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Molluscs and Echinoderms from the Emily Bay Settlement Site, Norfolk Island

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ABSTRACT. The Emily Bay archaeological molluscan fauna as an ensemble is almost entirely intertidal in its natural occurrence, with seven species preferring sand or mud substrates and 13 species preferring hard substrates. The only exceptions are the pelagic cephalopods *Nautilus* and *Spirula*. The gastropod species *Nerita atramentosa* is dominant in both numbers and by weight.

The rocky intertidal platform was the focus of mollusc collecting. The four most common species derive from this zone and habitually cluster in colonies, which would have made them a preferred prey.

Among the many factors that may have contributed to eventual abandonment of Norfolk Island, a scarcity of easily harvestable coastal marine resources would probably have been significant.

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It is assumed that those food resources on Norfolk Island that could be collected by people immediately on arrival would have been of great importance to Polynesian settlers. The availability and ease of collection of shellfish would have been an important factor, therefore, in the initial viability of settlement on Norfolk Island.

The molluscs that appear in the archaeological material reflect the natural environment of Norfolk Island, which is notable for its restricted range of suitable molluscan habitats (Anderson and White, *Approaching the Prehistory*… , this vol.). The greatest density of species occurs in the intertidal zone, but on Norfolk Island soft shore intertidal areas are restricted largely to the Kingston lagoon and only rocky shores are extensive.

Shellfish collection

The year-round abundance of mollusc resources is their greatest asset for people, and in times of scarcity of other resources they assume a greater significance in the diet (Higham, 1996; Meehan, 1982; Meighan, 1969; Swadling and Chowning, 1981). Shellfish therefore represent a stabilising factor in food procurement. In addition to their food value, mollusc shells can be raw material for artefacts.

Claasen (1998) working with the fishermen of San Salvador Island in the Bahamas reports on the important role of shellfish, including *Nerita* sp. as bait (Claasen, 1998: 10).

Site taphonomy

As discussed in this volume (Anderson, Smith and White) the stratigraphy for Trenches EB97:23 and EB97:24 reveals a cultural layer that was generally sealed by overlying sediments since its deposition. However, there is some evidence that it was exposed to both wind and wave action before the formation of the modern dune system. There is a history of cultural material being washed out of Emily Bay (Specht, 1984) and it is highly probable that the cultural layer was affected. In addition the cultural layer has itself suffered disturbance in the form of mutton bird nesting hollows.

The abundance of shell diminishes with depth in both trenches, although less so in Trench EB97:23. There is only a single occupation level, but bioturbation has been significant in moving material as much as 90cm below the surface of the cultural layer.

Methodology

The molluscan assemblage from Norfolk Island was identified by Dr Colin Campbell at the Department of Archaeology & Natural History (ANU). A small taxonomic reference collection was abstracted from the archaeological sample. Of the eight trenches excavated at Emily Bay, Trenches EB97:23 and EB97:24 were the most productive in terms of faunal remains and therefore the best suited for intensive analysis, the goal being to investigate prehistoric molluscan collection and use strategies.

The material recovered by excavation was sieved through 2 mm or 4 mm screens (Anderson, Smith and White, this vol.). The shell was then cleaned and all taxa were identified to species in the ANU laboratories. The left and right valves of bivalves were identified and counted, location of damage to valves noted, all shells weighed, and all fragments counted, weighed and taxonomically assigned as far as possible.

Minimum numbers of individuals (MNI) were calculated by counting whole shells, and in the case of bivalves by comparing right and left pairs. In the case of fragmented shells, hinges in bivalves and apices in gastropods were used to signify an individual. The common gastropod species *Nerita atramentosa* is represented by abundant whole specimens and fragments. MNIs from fragments were estimated by calculating the mean weight for whole *N. atramentosa* shells in each spit and dividing the total weight of fragments by that value.

Results of molluscan analysis

Trench EB97:24. Nineteen one metre squares were excavated from the cultural layer in this trench, each to a depth of 30 cm, producing a total of 5.7 m^3 of sediment. The total shell weight from this volume was 2.02 kg, producing a density of 0.35 kg/m^3.

Eighteen species of molluscs were present (Table 1), with four of those species having one occurrence only and with another five species appearing less than five times. *Nerita atramentosa* alone accounts for 65% by number and 86% by weight of the entire assemblage. The next three most common species, *Bembicium flavescens, Hinea brasiliana* and *Capulus* sp. account for 28% by number and 11% by weight, with the remaining 15 species therefore being responsible for only 7% by number and 3% by weight of the assemblage. The absolute predominance of *N. atramentosa* is clear, and is a consequence, presumably, of their natural abundance on the rock platform and the ease of their collection.

Table 1. Trench EB97:24 molluscs by species showing their weight and MNI counts.

species	MNI (no.)	MNI (%)	weight (g)	weight (%)
GASTROPODA				
Nerita atramentosa	755	65	1734.9	85.9
Bembicium flavescens	124	10.7	114.4	5.7
Hinea brasiliana	102	8.8	52.7	2.6
Capulus sp.	95	8.2	44.1	2.2
Gastropod sp.	20	1.7	10.7	0.5
Nassarius sp.	14	1.2	11.6	0.6
Tonna variegata	7	0.6	4.7	0.2
Siphonaria cf. *diemenensis*	6	0.5	0.7	0.0
Strombus labiatus	4	0.3	8.1	0.4
Morula sp.	4	0.3	3.6	0.2
Cypraea caputserpentis	2	0.2	2.1	0.1
Thais orbita	1	0.1	1.8	0.1
BIVALVIA				
Gari cf. *livida*	19	1.6	27.3	1.4
Pinctada maculata	2	0.2	0.3	0.0
Mactra rufescens	1	0.1	0.7	0.0
Saccostrea cucullata	1	0.1	0.7	0.0
Anapella cycladea	1	0.1	0.5	0.0
CEPHALOPODA				
Spirula spirula	3	0.3	0.7	0.0
totals	1161	100.0	2019.6	100

Remarkably, one of the four most common taxa, *Capulus* sp., is most unlikely to have been a food species. It is a very small mollusc, generally less than 8 mm in diameter, and lives attached to other shells. Its presence in the midden is almost certainly adventitious, as a rider on other shells, or possibly rocks. There are no recorded instances of this species being consumed.

Trench EB97:23. Thirty-nine one metre squares were excavated from the cultural layer in this trench, an average depth of 30 cm. This excavation resulted in a volume of 11.70 m^3 of sediment. The total shell weight from this volume was 6.54 kg, a density of 0.56 kg/m^3.

At least 20 species of mollusc are present (Table 2). Three of these are represented by single occurrences, another three are present less than five times, and a further five present between five and ten times. Here *N. atramentosa* is even more dominant, accounting for 87% by number and 95% by weight of the local assemblage. The next three most common species, *Siphonaria* sp., *Capulus* sp. and *Anapella cycladea* contribute 6.5% by number and 1.2% by weight, with the remaining 16 species contributing only 6.5% by number and 3.8% by weight.

Table 2. Trench EB97:23 molluscs by species showing weight and MNI counts.

species	MNI (no.)	MNI (%)	weight (g)	weight (%)
GASTROPODA				
Nerita atramentosa	2448	87.2	6206.4	95
Siphonaria cf. *diemenensis*	75	2.7	10.1	0.2
Capulus sp.	59	2.1	16.4	0.3
Hinea brasiliana	36	1.3	17.0	0.3
Tonna variegata	30	1.1	63.8	1.0
Thais orbita	11	0.4	79.8	1.2
Bembicium flavescens	9	0.3	3.9	0.1
Nassarius sp.	7	0.2	0.6	0.0
Serpulorbis sp.	1	0.0	1.3	0.0
Bulla sp.	1	0.0	0.5	0.0
Cypraea caputserpentis	1	0.0	11.1	0.2
BIVALVIA				
Anapella cycladea	48	1.7	54.2	0.8
Gari cf. *livida*	24	0.9	22.6	0.3
Cardita tasmanica	23	0.8	5.8	0.1
Mactra rufescens	9	0.3	31.4	0.5
Barbatia squamosa	8	0.3	2.5	0.0
bivalve sp.	7	0.2	2.3	0.0
Pinctada maculata	4	0.1	3.0	0.0
Saccostrea cucullata	3	0.1	1.4	0.0
CEPHALOPODA				
Nautilus repertus	4	0.1	1.8	0.0
totals	2808	100.0	6535.9	100.0

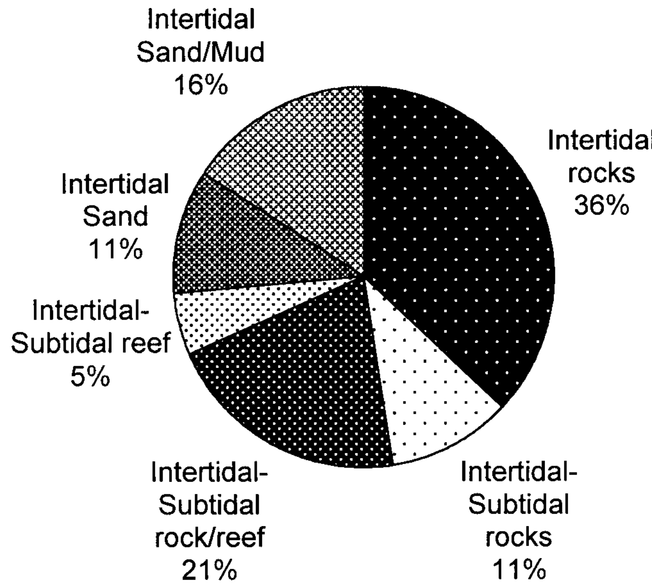

Figure 1. Percentage of Mollusc Species occupying Substrate Types at Emily Bay.

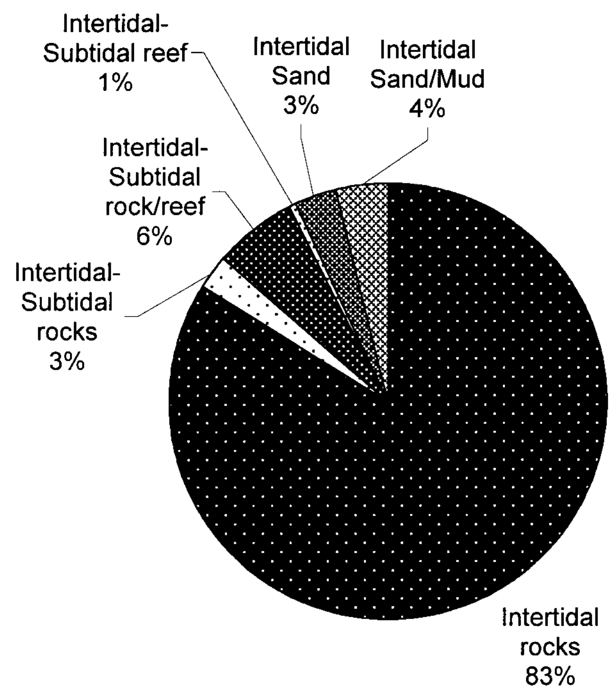

Figure 2. Molluscan substrate representation by percentage of shell weight recovered at Emily Bay.

Molluscan ecology

The habitat preferences of the species identified in the Emily Bay site range vertically from the upper intertidal to the subtidal zone (Dakin *et al*., 1980). The substrates that the species prefer range from sandy intertidal through rocky intertidal to shallow subtidal rocks. The known ecological attributes of the 24 identified species from the Emily Bay site are listed in Table 3, while the percentage of species that occupy each substrate zone is shown in Fig. 1.

Figure 1 illustrates by number of species the difference between the habitat zones. MNI and shell weight counts show consistently that the four species most commonly represented in the samples all inhabit rocky substrates of the intertidal zone. This result is further supported and illustrated in Fig. 2 which shows that, when measured by weight, the rocky intertidal zone was the main focus of collecting activity. The species representation and the inferred collection strategy may both be regarded as natural consequences of the intertidal geography of Norfolk Island in which rocky shores are predominant.

The collected molluscs

Most abundant species. Analysis of Trenches EB97:23 and EB97:24 reveals that *Nerita atramentosa* is dominant in the assemblage. In addition to *N. atramentosa*, two other species (*Bembicium flavescens* and *Hinea brasiliana*) were commonly collected. The adventitious occurrence of *Capulus* is excluded from this discussion. All three preferred species are similar in their ecology and in the possession of gregarious behaviour, clustering in easily collected colonies. All preferentially occupy the rocky intertidal zone, and are therefore easily collected at low tide.

Nerita atramentosa, Bembicium flavescens and *Hinea brasiliana* are all herbivorous grazing gastropods of the upper intertidal zone. None are particularly large, and in an area including mudflats with bivalves they would probably have been ignored as they require more effort to collect and process. However, on Norfolk Island, soft shore habitats are very limited, and there is little doubt that these three species were collected most often precisely because they

Table 3. Ecological preferences of the Norfolk Island archaeological molluscan fauna. Constructed with reference to Wilson (1993, 1994), Shepherd and Thomas (1989), Dakin *et al*. (1980) and Allen (1959).

taxon	depth	substrate
GASTROPODA		
Buccinidae (dog whelks)		
Nassarius sp.	intertidal	sand to mud
Bullidae (bubble shells)		
Bulla cf. *quoyii*	intertidal	silty sand near seagrass beds
Capulidae (cap shells)		
Capulus sp.	shallow subtidal to intertidal	attached to other molluscs or stones
Cypraeidae (cowries)		
Cypraea caputserpentis	intertidal and shallow subtidal	coral reef or rock
Epitoniidae (wentle traps)		
Epitonium sp.	shallow subtidal	rock or coral
Littorinidae (periwinkles)		
Bembicium flavescens	intertidal	rock
Muricidae		
Morula sp.	intertidal to shallow subtidal	rock and coral reefs
Thais orbita	intertidal to subtidal	coral and rock
Naticidae (moon snails)		
Polinices sp.	intertidal	sand bars and beaches
Neritidae		
Nerita atramentosa	uppermost intertidal	rock—often exposed for long periods
Planaxidae (clusterwinks)		
Hinea brasiliana	upper intertidal	wave exposed rock and rubble
Siphonariidae (siphons)		
Siphonaria diemenensis	intertidal	rocks
Strombidae		
Strombus labiatus	intertidal	sand
Tonnidae (tun shells)		
Tonna variegata	intertidal	sand
Vermetidae (worm shells)		
Serpulorbis sipho	shallow subtidal to intertidal	attached and zonally distributed on rocky shores
BIVALVIA		
Arcidae (ark shells)		
Barbatia pistachia	subtidal to shallow intertidal	under stones; medium to high energy coasts or currents
Carditidae		
Cardita tasmanica	intertidal	under reef rocks
Mactridae		
Mactra rufescens	intertidal	sand and mud
Mesodesmatidae		
Anapella cycladea	intertidal	rocks or coral
Ostreidae (oysters)		
Saccostrea cucullata	exposed to sheltered intertidal	rocks
Psammobiidae		
Gari cf. *livida*	intertidal	sand to gravelly mud
Pteriidae		
Pinctada maculata	intertidal	
CEPHALOPODA		
Nautilidae		
Nautilus repertus	oceanic	pelagic
Spirulidae		
Spirula spirula	oceanic	pelagic

were the most abundant and accessible in the area. *Nerita atramentosa* in particular far exceeds any other species in both shell weight and MNI count.

The minor species. Although approximately 30% of the species present have soft substrate preferences they are, as noted, very little represented in both MNI and weight counts. This is almost certainly due to the scarcity of suitable habitat. Those few species present in the midden which are large and meaty (e.g., *Tonna variegata* and *Gari livida*) are derived from this soft substrate habitat. All the *T. variegata* fragments, for example, could probably have come from one or two individuals. *Gari livida*, which inhabits sand or gravelly mud in the intertidal zone, is notable for the fact that the small amount of shell present often appears to have been worked to produce a cutting edge (Schmidt, Anderson and Fullagar, this vol.).

Echinoderms

Apart from the molluscan resources it is important to note that almost every spit excavated contained fragments of the test or spines of one or two species of sea urchin (phylum Echinodermata), which would have significantly supplemented the food value of the accompanying molluscs. In both of the analysed trenches the echinoid fragments were second only to *N. atramentosa* in weight, therefore representing a substantial resource (363g in Trench EB97:24 and 1,368 g in Trench EB97:23). Sea urchins are an easily collected resource.

Echinoids are considered a valuable food resource in the Pacific, particularly in Maori culture where they are considered a delicacy and are one of the most numerous taxa found in middens (Best, 1929: 70–71). Sea urchins are not molluscs and their presence in the midden does not affect the results of the molluscan analysis in regards to collection strategies but rather is supplemental to it. The harvesting of sea urchins may well have mitigated the effect of meagre shellfish beds by supplying a store of easily accessed protein although a major reliance on the species may well have resulted in overexploitation and stock collapses.

Due to their poor preservational qualities, the quantities of sea urchin collected at Norfolk Island in prehistory remain difficult to quantify with only highly fragmented remains occurring. Currently these remains are not amenable to further analysis in regards to measuring size or number of individuals. As a result their role in the resource strategy must remain speculative.

Discussion

A number of studies considering Polynesian methods of shellfish collecting have been conducted over the past three decades (e.g., Spennemann, 1987; Kirch, 1979; Kirch and Dye, 1979; Swadling and Chowning, 1981; Anderson, 1979, 1981; Szabó, 1999). As well as these Pacific examples, Meehan's (1982) seminal study among the Gidjingali of Australia is also pertinent.

Meehan (1982) and Anderson (1979, 1981) offer the most comprehensive studies of shellfish gathering strategies. Meehan's study concludes that particular species are targeted by gatherers, though other desirable species encountered fortuitously may also be collected (Meehan, 1982: 69). Anderson (1979, 1981) deduced that prehistoric inhabitants of Black Rocks, Palliser Bay, were collecting the largest individuals regardless of species. It follows, however, that some species attain a larger size than others, and are thus more desirable and more frequently collected (Anderson, 1981: 114). The difference in conclusions between these two studies can be seen as a consequence of the respective areas of study; Meehan's (1982) study focuses on the soft shore, which contains fewer species of generally high biomass, while Anderson's (1979, 1981) study revolves entirely around the rocky shore, which in general harbours a greater variety of species with each species being of significantly lower biomass. Hence, logically, it is easier and more productive to focus on the collection of certain species when gathering from the soft shore, and upon large individuals from the rocky shore. Given that shellfishing strategies and, hence, archaeological midden deposits, reflect the ecology of the area being exploited, it would appear that both Meehan (1982) and Anderson (1979, 1981) describe optimal strategies for different niches.

The Emily Bay deposits can be seen to follow both the pattern of exploiting the largest individuals, and certain species which tend to offer the largest individuals. *Nerita atramentosa, Bembicium flavescens* and *Hinea brasiliana* are the largest of the common intertidal molluscs inhabiting the rocky reef at Emily Bay. Where other desirable individuals of larger species were encountered, they too were collected. This tactic is represented by *Tonna variegata* and *Saccostrea cucullata*. It is difficult to say whether *Nerita atramentosa* individuals were being targeted due to their size, taste, visibility, convenient location or colonial tendencies—mostly likely it was a combination of some or all of these factors.

Conclusions

The aim of this analysis was to investigate shellfish collection strategies on Norfolk Island. The presence of 24 molluscan species when a mere four provide more than 90% of the discarded shells suggests a harvesting strategy concentrated on the gastropod *Nerita atramentosa*, but which involved the collection of any other shellfish encountered during collecting forays. This is a common resource procurement strategy for shellfish, one which allows for some taste variability in the diet without the necessity of expanding the collection effort (Meehan, 1982: 80). Some species like *Capulus* sp. were most likely gathered incidentally as attachments to the larger shells. The small size of *Nerita atramentosa*, the main gastropod collected, and the scarcity of shellfish habitat, would have imposed an intractable protein limit for molluscs as a food source. The relatively low abundance of shell in the site supports the view that molluscs represented a marginal food resource to the human group. The overall strategy displays efficiency in maximising the available molluscan resources by concentrating on the most numerous species, but at the same time including any mollusc that was large enough regardless of species, and supplementing this collection strategy with the inclusion of sea urchins.

Another explanation for the shellfish collection on Norfolk Island would be that *N. atramentosa* was used as bait for the important task of fishing on the protein-limited Norfolk Island. In this view the shellfish did not constitute only a food resource but a vital ingredient in the procurement of other marine resources. The lack of large quantities of shellfish resources on Norfolk Island would have placed a greater emphasis on the role of other resources for protein procurement. Norfolk Island has a rich biota of fish and marine turtles (Walter and Anderson, this vol.) that could have compensated to some extent for a meagre shellfish resource. However this alternative explanation is not supported by the archaeological evidence. The location of the *N. atramentosa* remains, within the food midden and close to earth ovens in the site points to the species being used as a food resource rather than as a bait resource. The use of nerites as bait usually results in the dispersal of the shell overboard or on the spot where the fishing is being carried out, as live mollusc bait is preferentially used. Whilst feasible as bait, the occurrence of the *N. atramentosa* shell in the midden leads to the conclusion that they were being harvested as a food resource for the human inhabitants of Norfolk Island.

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