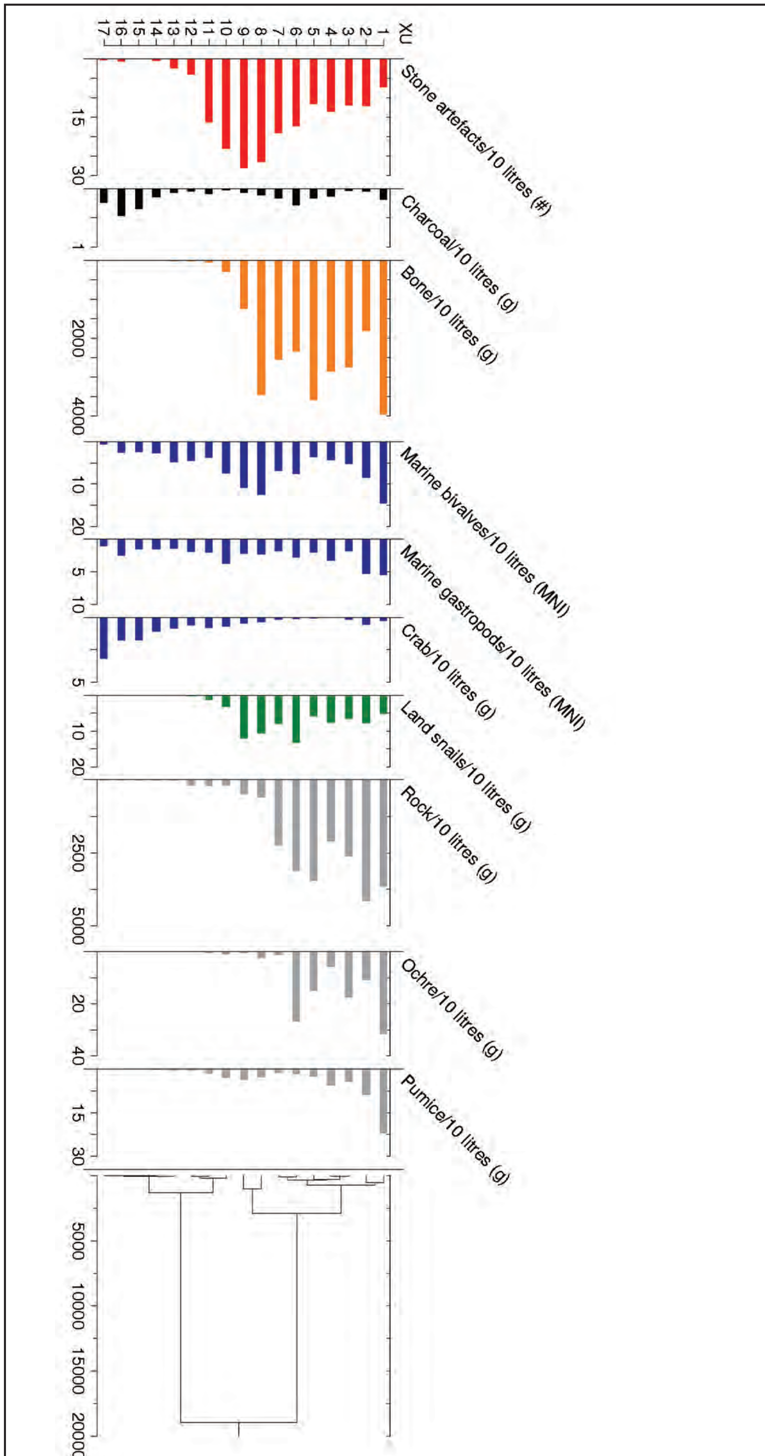


FIG. 40. Vertical changes in cultural and non-cultural materials, Square B, Goemu.

TABLE 14. AMS radiocarbon dates, Square B, Goemu.

Lab. No.	XU	Mean Depth Below Surface (cm)	Sample Type	δ13C‰	Conventional Radiocarbon Age (years BP)	Calibrated Age BP 68.3% (with probabilities)	Calibrated Age BP 95.4% (with probabilities)	Years Ago (cal BP) Circa*
Wk-25061	4	5.1-7.3	Seed pod charcoal Single fragment 0.01 g	-25.5 ±0.2	886±30	724-774 (0.957) 783-786 (0.043)	682-797 (1.000)	750
Wk-28769	4	5.1-7.3	*Paphies striata* Complete left valve, 0.69 g, 22.1 mm	1.7 ±0.2	1,339±35	894-1,020 (1.000)	799-1,078 (1.000)	950
Wk-25062	6	9.3-10.4	Wood charcoal Single fragment 0.09 g	-28.0 ±0.2	198±30	0-3 (0.021) 74-81 (0.039) 108-111 (0.016) 142-158 (0.132) 163-226 (0.537) 252-283 (0.255)	0-28 (0.085) 59-116 (0.148) 136-233 (0.520) 237-296 (0.247)	200
Wk-28770	6	9.3-10.4	*Paphies striata* Complete right valve, 0.57 g, 17.9 mm	1.9 ±0.2	1,370±43	916-1,047 (1.000)	846-1,141 (1.000)	1,000
Wk-25063	8	13.9-18.2	Wood charcoal Single fragment 0.08 g	-28.5 ±0.2	157±30	0-28 (0.221) 59-118 (0.444) 136-145 (0.067) 223-233 (0.080) 237-261 (0.188)	0-152 (0.718) 212-275 (0.282)	100
Wk-28771	8	13.9-18.2	*Paphies striata* Complete right valve, 1.16 g, 27.0 mm	1.9 ±0.2	1342±35	898-1,022 (1.000)	810-1,086 (1.000)	950
Wk-25064	10	23.1-26.8	Seed pod charcoal Single fragment 0.03 g	-25.7 ±0.2	870±30	689-701 (0.172) 720-766 (0.828)	680-775 (0.964) 778-788 (0.036)	750
Wk-28772	10	23.1-26.8	*Paphies striata* Complete left valve, 1.61 g, 27.9 mm	1.6 ±0.2	1,371±35	909-1,028 (1.000)	814-1,081 (1.000)	950
Wk-25065	12	29.9-34.7	Seed pod charcoal Single fragment 0.02 g	-24.9 ±0.2	987±30	801-875 (0.853) 884-886 (0.021) 897-909 (0.127)	788-924 (1.000)	850
Wk-28773	12	29.9-34.7	*Paphies striata* Complete right valve, 0.99 g, 23.7 mm	1.9 ±0.2	1,339±30	895-1,013 (1.000)	811-1,076 (1.000)	950
Wk-25066	16a	47.7-55.4	Seed pod charcoal Single fragment 0.01 g	-25.7 ±0.2	1,092±30	929-963 (1.000)	911-1,003 (0.939) 1,030-1,052 (0.061)	950
Wk-28774	16a	47.7-55.4	*Paphies striata* Complete left valve, 1.33 g, 25.1 mm	1.9 ±0.2	1,386±30	931-1,049 (1.000)	895-1,135 (1.000)	1,000

*Median probability of calibrated dates rounded to the nearest 50 years

Laboratory in New Zealand and calibrations followed methods employed for Square A dates.

The first series of six AMS dates was obtained on single charcoal fragments from six XUs (Table 14). Four of the dates were on fragments of carbonised seed and two dates were on fragments of wood charcoal. SU1a, taking in the mounded midden deposit and the main midden deposit, has four 14C dates – near identical ages of 886±30 BP and 870±30 BP (c.750 years ago) from the top and base of the unit respectively and two similar ages of 198±30 BP and 157±30 BP from the middle sections of the unit. As the dates are not in chronological order moving from the top to the base of SU1a, it is clear they reveal stratigraphic mixing of charcoal. The restriction of most European materials (glass, metal and ceramic) to the upper 5cm suggests only the surface levels of the mounded midden feature date to after European contact in the second half of the nineteenth century. Below the mounded midden feature dates of 987±30 BP (c.850 years ago) and 1092±30 BP (c.950 years ago) were obtained for XU12 (base of SU1b) and XU16a (top of SU2b) respectively. The lower 40 cm of sediments within Square B which contained few cultural materials remain undated.

The second series of six AMS dates was obtained on the filter-feeding marine bivalve *Paphies striata*. As with Square A, it was assumed that these larger items (size range: 1.8-2.8 cm) would have moved less through the dense Square B midden deposits compared to small charcoal fragments used for the first series of dates and thus provide a more reliable sequence of dates. Results were surprising with a very limited range of ages between 1339±30 BP and 1386±30 BP (Table 14). The dates reveal an instantaneous deposit given they all overlap at one sigma. Calibration suggests this rapid formation of midden deposit took place c.950-1,000 cal BP. This shell chronology matches up with only one of the charcoal dates – 1,092±30 BP from XU16a. All other charcoal dates are more recent and suggest that post-depositional charcoal infiltration and contamination of the midden deposit has been taking place over the past 950-1,000 years. Partial vertical consistency in the charcoal dates may reflect the simple fact that the longer a fragment of charcoal has been in the midden, the greater its chances of being moved down vertically by rainwater percolation and other taphonomic processes.

CULTURAL MATERIALS

Cultural materials include charcoal, vertebrate bone, mollusc shell, crustacean exoskeleton, stone artefacts and shell artefacts, and European contact items made from glass, metal and ceramic (Appendix 2). Unlike Square A, no sea urchin spine fragments were identified in Square B.

CHARCOAL

A total of 13.8 g of charcoal was recovered from Square B. Vertical changes in charcoal reveal a bimodal distribution (Figure 40). The first concentration, representing 22% of total charcoal, occurs within the main midden levels of XUs 1-9 in SU1a. The second concentration, representing 77% of total charcoal, is found in the culturally poor levels of XUs 11-17 in SU2b. While most charcoal in SU1a is associated with infiltration of charcoal from wood burnt in hearths in the general area over the past c.950 years, most charcoal in lower levels is not, particularly given Figure 40 excludes charcoal within the two cooking pits represented by XUs 14b, 15b, 16b,c and 17b,c. The lower level charcoal concentration is associated with landscape burning around c.950-1,000 years ago (see Discussion).

TABLE 15. Bone data, Square B, Goemu.

XU	Large Verte-brate (g)	Turtle (g)	Dugong (g)	Small Verte-brate (g)	Fish (g)	Shark/ Ray (g)	Snake/ Lizard (g)	Rodent (g)	Frog (g)	Dog (g)	Human (g)	Total (g)
1	2,688.7	0	1,641.7	0.7	1.1	0.2	0.1	0	0	0	0	4,332.5
2	2,263.3	0	1,149.4	1.7	0.8	0.1	0.1	0	0	0	0	3,415.4
3	3,463.8	2.7	7,046.4	5.3	2.8	0.2	0.1	0	0	0.1	0	10,521.4
4	2,917.9	0.5	5,710.6	5.0	0.5	0.3	0.1	0	0	0.3	0.8	8,636.0
5	2,740.0	11.0	6,421.6	2.6	0.4	0.1	0.1	0	0.1	0.3	0.6	9,176.8
6	1,459.3	8.2	1,926.6	2.0	0.1	0.1	0.1	0	0	0	0	3,396.4
7	5,821.3	69.9	3,870.6	4.0	0.7	0.2	0.2	0	0	1.9	0	9,768.8
8	6,656.9	47.3	9,716.1	9.3	3.3	0.4	2.6	0	0.1	0.7	0	16,436.7
9	3,525.5	6.8	3,383.6	3.2	3.1	0.3	2.7	0	0	0.3	1.9	6,927.4
10	736.9	8.8	565.1	2.0	0.7	0.1	0.5	0.1	0.1	1.1	0	1,315.4
11	218.7	2.7	21.8	0.9	0.4	0.1	0.5	0	0	0	0	245.1
12	113.5	2.2	42.2	0.2	0.1	0.1	0	0	0	0	0	158.3
13	43.2	3.5	12.6	0.1	0.1	0.1	0	0	0	0	0	59.6
14a	22.2	8.7	0	0.1	0.3	0	0	0	0	0	0	31.3
14b	10.8	2.2	5.7	0.1	0	0	0	0	0	0	0	18.8
15a	19.4	6.1	0	0.1	0.1	0	0	0	0	0	0	25.7
15b	10.1	0.6	0	0	0	0.1	0	0	0	0	0	10.8
16a	24.2	2.6	0	0.1	0.1	0	0	0	0	0	0	27.0
16b	2.2	0.4	0	0	0	0	0	0	0	0	0	2.6
16c	0.5	2.8	0	0	0	0	0	0	0	0	0	3.3
17a	12.4	2.1	0	0.1	0.1	0	0	0	0	0	0	14.7
17b	0.3	0	0	0	0	0	0	0	0	0	0	0.3
17c	0.1	0	0	0	0	0	0	0	0	0	0	0.1
Total	32,751.2	189.1	41,514.0	37.5	14.7	2.4	7.1	0.1	0.3	4.7	3.3	74,524.4

BONE

A total of 74,524.4 g of bone was recovered from Square B in XUs 1-17 (Table 15). While bone was recovered from all XUs, nearly all (97%) came from XUs 1-9 (SU1a) representing the main midden deposit (Figure 40). Within XUs 1-9 the mean density of bone was very high at 2.6 kg / 10 litres of deposit with the highest density 3.9 kg / 10 litres of deposit recorded in XU1 followed by 3.6 kg / 10 litres of deposit recorded in XU5. A considerable amount (44%, 32,751.2 g) of the bone assemblage was designated 'large vertebrate' which most likely represents dugong given the range and relative abundance of identified taxa and morphology of bones. 'Small vertebrate' bone (37.5 g) comprised only <0.1% of the bone assemblage and is probably mostly fish bone given the range of identified taxa and morphology of bones. The remaining bone assemblage comprises dugong (56%, 41,514.0 g), turtle (0.3%, 189.1 g), fish (including shark/ray) (<1%, 17.1 g), snake/lizard (<1%, 7.1 g), rodent (<1%, 0.1 g), frog (<1%, 0.3 g), dog (<1%, 4.7 g) and human (<1%, 3.3 g). No bird bone was identified. Thus, nearly all (99.7%) of the bone assemblage is either dugong or probably dugong (i.e. 'large vertebrate').

Dugong

All dugong bone was restricted to XUs 1-14 within 44 cm of the surface, with most (98%) bone found within XUs 1-9 in SU1a (Figure 41, Table 15). Using right and left

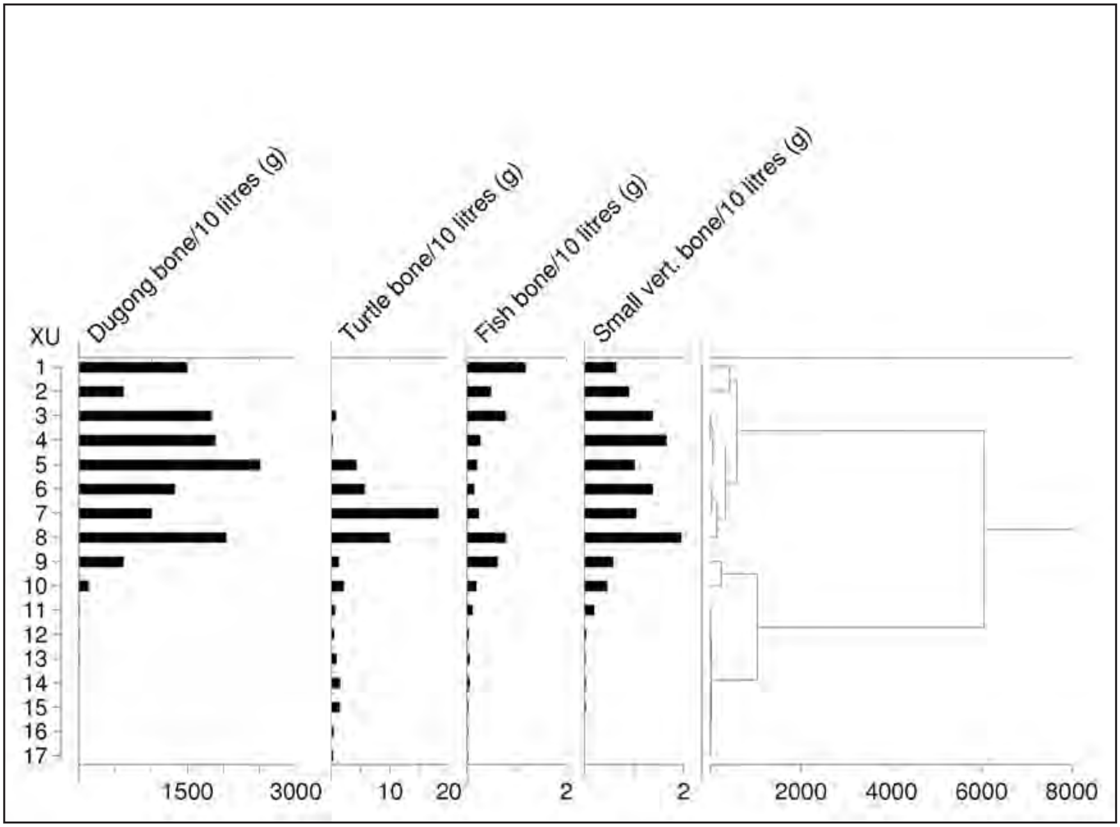


FIG. 41. Vertical changes in bone, Square B, Goemu.

TABLE 16. Dugong bone elements, Square B, Goemu.

	Ossicles			Tusks/Teeth		Mandible		Other Skull		Total Skull	
XU	Total (g)	Burnt (g)	MNI	Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)
1	32.1	0	1	95.4	0	259.5	82.6	571.1	108.9	958.1	191.5
2	0.2	0	0	76.6	0	119.9	0	351.6	45.5	548.3	45.5
3	332.7	0	5	146.9	0	1,391.6	118.7	3,796.8	178.3	5,668.0	297.0
4	260.8	0	3	384.0	0	581.2	0	3,698.8	200.8	4,924.8	200.8
5	311.7	20.1	5	366.9	4.3	762.0	157.0	4,169.7	270.4	5,610.3	451.8
6	62.8	0	1	63.1	23.9	15.3	0	1,432.2	243.7	1,573.4	267.6
7	521.1	202.6	7	163.5	31.6	485.5	35.5	2,165.0	1,286.4	3,335.1	1,556.1
8	949.1	372.8	13	331.3	73.9	131.2	78.3	7,371.5	2,304.9	8,783.1	2,829.9
9	429.7	35.7	5	156.9	6.1	8.3	8.3	2,604.6	739.1	3,199.5	789.2
10	7.7	0.4	0	94.9	0.9	0	0	430.8	0	533.4	1.3
11	2.7	0	0	2.7	0	0	0	0	0	5.4	0
12	0.6	0.6	0	4.9	0	0	0	0	0	5.5	0.6
13	0	0	0	0	0	0	0	0	0	0	0
14a	0	0	0	0	0	0	0	0	0	0	0
14b	0	0	0	0	0	0	0	0	0	0	0
Tt:	2,911.2	632.2	40	1,887.1	140.7	3,754.5	480.4	26,592.1	5,378.0	35,144.9	6,631.3

ear bones (tympano-periotic complex), the minimum number of individuals (MNI) represented by these bones is 40. The dugong bone assemblage comprises skull (85%), followed by ribs (13%), vertebrae (2%) and scapula (<1%) (Table 16). No limb bones were identified. Using a modern reference dugong skeleton, representation (by weight) of bone elements is ribs (45%), vertebrae (27%), skull (20%), limbs (4%) and scapula (4%) (Skelly *et al*., 2011). As such, the Square B dugong bone assemblage is heavily over-represented by skulls and heavily under-represented by vertebrae and ribs. As seen at Square A, the considerable under-representation of vertebrae probably is explained by modern ethnographic dugong butchering

Ribs		Scapula		Limbs (incl. Scapula)		Vertebrae		Total	
Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)	Total (g)	Burnt (g)
643.8	94.6	28.5	0	0	0	11.3	0	1,641.7	286.1 (17.5%)
494.8	36.4	61.8	0	0	0	44.5	0	1,149.4	81.9 (7.1%)
1,104.3	70.7	40.6	0	0	0	233.5	0	7,046.4	367.7 (5.2%)
615.3	48.4	0	0	0	0	170.5	0	5,710.6	249.2 (4.4%)
607.9	164.7	66.6	0	0	0	136.8	0	6,421.6	616.5 (9.6%)
262.5	141.2	0	0	0	0	90.7	56.7	1,926.6	465.5 (24.2%)
442.1	162.7	0	0	0	0	93.4	5.8	3,870.6	1,724.6 (44.6%)
845.8	585.3	0	0	0	0	87.2	4.7	9,716.1	3,419.9 (35.2%)
155.0	52.9	0	0	0	0	29.1	7.0	3,383.6	849.1 (25.1%)
31.7	0	0	0	0	0	0	0	565.1	1.3 (0.2%)
16.4	0	0	0	0	0	0	0	21.8	0
13.4	0	0	0	0	0	23.3	0	42.2	0.6 (1.4%)
12.6	7.0	0	0	0	0	0	0	12.6	7.0 (55.6%)
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	5.7	0	5.7	0
5,245.6	1,363.9	197.5	0	0	0	926.0	74.2	41,514.0	8069.4 (19.4%)

practices on Mabuyag where vertebrae are discarded away from domestic areas soon after butchering. Overall, 19% of dugong bones show some signs of burning, with most burning associated with ribs (26%), skull (1%) and vertebrae (8%) (Table 16). As with Square A, the concentration of burning on ribs is consistent with cooking over an open fire.

Turtle

As with Square A, turtle bone in Square B was represented mostly by fragments of osteoderm and limb bones probably belonging to green sea turtle (*Chelonia mydas*). While turtle bone was found throughout most of Square B, the majority (72%) was recovered from XUs 5-8 between 7 cm and 18 cm below the surface within SU1a (Figure 41, Table 15).

Fish (including shark and ray)

Fish bone (including shark/ray) was found in most XUs through Square B with most (86%) recovered from XUs 1-9 in SU1a down to a depth of 23 cm below the surface (Figure 41). The diameter of 56 bony fish vertebrae (centra) averaged only 4.47 mm (range: 1.84-11.14 mm) which is indicative of small fish (Figure 42). The Elasmobranchii class consisted of 50 vertebrae with an average centra width of 3.88 mm and range of 2.19-6.68 mm (Figure 43). As with Square A, the size range for Elasmobranchii centra indicates the exploitation of small sharks/rays less than a metre in length.

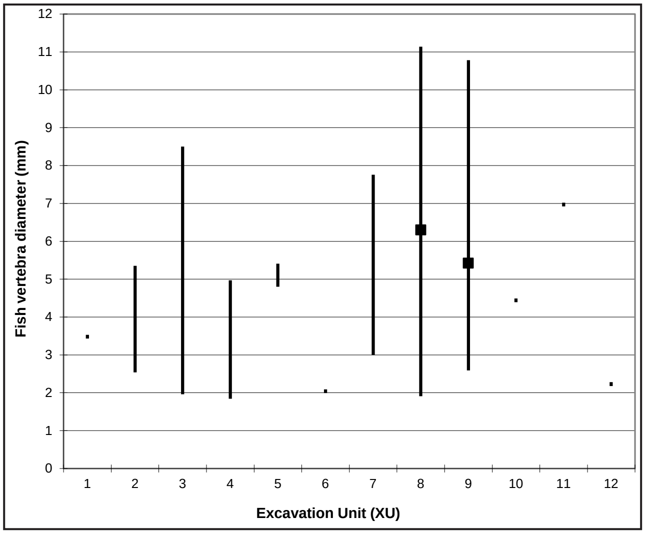


FIG. 42. Range and mean diameter of vertebra centra, bony fish, Square B, Goemu.

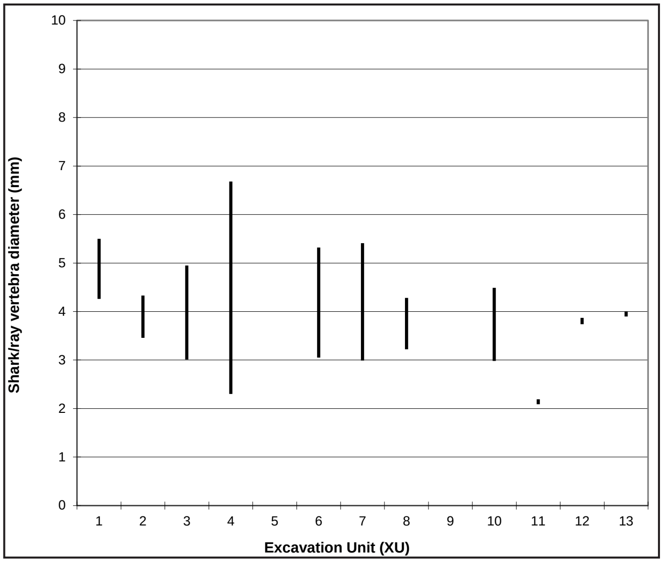


FIG. 43. Diameter range of vertebra centra, sharks/rays, Square B, Goemu.

Lizard/snake

All lizard/snake bone was recovered from XUs 1-11 taking in SUs 1a and 1b down to a depth of 30 cm (Table 15). In terms of NISP (Number of Identified Specimens), the assemblage is represented mostly by pythons (Pythonine) (39), followed by Dragon lizards (Agamidae) (10), skinks (Scincidae) (10), venomous snakes (Elapidae) (9) and goannas (*Varanus* sp.) (1) (Table 17). As with Square A, the skinks from Square B are mostly small and are considered to be natural on-site deaths. Pythons (small to medium sized), dragon lizards (small), goannas (small) and venomous snakes (mostly small) are considered food items. The low representation of lizards and snakes follows the meagre ethnographic evidence for consumption of these animals (e.g. Haddon, 1912: 138, 1935: 175, 303).

TABLE 17. Reptile bones, Square B, Goemu.

XU	Taxon (element)
1	Venomous snake (1 vertebra)
2	Venomous snake (3 vertebrae) Python (1 vertebra) Dragon lizard (1 vertebra)
3	Venomous snake (1 vertebra) Python (1 vertebra)
4	Dragon lizard (3 vertebrae) Skink (1 vertebra)
5	Python (2 vertebrae) Skink (1 vertebra)
6	Dragon lizard (1 vertebra)
7	Venomous snake (1 vertebra) Python (1 vertebra) Dragon lizard (2 vertebra) Skink (1 vertebra)
8	Venomous snake (1 vertebra) Python (14 vertebrae) Dragon lizard (2 vertebrae)
9	Venomous snake (2 vertebrae) Python (13 vertebrae) Goanna (1 caudal vertebra) Skink (6 dorsal vertebrae)
10	Python (4 vertebrae)
11	Python (3 vertebrae) Dragon lizard (1 vertebra) Skink (1 vertebra)

Rodent

A single rodent bone (incisor) was recovered from Square B in XU10 at a depth of 23-27 cm (Table 15). It likely represents a natural death and natural incorporation into the midden deposit. That rodents were rarely, if ever, eaten across Torres Strait is revealed by their absence in local ethnographic recordings on subsistence.

Frog

Three frog bones were recovered from Square B – all vertebrae (XUs 5, 8 and 10) (Table 15). While ethnographic evidence exists for consumption of frogs in eastern Torres Strait, Haddon (1912: 139) also pointed out that the 'Mabuiag people speak contemptuously of the Miriam and Erub natives [of the Eastern Islands] as foreigners who eat frogs'. Thus, while the frog bones in Square B may be food remains, it is more likely they represent natural on-site deaths.

Dog

Dog remains (teeth and bones) were recovered from XUs 3-10 in SU1a between 5 cm and 27 cm below the surface (Tables 15, 18). Most of the remains were teeth with bones restricted to two metatarsal fragments in XU7. It is possible some of the 'large vertebrate' bone fragments are dog. No ethnographic evidence for consumption of dog exists for Torres Strait.

Human

Six human teeth (whole and fragments) were excavated from XUs 4, 5 and 9 between 5 cm and 23 cm below the surface (Table 19). None of the teeth are attached to bone and it appears that only teeth and no human bone occurs in Square B. The teeth are represented by an incisor (maxillary), two premolars (maxillary) and three molars

TABLE 18. Dog teeth and bones, Square B, Goemu.

XU	Wt (g)	Element	Side	Jaw	Comments
3	0.13	3rd incisor	left	mandible	Missing distal root tip (recent break)
4	0.30	2nd molar	left	mandible	Complete
5	0.31	3rd premolar	left	mandible	Missing one root (old break)
7	0.45	4th premolar	right	mandible	Incomplete and three fragments (recent breaks)
7	1.26	3rd metatarsal	left		Proximal fragment (old breaks)
7	0.18	5th metatarsal	right		Distal fragment (old break)
8	0.27	2nd incisor	left	maxilla	Complete
8	0.14	1st premolar	left	maxilla	Complete
8	0.26	3rd molar	left	maxilla	Complete
9	0.31	3rd premolar	right	mandible	Complete
10	0.18	2nd incisor	left	maxilla	Complete
10	0.90	1st molar	left	maxilla	Missing front half (old break)

TABLE 19. Human teeth, Square B, Goemu.

XU	Wt (g)	Type	Side	Jaw	Eruption	Comments
4	0.15	2nd incisor	left	maxilla	deciduous	Complete and unburnt. Probably extracted from jaw prematurely (most likely post-mortem) as root shows no evidence (i.e. wear and absorption) of impact from underlying permanent tooth. Removed from a child under 12 years of age.
4	0.43	1st molar	right	maxilla	deciduous	Complete and unburnt. Probably extracted from jaw prematurely (most likely post-mortem) as root shows little evidence (i.e. wear and absorption) of impact from underlying permanent tooth. From a child around 10 years of age.
4	0.21	1st molar	?	maxilla	deciduous	Incomplete crown and burnt. Two conjoining fragments (recent break). Probably extracted from jaw prematurely (most likely post-mortem) as root shows no evidence (i.e. wear and absorption) of impact from underlying permanent tooth. From a child under 10 years of age.
5	0.58	2nd molar	?	mandible	deciduous	Missing crown and burnt. Possibly extracted from jaw prematurely (most likely post-mortem) as root shows no evidence (i.e. wear and absorption) of impact from underlying permanent tooth. Probably removed from a child just under 12 years of age.
9	0.94	2nd premolar	right	maxilla	permanent	Complete and unburnt. Extracted prematurely (most likely post-mortem) as it is a permanent tooth that had only recently erupted. Probably from an 11-12 year old child. Could be from same individual as other tooth from XU9.
9	0.97	1st premolar	right	maxilla	permanent	Complete and unburnt. Extracted prematurely (most likely post-mortem) as it is a permanent tooth that had only recently erupted. Probably from an 11-12 year old child. Could be from same individual as other tooth from XU9.

(maxillary and mandibular). The incisor and molars are deciduous while the premolars are permanent teeth. In all cases, phase of eruption and wear indicates definite or probable premature extraction from children less than 12 years of age. While it is technically possible the teeth were surgically removed from children, Haddon (1912: 12) reported that ritual tooth extraction was not practiced in Torres Strait. It is more likely that the teeth were removed post-mortem (Professor John Clement, Chair of Forensic Odontology, University of Melbourne Dental School, pers. comm. 2010).

SHELLFISH

Analysis of marine shellfish from Square B followed the same methods as detailed above for Square A.

Taxa

A total minimum number of individuals (MNI) of 546 marine shellfish divided into bivalves (MNI=386), gastropods (MNI=152) and Polyplacophera (Chitons) (MNI=8) was identified from Square B (Table 20). These shells are represented by 39 taxa with slightly more bivalve (n=21) compared to gastropod taxa (n=17). However, 84% of shellfish MNI are made up by only six taxa: four bivalves – *Paphies striata* (50%, MNI=273), *Chama* sp. (6%, MNI=30), *Fragum* sp. (3%, MNI=19) and *Tellina* spp. (3%, MNI=16), and three gastropods – Cerithiidae (10%, MNI=56), *Nerita* spp. (9%, MNI=47) and *Terebralia sulcata* (3%, MNI=16). The majority of taxa (67%, n=26) can be considered incidental in terms of shellfishing practices with MNI representations of five or less. Indeed, it is probable that six of these incidental taxa are non-cultural as they occur only in lower levels of Square B in SU2b (XUs 14-17) which contain few indications of cultural activity (i.e. Fissurellidae, Haminoeidae, *Tawera armata*, *Dosinia* sp., Mytilidae and *Gafrarium australe*) (Table 20). Similarly, it is highly likely that most, if not all, Cerithiidae and *Fragum* sp. shells are non-cultural as most (68% and 63% respectively) were similarly found in XUs 14-17. Thus, of the 39 shell taxa identified, 31 taxa are considered cultural of which two-thirds (n=21) are incidental.

Habitats

The 10 non-incidental cultural shell taxa indicate that a broad and comprehensive range of habitats was exploited – rocks and mangroves trees (*Nerita* spp. and *Monodonta labio*), rocks (Polyplacophera), mud (*Terebralia sulcata* and *Polymesoda erosa*), rocks and coral reef (*Cypraea* spp. and *Chama* sp.), sand (*Paphies striata*, *Fragum* sp. and *Asaphis violascens*), and sand and mud (*Tellina* spp. and *Anadara* sp.). All of these habitats are located within 1 km of Goemu (Figure 3).

Chronological changes

Just over half (55%) of shells from cultural taxa were restricted to XUs 1-10 which represent SU1a and the main midden deposit within 27 cm of the surface (Figure 40). That upper levels of Square B contain a higher proportion of shells compared to lower levels is borne out by the fact that the mean density of cultural shells in XUs 1-10 (10 shells / 10 litres of deposit) is treble that compared to XUs 11-17 (3 shells / 10 litres of deposit). Similarly, the number of cultural taxa per XU in upper levels (XUs 1-10) ranges from 6 to 13 which is more than the range (1-11) for lower levels (Table 20). Thus, formation of the main midden deposit over a rapid period of perhaps less than 50 years or less sees an increase in the density and diversity of shells. In terms of changes in shellfishing practices through time, the focus consistently remained bivalves supplemented by gastropods (Figure 40). However, a number

TABLE 20. Shellfish MNI, Square B, Goemu (shaded rows = non-cultural taxa).

Taxon	Tidal Zone	Substrate	MNI	%	1	2
Minimum number of taxa (total):					9	12
Minimum number of taxa (cultural):					8	12
GASTROPODS						
Cerithiidae	IT	SM	56		1	
Nerita spp.	UIT	RMT	47		2	4
Terebralia sulcata	IT	MM	16		1	2
Monodonta labio	UIT	RMT	8		1	1
Cypraea spp.	IT	RCR	8			
Melo sp.	IT+ST	S	2			1
Fissurellidae (Limpet)	IT+ST	RCR	2			
Strombus luhuanus	IT+ST	CR	2			
Syrinx aruanus	IT+ST	S	2		1	1
Planaxis sulcatus	IT	R	2			
Haminoeidae	IT+ST	SM	1			
Turbo spp.	IT+ST	RCR	1			
Nassarius splendidulus	IT+ST	S	1			
Pleuroploca sp.	IT+ST	CR	1			1
Oliva sp.	IT+ST	SCR	1			
Polinices putealis	IT+ST	SCR	1			
Pyrene sp.	IT+ST	RCR	1			
Subtotal:			152			
BIVALVES						
Paphies striata	IT+ST	S	273		9	9
Chama sp.	IT+ST	RCR	30		5	2
Fragum sp.	IT	S	19			
Tellina spp.	IT	SM	16			
Asaphis violascens	IT	S	9			
Anadara sp.	IT	SM	9		1	1
Polymesoda erosa	IT	MM	7			
Pinctada spp.	IT+ST	MSCR	3			2
Gafrarium sp.	IT	SM	3			
Tawera armata	IT+ST	S	2			
Cardita muricata	IT	S	2			
Anadara gubernaculum	IT	S	2			
Davila plana	IT	S	2		1	1
Mactra sericea	IT	S	2			

3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	9	7	9	11	15	8	11	5	11	7	8	5	11	4
9	7	6	9	10	13	7	10	5	10	5	5	1	5	1
	1				2	2	4		4	4	8	5	16	9
3	2	2		2	2	7	9	6	3	1	1		3	
3	4		1	1	1	2		1						
		1	1	1		1			2					
		1		1	4					1	1			
			1											
												1	1	
	1		1											
					1		1							
												1		
							1							
									1					
	1													
		1												
									1					
9	11	7	4	16	36	54	26	16	20	17	12	12	11	4
3			2	6	12									
1	1	1		1	2					1	3	3	4	2
2			3	1	3	3	1		1	1			1	
1	1		1	1	2		2						1	
2		1	1		1		1						1	
2				1		2	1	1						
					1									
					1				2					
													1	1
									1		1			
					1						1			
							1		1					

TABLE 20. Cont.d

Taxon	Tidal Zone	Substrate	MNI	%	1	2
Divaricella ornata	IT	S	1			
Dosinia sp.	IT	S	1			
Mytilidae	IT+ST	RCRMS	1			
Codakia tigerina	IT	S	1			
Acrosterigma vlamingi	IT	S	1			1
Arca avellana	IT	RCR	1			
Gafrarium australe	IT	SM	1			
Subtotal:			386			
POLYPLACOPHERA						
Chitons	IT+ST	R	8			
TOTAL:			546			

IT = intertidal, UIT = upper intertidal, ST = subtidal
R = rocks, CR = coral reef, S = sand, MT = mangrove trees, MM = mangrove mud, M = mud

of changes in shellfishing foci are evident moving from lower levels to upper levels of the sequence. For example, in terms of non-incidental cultural taxa, SUs 1a and 1b (XUs 1-11) contain all *Terebralia sulcata*, *Chama* sp. and *Polymesoda erosa*, and most *Asaphis violascens* (89%), *Anadara* sp. (89%), *Nerita* spp. (83%), *Tellina* spp. (81%), *Monodonta labio* (75%), *Cypraea* spp. (75%), and *Paphies striata* (72%).

CRUSTACEA

Crustacean remains were in the form of exoskeleton (crabs and crayfish) and shell (barnacles). Crab remains (mostly claws) totalling 83.1 g were found in all levels of Square B with most remains and highest densities found in SU2 (Figure 40, Appendix 2). While many crab remains in SU1a (main midden deposit) are likely to be food remains, most crab remains in SU2 are considered to be the result of natural deposition within biogenic shelly sands. Overall, crab contributed a minor albeit consistent part of local diets c.950-1,000 years ago. In marked contrast, a single crayfish mouthpart (0.1 g) was identified in XU16a and indicates clearly that crayfish represented an insignificant part of local diets. Only two barnacle shells were identified in Square B – goose barnacle (*Lepas* sp.) in XU3 (0.09 g) and acorn barnacle (Balanomorpha) in XU4 (0.13 g). Following Square A, the Square B barnacles are considered to be non-dietary and to have entered the site attached to either turtle shell or drift wood.

MATERIAL CULTURE

A broad range of material culture items made from stone, shell, ochre, metal, ceramic and glass was recovered from Square B.

Flaked stone artefacts

A total of 750 flaked stone artefacts (flakes and cores) weighing 129.9 g was recovered from Square B. Some of the artefacts exhibit bipolar flaking and indicate use of anvils to aid manufacture (Figure 44). Nearly all (n=726, 97%) flaked stone artefacts are made from quartz (milky and crystal) with

3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
										1				
													1	
													1	
									1					
						1								
											1			
1	1			2	1		1	2						

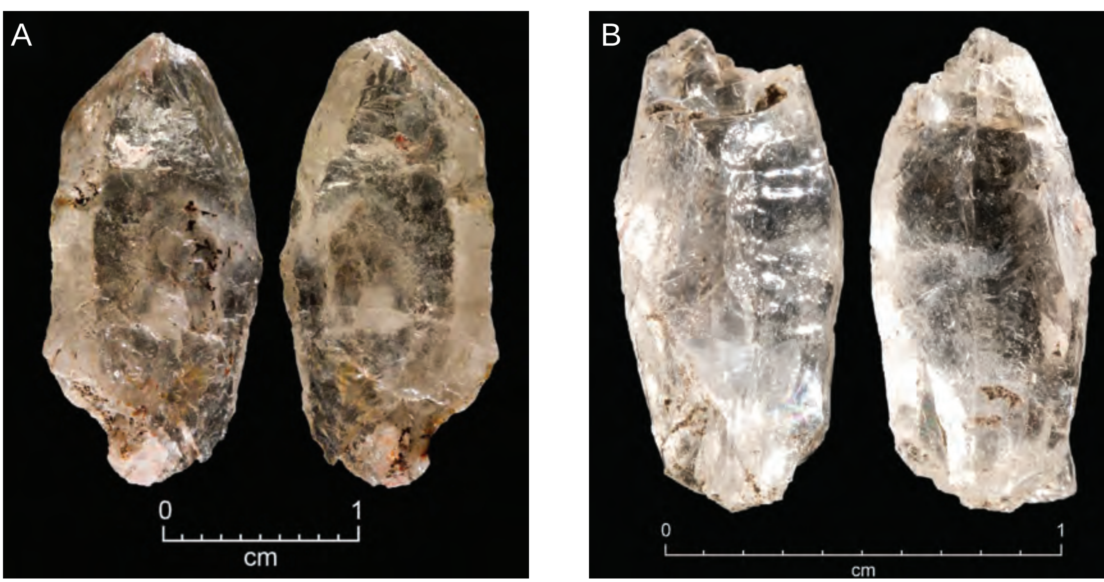


FIG. 44. Crystal quartz bipolar artefacts dating to c.950-1,000 cal BP from Square B, Goemu (A: crystal quartz flake, XU10, B: crystal quartz core, XU7).

the remainder made from volcanic stone (n=24, 3%) (Table 21). Both raw materials are available locally on Mabuyag and surrounding islets. The mean weight of flaked artefacts is 0.2 g with quartz artefacts (0.1 g) considerably smaller on average than volcanic artefacts (1.2 g). Most (94%) flaked artefacts were recovered from SU1 in XUs 1-11 with highest concentrations in XUs 8-10 in the lower sections of SU1a (Figure 40).

Shell artefacts

Four shell artefacts were recorded in Square B (Figure 45). First, a right hinge section of a large pearl shell (cf. *Pinctada maxima*) from XU1 exhibits flaking and subsequent smoothing (bevelling) in two locations along a convex edge (Figure 45A). The artefact has a maximum length and thickness of 50 mm and 13 mm respectively, weight of 18.7 g and given that it is found in the surface deposits of the site it could date to anytime between 100 and 950 years ago. The form of the artefact is consistent with ethnographically-recorded pearl shell scrapers from Mabuyag. For example, Haddon (1912: 65) noted that 'leaf-strips used in the making of mats and baskets are rendered supple by being scraped with … semilunar pieces of pearl-shell of which the convex edge is blunt and smooth through

TABLE 21. Flaked stone artefact raw materials, Square B, Goemu.

XU	Total (#)	Total (g)	Quartz (#)	Quartz (g)	Volcanic (#)	Volcanic (g)
1	8	13.2	6	3.1	2	10.1
2	23	2.3	22	2.2	1	0.1
3	46	5.9	39	2.8	7	3.1
4	41	3.7	41	3.7	0	0
5	30	6.2	28	3.8	2	2.4
6	25	1.6	25	1.6	0	0
7	73	6.1	73	6.1	0	0
8	126	13.6	123	13.0	3	0.6
9	156	39.7	155	38.5	1	1.2
10	100	18.7	98	16.0	2	2.7
11	74	9.9	72	5.4	2	4.5
12	24	5.1	22	2.7	2	2.4
13	10	1.5	9	0.5	1	1.0
14a	3	0.2	3	0.2	0	0
14b	3	0.7	3	0.7	0	0
15a	0	0	0	0	0	0
15b	0	0	0	0	0	0
16a	5	0.5	4	0.4	1	0.1
16b	0	0	0	0	0	0
16c	0	0	0	0	0	0
17a	3	0.1	3	0.1	0	0
17b	0	0	0	0	0	0
17c	0	0	0	0	0	0
Total	750	129.0	726	100.8	24	28.2

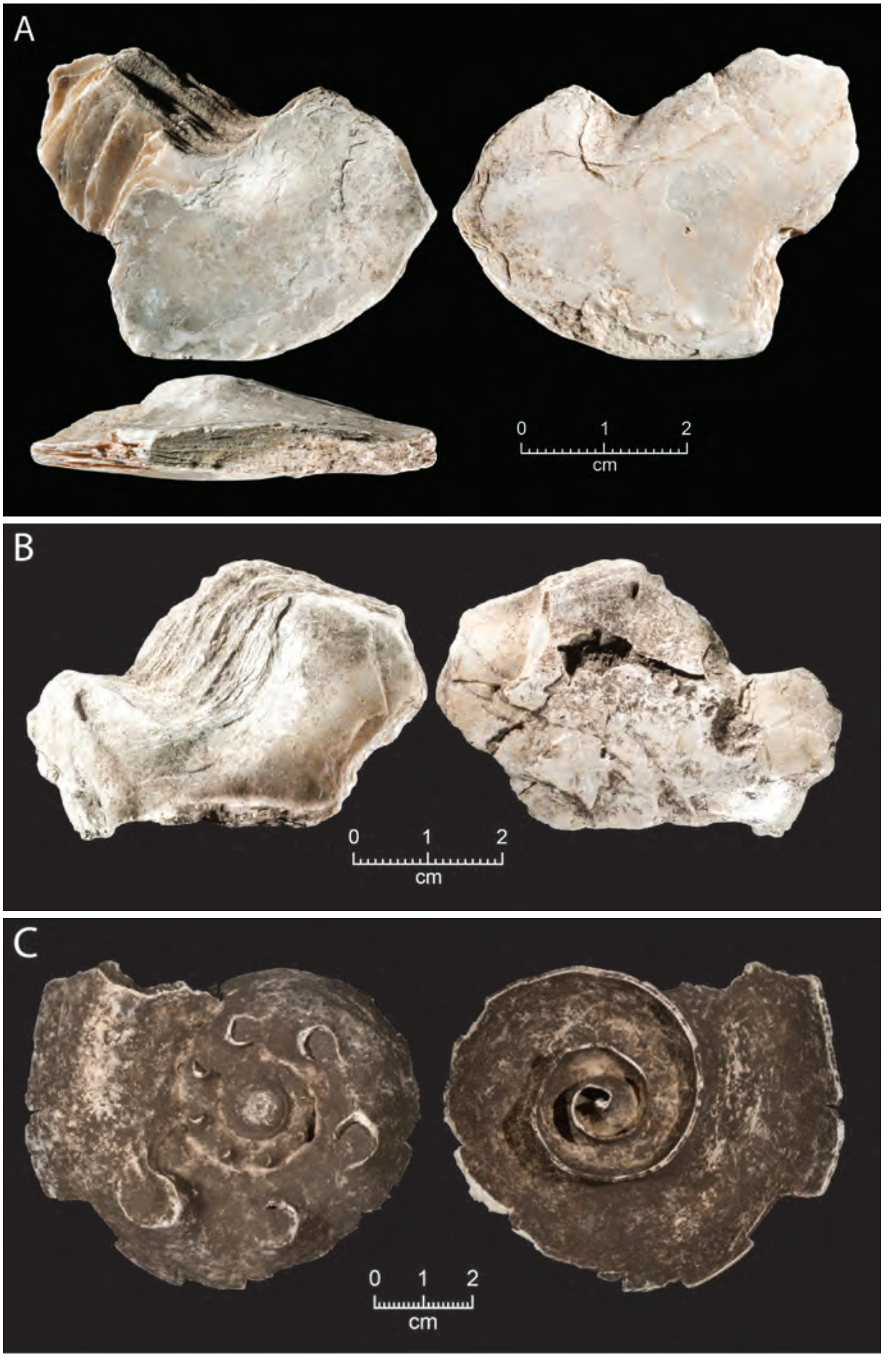


FIG. 45. Shell artefacts from Square B, Goemu.
A: *Pinctada maxima* hinge scraper, XU1, dating to c.100-950 cal BP.
B: *Pinctada maxima* hinge scraper, XU2, dating to c.950-1,000 cal BP.
C: *Melo* sp. shell container fragment, XU6, dating to c.950-1,000 cal BP.

use … their length varies from about 10-16 cm' (Figure 46). Similarly, Haddon collected a pearl shell scraper that exhibits 'signs of rubbing or polishing' from Mer in the Eastern Islands in 1898 (Moore, 1984: 65, Pl. 30 #248) (Figure 47).

Second, another modified hinge (left) fragment of a large pearl shell (cf. *Pinctada maxima*) was recovered from XU2 (Figure 45B). It has a maximum length and thickness of 54 mm and 15mm respectively, weight of 22.3 g and similarly dates to within the past 950 years. Unlike the XU1 artefact, the XU2 artefact exhibits flaking without edge smoothing. This artefact also probably functioned as a scraper.

Third, an olive shell (*Oliva* sp.) with a maximum length and width of 12.2 mm and 6.6 mm respectively was found in XU4 and probably dates to the time of midden formation c.950-1,000 years ago. The shell is whole except for removal of the apex (protoconch) and an underlying internal section of columella such that a straight internal passage has been created from one end of the shell to the other (i.e. from the apex to the anterior canal). Similarly modified olive shells were recorded ethnographically in Torres Strait as beads for body adornments in the form of necklaces and headdresses (Haddon, 1912: 41, Plate IX, 1935: 183, 198, 295; Moore, 1984: 69, 100, Pl. 34 #301, Pl. 35 #305, Pl. 77 #663).

Fourth, the apex of a large *Melo* sp. shell (38.7 g, 83 mm maximum length) was recovered from XU6 and dates to c.950-1,000 years ago (Figure 45C). The fragment exhibits flaking which has removed internal whorls consistent with baler shell containers known ethnographically for the region (Haddon, 1912: 122-123, 1935: 302-303).

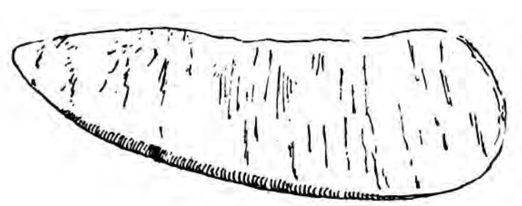


FIG. 46. Pearl shell scraper from Mabuyag, collected by Alfred Haddon, 1898 (from Haddon, 1912: Fig. 82; see also Moore, 1984: 43).

FIG. 47. Pearl shell scraper from Mer, collected by Alfred Haddon, 1898. Length: 14.8 cm (Courtesy: CUMAA, Z.7971) (Moore, 1984: 65, Pl. 30 #248).

Ochre

A total of 241.5 g of ochreous rock was excavated from Square B. Most (90%) ochre occurred in XUs 1-6 within the upper sections of SU1a within 10 cm of the surface dating mostly to c.950-1,000 years ago (Figure 40, Appendix 2). No ochre was found in XUs 16 and 17. Following local ethnographic information, most ochre from Square B was probably used as a source of pigment (McNiven & David, 2004).

Rocks

A considerable amount of rock (59.0 kg) was recovered from Square B. Nearly all (99%) came from XUs 1-12 (SU1) where the mean density was 1.4 kg / 10 litres of deposit (Figure 40, Appendix 2). However, highest densities were recorded in XUs 1-7 within 14 cm of the surface where the mean density was 2.8 kg / 10 litres of deposit. The rock assemblage is dominated by angular fragments of local volcanic rock and most appear to be fire-cracked cooking stones associated with ground ovens (*amai*) (see also

Ghaleb, 1990: 370). However, as no cooking pit features were located within the midden deposits, it is probable that the rocks were used in ovens located elsewhere at Goemu. In contrast, the two pit features within SU2b with concentrations of charcoal and fire-cracked rocks are seen as in situ ground oven features dating to c.950-1,000 cal BP (see above).

Ceramics

Ceramic sherds were recovered from XU1 (n=3, 44.1 g), XU2 (n=8, 230.3 g) and XU3 (n=1, 20.4 g). All sherds are a stoneware with decoration confined to white-cream-coloured glaze on inner and outer surfaces. All ceramic pieces are curved body sherds except for a single tabular base sherd in XU1. One sherd exhibits white-cream glaze on the inner surface and a light tan glaze on the out surface (XU2). The curvature on a sherd from XU2 (Find #35) is consistent with a vessel with an outside diameter of 23.5 cm. All sherds appear to derive from a large vessel, with the form, size and colour of sherds consistent with a demijohn dating to either the late nineteenth or early twentieth century (see Surface Collections section below). Demijohns were used to carry water from a spring immediately south of Goemu back to the village (Cygnet Repu, Mabuyag, pers. comm. 2010).

A 70 mm-long base sherd from XU1 (Find #94) features bifacial flaking along one edge (Figure 48). The flaking is systemic and clearly is not the result of treadage or accidental breakage. As such, the flaking is associated with deliberate modification of the sherd edge, most likely to create an implement such as a scraper.

Metal

A total of 717 rusty metal fragments weighing 36.5 g was recovered from Square B (Appendix 2). The fragments are small (mean weight = 0.05 g) and tend to be thin

FIG. 48. Flaked ceramic sherd, Sq B XU1, Goemu.

chips representing rusty pieces of thin metal or rust spalls from larger pieces of rusty metal. The source objects for the rusty fragments are unknown. The largest piece of metal came from XU2 (1.60 g, 26 mm maximum length). While metal fragments were found from XU1 down to XU10 at a depth of 27 cm, most fragments by number (n=484, 68%) and weight (29.5 g, 81%) were found in XUs 1-4 within 7 cm of the surface. Furthermore, the maximum length and mean weight of metal fragments decreases dramatically below XU3, a pattern consistent with vertical downward displacement of smaller metal fragments through post-depositional disturbance such as bioturbation (see above) (Figure 49). All metal fragments are considered to date to the nineteenth and possibly early twentieth centuries.

BOTTLE GLASS

A total of 1528 pieces of glass weighting 4788.9 g was recovered from Square B (Appendix 2). While glass was found in XUs 1 to 10, nearly all pieces by number (1223, 80.0%) and weight (4668.8 g, 97.5%) were restricted to the upper 5 cm of deposit in XUs 1 to 3. The very high

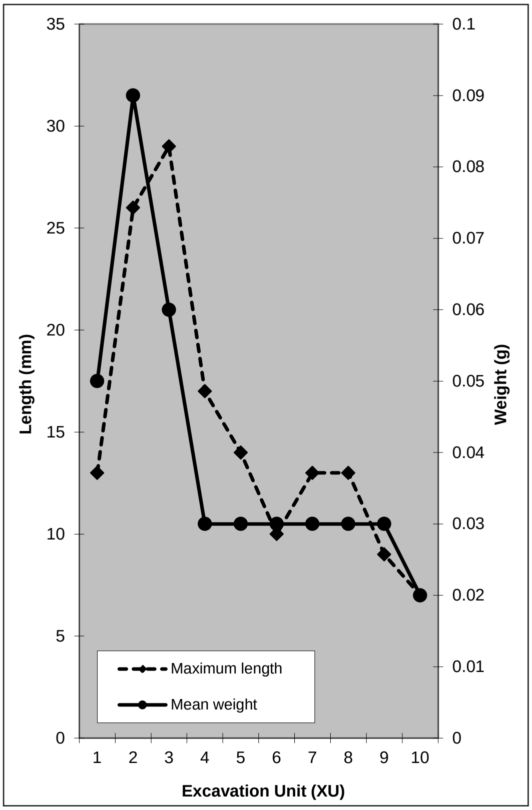


FIG. 49. Vertical changes in the size of metal fragments, Square B, Goemu.

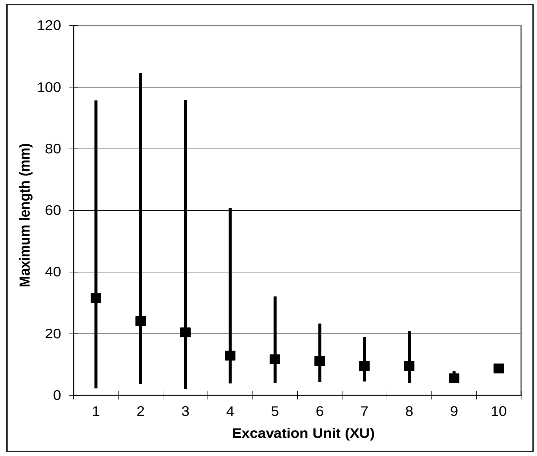


FIG. 50. Maximum length (range and mean) for glass fragments in Square B, Goemu.

density of glass in surface levels of the midden deposit is indicated by a mean density of 224 pieces of glass per 10 litres of deposit in XUs 1 to 3. All pieces of glass were broken fragments with all diagnostic pieces deriving from bottles.

Fragment size

Pieces of glass ranged in maximum length from 2 mm to 105 mm with a mean of 22 mm. This small mean size reflects the highly fragmented state of the glass assemblage. The mean maximum length of glass pieces in XUs 1-3 (24.4 mm) is double the mean length in XUs 4-10 (11.9 mm) (Figure 50). This pattern, coupled with decreasing mean length with depth moving from XUs 1 to 10, is consistent with most glass pieces in XUs 4-10 not being in situ but the result of post-depositional disturbance and downward movement through bioturbation (see also McNiven *et al*., 2009b).

Colour

Glass colour could only be identified on 1417 pieces as weathering patination masked glass colour on 111 pieces. Of the 1417 diagnostic pieces, three different colours of glass were identified – green (n=1115, 79%), clear with a green tinge (n=276, 20%) and clear (n=26, 2%). As such, nearly the entire assemblage is green glass as essentially all of the 'green tinge' pieces were small and thin and most likely would be green if larger and thicker in size.

Corrosion

Most of the glass assemblage (n=1256, 82%) exhibited signs of weathering and corrosion due to exposure to alkaline sediments, high rainfall and salt from the adjacent sea (see Hamilton, 1999; McLoughlin *et al*., 2005; Römich, 2003). Most of these fragments (n=1157, 76%) exhibited heavy weathering in the form of surface leaching to form a white patina crust (calcium-rich silicate layer), pitting and iridescence, with the remaining non-patinated fragments showing

TABLE 22. Diagnostic bottle parts, Square B, Goemu,

Part	#	%
Stopper	2	0.2
Finish	7	0.8
Neck	52	6.1
Shoulder	3	0.4
Body	674	79.5
Base	13	1.5
Base + body	36	4.2
Body + shoulder	22	2.6
Shoulder + neck	15	1.8
Neck + finish	23	2.7
Body + shoulder + neck	1	0.1
Total	848	100

surface pitting and iridescence (n=99, 6%). As surface pitting and iridescence was observed on many glass fragments where the thick, white surface crust exfoliated away with handling during analysis, it is probable that many non-patinated glass fragments were once patinated.

Bottle part and decoration

No complete or near-complete bottles were recovered. Of the 848 pieces of glass where bottle parts could be determined, most pieces were body fragments (79.5%), followed by neck fragments (6.1%) and base and body fragments (4.2%) (Table 22). Thirty fragments exhibited bottle tops, all with an applied finish. Two conjoinable fragments of a glass stopper (XU1, Finds #30 & #98) were also recorded (Figure 51). Only one piece of glass exhibited three bottle parts – a neck, shoulder and body fragment from XU1. None of the 1528 glass fragments exhibited embossed lettering or designs.

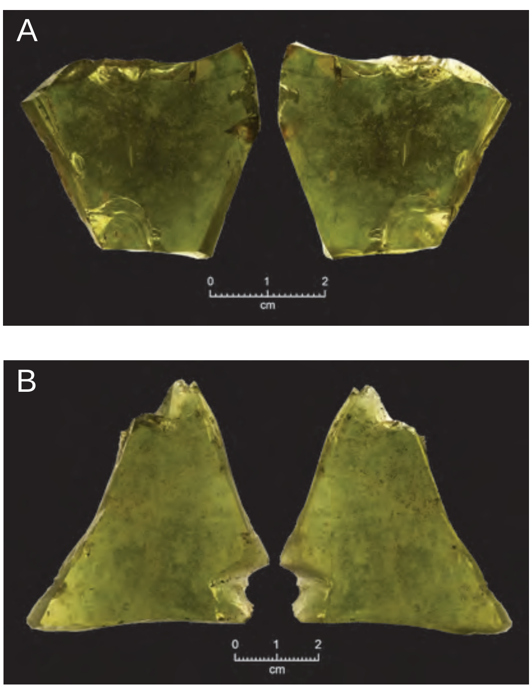
Bottle type and date of manufacture

Of the 851 glass fragments where the original basic bottle form (round or flat sided) could be determined, nearly all (n=848, 99.6%) were from round (i.e. cylindrical) bottles. Only three fragments were from flat-sided bottles, such as case gin bottles. The highly fragmented nature of the bottle assemblage also limited insights into moulding techniques and date of manufacture. Despite this limitation, a number of pieces exhibited a mould seam running up the neck and terminating near the neck finish. Also, all diagnostic finish fragments exhibited an applied molten glass finish which was shaped by tooling to create a rim or lip with a top surface that is angled/bevelled and a band or collar just below the rim (i.e. 'champagne' type finish) (Figure 51). Such finishes were manufactured from the 1880s through to 1920. The form, colour and finish of bottles are consistent with wine bottles (Boow, 1991: 68; Coutts, 1984; Lindsey, 2010).

FIG. 51. Bottle part types, Square B, Goemu (Top stopper, XU1, #30 & #98; Bottom: finish and neck fragment, XU2, #2).

Glass flaking

A high proportion of glass fragments were either flakes with a diagnostic ventral surface indicative of removal from a larger piece of glass (n=535, 35%) or cores with diagnostic flake removals at least 10 mm in length (n=34, 2%). Flakes ranged in maximum length from 2mm to 32 mm (mean = 9.2±0.2 mm) and in weight from 0.01 g to 2.38 g (mean = 0.11±0.01 g). In contrast, cores were much larger, ranging in maximum length from 20 mm to 81 mm (mean = 43.8±3.3 mm) and in weight from 0.9 g to 82.0 g (mean = 10.7±2.5 g). Ten cores showed signs of bipolar flaking (i.e. anvil resting to aid flaking). The mean length of bipolar cores is 39.4 mm while the mean length of the longest flake scar on these cores is 16.1 mm (Figure 52). The lack of bipolar flakes is curious and may reflect that very few flake removals from bipolar cores extended the entire length of the core. The mean length of free-hand percussion cores was 45.7 mm with the mean length of the longest flake scar 14.3 mm. Retouching (defined as flake scars ≥2



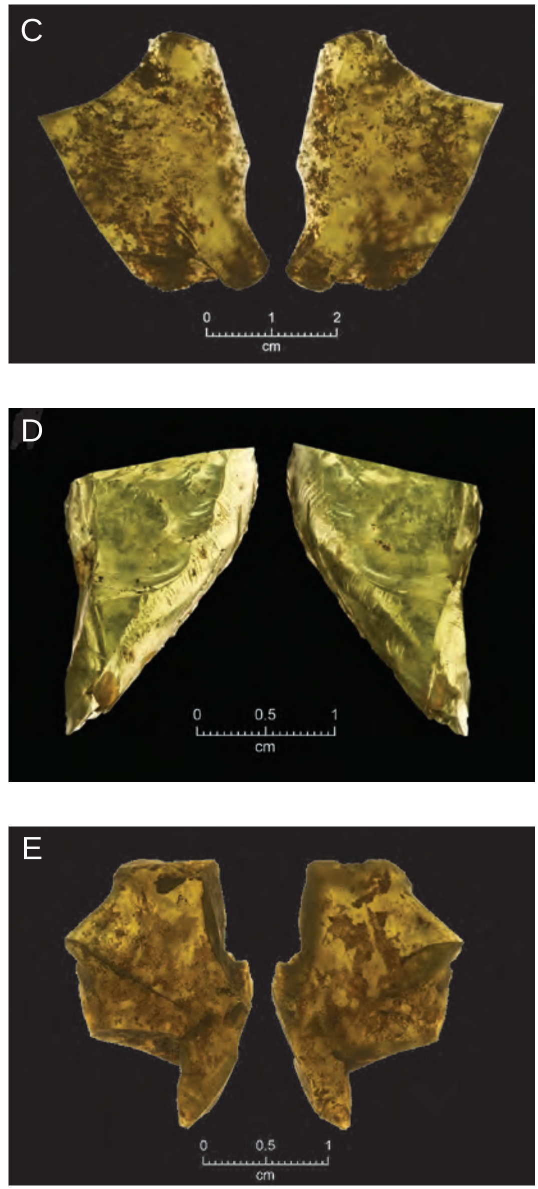


FIG. 52. Flaked bottle glass artefacts (bipolar cores), Square B, Goemu. (A: XU3, #39; B: XU2, #125; C: XU3, #17; D: XU3, #29; E: XU1, #114).

mm in length extending continuously for at least 10 mm along an edge) was found on one flake with all remaining 44 examples of retouching located on glass sherds (Figure 53). While many flakes and cores probably were the result of accidental breakage, many flakes, cores (especially bipolar cores) and retouched pieces appear to have been deliberately produced to form cutting and scraping tools.

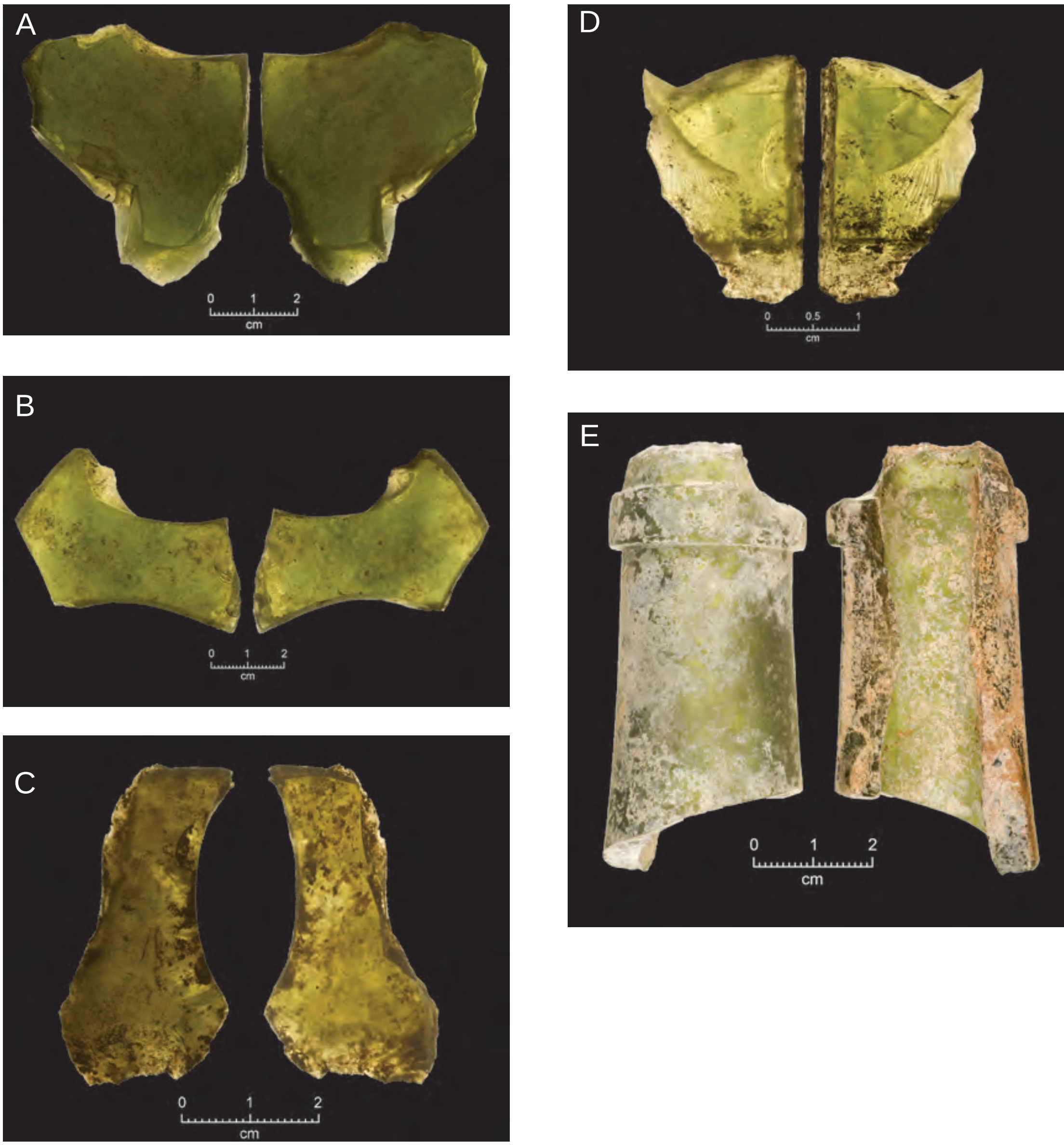


FIG. 53. Flaked bottle glass artefacts (retouched sherds), Square B, Goemu. (A: XU1, #79; B: XU2, #117; C: XU3, #30; D: XU1, #97; E: XU1, #29).

SURFACE COLLECTIONS

STONE ARTEFACTS

Two stone artefacts representing formal implement types were surface collected by one us (IM) from Goemu in November 1996. Both artefacts are in the care of the Gumulgal Kod cultural heritage group on Mabuyag and on display in a glass case in the Mabuiag Island community library.

Gabagab

A fragment of a stone club head known locally as *gabagab* was found in the southeast section of Goemu (McNiven, 1998) (Figure 54). It most likely dates to the nineteenth century given is surface stratigraphic context. The artefact is half of a crudely-shaped, knobbed club head with the remains of an hourglass-shaped hafting hole and six rounded knobs aligned evenly into two rows. When complete the *gabagab* would have exhibited two rows of eight knobs (16 knobs in total). The raw material is volcanilithic sandstone which is unknown for Mabuyag and surrounding islets but outcrops in layers on selected islands in the Prince of Wales group, southwest Torres Strait. As such, the club head was most likely traded northwards to Mabuyag through ethnographically-known trade routes (Vanderwal, 2004). Stone club heads are well-documented ethnographically in Torres Strait as weapons and exchange items (McNiven, 1998; McNiven & von Gnielinski, 2004).

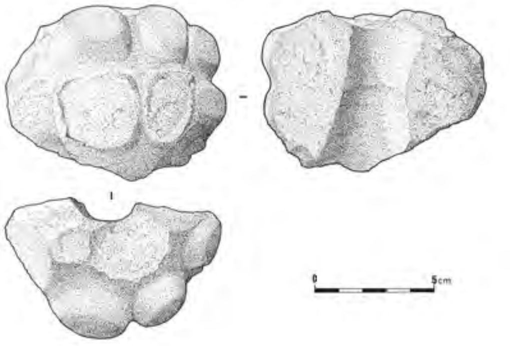


FIG. 54. Stone club head (*gabagab*), 1996 surface collection, Goemu.

Axe/adze

A 5.5 cm-long axe/adze was in the southeast section of Goemu near to where the *gabagab* was found (Figure 55). Raw material is a dark green-grey very fine-grained chlorite altered equigranular hornblende(?)-pyroxene-plagioclase microdiorite or possibly a microgabbro (Friedrich von Gnielinski, Geological Survey of Queensland, pers. comm. 2013). The source of this raw material is likely to be a dyke outcrop within the Badu Suite. As no known sources of such dyke material have been recorded on Mabuyag, it is likely the stone axe/adze was imported from another island in western Torres Strait. The UCL team also surface collected a ground-edge 'stone adze' (fragment) from Goemu (Ghaleb, 1990: Figure. 13a, 308).

FIG. 55. Stone axe/adze, 1996 surface collection, Goemu.

SHELL ARTEFACTS

Four shell artefacts were collected from the surface of Goemu by one of us (IM) during the excavation field season in November/ December 2005 (Figure 56).

Curved shell band

This shell artefact was collected 1.8 m west of the northwest corner of Square B (Surface Find #10) (Figure 56A). It has a maximum length of 52 mm, width of 12 mm, thickness of 7 mm, and weighs 8.5 g. The artefact appears to be a section of spiral ridge from a very large gastropod that has been ground flat on the sides leaving the crest of the ridge intact. Extrapolation from the curvature of the band indicates the shell had a diameter of 14 cm which is approximately the diameter of the second last spiral ridge on an adult trumpet shell (*Syrinx aruanus*) (*bu* in Mabuyaagi language). The artefact may have formed part of a body adornment.

Ground and drilled clam shell

This object was collected adjacent to the northeast corner of Square B (Surface Find #11) (Figure 56B). It has a maximum length of 42 mm, width of 30 mm, thickness of 11 mm and weighs 13.9 g. The raw material appears to be giant clam shell (*Tridacna gigas*) which has been ground to form a lobe-shaped object which is lenticular in cross-section. One end of the object exhibits a break that has truncated a drilled hole that is biconical in section. The function of the object is unknown but its form, including perforation, suggests a body adornment.

Ground and grooved clam shell

This item was found 10 m south of the shed located in the centre of Goemu (Figure 56C).

FIG. 56. Shell artefacts, 2005 surface collection, Goemu (A: shell band fragment, surface collection #10; B: clam shell adornment fragment, surface collection #11; C: clam shell adornment fragment, surface collection; D: pearl shell button, surface collection #12).

The broken fragment has a maximum length of 52 mm, width of 27 mm, thickness of 12 mm and weighs 21.9 g. The raw material is a thick piece of shell consistent with giant clam shell (*Tridacna gigas*). It exhibits grinding across one face, across part of the opposite face, and along one margin. The face with extensive grinding also features of curvilinear groove that is 1.6-1.8 mm wide and 0.7 mm deep. Fractured surfaces on three sides of the object and truncated grinding indicates the object comes from a larger artefact. While the function of the object is unknown, the decorative groove suggests some form of body adornment.

Pearl shell button

The complete button was found in the southern part of Goemu near Square B (Surface Find #12) (Figure 56D). It has a diameter of 18.2-18.4 mm and thickness of 1.3-1.6 mm with a weight of 0.7 g. The centre of the button exhibits two holes set into a depression on one side only. While parsimony suggests the button formed part of an article of clothing, ethnographically-known incorporation of buttons as decorative items on material culture such as dance arm-guards, shell pubic covers, *dibidibi* chest ornaments and *dari* headdresses (Florek, 2005: 80, 83, Fig. 71; Haddon, 1912: 71-72, Pl. XIV, Fig. 11) suggests a range of uses should be entertained.

METAL ARTEFFACTS

Numerous small pieces of rusty metal occur across the surface of Goemu. A major concentration of such items representing 'corrugated iron roofing' and 'a large drum used as a water container' are associated with a house dating to the late 1940s / early 1950s located at the far southern end of Goemu (Ghaleb, 1990: 184). Only one item was collected.

Cast iron decorative fitting

This item was found 12 m south of the shed located in the centre of Goemu (Figure 57). It is a heavily-rusted cast iron decorative fitting with a fleur-de-lis design in relief on two sides. The object weights 340.2 g and measures 65 x 72 x 29 mm. Two parallel metal tubes run through the object and appear to have been incorporated into the floral fitting during the casting process. The internal diameter of the tubes is 8 mm. These tubes appear to be remnants of longer sections of tubing that extended out from the decorative fitting. Similar items are found in headboards and footboards of nineteenth century cast iron beds. Whether or not the decorative fitting entered Goemu as is or part of a complete bed is unknown.

FIG. 57. Cast iron flur-de-lis, surface collection, Goemu.

DISCUSSION

VILLAGE ESTABLISHMENT AND EXPANSION

Excavations reveal the onset of midden formation (i.e. base of SU1) around c.950-1,000 cal BP in the southern part of Goemu (Square B) and c.800 cal BP in the northern part of the village (Square A). As mounded midden formation is associated with the beginnings of village life (at least ephemerally – see McNiven, 2012; Wright & Goemulgaw Kod, 2011), establishment of Goemu most likely took place during the 10th century AD. If the difference in the commencement of midden formation in Squares A and B is representative for midden development across Goemu respectively, then village formation may have commenced across the larger southern sections first and then expanded to include the smaller northern sections of the site. This dating compares favourably with radiocarbon dates of 600±70 BP (c.550 years ago) and 1,050±100 BP (c.900 years ago) obtained by the UCL team (Harris & Ghaleb, 1987: 18) on charcoal near the base of midden deposit in Square M (depth = 35 cm) and immediately under the midden deposit in Test Pit 7 (depth = 42 cm) respectively. Square M is located 5 m S of Square A and Test Pit 7 is located 17 m SSW of Square A (Figure 7).

Expansion of midden deposits across the northern parts of Goemu commencing around c.800 years ago was followed by major increases in midden deposition and mound formation c.350-400 cal BP. This midden expansion probably represented an expansion of Goemu village related to increased population which most likely was sustained through to the end of midden deposition and abandonment of the village 100 years ago. This pattern of occupation at Goemu is significant because it fits in with broader historical processes operating across much of Torres Strait during the past 600-800 years modelled by McNiven (2006b). That is, while marine specialists have been living in Torres Strait for at least 6,000-7,000 years (Wright, 2011), the past 600-800 years 'herald the emergence of ethnographically-known social arrangements marked by a rapid phase of site establishment and intensified site use consistent with population increase' (McNiven, 2006b: 1).

Early stone alignment

Sometime between c.900 and c.1,650 cal BP, a stone alignment was constructed at the northern end of Goemu. While this feature pre-dates midden deposit in Square A, it is possible that the structure was either built, or at least known about, by people who created the Square B midden mound at the southern end of Goemu c.950-1,000 cal BP. The stone alignment is located within prograded shell beach sands which contain very low densities of cultural materials (bones, shells and stone artefacts). No evidence indicates the stone alignment is a domestic structure. It is probable that the alignment is ceremonial given that existing archaeological and ethnographic evidence for the region similarly associates stone alignments dating to before European settlement with ceremonial practises (e.g. David *et al*., 2004; McNiven *et al*., 2004; see also Ash *et al*., 2010; Ghaleb, 1990: 184; McPhee, 2004). While speculative, it is hypothesised that the stone alignment found buried at Goemu represents some form of ceremonial stone arrangement constructed near the beach immediately north of the early settlement area of Goemu around 950-1,000 cal BP. Eventually the feature was buried in shelly beach sands and soon after midden deposit began forming at the same location as a result of increased settlement of Goemu.

Comparisons with Pulu

Expansion of settlement activity at Goemu c.800 cal BP and particularly c.350-400 cal BP parallels settlement changes and cultural developments on the nearby islet of Pulu.

Excavations at Tigershark Rockshelter midden located at the southern end of Pulu revealed 'a major burst of activity between 500 and 700 cal BP after which occupation of the site essentially ceased' (McNiven *et al*., 2008: 29). McNiven *et al*. (2008: 29) hypothesised that for Mabuyag Islanders, 'small sites such as Tigershark Rockshelter may have become obsolete as Mabuyag settlement arrangements 500 years ago required larger, more communal settlements (i.e. open villages) to accommodate numerous people for extended periods of time'. Extended understanding of the chronology of Goemu allows comparisons to be made with midden formation at Tigershark Rockshleter. While a major increase in midden mounding activity was recorded at Goemu c.350-400 cal BP, initial expansions took place sometime between c.400 and 800 cal BP at around the same time occupation intensified at Tigershark Rockshelter c.500-700 cal BP. Cessation of occupation of Tigershark Rockshelter c.500 cal BP coincides with the final phase of settlement expansion at Goemu and development into its ethnographically-known form. This final phase also coincided with intensified occupation of the village at the northern end of Pulu around 500 years ago before it was abandoned around 400 years ago to make way for establishment of the ceremonial *kod* site (McNiven *et al*., 2009a). Thus, archaeological excavations on Pulu indicate that the unfolding occupational history of Goemu was linked socially to broader changes in settlement patterns taking place across other parts of Goemulgaw territory.

LANDSCAPE CHANGE

Charcoal and land snails provides rare insights into the Goemu landscape both prior to and during village occupation.

Pre-village landscape burning

Both Squares A and B registered a bimodal distribution of charcoal with the upper peak associated with midden deposits and the lower peak associated with pre-midden deposits dating to before c.800 cal BP (Square A) and c.1,000 cal BP (Square B). While the upper charcoal peak is associated with hearths, the lower peak is more complex as little evidence exists for occupational activity in these levels. It is probable this lower concentration of charcoal reflects deliberate burning of local vegetation to open up the area for camping and other activities. A similar pattern of pre-midden landscape burning has been documented on the islet of Koey Ngurtai located 5 km south of Mabuyag (David *et al*., 2009). Landscape burning may also help explain the anomalous date of 6950 years ago obtained from the lower charcoal concentration in Square A. Local burning most likely included the adjacent hill slope, resulting in removal of ground cover and the exposure of sediments to erosion from rainfall runoff. It is possible that erosion associated with fires around 900 cal BP exposed 6950 year old charcoal which subsequently washed down-slope and became mixed with beach deposits. Higher levels of pumice associated with the pre-midden charcoal concentration in Square A may reflect the increased ability of beach pumice to be blown inland due to the removal of vegetation ground cover through firing.

Village trees and shade

Today, Goemu is largely grassland with a few scattered coconut trees. Yet the six species of land snails excavated from Squares A and B indicate that vine thickets once existed across much of Goemu during the period of midden formation (i.e. village occupation). On many islands of Torres Strait, vine thickets are found typically on rocky areas, often adjacent to the sea. The rocks, apart from providing rich soils through breakdown, also act as a moisture sink and offer some protection from fire. This regime favours nutrient-hungry, fire-sensitive rainforest plants. In some cases, vine thickets also occur on foredunes where there has been an inadvertent accumulation of nutrients to allow the establishment of rainforest plant species. The vine thicket, once established on the sand, would create its own nutrient cycle through annual leaf fall and the subsequent decomposition of the litter. At Goemu, this process of vine thicket development was aided considerably by village establishment and associated midden formation. That is, paedogenesis was enhanced at the site by increased human occupation which led to organic enrichment of local sediments through discard of food remains etc. The rocky slope backing Goemu was probably also covered in vine thicket in the past. Its demise was most likely due to seasonal burning of the surrounding grassland. In the latter case the damage would have been gradual through the destruction of the outer layer of trees with the onset of each burn.

A key implication of the land snail evidence is that rainforest trees once existed across Goemu village. It is likely that these trees were scattered across the village to provide shade in between houses. It is highly unlikely that these trees were exposed to fire damage as open fires would have been a major risk to the traditional form of thatched house (Figure 58). With the cessation of formal use of the village in the late nineteenth century, regular burning of the site probably caused cumulative damage to these trees and their eventual

FIG. 58. House on fire, Mabuyag, 30 September 1898. Photograph by Alfred Haddon. (CUMAA: N.22987.ACH2).

demise. Thus, grasslands which currently occur across Goemu represent the results of a century of fire management of the site.

Pumice and vegetation clearance

The restriction of most pumice to midden levels and not in underlying pre-midden levels suggests that the occurrence of pumice is related to human occupation of Goemu. One hypothesis to account for this pattern is that as grass cover of Goemu is removed with human occupation, beach deposits of pumice can move more freely inland by the wind uninhibited by vegetation cover. Alternatively, pumice may have been purposely collected from beaches and deposited on site. While small pieces of pumice were recorded ethnographically across Torres Strait as being used as an abrasive (Haddon, 1912: 127, 1935: 403; see also Ghaleb, 1990: Fig. 19b), most of the pieces of pumice at Goemu are small water-rolled nodules showing no signs of human use.

RITUALISED MIDDEN FORMATION

Ghaleb (1990) recognised that midden deposits at Goemu were more than simply accumulations of refuse. The highly structured way midden materials were formed into mounded linear, circular and platform features indicated to Ghaleb that these deposits also had ceremonial and symbolic dimensions. That Torres Strait Islanders carefully curated subsistence-related remains was explored in detail by McNiven and Feldman (2003) in relation to dugong bone mounds. They noted that across the western and central parts of Torres Strait, dugong bones were often arranged into carefully constructed mounds. It was argued that these bone mounds were associated with hunting magic rituals and were seen to have broader social and spiritual meaning. An important implication of McNiven and Feldman's (2003) study was that if dugong bones were placed into special mound sites then many midden deposits at settlement sites would under-represent dugong bones and dugong hunting and subsistence activities. More recently, McNiven & Wright (2008) explored 'ritualised marine midden formation' at Goemu and concluded that the separation between ritualised dugong bone mounds and secular middens was more complex and blurred. They found that:

> Compositional analysis of the three types of mounded midden features at Goemu (circular, platform and ridge) reveal some similarities with ritual dugong bone mounds, viz. ribs and usually skull bones are the majority component (by weight) of dugong bone assemblages. On the other hand, key features of midden mounds that distinguish them from ritual bone mounds are the higher representation of dugong limb bones and vertebrae and considerable quantities of other midden materials (e.g. shells, fish and turtle bones, stone artefacts, cooking stones and charcoal) (McNiven & Wright, 2008: 142-143).

Analyses of midden deposits at Goemu by McNiven & Wright (2008) were limited to the 2005 Square A excavations and 1985 excavations documented by Ghaleb (1990). The 2005 excavation results from Square B add to the emerging picture of complex, varied and ritualised middening practices at Goemu village. Three key components of Square B that add to this picture are dugong bones, bottle glass, and dog and human teeth.

Dugong bones

While compositionally the Square B linear mound feature conforms to other mounded midden features at Goemu, the quantities and densities of dugong bone and representation of dugong bone types place the deposit much closer to dugong bone mounds. For example, whereas the density of dugong bone in SU1a in Square A was 0.2 kg / 10 litres of deposit, in Square B the density of dugong bones in SU1a was eight times higher at 1.5 kg / 10 litres of deposit. Similarly, the mean dugong MNI (based on ear bones) in SU1a in Square A is 0.25 dugongs / 10 litres of deposit while in Square B it is nearly six times higher at 1.44 dugongs / 10 kg of deposit. At Dabangay Bone Mound located on the northeast coast of Mabuyag, the mean dugong MNI (also based on ear bones) is 3.22 dugong / 10 litres of deposit which is 12.9 times the density of Square A and 2.2 times the density recorded in Square B at Goemu (McNiven & Bedingfield, 2008). For the Moegi Sibuy dugong bone mound at the ceremonial *kod* site on Pulu, the density of dugong bones is 1.6 kg / 10 litres of deposit and the mean MNI (based on ear bones) is 2.3 dugongs / 10 litres of deposit. As such, while dugong bone mounds contain a higher density of dugong MNIs compared to midden deposits at Goemu, Square B midden at Goemu contains the same density of dugong bones as found at Moegi Sibuy dugong bone mound on Pulu.

In terms of dugong skeletal element representation, a more complex picture emerges on the comparability of Squares A and B to dugong bone mounds. For example, Square A was dominated by ribs and few skull bones (62% and 16% of all elements respectively) while Square B was dominated by skull bones and few ribs (85% and 13% of all elements respectively). In this sense, both Squares A and Square B resemble dugong bone mounds as the representation of skull bones and ribs at excavated dugong bone mound sites varies considerably: Tudu Bone Mound (Square K10): 8% and 92% respectively, Koey Ngurtai bone mound KN6: 21% and 57% respectively, Koey Ngurtai KN17: 42% and 31% respectively, Moegi Sibuy bone mound: 48% and 50% respectively, and Koey Ngurtai KN18: 78% and 8% respectively (Skelly *et al*., 2011). Similarly, while the moderate representation of vertebrae and limbs (including scapula) bones in Square A (19%) compares favourably with that found in Koey Ngurtai mounds KN17 (26%), KN6 (22%) and KN18 (13%), the low representation of these bones in Square B (2%) compares well with values found in Moegi Sibuy bone mound (2%) and Tudu Bone Mound (<1%).

It is likely that the higher concentration of dugong bones in Square B reflects the fact that it dates mostly to c.950-1,000 cal BP and thus pre-dates the tradition of specialised dugong bone formation which is limited to the past 400-500 years (David *et al*., 2009; McNiven *et al*., 2009a). That is, whereas after 400-500 years ago many dugong bones were placed into specialised bone mounds, prior to this date most dugong bones simply formed part of more generalised midden deposits.

Post-contact additions (bottle glass)

The seven small flakes representing the bottle glass assemblage from Square A reflect the incorporation of aspects of tool technology into the surface levels of the midden deposit. The number of glass flakes is low and unremarkable. In marked contrast, the bottle glass assemblage comprising 1528 fragments from Square B is remarkable in size and form. Not only is the linear mound feature with Square B the most concentrated location for glass deposition recorded at Goemu, it is also the largest and densest glass assemblage associated with a midden recorded in Torres Strait. However, the glass assemblage also exhibits two features suggestive of special treatment prior to deposition.

First, the glass assemblage consists of a narrow range of bottle types. Indeed, nearly all diagnostic fragments point to a single type of green wine bottle with a champagne style finish dating from the 1880s to 1920. It is clear that residents of Goemu would have had access to a wide range of bottle types from missionaries and pearlshellers on the island. While very few bottle glass fragments occur across the surface of Goemu, Sunday's Grave (which contains the second highest concentration of bottle glass at Goemu), features at least four bottle types, including green wine bottles with a champagne style finish. Analysis of glass fragments at Totalai village on the island of Mua located south of Mabuyag also revealed a wide range of bottle types (Ash *et al*., 2008). Clearly, only bottles of a particular type were selected for deposition onto the Square B linear midden mound.

Second, the glass assemblage is highly fragmented with the mean length of pieces only 22 mm and the largest fragment 105 mm in length. While many tiny pieces of glass may have been formed during the process of deposition, it is clear that pieces of glass added to the midden were fragments prior to deposition. No evidence was found for whole or near whole bottles fragmented in situ through treadage or weathering. The available evidence suggests strongly that small bottle fragments were deliberately selected for incorporation into the midden feature. Such deliberate selection is consistent with 'structured deposition' and ritualised behaviour (cf. Richards & Thomas, 1984; Thomas, 1999: 63, 70-71). It is probable that the bottles were associated with a special event.

Dog and human teeth

Remains of dog and humans within midden deposits in Torres Strait are rare. The only other dog remains excavated archaeologically in Torres Strait are 'teeth and fragmented vertebrae' dating to 1,600-1,900 years ago from Ormi site on Dauar in the Eastern Islands (Carter, 2004: 225, 322-323). While no human remains have been excavated from midden deposits in Torres Strait, Harris *et al*. (1985: 38-40) uncovered human hand bones and teeth at a depth of 28 cm in an occupation deposit within a rockshelter on Muralag in southwest Torres Strait. Not only are the dog bones and teeth and human teeth from Square B at Goemu the first known from a midden in the western half of Torres Strait, they also represent the first midden excavated in Torres Strait containing dog and human remains together. Significantly, people of Mabuyag informed Haddon (1904: 290) that 'To this day no Mabuiag family keeps dogs because, as they say, if they tread upon dogs' foot-prints it makes their own feet sore'. Thus, the dog remains from Square B suggest strongly that people on Mabuyag once kept dogs and that dogs had special status. This significance is enhanced given that all of the human teeth belong to children and appear to have been removed post-mortem. This pattern indicates extreme selectivity in the incorporation of human remains within the midden feature. The recovery of human and dog teeth throughout the main midden deposit indicate that the ritualised practice of tooth selection spanned one or two generations around 950-1,000 years ago.

The highly selective nature of dugong bone, bottle glass, and human and dog tooth deposition into the Square B linear midden mound indicates that a great deal of thought and care could be associated with midden formation at Goemu. Such selection further supports the contention first proposed by Ghaleb (1990) and elaborated by McNiven and Wright (2008) that midden formation at Goemu was formalised and ritualised and far from a simple exercise of rubbish disposal. We suggest that deposition of materials in midden mounds was part of a tradition of remembering, where the biography of remains was to be honoured and respected in monumental form as a dimension of familial and ancestral connection to place (for a detailed discussion of ritualised middening practices at Goemu, see McNiven, 2013).

MARINE SPECIALISATION

Faunal remains (bones and shells) from Squares A and B support previous excavation results from Goemu and other parts of Torres Strait of marine subsistence specialisation by Torres Strait Islanders. Terrestrial vertebrates such as snakes, lizards, crocodiles, frogs and rodents comprise only a small fraction of faunal remains and many may represent natural deaths and not food remains. The following discussion focuses on similarities and differences in faunal remains between Squares A and B and Ghaleb's (1990) excavation results.

Dugong hunting

Bone assemblages from Squares A and B were dominated by dugong bones with the majority of 'large vertebrate' bone probably also representing dugong. In both squares, high densities of dugong bone were found in midden deposits down to 20 cm below the surface and dating to within the past 1,000 years. Such quantities of dugong bone is significant in terms of the issue raised by McNiven & Feldman (2003) and McNiven (2010) that the formation of dugong bone mounds within the past 400-500 years may have subsequently impacted the representation of dugong bones in contemporaneous midden deposits. In this sense, dugong bones in Square A most likely under-represent the relative importance of dugong in diets compared to other protein sources such as turtle, fish and shellfish. That this under-representation is absolute and not simply in terms of selective removable of particular bone elements is indicated by the fact that the Square A midden deposit and dugong bone mounds overlap considerably in the representation of dugong bone elements. Thus, the development of dugong bone mounds appears to signify an increase in dugong hunting over the past 400-500 years that is similarly registered in village midden deposits.

Turtle hunting

Whereas in Squares A and B dugong bone comprised 15% and 56% of bone assemblages, turtle bone represented only 1% and 0.3% respectively. It is likely that turtle is proportionally under-represented in the midden deposits at Goemu due to methodological issues (i.e. difficulty of identifying turtle bone fragments) and taphonomic issues (e.g. secular and ritual discard of turtle bones away from domestic sites). In terms of secular discard, turtle butchering today takes place on the beach adjacent to the settlement and bones (including carapaces) are left for removal by the next high tide (Figure 59). However, not all carapaces are left at beach butchering sites as many are used as cooking receptacles for turtle meat and organs in ground ovens located within the settlement of Bau. In the late nineteenth century, turtle butchering similarly took place on the beach adjacent to Bau (Figure 28). However, it is likely that most carapaces in the past were used in cooking turtle meat and organs in ground ovens. Today, the need for carapaces is less as much turtle meat and organs (mostly intestines) are cooked in metal pots in homes. Use of ground ovens is usually associated with feasts for special events. Ritual discard of turtle bone is poorly understood but potentially of significance to Mabuyag middens. Haddon (1904: 149) recorded that turtle bone was collected, 'charred' in a fire and placed into the sea by particular

FIG. 59. Turtle shells on the beach following butchering, Bau, Mabuyag, 2 November 2006 (Photo: Ian J. McNiven).

individuals to attract *gapu* (remora) which are used in turtle hunting. Perhaps of greater significance is the inclusion of turtle carapaces on ceremonial platforms (*agu*) on Mabuyag. Haddon (1904: 331) stated:

> Formerly the shells of turtles were placed on a long platform (*agu*), and as each canoe had its separate *agu* the crew that could show the greatest number of turtles at the end of the season acquired the greatest glory. The *agu* consisted of a bamboo staging covered with leaves of coco-nut palms and on these were placed the heads and shells of the turtles (see also Haddon, 1912: 235).

Fishing

The range of fish taxa found in Square A is typical of previously recorded fish remains at the site and fish remains recovered from other midden deposits across Torres Strait. The Square A fish is dominated by near-shore, reef-dwelling taxa – Labridae (wrasses), Scaridae (parrotfish) and Lethrinidae (emperors), which is identical to the pattern documented by Ghaleb (1998). These fish taxa similarly dominate fish bone assemblages at other sites in the region: Tigershark Rockshelter on Pulu (Labridae and Lethrinidae) (McNiven *et al*., 2008), Kurturawniaiwak on Badu (Scaridae and Labridae) (David & Weisler, 2006), Berberass near Badu (Lethrinidae, Labridae and Scaridae) (Crouch *et al*., 2007), and Mua 36 (Lethrinidae, Labridae and Scaridae) (David *et al*., 2008).

Overall, the size of fish (including sharks and rays) caught by residents of Goemu over the past 1,000 years was small. This pattern has been observed at other sites across western Torres Strait and again reinforces the conclusion that Torres Strait Islander fishing practices focused on capture of small fish using spears and stun poisons from reefs via pedestrian access during low tide and canoe access during high tide (David & Weisler, 2006; Ghaleb, 1998; McNiven *et al*., 2008). It is also possible that some fish were procured using stone-walled, tidal fishtraps which are located to the south of Goemu (Ghaleb, 1998). Yet a number of fish vertebrae in Square B and especially in Square A were ≥ 10 mm in diameter, indicating that fishing practices also included large fish. It is likely that such fish were captured from deeper waters from canoes, possibly using hooks. These larger fish may have been used as a feasting food given that larger fish can be associated with greater prestige and status (e.g. Bliege Bird, 2007: 449; Lahn, 2006: 299; cf. Ghaleb, 1998; see also Weisler *et al*., 2010).

Shellfishing

In terms of components of shellfish assemblages considered to be cultural, broad similarities exist between Squares A and B. Both squares are dominated by the bivalve *Paphies striata* which represents 62% and 50% of MNIs respectively. The next dominant bivalve is *Chama* sp. which represents only 5% and 6% of MNIs respectively. In terms of gastropods, Squares A and B are dominated by *Nerita* spp. (15% and 9% of MNIs respectively), followed by *Monodonta labio* in Square A (4% of MNIs) and *Terebralia sulcata* in Square B (3% of MNIs). The dominance of the sandy species *Paphies striata* may reflect extensive areas of sand within the intertidal zone separating the beach and reef fronting Goemu (see Figure 3). The dominance of *Nerita* spp. and *Monodonta labio* reflects the proximity of their preferred habitats of mangrove trees and rocks to the immediate south of Goemu (see Figure 3). *Chama* sp. and *Terebralia sulcata* are similarly available from adjacent reefs and mudflats opposite mangroves to the south. Thus, the representation of highest ranking shellfish taxa within Squares A and B reflects largely the relative abundance and proximity of these taxa to Goemu, with the sandy habitat of the dominant taxon – *Paphies striata* – located closest to Goemu.

In marked contrast to the highest ranking shellfish taxa, major differences exist between Squares A and B in terms of lower ranking and incidental shellfish taxa. For example, eight gastropod taxa (*Cerithium salebrosum*, *Clypeomorus batillariaeformis*, *Cerithium torresi*, *Trochus* sp., *Littoraria* sp., *Lataxiena* sp.?, *Cerithium balteatum* and Buccinidae) and 10 bivalve taxa (*Saccostrea* sp., *Dosinia mira*, *Felaniella scalpta*, *Mactra* sp., *Spondylus* sp., *Tridacna squamosa*, *Timoclea marica*, *Antigona chemnitzii*, *Irus irus* and *Acrosterigma cf. gratiosa*) found in Square A were not found in Square B. Alternatively, the following eight taxa were found in Square B but not in Square A – gastropods (*Pleuroploca* sp., *Oliva* sp., *Polinices putealis* and *Pyrene* sp.) and bivalves (*Anadara gubernaculum*, *Codakia tigerina*, *Arca avellana* and *Gafrarium australe*). As all these taxa are considered to be either incidental food items or non-cultural, such differences probably reflect chronological changes in the nature of shellfish assemblages on adjacent reefs and shellfishing practices.

The 58 shellfish taxa found in Squares A and B compares well with the 59 shellfish taxa identified by Ghaleb (1990: 187-189, 270) across the surface of Goemu, but double the 28 taxa excavated by Harris/Ghaleb from various squares across Goemu. As with our excavations, Ghaleb (1990: 272, 339) found that the 'single most abundant species of shellfish' was *Paphies* (*Mesodesma*) *striata*. Ghaleb (1990: 278) similarly concluded that the range of shellfish habitats exploited by people (sandy, rocky, coral and mangroves) occur 'all within a few minutes walk of the site of Gumu'. The close proximity of shellfish resources to Goemu also suggests strongly that few shellfish species are under-represented within midden deposits due to discard of shells within the intertidal zone prior to transport of meat back to Goemu. Such selective shell culling tends to be associated with shellfish with large and heavy shells where the place of foraging (i.e. intertidal zone) is located a number of kilometres from the place of consumption (i.e. village) (see Bird & Bliege Bird, 1997). Yet it is likely that culling of larger *Tridacna* spp. shells did take place to reduce transport loads and that *Tridacna* spp. are under-represented in midden deposits at Goemu (see Bird *et al*., 2002, 2004). However, clam shell technology (see below) indicates that not all *Tridacna* spp. shells were considered waste and at least some large clam shells, or at least fragments of large clam shells, were transported from the intertidal zone back to Geomu (see Bird & Bliege Bird, 1997: 48).

Compared to the protein staples of dugong, turtle and fish, we concur with Ghaleb's (1990: 279) conclusion that 'the overall low abundance of shellfish remains may suggest that they were a supplementary food in the diet rather than a staple, at least in terms of the amounts consumed (rather than the frequency of consumption).' This supplementary role may explain in part the lack of reference to *Paphies striata* as a food item in the Haddon *Reports* (Ghaleb, 1990: 339).

Terrestrial animals

The low representation of lizards, snakes, crocodiles and frogs follows the meagre ethnographic evidence for consumption of these animals (e.g. Haddon, 1912: 138-139, 1935: 175, 303; Johannes & MacFarlane, 1991: 214). However, the crocodile bones are significant as they represent the first such remains recovered archaeologically from Torres Strait (see McNiven & Hitchcock, 2004: 110). The near absence of rodent bones is also consistent with their absence in ethnographic recordings on subsistence. Ghaleb (1998) similarly found only a 'few' lizard and rodent bones at Goemu.

SHELL TECHNOLOGY

A range of shell artefacts representing items of technology were excavated from Squares A and B by us in 2005 and excavated and surface collected by the UCL team in 1985. The following section discusses these shell artefacts in relation to similar finds from other archaeological excavations across Torres Strait.

Baler shell containers

The remains of two baler shell (*Melo* sp.) containers were recovered from Squares A and B dating to the past 950-1,000 years. The UCL team made no recordings of similar items at Goemu. Baler shell containers, probably also dating to the past 1,000 years, have been recorded on the surface of sites across western Torres Strait – rockshelter sites on Kirriri, Mua and Gebar (Barham *et al*., 2004: 32, Fig. 10; McNiven & David, 2004: 215) and open occupation sites on Mua and Koey Ngurtai (Ash *et al*., 2008: 487-488; David & McNiven, 2005).

Clam shell implements

Of the three flaked pieces of giant clam shell (*Tridacna gigas*) recovered from Square

A, one was a 6 cm-long implement with a bifacially-flaked working edge. Ghaleb (1990: 196, Figs 14 and 17e) reports two clam shell (*Hippopus hippopus*) 'adzes' (7 cm and 9 cm long) and an 'edge-ground fragment of *Hippopus* or *Tridacna* sp.' collected from the surface of Goemu. As with the Square A artefacts, the surface-collected artefacts probably date to the past 400 years. Axe/adzes made from giant clam shell have also been found on the surface of Mui village site on Mabuyag and in various places on Iama in the central Strait (McNiven, pers. obs). Haddon (1935: 302, Fig. 29) reports an 'axe blade' made from *Tridacna* shell 'dug up on Badu'. Carter (2004: 261, 273) documents a clam shell (*Tridacna gigas*) adze fragment with 'one ground edge with use wear' from Sokoli site on Dauar in the eastern Strait in a level dated 900-1,400 years ago. While clam shell axes/adzes remain poorly understood in Torres Strait, it is clear that the technology was employed across the region from at least 900-1,400 years ago through to the time of early European contact in the nineteenth century (Haddon, 1912: 125-126).

Pearl shell scrapers

Two types of pearl shell (*Pinctada* sp.) scraper were recovered from Squares A and B – a denticulate scraper dating to c.350-400 cal BP and two hinge scrapers with flaked edges and associated edge smoothing (bevelling) dating to c.100-950 and c.950-1,000 cal BP. Ghaleb (1990: 190, 195, Fig. 18a-e, g) reports six 'crescent-shaped hinge fragments of Pinctada sp.' recovered from the surface of Goemu that may also have been used as 'scraper[s]'. Another flaked hinge fragment of pearl shell with a ground edge was hypothesised to be a 'scraper to soften leaf strips for basketry' based on Haddon (1912: 65) (Ghaleb, 1990: 190, 195, Fig. 18f). We associate the same hypothesis with the flaked and ground edge pearl shell hinge scraper from Square B. However, Barham *et al*. (2004: 30) hypothesise that these implements, particularly the larger examples, may have been hafted and used as gardening hoes based on similar shell hoes known ethnographically for the adjacent New Guinea coast (e.g. Kiwai).

CONTINUITIES AFTER EUROPEAN CONTACT

Excavations at Squares A and B revealed European materials (mostly bottle glass) in the surface levels of midden deposits, demonstrating that occupation of Goemu continued into the early years of European contact in the late nineteenth century. This continuity of occupation after contact was demonstrated also by the UCL team through excavation and surface recordings. Glass fragments were excavated from the 'lower layers' of the 24 cm-high circular midden Mound 87 which 'indicates that that particular mound was made sometime after Torres Strait Islanders had access to glass (unless, of course, the fragments intruded later)' (Ghaleb, 1990: 234, 301). Glass was on 28% of mounded midden features at Goemu recorded by the UCL team (Ghaleb, 1990: 191). A surface-collected clay pipe stem fragment made in Glasgow and dated c.1863-1910 also reveals use of Goemu during the late nineteenth and possibly early twentieth centuries (Ghaleb, 1990: 196). These results match up with dates of between 1880 and 1920 for bottle glass in Square B. Clear evidence for activities at Goemu during the first half of the late nineteenth and early twentieth centuries includes the graves of Sunday and Ned Katai located at the northern and southern ends of the village respectively (Figures 7, 12-14). These graves reveal ceremonial use of Goemu after 1870. A house was built and occupied at the southern end of Goemu between 1947 and 1951 (Ghaleb, 1990: 184). In recent years, a number of tin sheds have been constructed across Goemu to be used as weekenders.

FUTURE RESEARCH

Goemu is the most comprehensively-excavated and comprehensively-analysed village site in Torres Strait. As well as revealing important insights into past settlement-subsistence patterns on Mabuyag, excavations demonstrate an unprecedented level of complexity in midden formation and ritual mounding behaviour. Yet only a small sample of mounded middens has been excavated at Goemu. More than 90% of the midden mounds mapped by the UCL team in 1985 have not been excavated. As midden mounds range in age from at least c.1,000 to 100 years ago, it is clear that the history of midden mounding behaviour over the past 1,000 years remains rudimentary. In particular, more detailed understanding is required of changes and continuities in mounding practices occurring during the period of sustained European contact on Mabuyag commencing around 1870 (see Shnukal, this volume). More midden mounds at Goemu need to be excavated from across the site to ascertain three key elements: 1. chronology of formation, 2. contents, and 3. internal structure. In many respects, the need for this research is critical as less than 30% of the midden mounds recorded by the UCL team remain intact. This destruction reinforces the need for enhanced commitment by government authorities to ensure that appropriate cultural heritage management and ranger programs are in place to ensure protection of the unique archaeological heritage of Torres Strait for future generations of Torres Strait Islanders (see McNiven *et al*., 2004). As Goemu currently represents a unique Torres Strait Islander village midden site in terms of the scale and complexity of mounded deposits, the cultural heritage importance of remaining midden mounds at the site is extremely high. Goemu represents a rare archive of material on the history of the Goemulgal and for all Torres Strait Islanders.

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APPENDIX 1. FINDS DATA FOR SQUARE A, GOEMU.

XU	Mean Depth Below Surface (cm)	Mean Thickness (cm)	Wt. (kg)	Vol (l)	SU	Bone (g)	Crab (g)	Barnacles (g)
1	0.6	0.6	6.0	8.0	1a	2,670.6	0.9	0.7
2	1.5	0.9	10.3	11.0	1a	1,847.5	0.5	1.7
3	3.5	1.9	24.9	26.5	1a	2,985.2	4.9	3.5
4	4.8	1.3	22.0	22.5	1a	2,560.5	3.3	1.5
5	7.0	2.2	30.3	31.0	1a	4,354.9	2.9	4.8
6	9.5	2.6	33.0	32.0	1a	5,188.5	6.9	1.0
7	12.4	2.9	34.4	34.5	1a	4,122.5	4.1	3.7
8	16.0	3.6	43.0	42.5	1a	5,377.8	2.2	6.9
9	20.0	4.0	50.6	48.0	1a	6,099.5	3.3	7.7
10	24.1	4.1	45.3	42.5	1a (1b)	3,970.4	3.9	11.9
11	28.3	4.2	54.7	54.0	1a, 1b	3,798.4	8.2	3.6
12	31.9	3.6	40.6	36.5	1b (1a)	1,334.5	5.0	3.8
13	34.7	2.8	37.9	34.0	1b	939.3	3.0	2.7
14	37.5	2.8	28.3	24.0	1b (1c)	334.9	1.4	0.2
15	40.3	3.5	46.0	40.5	1b (1c)	321.4	1.8	0.1
16a	43.8	3.3	33.7	27.0	1b, 1c	120.1	2.5	0
16b			6.0	5.0	1b, 1c	42.3	0.2	0
17a	49.3	5.5	39.3	32.0	1c (1b, 2a)	175.9	1.7	0.7
17b			26.6	23.0	2a (1c)	87.6	1.0	0
18a	54.4	5.1	22.3	20.0	2a (1c, 2b)	23.4	1.6	0.1
18b			27.7	25.0	2a (2b)	81.3	1.5	0
18c			4.9	4.0	2a	13.2	0.1	0
19a	59.5	5.1	15.2	14.5	2a, 2b	2.0	0.9	0
19b			45.2	44.0	2b (2a)	10.4	1.7	0
19c			4.8	4.5	2b	11.4	0.2	0
20a	66.8	7.3	12.0	10.5	2b	10.2	0.6	0
20b			58.1	54.0	2b	9.6	1.6	0.1
20c			4.5	4.0	2b	4.8	0.2	0
21a	73.5	6.7	7.7	7.5	2b	0.8	0.3	0
21b			69.7	65.0	2b	5.8	2.6	0.1
21c			2.7	2.5	2b	3.5	0.1	0
22a	81.1	7.6	6.9	6.5	2b	0.4	0.6	0
22b			74.9	75.5	2b (2c)	9	4.9	0
22c			6.4	6.5	2b	1.3	0.4	0

Cuttlefish (g)	Sea Urchin (g)	Flaked Stone Artefact # (g)	Char. (g)	Ochre (g)	Snail Shell (g)	Pumice (g)	Rock (g)
0	0	20 (7.75)	0.3	0.9	2.6	109.9	1,609.9
0	0	15 (1.14)	0.3	0.6	2.4	23.0	3,076.8
0	0	35 (3.47)	0.2	18.6	8.2	59.8	4,524.1
0	0	42 (5.26)	0.3	69.4	5.6	78.0	2,134.1
0	0	48 (6.34)	1.5	127.9	6.2	94.8	1,612.5
0	0	55 (4.97)	3.8	126.0	10.1	140.5	2,103.3
0	0	57 (11.83)	3.4	42.3	4.4	100.0	1,166.7
0	0.1	91 (21.53)	4.9	52.3	4.9	119.3	3,091.9
0	0.1	117 (32.28)	5.7	92.6	12.7	151.5	6,219.6
0	0.3	115 (110.98)	4.8	179.5	7.9	187.7	4,348.4
0	0.1	112 (35.21)	8.8	121.7	8.9	228.9	3,896.6
0	0.1	73 (18.54)	3.9	5.2	3.5	125.4	4,041.3
0	0.1	50 (3.72)	2.4	5.5	5.8	93.5	2,198.6
0	0.1	37 (9.99)	2.2	71.6	2.8	54.3	1,332.5
0	0.1	46 (8.91)	2.3	2.7	3.4	79.2	1,157.0
0	0	17 (1.04)	1.9	3.2	2.0	50.0	2,316.0
0	0.1	1 (0.4)	0.1	0.2	0.1	8.6	1.3
0	0	14 (2.77)	2.0	2.0	2.8	67.7	1,087.7
0	0	9 (0.79)	0.5	0.5	0.2	21.2	28.8
0	0	4 (3.12)	2.3	0.1	0.4	27.8	335.2
0	0	2 (0.07)	0.3	0.1	0.8	95.6	27.0
0	0	1 (0.76)	0.1	0	0.1	8.3	0.4
0	0	0	2.6	0.1	0.8	16.3	110.6
0	0	2 (0.07)	1.0	0.2	1.7	512.4	29.1
0	0	0	0.1	0	0.1	44.9	2.4
0	0	0	4.7	0.3	0.7	28.1	64.5
0.6	0	2 (0.13)	3.2	0.7	1.7	374.4	52.9
0	0	0	0.1	0.1	0.1	11.0	3.9
0	0	0	0.7	3.5	0.1	22.3	40.5
1.0	0	1 (0.01)	4.3	0.5	0.2	176.8	41.4
0	0	0	0.2	0	0.1	9.5	18.5
0	0	0	0.4	0	0.1	16.7	2.4
5.5	0	1 (0.05)	2.3	0.1	0.1	130.8	25.2
1.2	0	0	0.2	0.1	0.1	25.3	2.8

APPENDIX 1. Cont.d

XU	Mean Depth Below Surface (cm)	Mean Thickness (cm)	Wt. (kg)	Vol (l)	SU	Bone (g)	Crab (g)	Barnacles (g)
23	89.6	8.5	89.5	88.5	2b, 2c	2.3	5.1	0.1
24	97.8	8.2	85.7	82.0	2c (2b)	1.8	5.7	0.1
25	104.2	6.4	30.5	27.0	2c	0.7	2.8	0.1
26	106.7	2.5	79.6	74.0	2c	1	3.7	0.9
27	113.5	6.8	86.1	78.5	2c	1.9	5.0	0
28	122.4	8.9	117.1	113.0	2c	16.2	23.9	1.0
29	131.2	8.8	103.0	95.5	2c	1.5	2.5	0.1
30	142.4	11.2	24.7	22.0	2c	0.3	1.6	0
31	155.9	13.5	26.9	28.0	2c	14.7	7.0	0
32	170.9	15.0	26.3	29.0	2c (2d)	32.5	19.0	0.1
33	185.5	14.6	31.0	32.0	2d (2c)	2.6	0.8	0
34	201.0	15.5	39.2	37.5	2d	0.5	2.3	0.1
Total:			1,715.5	1,625.5		46,594.9	154.4	57.3

0.1g = ≤0.1g

Cuttlefish (g)	Sea Urchin (g)	Flaked Stone Artefact # (g)	Char. (g)	Ochre (g)	Snail Shell (g)	Pumice (g)	Rock (g)
0.3	0	0	0.5	0	0.2	21.8	26.8
0.1	0	1 (0.05)	0.8	0	0	25.9	48.7
0	0	1 (22.2)	0.1	0	0	2.0	28.3
1.3	0	1 (0.03)	1.1	0	0	5.8	86.4
0.1	0	2 (0.03)	0.1	0	0	1.0	146.3
0.2	0	3 (0.12)	0.1	0	0	1.2	356.4
0	0.1	1 (0.05)	0.1	0	0	0.2	43.6
0.1	0	1 (0.2)	0.1	0	0	0.4	36.4
0	0.1	0	0.1	0	0	0.1	106.1
0	0.1	1 (0.79)	0.3	0	0	0.9	91.3
0	0	1 (0.08)	0.1	0	0	0	12.8
0	0	1 (0.16)	0	0	0	0.1	96.0
10.4	1.4	980 (314.84)	75.2	928.5	101.8	3,352.9	47,783.0

APPENDIX 2. FINDS DATA FOR SQUARE B, GOEMU (NB. finds data for XUs 18-20 missing).

XU	Mean Depth Below Surface (cm)	Mean Thickness (cm)	Wt. (kg)	Vol (l)	Bone (g)	Crab (g)	Stone Artefact # (g)	Glass # (g)
1	0	0.5	9.9	11.0	4,332.5	0.3	8 (13.2)	259 (1448.1)
2	2.0	1.5	18.7	19.0	3,415.5	1.0	23 (2.3)	533 (2194.6)
3	5.1	3.1	41.6	38.0	10,521.4	0.7	46 (5.8)	431 (1026.1)
4	7.3	2.2	33.7	30.5	8,636.0	0.1	41 (3.7)	151 (79.7)
5	9.3	2.0	31.5	25.5	9,176.7	0.2	30 (6.2)	87 (30.8)
6	10.4	1.1	16.6	14.5	3,396.4	0.2	25 (1.6)	23 (3.9)
7	13.9	3.5	46.4	38.5	9,768.9	0.7	73 (6.1)	28 (3.6)
8	18.2	4.3	54.9	47.5	16,436.6	1.6	126 (13.6)	12 (1.9)
9	23.1	4.9	61.0	54.5	6,927.4	2.5	156 (39.7)	3 (0.1)
10	26.8	3.7	47.8	44.0	1,314.9	3.1	100 (18.7)	1 (0.1)
11	29.9	3.1	47.3	44.5	245.1	3.7	74 (9.9)	0
12	34.7	4.8	64.1	58.0	158.3	3.6	24 (5.1)	0
13	38.2	3.5	44.2	42.5	59.6	3.5	10 (1.5)	0
14a	44.1	5.9	61.2	60.5	31.3	6.3	3 (0.2)	0
14b			9.8	9.5	18.8	1.1	3 (0.7)	0
15a	48.7	4.6	47.6	44.5	25.7	7.9	0	0
15b			10.6	10.5	10.8	1.7	0	0
16a	55.4	6.7	74.3	75.0	27.0	13.5	5 (0.5)	0
16b			3.3	3.5	2.6	0.9	0	0
16c			2.3	2.5	3.3	0.5	0	0
17a	63.1	7.7	82.0	87.0	14.7	28.7	3 (0.1)	0
17b			1.5	1.5	0.3	1.1	0	0
17c			0.8	0.5	0.1	0.2	0	0
18a	69.8	6.7	71.8	83.0	-	-	-	-
18b			1.6	2.0	-	-	-	-
19	77.9	8.1	111.5	110.5	-	-	-	-
20	90.5	12.6	153.2	160.5	-	-	-	-
Total:			1,149.2	1,119.0	74,523.9	83.1	750 (128.9)	1,528 (4788.9)

0.1g = ≤0.1g

Glass # (g)	Ceramic # (g)	Metal # (g)	Char. (g)	Ochre (g)	Snail Shell (g)	Pumice (g)	Rock (g)
259 (1448.1)	3 (44.1)	33 (1.52)	0.2	34.8	5.6	24.1	3,993.8
533 (2194.6)	8 (230.3)	170 (15.05)	0.1	20.6	14.7	16.8	7,805.0
431 (1026.1)	1 (20.4)	154 (8.78)	0.1	67.2	24.7	16.9	10,063.2
151 (79.7)	0	127 (4.13)	0.4	17.7	23.2	17.3	6,314.6
87 (30.8)	0	81 (2.45)	0.4	38.2	15.2	6.7	8,846.5
23 (3.9)	0	38 (1.00)	0.4	38.9	19.1	2.5	4,489.6
28 (3.6)	0	55 (1.78)	0.6	4.8	30.7	5.2	8,579.2
12 (1.9)	0	43 (1.33)	0.5	10.7	50.7	14.1	2,862.8
3 (0.1)	0	14 (0.43)	0.4	2.5	66.3	21.3	2,710.3
1 (0.1)	0	2 (0.03)	0.1	3.6	14.0	13.1	809.9
0	0	0	0.4	1.6	5.7	7.5	909.6
0	0	0	0.3	0.3	1.6	2.7	1,089.6
0	0	0	0.3	0.1	0.2	2.1	71.0
0	0	0	1.4	0.1	0.1	1.7	54.6
0	0	0	0.1	0.1	0.4	0.7	50.0
0	0	0	1.6	0.1	0.1	0.5	76.6
0	0	0	0.3	0.2	0.4	0.3	16.8
0	0	0	3.6	0	0	0.8	110.6
0	0	0	0.1	0	0	0	7.2
0	0	0	0.1	0	0	0.1	2.7
0	0	0	2.2	0	0	1.5	120.6
0	0	0	0.1	0	0	0.1	2.3
0	0	0	0.1	0	0	0.1	1.4
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
1,528 (4788.9)	12 (294.8)	717 (36.5)	13.8	241.5	272.7	156.1	58,987.9