ARCHAEOLOGICAL EVIDENCE FOR ENVIRONMENTAL CHANGE IN DARWIN HARBOUR.

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ABSTRACT

Chronological change in the coastal environment of Darwin Harbour, Northern Territory, is documented by archaeological sites. Molluscs gathered by prehistoric people for food between 1,400 and about 900 years ago reveal that humans were foraging along largely open beaches. The dense and continuous mangrove forests found in the harbour today have formed in the last 1,000 years.

KEYWORDS: Archaeology, prehistory, middens, shell mound, Darwin Harbour, palaeoenvironments.

INTRODUCTION

Archaeological sites may be considered as convenient information traps, preserving evidence of environmental change. As part of their exploitation of the landscape, prehistoric humans procured food resources from the local area in which they lived. These hunter-gatherers carried materials to a locality where food debris was discarded and became protected in the archaeological deposit. In this way a selection of organic materials from past time periods has been preserved. While archaeologists typically concentrate on human economic activities represented by the food debris, archaeological material also reflects the kind of environment in which humans were foraging. Shell middens in particular have been used as indicators of environmental change in coastal landscapes. For example, in the Alligator Rivers region of the Northern Territory, Schrire (1982) and Allen and Barton (n.d.) have related change in shell midden composition to changes in the form or proximity of mangrove forests. Further to the west, along the Kimberley coast, Wells and Slack-Smith (1981: 273) used similar logic to infer chronological change:

> A number of Aboriginal kitchen middens are located on the hills adjacent to the Warrender mangroves. The middens are largely composed of marine molluscan shells and may reach a diameter of 5 m with a height of 1 m. The shells are mainly from the most abundant species of large molluscs in the mangal. An exception to this is the high percentage of valves of *Anadara granosa* (Linnaeus, 1758). This species was not encountered in the quantitative mangrove survey but a few live individuals were collected on the surface of the mudflat seaward of the swamp. The large number of *Anadara* shells in the middens suggests that once the species was more abundant in the area than it is now. The middens have not been dated so we have no idea of the period in which the population declined.

Similar shell mounds are found around Darwin Harbour, where they are typically located on raised rocky knolls and slopes, less than 20 m above sea level, overlooking the mangroves. These shell middens are also dominated by *Anadara* not found in the mangrove-lined coast, and are indicative of different coastal landscapes. Fortunately, archaeological investigations in the Darwin region are beginning to reveal the antiquity of these shell middens, and by implication those past coastal environments. This paper describes the environmental implications of archaeological excavations at one shell midden near Darwin.

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BAYVIEW HAVEN 3

Bayview Haven 3 is a mound of shell situated south of Tiger Brennan Drive on a promontory of land jutting out into Francis Bay (Australian Map Grid 701 305E, 862 4175N) in Darwin harbour. At this point there is a broad fringe of mangroves around the edge of the bay, and land rises steeply to more than 20 m above sea level.

The shell midden is located on the top of a ridge, 30 m from a steep hill slope. Vegetation is predominantly grass. There has been extensive disturbance in this area and a road passes very close to the site. Recent activities in this area have adversely affected this shell midden, but the bulk of the deposit remains intact. The shell midden is approximately 10-12 m in diameter and has a 50 cm deposit of shell material. In 1993, archaeological excavation of the site took place. Shell-rich sediments recovered from the deposit were typical of archaeological middens, containing bones of fish and macropods together with abundant large shells generally well preserved in a highly alkaline matrix. A small number of stone artefacts were also found. All material from this trench was sieved through paired 6 mm and 3 mm meshes, and the 6 mm sieve residues provide a quantitative measure of the kinds of molluscan fauna procured in the past.

Faunal composition. Relative abundance of the various invertebrate taxa represented in the midden was calculated using standard zooarchaeological measures (as described in Grayson 1984). For each taxon the weight and number of identified shell fragments (called NISP) were recorded. An estimate of the minimum number of individual (called MNI) molluscs necessary to account for the fragments of each taxon was based on the number of distinctive elements (hinges for bivalves and apertures for gastropods) in each excavation spit. These measurements were completed for spit 9, square F0, a unit of the deposit 1 m^2 in area and 6 cm thick. This excavation unit is typical of the midden and can be used to typify faunal composition.

A total of 7007.9 g of marine shell was retained in the 6 mm sieve from this excavation unit. Of this material only 101.4 g (1.4%) was not identified to genera. These unidentified fragments were small, often only 3-5 mm in maximum dimension, heavily weathered and without diagnostic features. The remaining 6906.5 g of marine shell was identified, counted and weighed. Faunal composition is summarised in Table 1. This assemblage is entirely consistent with economic activities of hunter-gatherers selecting for large, edible shell fish. This shell midden consisted of shells of animals from several gastropod genera (*Telescopium, Terebralia, Nerita, Chicoreus, Cassidula,* and *Pugilina*) and several bivalve genera (*Anadara, Marcia, Crassostrea, Geloina, and Placamen*). As quantified by weight, NISP or MNI calculations, *Anadara* is the numerically dominant taxon (Table 1). At least three-quarters of the midden mound consisted of fragments of shells from *Anadara*. Archaeological investigations aimed to determine the time period in which these *Anadara*-dominated piles of shell accumulated.

Radiocarbon chronology. Antiquity of the site was evaluated by submitting four samples of *Anadara* shells to radiocarbon analysis. C13 adjusted assays were calibrated using the University of Washington's CALIB 3.03 program, implemented with the marine bidecadal data set and the standard Delta R value of -5±35. Resulting age estimates are provided in Table 2.

These data, particularly Beta-72152 and Beta-72153, reveal that the latest shells deposited on

Table 1. Quantitative description of molluscan faunal debris in spit 9 of square F0 at Bayview Haven 3.

Genus	Weight of fragments (in grams)	Number of Fragments (NISP)	MNI_{Spit}	% by weight	% by NISP	% by MNI	Rank (by MNI)
Anadara	5703.8	5092	348	82.6	84.3	74.5	1
Nerita	51.4	107	33	0.7	1.8	7.1	2
Terebralia	354.8	202	24	5.1	3.3	5.1	3
Telescopium	430.9	291	15	6.2	4.8	3.2	4
Cassidula	6.6	19	13	0.1	0.3	2.8	5
Chicoreus	153.0	196	11	2.2	3.2	2.4	6
Pugilina	151.0	68	10	2.2	1.1	2.1	7
Marcia	30.4	30	6	0.4	0.5	1.3	8
Crassostrea	15.6	25	4	0.2	0.4	0.9	9
Geloina	7.7	11	1	0.1	0.2	0.2	10
Placamen	1.3	1	1	0.1	<0.1	0.2	11

the mound came from molluscs that died approximately 700-1050 years ago, and probably 850-950 years before present (bp). At some point within that period, deposition of food debris on the midden ceased, and the mound was abandoned.

In deriving these chronological estimates of site abandonment the standard Australian -450±35 years marine reservoir correction factor was used. It is worth noting that there is some evidence in favour of a smaller marine correction factor in the greater Darwin region (Woodroffe *et al.* 1988: 98; Scott Mitchell pers. comm.). If a smaller correction factor were appropriate, then the corrected and calibrated dates in Table 2 would slightly under-estimate the antiquity of the final occupation of the site. Nevertheless, any future revision of the marine correction will have minimal effect on the estimated age of occupation at the mound, and it can be concluded that the site was in use until approximately 700-1000 years ago.

The earliest age estimate, from the base of the shell deposit in square G8, indicates that formation of the deposit had begun at least 1250-1550 years ago. Since dated samples came from only the eastern part of the site, it is possible that shell in square G8 might have accumulated after other portions of the midden were already in place. Beta-72155 should therefore be considered a minimum age for the mound, but probably provides a useful indication of the date at which shell started to be deposited.

Using these corrected and calibrated radiocarbon dates, it is clear that humans occupied the site for at least 300 years, and possibly for as much as 850 years. A best estimate for the duration of site occupation is about 500 years, with occupation beginning about 1400 years ago and ending 900 years ago. Throughout the history of occupation the faunal assemblage remained remarkably similar, being dominated by *Anadara* in all levels. The dominance and persistence of this bivalve in the mound has implications for palaeo-environmental reconstructions of the harbour shorelines during the late Holocene.

Palaeo-environmental implications. Using MNI_{spit} as a measure of the number of animals captured by the people who discarded debris at Bayview Haven 3, it is clear that at least several hundred thousand individuals of *Anadara* are represented at the site, whereas only a few thousand molluscs typical of the current mangrove communities are present. This pattern cannot easily be reconciled with selective gathering of *Anadara* from within the existing mangroves or along the mangrove margins. The archaeological pattern is more likely to reflect the general availability of the mollusc taxa within the local prehistoric landscape.

Anadara, which forms the bulk of the mound, thrives on the silty-sandy substrates of open beaches (Broom 1985). Shorelines of this type are rare in the north-eastern portion of the Darwin Harbour embayment, and today do not occur near Bayview Haven 3, where dense stands of mangroves currently extend several hundred metres from the base of the colluvial hill slope into the harbour.

Cessation of mound building at Bayview Haven 3 is therefore likely to have been associated with environmental change in shoreline characteristics. It is hypothesised that during the period over which the site formed, roughly 900-1400 years ago, the local shoreline consisted of largely open beaches, perhaps with scattered stands of mangrove but without the dense and continuous mangrove forests found today. The presence of molluscs occupying sandy substrates, such as *Marcia* (see Lamprell and Whitehead 1992), within the midden, support such a proposition.

If this were the only evidence available it would be consistent with small scale chronological variations in the density of mangroves in the extreme north-east of the harbour. However, other archaeological evidence suggests that open

Table 2. Radiocarbon dates from Bayview Haven.

Code	Sample	Sample (g)	C^{13} adjusted date	Calibrated date (bp)	One sigma range (Cal bp)	Two sigma range (Cal bp)
Beta-72152	F8/5s	44.9	1310 ± 60	873	765 - 921	693 - 974
Beta-72153	F8/8s	30.5	1370 ± 50	916	871 - 957	772 - 1034
Beta-72154	G8/4s	33.5	1520 ± 70	1058	966 - 1155	911 - 1241
Beta-72155	G8/1s	37.1	1870 ± 60	1395	1321 - 1494	1274 - 1552

coastlines may have been widespread. Ten kilometres to the south of Bayview Haven 3, a series of similar *Anadara*-dominated midden mounds on the Middle Arm Peninsula have been dated by the author (further descriptions of these sites are being prepared). Samples of *Anadara* shells from the surface of four sites were radiocarbon dated and subjected to correction and calibration as described earlier for the Bayview Haven 3 samples. Resulting age estimates indicate that the upper levels of these *Anadara*-rich middens ceased accumulating about 700-1000 years ago (see Table 3).

Archaeological evidence therefore reveals that in two separate locations on the eastern side of Darwin Harbour, *Anadara*-rich midden deposits ceased to accumulate roughly 700-1000 years ago. I have advanced the argument that the composition of these middens largely reflects the relative availability of various molluscan taxa within the landscape. If that is the case, then the cessation of the *Anadara*-dominated middens probably signifies declining abundance of *Anadara* within the harbour and the expansion of mangrove communities at the expense of relatively open shorelines. The spatial extent of such environmental changes is ill-defined, but may well be widespread within Darwin Harbour. Consequently the palaeo-environmental implications of archaeological shell middens along the eastern margin of the harbour is that the dense, extensive mangrove communities found today may have an antiquity of not more than 700-1000 years.

CONCLUSIONS

Archaeological investigations near Darwin have palaeo-environmental implications and raise a number of questions concerning environmental change in Darwin Harbour. Issues addressed in this paper can be listed as follows:

1. On the eastern side of the harbour there are a number of mounded archaeological middens that are composed largely of *Anadara* shells. These middens ceased accumulation approximately 700-1000 years ago. At least one of these middens, Bayview Haven 3, began to accumulate about 1400 years ago.

2. Middens of this kind are thought to reflect the economy and diet of prehistoric people, and to indirectly reflect the availability of food species within the environment. In this instance, the shells of *Anadara* are so overwhelmingly abundant that it is suggested that that taxon must have been more abundant relative to other molluscs during the period in which the sites formed. By reference to the preferred habitats of the molluscs represented in the archaeological assemblage, it is hypothesised that the harbour shore consisted of open beaches with scattered stands of mangrove. Consequently, archaeological evidence suggests the dense, extensive mangrove communities found today may have an antiquity of only 700-1000 years.

This conclusion can be tested in a number of ways. Archaeological investigations throughout at least the eastern portions of the harbour should continue to document *Anadara*-rich middens dated to the second millennia before the present if open shores were widespread. Furthermore, there may be geomorphic or palynological evidence for a substantial increase in mangrove stands during the last thousand years. Such evidence has been successfully used in the Alligator Rivers region to define changes in estuarine/coastal conditions (see Woodroffe *et al* 1986), and has the capacity to test the proposal advanced here.

If the palaeo-environmental trends discussed here are corroborated by further research, it remains necessary to place those changes within a longer-term framework of landscape transformations. Archaeological evidence described in this paper cannot differentiate between two possibilities:

1. Extensive mangrove communities developed for the first time only in the last 700-1000 years.

Table 3. Radiocarbon dates from Middle Arm.

Code	Site	C^{13} adjusted date	Calibrated date (bp)	One sigma range (Cal bp)	Two sigma range (Cal bp)
Beta-55467	HR5	1420 ± 60	948	904 - 1029	819 - 1108
Beta-55464	HR14	1150 ± 50	678	646 - 735	610 - 801
Beta-55465	HR15	1500 ± 60	1042	956 - 1124	910 - 1197
Beta-55466	HR17	1380 ± 60	921	873 - 974	765 - 1059

2. Mangrove communities were widespread within the harbour prior to about 1400 years ago, but became spatially restricted for a period following environmental change (such as a series of severe cyclones). In this scenario it is possible that repeated cycles of mangrove destruction and re-colonisation have occurred and that this evidence identifies the most recent of these cycles.

Future research, by archaeologists and others, may determine which possibility best describes the late Holocene environmental history of Darwin Harbour.

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