Chapter 5.
The Molluscan Remains of Tanamu 1: Subsistence and Resource Habitats

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Introduction

For millennia coastal populations of Papua New Guinea (PNG) have exploited the rich shellfish resources of open coast, estuarine and riverine environments. People have utilised these resources for food, the manufacture of tools, and the production of shell valuables as items of prestige and exchange (for examples from the south coast of mainland PNG, see Allen 1977a; Bulmer 1978; McNiven *et al.* 2011). However, the nature of landscape engagements in the region have up until relatively recently been largely unknown, and the advent of the Caution Bay research programme has more than doubled the known antiquity of human presence in the Port Moresby region, extended the number of sites excavated, and re-invigorated palaeoenvironmental research (for a recent review, see McNiven *et al.* 2012b; see also David *et al.* 2011; McNiven *et al.* 2011). Given the lacuna of details on past landscape engagements, analyses of temporal trends in molluscan remains found in archaeological sites are likely to contribute significantly to a better understanding of subsistence patterns and resource exploitation strategies; in particular the relative importance of individual species and the resource zones used for subsistence or other purposes. Such data can also inform on the nature of local habitats and signal changes in environmental conditions over time (e.g., Anderson 1981; Bird *et al.* 2002; Bourke *et al.* 2007; Morrison and Cochrane 2008; Szabó 2009).

Tanamu 1

The molluscan assemblage reported here is from Tanamu 1 at Caution Bay, an archaeological site dating from *c.* 5,000 cal BP to *c.* 100 cal BP. Two 1m × 1m squares (A and B) were excavated in 2.1 ± 0.5cm excavation units (XUs) to 2.82m depth, with all excavated materials retained in 2.1mm mesh sieves undergoing systematic analysis in dedicated archaeological laboratories (see Chapter 2 for excavation details). The 134 XUs at Tanamu 1 are partitioned into seven major stratigraphic horizons or units (SUs), each continuous across the two contiguous main excavated squares (A and B). SU1 (700–*c.* 100 cal BP), SU3 (2800–*c.* 2750 cal BP) and SU5 (4350–4050 cal BP) consist of rich cultural deposits (the Upper, Middle and Lower Horizons respectively); which are separated by the culturally sparser SU2, SU4 and basal SU6–SU7. SU1, SU3 and SU5 contain pronounced and distinct shell concentrations: XU3–XU6 (Upper Horizon); XU24–XU35 (Middle Horizon) and XU48–XU69 (Lower Horizon). In each of these, the total shell weight is on average >2000g for each XU from Square A and Square B combined. These dense shell horizons correspond with the three dense occupation horizons identified for the site as a whole, associated with pre-ceramic, Lapita and post-Lapita occupation periods (see Chapter 2).

Excavation at Tanamu 1 produced a total shell sample of 127,355.6g, with Square A containing 62,270.3g and Square B 65,085.3g. While the majority of these shells represent discarded food remains, a number of shell artefacts were also recovered. The shell artefacts are presented separately in Chapter 7. However, they are included in the weights and MNI counts reported here. The clearly stratified Tanamu 1 cultural sequence provides an ideal opportunity to investigate change over time in the use of molluscan resources.

Methods

The shells were analysed using the standard Caution Bay Archaeology Project procedures detailed in David *et al.* (2016a). All shells >2.1mm long and shell fragments irrespective of size were identified to the lowest possible taxonomic level using a specifically developed, regionally-derived modern and archaeological shell reference collection and in comparison with photographs and descriptions in several reference texts (Abbot and Dance 1982; Hinton 1972; Lamprell and Healy 1998; Lamprell and Whitehead 1992; Poutiers 1998). While names of some taxa are currently under review, all nomenclature used here is consistent with the World Register of Marine Species (WORMS) database (as of 16 September 2019).

Four quantification methods were used: minimum number of elements (MNE), minimum number of individuals (MNI), number of identified specimens (NISP) and shell weight (for strengths and limitations of each method, see Claassen 2000; Giovas 2009; Glassow 2000; Mason *et al.* 1998, 2000; Nichol and Williams 1981).

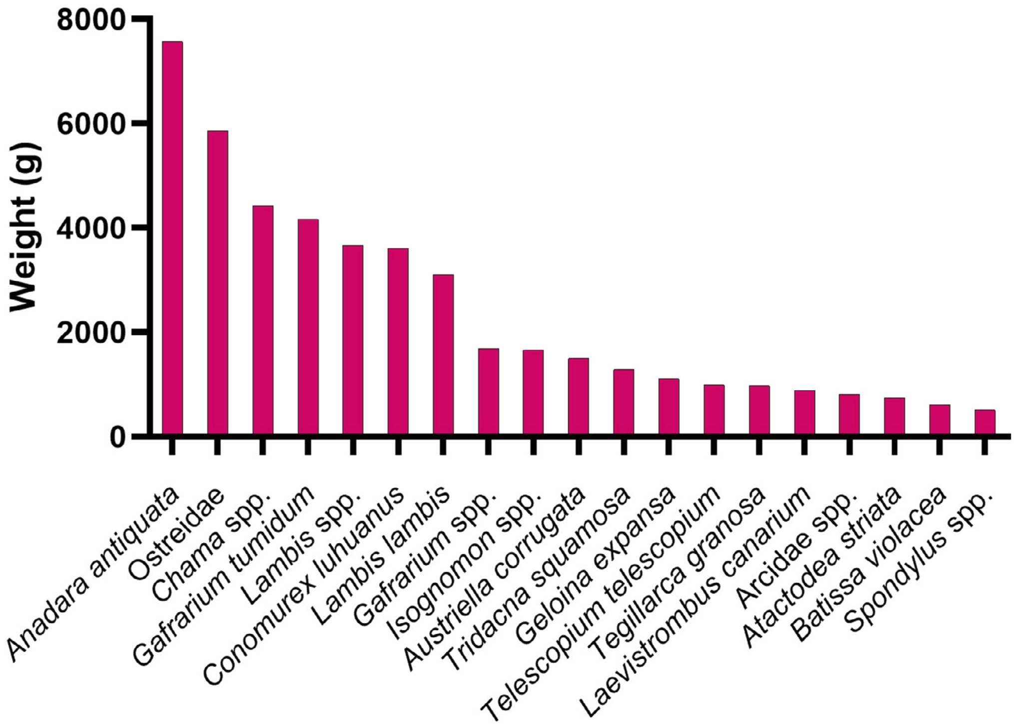

Figure 5.1. Molluscan taxa represented by >500g identified from Square A, Tanamu 1.

The majority of analyses are based on MNI and weight. Counts of non-repeating elements (NRE) were used to calculate MNI values, and NREs were held constant for each taxon throughout all XUs to avoid inflation of counts.

Results—Square A

Summary of Taxa Quantities

In total 83% of all shell by weight in Square A was identified to family, genus or species level. This comprises 36,088.5g (58%) from 55 bivalve taxa, and 15,609.0g (25%) from 96 gastropod taxa. Appendix C provides the total weight per XU for each taxon recorded for Square A. Figure 5.1 shows the relative abundance by weight of each taxon with a combined total of 500g of shell or more.

By weight, 10,572.8g (17%) of shell were not identified to class, family, genus or species due to their high degree of fragmentation and/or weathering. In XUs where shell is present, total shell weight ranged between 2.1g (XU17) and 2662.2g (XU66) per XU. (Note: shell from XU9 and XU10 was combined during excavations). In addition, small quantities of Cirripedia (barnacle, 57.2g), Polyplacophora (chiton, 8.7g) and polychaete (wormtube, 11.1g), Camaenidae and Subulinidae (land snails, 1.3g) were also identified in the sequence. When viewed as a whole, 25 species account for almost three quarters (75%) of the total Square A assemblage by weight.

The 10 most abundant taxa by weight account for 72% of the identified assemblage. These comprised *Anadara antiquata* (7567.2g, 15%), Ostreidae (5866.9g, 11%), *Chama* spp. (4429.1g, 9%), *Gafrarium tumidum* (4173.0g, 8%), *Lambis* spp. (3664.7g, 7%), *Conomurex luhuanus* (3613.1g, 7%), *Lambis lambis* (3108.2g, 6%), *Gafrarium* spp. (1690.1g, 3%), *Isognomon* spp. (1656.6g, 3%) and *Austriella corrugata* (1498.5g, 3%).

Square A yielded a total MNI value of 7644. Appendix D shows MNI values for each taxon by XU for Square A. Bivalves (MNI = 5026) clearly dominate the assemblage over gastropods (MNI = 2618). Figure 5.2 shows the taxa with 100 or more individuals (MNI) each.

When analysed by MNI, the Square A shell assemblage is clearly dominated by Ostreidae, which has a MNI of 773 (10%). The 10 most abundant taxa by MNI account for 58% of the total assemblage: *Gafrarium tumidum* (MNI 674, 9%), *Isognomon* spp. (MNI 602, 8%), *Anadara antiquata* (MNI 595, 8%), *Atactodea striata* (MNI 465, 6%), *Gafrarium* spp. (MNI 340, 4%), *Conomurex luhuanus* (MNI 332, 4%), *Nerita* spp. (MNI 264, 3%), *Pinctada maculata* (MNI 207, 3%), and *Chama* spp. (MNI 186, 2%).

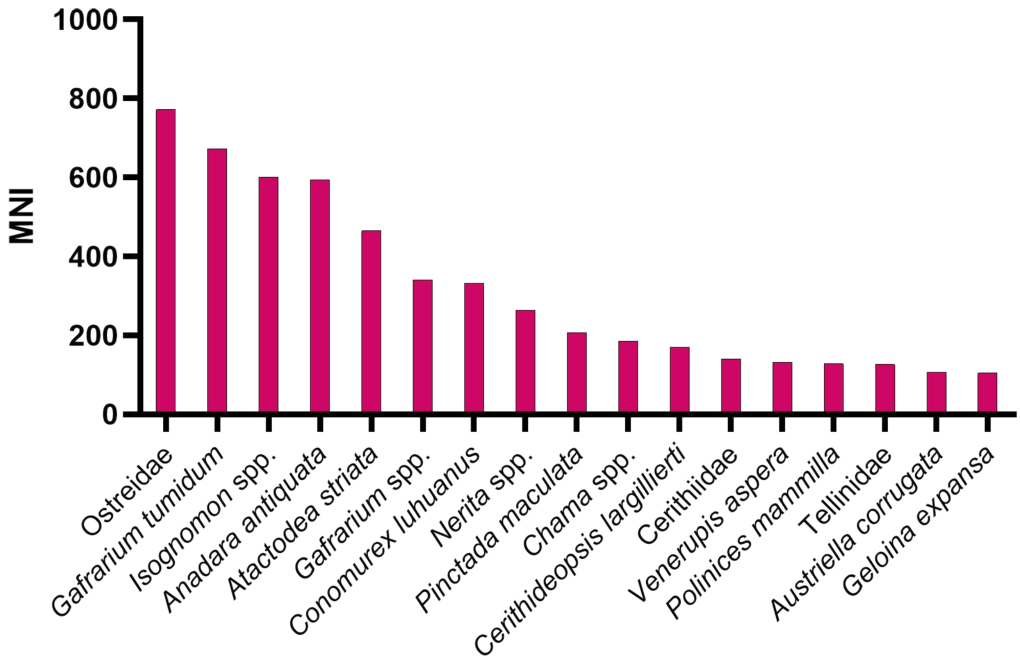

Figure 5.2. Molluscan taxa represented by 100 or more MNI identified from Square A midden deposits, Tanamu 1.

Results—Square B

Summary of Taxa Quantities

In total 77% of all shell by weight in Square B was identified to family, genus or species level. The assemblage consists of 33,728.2g (52%) from 48 bivalve taxa, and 16,398.4g (25%) from 91 gastropod taxa. Appendix E shows the weight for each taxon by XU.

By weight, 14,958.8g (23%) of the molluscan assemblage could not be identified due to advanced stages of fragmentation and/or weathering. Shell weight per XU varied from 0.1g (XU125) to 4710.4g (XU67). (Note: shell from XU5 and XU6 were combined during excavation and XU132 contained no shell). Small quantities of Cirripedia (barnacle, 33.3g), Polyplacophora (chiton, 6.9g), polychaete (wormtube, 2.7g), Camaenidae and Subulinidae (land snails, 3.8g) were also identified in the sequence. Twenty-five mollusc taxa account for 71% of the total assemblage by weight. Figure 5.3 shows the taxa that each have 500g of shell or more.

The 10 most abundant species by weight account for 55% of the total assemblage: *Anadara antiquata* (7509.7g, 12%), Ostreidae (5855.4g, 9%), *Chama* spp. (5379.3g, 8%), *Lambis* spp. (4566g, 7%), *Conomurex luhuanus* (3591.4g, 6%), *Lambis lambis* (2352.8g, 4%), *Gafrarium* spp. (2027.9g, 3%), *Telescopium telescopium* (1806.7g, 3%), *Geloina expansa* (1501.5g, 2%), and *Austriella corrugata* (1481.7g, 2%).

Square B yielded a total MNI of 7021 (presented by XU). Appendix F provides MNI values for each taxon by XU. As was the case in Square A, bivalves (MNI = 4417) dominate the assemblage over gastropods (MNI = 2604). Figure 5.4 shows the taxa with MNI values of 100 or more; these make up 70% of Square B's total MNI count.

When analysed by MNI, the Square B shell assemblage is clearly dominated by Ostreidae, which contribute 829 (12%) of the Square's total MNI. The 10 most abundant species by MNI together account for 58% of the total assemblage: *Isognomon* spp. (MNI 548, 8%), *Atactodea striata* (MNI 538, 8%), *Anadara antiquata* (MNI 495, 7%), *Gafrarium* spp. (401 MNI, 6%), *Conomurex luhuanus* (322 MNI, 5%), *Pinctada* sp. (MNI 263, 4%), *Cerithideopsis largillierti* (MNI 227, 3%), *Nerita* spp. (MNI 222, 3%), and *Chama* spp. (MNI 214, 3%).

Discussion

Squares A and B are adjacent, and SUs are continuous across the squares. Given this, the two data sets are combined in the following discussion. A notable feature of the sample is the rich variety of taxa. Most (84% by weight) taxa are represented in each of the three dense cultural horizons (the Upper, Middle and Lower Horizons: see Chapter 2, this volume).

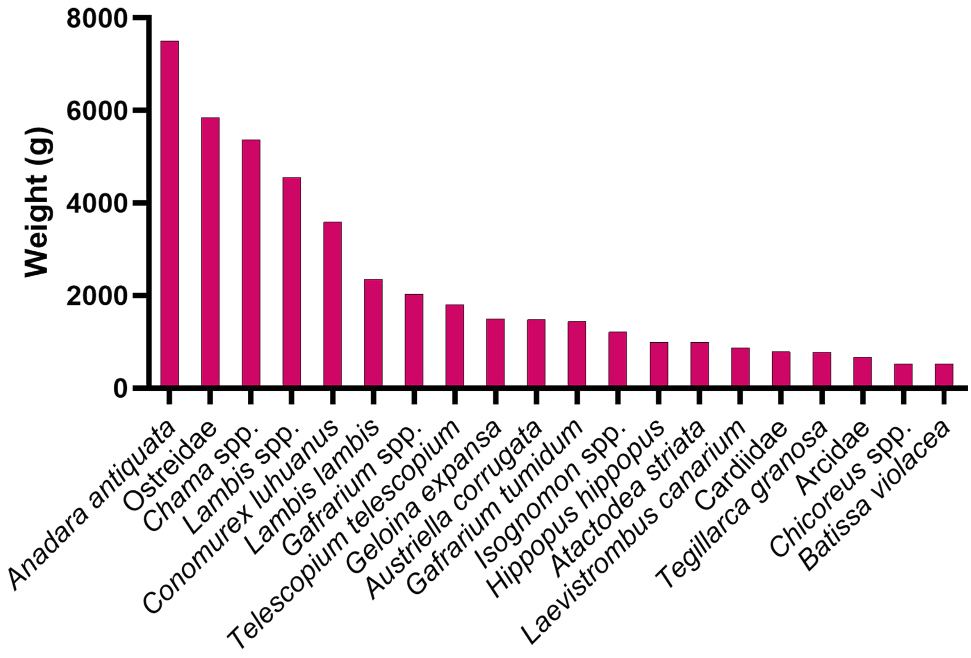

Figure 5.3. Molluscan taxa represented by >500g identified from Square B, Tanamu 1.

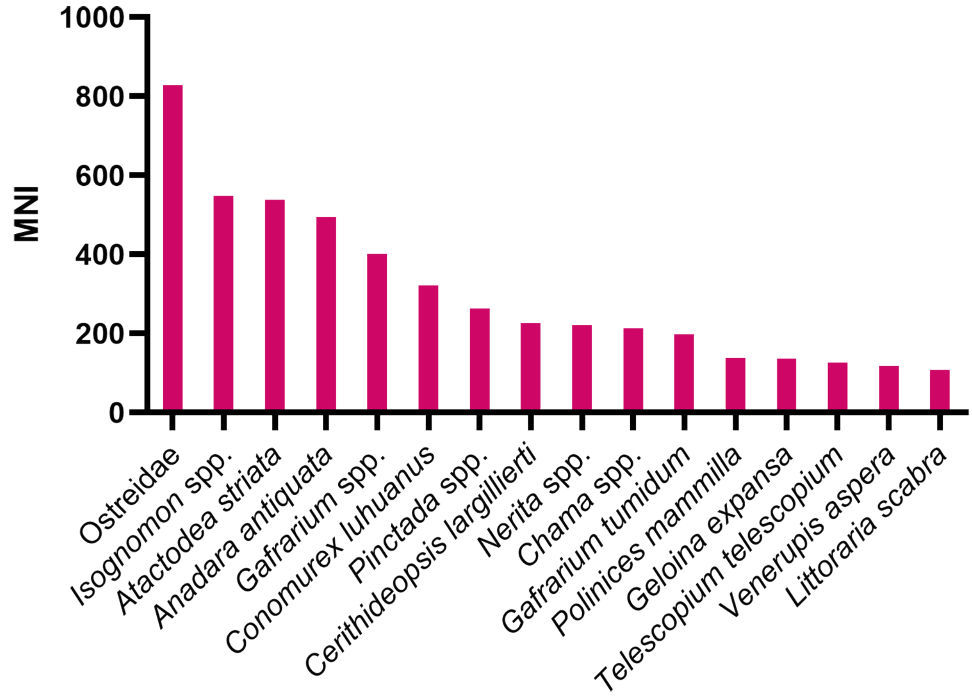

Figure 5.4. Molluscan taxa represented by 100 or more MNI identified from Square B midden deposits, Tanamu 1.

Subsistence Value of Most Common Taxa

The predominant taxa exploited at Tanamu 1 range significantly in average size and meat weight, from ≥1g (e.g., *Atactodea striata*) to 35g (e.g., *Lambis* spp.) (Bird *et al.* 2002: 462; Thomas 2002: 198). Oysters (Ostreidae) have the highest representation (based on MNI) in Tanamu 1 and, depending on size, an oyster specimen can yield 6–15g of edible meat (Sydney Fish Market 2008). A *Conomurex luhuanus* specimen contains on average 2g of edible meat (Thomas 2001: 83; Szabó 2011). Some taxa found in large quantities have low meat weights (estimated at 1g or less) (e.g., *Cerithideopsis largillierti*, *Littoraria scabra*, *Nerita* spp., *Planaxis sulcatus* and *Tellina* spp.). However, despite the small meat weight per specimen, the sheer number of shells from these species throughout the Middle and Lower Horizons suggests that they were of subsistence importance.

A small proportion of the taxa (approximately 4%) is most likely non-economic (i.e., not deliberately collected for food or other economic purposes). These are taxa (e.g., Ellobiidae, *Hemitoma* spp.) measuring less than 10mm in length that are regarded in this instance as having been introduced to the matrix by natural processes, or brought in incidentally (e.g., attached to larger shells) (Gill 1951: 251; but see Rowland 1994).

A careful examination of all shells indicates that some may represent shell valuables, artefacts in the making or detritus from the manufacture of shell tools or valuables. These are presented in Chapter 7. Many of the important shell taxa favoured by Pacific shell-workers (Szabó 2010: 116), such as giant clams (Tridacnidae), pearl oysters (*Pinctada* spp.), cone shells (Conidae spp.), conch shells (Strombidae), cowries (Cypraeidae spp.) and top shells (*Rochia nilotica*), appear to have been readily available at Caution Bay. Notably the majority of these favoured taxa were found in SU1, SU3 and SU5; the three dense cultural horizons. *Placuna placenta* was found in small numbers in the SU3 Lapita Middle Horizon, with one modified specimen coming from XU64 in the SU5 Lower Horizon.

Chronological Changes

Figure 5.5 shows the proportional distributions of major shell taxa in each of the three cultural horizons. SU1 (Upper Horizon) is associated with post-Lapita occupation, SU3 (Middle Horizon) is associated with Lapita occupation and SU5 (Lower Horizon) is associated with pre-ceramic occupation.

SU1 (XU3–XU6) is relatively meagre in both shell abundance and number of taxa (30 taxa) when compared with SU3 (XU24–XU35) (104 taxa) and SU5 (XU48–XU69) (130 taxa). This suggests that shell gatherers during the SU1 period either 1) deliberately targeted fewer species; 2) saw altered environments (see below for discussion); or 3) that the lower number of taxa observed here is a function of smaller sample size. The highest densities of shell in SU1 occur in XU3 to XU5–XU6. Predominant species during this time are *Conomurex luhuanus*, *Telescopium telescopium*, Ostreidae, *Geloina expansa* and *Lambis lambis*. Small amounts of *Cypraea* spp., *Pinctada* spp. and *Tridacna* sp. were also occasionally collected, possibly for shell-working (e.g., Szabó 2010: 116).

Both the Middle Horizon (SU3) and the Lower Horizon (SU5) contain a diverse range of mollusc species. The shell in these SUs is densest from XU24 to XU35 and again from XU48 to XU69. During these phases, large quantities of *Anadara antiquata*, *Atactodea striata*, *Chama* spp., *Gafrarium* spp., *Isognomon* spp. and Ostreidae were exploited (Figure 5.5). The range and relative abundance of taxa is similar in SU3 and SU5, suggesting that many targeted shellfish during Lapita times were comparable to earlier (pre-Lapita) exploitation strategies. However, there are also notable differences.

Relatively similar amounts of *Anadara antiquata* occur in SU3 and SU5 by MNI (SU3 MNI 443; SU5 MNI 454), however by weight this taxon is represented to a far greater degree in SU5 (SU3 3017.1g; SU5 9783.2g). This discrepancy is accounted for by the fact that whole shell valves in SU3 are slightly smaller than those of SU5. A similar pattern is also evident for all other Arcidae species in the sample. Larger gastropods such as *Laevistrombus canarium*, *Conomurex luhuanus, Lambis* spp. and *Gibberulus gibberulus* are present in greater quantities in SU3 than in SU5. During the Lapita phase, more *Gafrarium* spp. bivalves were collected than earlier on. *Conomurex luhuanus* is among the most common taxa of Tanamu 1. Its percentage contribution to the total shell assemblage, by both MNI and weight, suggests that it was an important subsistence resource. However, *C. luhuanus* largely occurs in the top 47 XUs (101 cm and above) in both Squares A and B, with only two individuals appearing in XUs 48 and 58 in Square A. The question remains as to whether the relative absence of *C. luhuanus* from SU5 to SU7—keeping in mind also that SU5 is a dense shell horizon—indicates cultural choice or environmental change.

In contrast to the situation with *C. luhuanus*, SU5 contains three times more *Atactodea striata* than SU3 by MNI. Other species more common in SU5 than SU3 include *Batissa violacea*, *Geloina expansa*, *Chama* spp., *Venerupis aspera,* Ostreidae, *Isognomon* spp. and *Pinctada* spp. Common gastropods in SU5 include *Chicoreus* spp., *Conus* spp., *Terebralia* spp., *Cypraea* spp. and small species that are only economical for subsistence in high numbers, such as *Calliostoma* spp., *Nerita* spp., *Oliva* spp., *Nassarius* spp., *Cerithideopsis largillierti* and *Littoraria* spp.

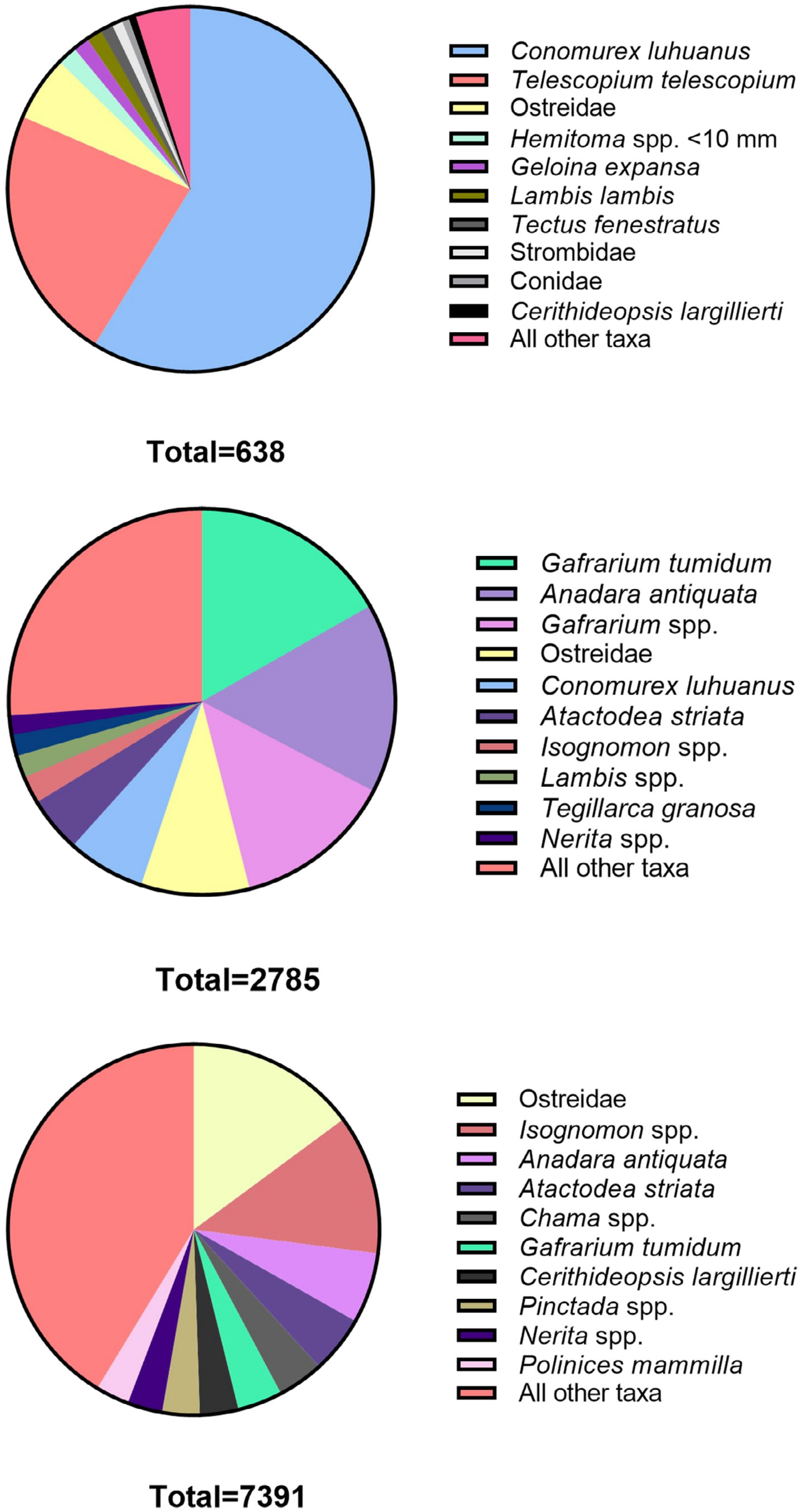

Figure 5.5. Percentage distributions of midden shell taxa in SU1 (top), SU3 (middle) and SU5 (bottom), as calculated from MNI values.

In SU3 these shellfish may have been considered too small to provide worthwhile meat yields and passed over.

Low quantities of shell recovered from XU10 to XU23 indicate that SU2 saw an approximately 2000-year hiatus following site abandonment by Lapita peoples around 2750 cal BP and prior to renewed settlement during post-Lapita times sometime after *c.* 700 cal BP. There are relatively few shells in SU4, although here the decrease in abundance is not as pronounced as in SU2. As indicated by the radiocarbon dates, SU4 probably contains a post-depositional mixture of Lapita-period (SU3) and pre-Lapita shells. There does not appear to be a great reduction in the number of taxa, although fewer of the robust specimens are present, and in particular there is a complete absence of giant clams (*Tridacna squamosa* and *Hippopus hippopus*) and large conch shells (*Lambis* spp.). In SU6 and SU7, the lowest levels of the site (between XU70 and XU134), all of the most common species (e.g., *Anadara antiquata*, Ostreidae, *Gafrarium* spp., *Geloina expansa, Telescopium telescopium*, *Atactodea striata*, *Nerita* spp., *Cerithideopsis largillierti*, Tellinidae) represent resources that were readily available by foraging the inshore tidal flats, mangroves and rocks. The presence of these molluscs in SU6 suggests that people have been using the local environment fronting the beach dune for at least 4700 years.

Site Environment and Habitats

Today, Caution Bay is a mangrove-fringed embayment fed by the Lea Lea River and flanked by the Vaihua River. Present-day marine habitats within the bay include coral reefs, seagrass beds, intertidal mangroves, and subtidal and intertidal muddy and sandy substrates (Coffey Natural Systems 2009). Large areas of seagrass occur in Caution Bay, generally on the flat, sandy seafloor between the mangroves and the fringing reef (Coffey Natural Systems 2009: 13.3.1.2). Sandy beaches occur in small patches along the coast in regions not supporting mangroves (Coffey Natural Systems 2009: 13.3.1.1).

Tanamu 1 is located on the edge of an exposed coastal sand dune flanked by open tidal mudflats to the east and an extensive intertidal mangrove forest to the west. However, the coastline has been continuously changing since the sea-level highstand at *c.* 6000 BP into the Late Holocene (Pain and Swadling 1980). Initially the landscape was a dynamic open coastline conducive to the aeolian accumulation of beach-bordering sand dunes (David *et al.* 2012). Coral reef growth was active until the reef caught up with sea level and blocked ocean swells and wave action. The reef progressed seaward with the lowering of sea level (Hope and Haberle 2005: 548). A pronounced fall in sea levels *c.* 2000 cal BP (Lewis *et al.* 2012) and resultant lower tides initiated rapid siltation, enabling a *Rhizophora* mangrove forest to colonise and dominate the tidal mudflats *c.* 2000–1700 cal BP, as indicated by pollen-sediment cores from Caution Bay (Rowe *et al.* 2013).

Inland erosion associated with human land-use activities likely contributed to shoreline changes and mangrove development through deposition of terrestrial sediments in the intertidal zone (McNiven *et al.* 2012b: 150). As outlined in Volume 1 (Rowe *et al.* 2013), inland, the coastal thicket and forest dominated until *c.* 2000 cal BP, after which there was a decline in tree cover and a transition towards coastal scrub. Charcoal records also indicate an increase in burning between *c.* 2000 and 1400 cal BP. After *c.* 1000 cal BP a spike in sedimentation resulted in less frequent tidal inundation, consequential changes to mangrove composition, and establishment of a saltmarsh and unvegetated mudflat (Rowe *et al.* 2013). Consequently, the availability of marine resources has altered substantially over the past 5000 years as a result of changing habitats, and impacts on local subsistence practices may have been considerable.

The wide array of habitats represented by the Tanamu 1 cultural shells include intertidal rocky substrates, sandy habitats and seagrass meadows, muddy tidal flats and mangroves, coral reefs and freshwater environments (Figure 5.6). This indicates that, over time, Caution Bay communities exploited a broad range of tidal habitats with different substrates. A brief overview of preferred habitats for the more common taxa follows.

Intertidal Rocky Substrates

Tanamu 1 taxa commonly associated with intertidal rocky shore environments include oysters (Ostreidae), *Planaxis sulcatus*, *Nerita* spp. and *Lunella cinerea*.

Shallow Sandy Seafloor and Seagrass Beds

Anadara antiquata is a poor burrower and prefers sandy gravels and shallow lagoon bottoms (Carpenter and Niem 1998). *Gafrarium* spp. also favour shallow, sandy habitats and seagrass meadows of the high intertidal zone. The Strawberry Conch (*Conomurex luhuanus*), along with other strombid species (e.g., *Gibberulus gibberulus* and *Laevistrombus canarium*), reside in shallow waters in muddy-sand habitats and in seagrass beds (Carpenter and Niem 1998: 475; Coleman 2003). In Figure 5.6, *C. luhuanus* is presented in the sandy seafloor and seagrass bed category.

Estuaries, Mangroves, and Upper Tidal Mudflats

Common species at Tanamu 1, including *Tegillarca granosa*, *Geloina expansa*, *Austriella corrugata* and

Telescopium telescopium inhabit the muddy bottoms of mangroves and tidal flats. *Isognomon* spp. live in dense colonies, attached to rocks or trees and other hard substrates in muddy estuaries and mangroves (Carpenter and Niem 1998: 190).

Coral Reef Flats

The jewel-box shell (*Chama* spp.) and pearl oyster (*Pinctada* spp.) are commonly found attached to coral and rock reefs in the littoral and sublittoral zones. Giant clam shell (*T. squamosa*, *H. hippopus*) and top shell (*Rochia nilotica*) are obtained from clear, shallow waters of coral reefs. Relatively large conch shells (*Lambis* and strombid species) also inhabit reef flats and coral rubble bottoms of the intertidal and subtidal zones (Carpenter and Niem 1998: 467).

Freshwater Environments

Taxa from freshwater environments include *Batissa violacea* and small neritid gastropods (e.g., *Neripteron violaceum)* (Lamprell and Healy 1998: 180–182).

Chronostratigraphic Trends in Mollusc Collection

Figure 5.6 shows the frequency and relative proportions of taxa (by MNI) by habitat. The array of habitats and relative frequencies of shell from particular resource zones confirm that the peoples of Caution Bay exploited a wide range of tidal habitats with different substrates—sand, rock, mud, coral reef and mangrove. However, not all these habitats were equally targeted at all periods of time. An analysis of the chronostratigraphic trends in habitat utilisation indicates minimal change through time in the general habitats exploited, but with some notable changes over the past 4350 years.

SU7 (*c*. 5000–4500 cal BP): In the lowest level of the site, the most abundant taxa (e.g., Tellinidae, *Calliostoma* spp., *Nerita* spp., Ostreidae, and *Gafrarium* spp.) came from rocky and sandy intertidal habitats. About half of these specimens are water-worn, indicating water-rolling and thus at least periodic submergence below high tide. Other taxa occurring in high numbers are those under 10 mm long (e.g., Arcidae, *Cerithideopsis largillierti* and *Fragum* spp.), indicating the presence of storm surge or intertidal sediments. All of this is consistent with topographic and stratigraphic evidence for SU7 partially representing natural beachline sediments, with much of the SU7 molluscan assemblage unlikely to be cultural.

SU6 (*c*. 4500–4350 cal BP): The majority of cultural taxa in SU6 represent resources that were readily available by foraging the intertidal sand and mudflats, mangroves and rocky shore. Sandy substrate bivalves (e.g., *Atactodea striata*, Tellinidae, *Gafrarium* spp. and *Venerupis aspera*) account for 44% of the SU6 assemblage; 31% is a mix of bivalve and gastropod species (*Austriella corrugata*, *Geloina expansa* and *Cerithideopsis largillierti*) from muddy substrates of intertidal flats and mangrove habitats. Small rocky substrate specimens in SU6 comprise turbo snails (*Lunella cinerea*), rock oysters (Ostreidae) and numerous nerite species.

SU5 (*c*. 4350–4050 cal BP): Inshore habitats (i.e., intertidal sand and mudflats, mangroves and rocks) represent the most heavily exploited environment by in pre-ceramic times of the Lower Horizon. Taxa from these environments make up 88% of the SU5 shell assemblage. Three additional habitats, seagrass beds, freshwater and reef flats, are also exploited. *Venerupis aspera*, *Atactodea striata* and *Asaphis violescens* continue to be actively collected from sandy flats. People also

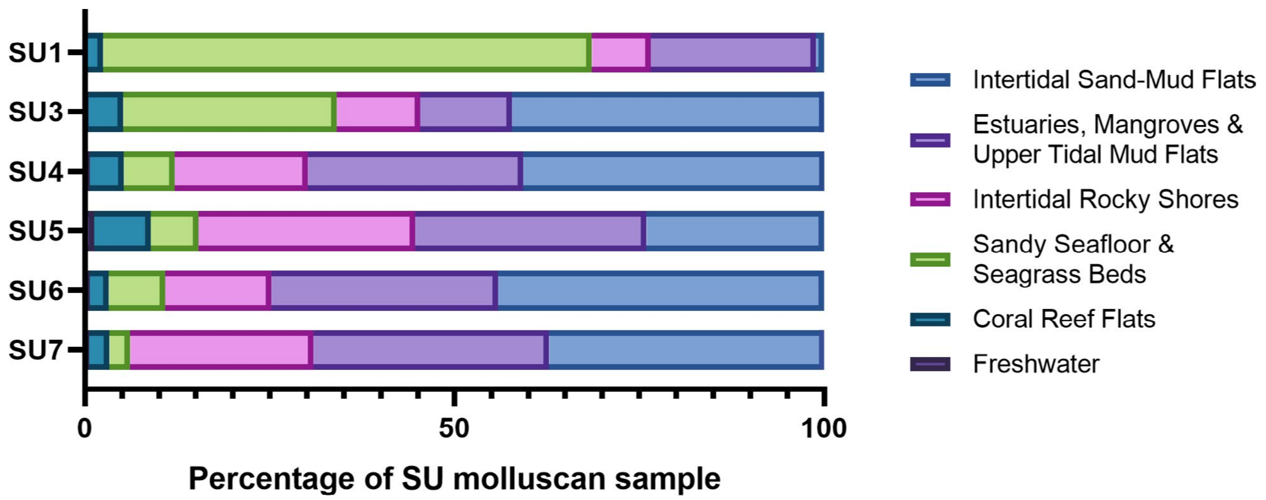

Figure 5.6. Proportions of molluscs deriving from different aquatic habitats for each Tanamu 1 SU, as calculated from MNI values.

persisted with collecting oysters and nerites from rocky shores, also collecting the jewel-box shell (*Chama* spp.). Taxa from muddy substrates that exhibit high numbers in SU5 include *Geloina expansa*, *Austriella corrugata*, *Cerithideopsis largillierti* and *Terebralia* spp. Exploitation of fresh/brackish water habitats is demonstrated by larger numbers of *Batissa violacea*. The presence of murex shells (*Chicoreus* spp.), cone shells (Conidae spp.) and cowries (Cypraeidae spp.) indicate that people were also venturing further out to rock and reef platforms for shellfish resources. The presence of a few specimens of top shell (*Rochia nilotica*) and giant clam shell (Tridacnidae) indicates that people were accessing the clean edges of coral reef systems.

SU4 (*c*. 4050–2800 cal BP): Inshore locales continue to be the most heavily exploited habitats, but we see in this SU a shift toward sandy substrate taxa (41% of the SU4 assemblage), away from rocky shore (18%) and muddy substrate mangrove-associated species (29%). There also continues to be evidence for increased access to resources from reef flats. Although minimally occurring in SU5, *Conomurex luhuanus*, a species that inhabits sandy substrates and intertidal-seagrass meadows, forms a substantive component of the SU4 assemblage (from XU47). The fact that this species is minimally represented to absent from the culturally rich SU5 Lower Horizon and into SU6 and SU7, suggests a major shift in exploitation of resource zones. Whether this also involved environmental change is not clear from the Tanamu 1 archaeological evidence.

SU3 (c. 2800–2750 cal BP): There are some notable differences between the dense cultural horizons of SU5 and SU3, indicating either that environmental conditions or targeted resource zones changed between *c*. 4350 cal BP (pre-Lapita) and 2800 cal BP (Lapita). *Laevistrombus canarium* (muddy-sand bottoms and seagrass meadows), *Gibberulus gibberulus* (sandy reef flats) and *Conomurex luhuanus* (sandy substrates and seagrass meadows) are present in greater quantities in SU3 than in SU5. Also occurring in greater numbers in SU3 are species from clean coral reef environments. Following the trend commenced in SU4, in SU3 quantities of harvested taxa are greatest from intertidal sand and mudflats (SU4: 41% of MNI; SU3: 42% of MNI) than from any other habitat. Here *Gafrarium tumidum*, *G. pectinatum*, *Anadara antiquata*, *Atactodea striata* and Tellinidae predominate. The rocky substrate taxa Ostreidae and *Chama* spp. are still present in reasonably high numbers, but unlike SU5, *Isogonomon* spp. and small nerites are only found in minor quantities. Similarly, the mangrove gastropods *Terebralia* spp. and cerithiids are represented in low numbers. These notable differences suggest not so much a change in the range of exploited habitats as in the proportional exploitation of habitats (with increased targeting of intertidal sand and mudflats, and reef environments) with the first signs of Lapita at Tanamu 1 *c*. 2800 cal BP (SU3) or slightly beforehand (within the period of SU4, as suggested by slightly earlier dates of around 2900 cal BP for the arrival of Lapita ceramics at Bogi 1 *c*.140m away (see McNiven *et al*. 2011)).

SU2 (*c*. 2750–700 cal BP): This SU contains insufficient quantities of shell from which to adequately determine environmental data.

SU1 (*c*. 700–100 cal BP): Post-Lapita peoples of the past 700 years targeted a significantly reduced variety of taxa. The indication is for a more intensive focus on gathering Strawberry Conch (*Conomurex luhuanus*), commonly collected from sandy substrates and intertidal seagrass beds, and Spider Conch (*Lambis lambis*), which inhabit reef flats and coral-rubble bottoms. Mangrove-associated species were once again utilized, with *Telescopium telescopium*, *Geloina expansa* and *Terebralia* spp. well represented. Rock oysters were a staple throughout occupation of the site and continue to be targeted into SU1.

The evidence from Tanamu 1 confirms that peoples of Caution Bay targeted a wide range of littoral habitats with different substrates (e.g., sand, rock, mud, coral reef and mangrove trees) for subsistence. This was supplemented with mollusc resources from reef flats, intertidal seagrass meadows and freshwater environments. The variation in habitats targeted over time may be an indication of different cultural strategies or it could be a reflection of changing environments or a combination of both. Notable differences between the three major cultural horizons are:

1. During pre-ceramic times (SU5 Lower Horizon), people obtained their resources in similar quantities from a variety of intertidal habitats, and had already begun to venture offshore for some prized specimens (e.g., occasional giant clams and nacreous top shells).
2. During Lapita (SU3 Middle Horizon) times, there was a greater focus on sandy and rocky intertidal rather than mangrove species, and more time was spent offshore accessing the clean coral reef environments.
3. More than half of the post-Lapita, proto-ethnographic (SU1 Upper Horizon) assemblage consists of a single species (*C. luhuanus*) collected from sandy substrates and intertidal seagrass beds.

Conclusions

A broad picture of shell exploitation strategies through time has been gleaned from the molluscan assemblage of Tanamu 1. Shell taxa in SU6 and SU7 indicate that the site was initially subject to intertidal conditions, as the array and size of specimens are consistent with those normally found in beach-line sediments (e.g., Rowland 1994; Sullivan and O'Connor 1993). Culturally sparse SU2 witnessed a slow sediment build-up largely devoid of shell, while SU4, also from a period of relatively infrequent cultural activity at Tanamu 1, nevertheless exhibits a large amount of shell.

The distribution of shell from the early cultural layers (SU7 to SU5) suggests the relatively consistent exploitation of a core set of species, with further exploitation of other species from a wide range of habitats. Around 39 bivalve and 72 gastropod taxa contributed to the diet and/or had other social value during this time.

Subsistence economies of pre-ceramic and Lapita populations at Tanamu 1 had a strong focus on marine resources, as reflected by the 68,474.6g of mollusc shell recovered from SU5 (Lower Horizon) and the 27,743.5g of shell from SU3 (Middle Horizon) respectively. Such a focus on marine resources suggests that both pre-Lapita and Lapita peoples at Tanamu 1 were marine specialists who exploited a diverse range of coastal to shallow marine and freshwater habitats including estuaries, mangroves, the sandy seafloor, seagrass beds and coral reefs. The use of watercraft may have been necessary to access and transport shellfish such as *Tridacna squamosa* and *Rochia nilotica* collected from the outer reef edge and deeper waters up to 2 km away (Coffey Natural Systems 2009). While an increase in the abundance of shells originating from seagrass beds and mangrove habitats is evident in the SU1 Upper Cultural Horizon, people also continued to exploit other habitats.

Regional and local biogeographic patterns and cycles of resource abundance must also be considered when explaining and interpreting faunal assemblages (Moss 2012: 2). Resource characteristics of the intertidal zones that were most accessible to people are reflected in the composition of the shellfish assemblage. Higher percentages of subtidal resources in the SU3 and SU5 assemblages indicate that pre-ceramic and Lapita peoples regularly accessed submerged marine habitats, suggesting that people had better access to the bay before mangroves choked the shoreline. These results are best interpreted in conjunction with other cultural materials from Square A and Square B for a better understanding of the Tanamu 1 overall site context.