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The archaeology of the Port Hedland coastal plain and implications for understanding the prehistory of shell mounds and middens in northwestern Australia

Rodney Harrison

Abstract

With the exception of rock art research carried out by McCarthy in the 1960s, there has been no systematic academic archaeological research in Port Hedland, in the coastal Pilbara region of Western Australia. This paper reports the archaeological salvage, radiocarbon dating and analysis of seven shell midden sites located south of Port Hedland, and makes observations regarding the archaeology of the Port Hedland region and the Abydos coastal plain. The excavations revealed an almost continuous sequence of archaeological sites dating between 5350calBP and 50calBP years. These include some of the earliest and latest radiocarbon ages associated with *Anadara granosa* dominated middens, shell mounds and earth mounds from northwestern Australia. Where earlier researchers had suggested that *Anadara* exploitation in northwestern Australia, and particularly on the Abydos plain and Burrup Peninsula, was limited to between 4200 and 1600 BP, these excavations demonstrate that the exploitation of *Anadara* shell in the Port Hedland region was continuous from at least 4400calBP (and possibly as early as 5250calBP) until the early twentieth century. Based on a consideration of their contents and ages, it is suggested that the various forms of shell accumulations in the study area, including shell mounds, earth mounds, surface scatters and stratified lenses of shell midden, are likely to vary more as a result of site formation processes than Aboriginal people's gathering practices in the past. This finding has broader implications for understanding the place of *Anadara* shell mounds and middens in the prehistoric regional economy of northwestern Australia.

Keywords

Archaeology • shell middens • Port Hedland • Pilbara • *Anadara granosa*

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Background to the study

In 2005 an ethnographic and archaeological survey for Aboriginal sites was undertaken by consultants Anthropos Australis (Green *et al.* 2006) with members of the *Kariyarra* (WC 99/003) native title claimant group for Fortescue Metals Group Pty Ltd (FMG), who intend to construct a Port and Load-out Facility at Anderson Point, between South Creek and South West Creek adjacent to the southwest end of the town of Port Hedland. In addition to a number of ethnographic sites, 107 Aboriginal archaeological sites were located and recorded within the area to be impacted. These sites were all shell middens or shell scatters dominated by *Anadara granosa*. Most shell scatters were low density surface expressions of weathered shells. The largest and densest shell scatters were located in areas closest to the coast. Green *et al.* noted that few stone artefacts were associated with the shell midden sites (2006: 355).

On 9th January 2006, FMG applied to the Minister for Indigenous Affairs under section 18 of the *Aboriginal Heritage Act 1972* to develop land within the proposed Port and Load-Out facility area. 71 of the 107 sites recorded by Green *et al.* (2006) will be impacted by FMG's proposed development. Green *et al.* (2006) recommended that 25 of these sites be salvaged prior to any development.

On 10th March 2006, the Minister granted conditional consent to FMG to develop the land as proposed. Consent was dependant on engaging a suitably qualified archaeologist to undertake excavation and analysis of Aboriginal archaeological sites to determine the extent, content and significance of any sub-surface archaeological material through archaeological test excavation of at least seven archaeological sites. Green *et al.* (2006) had divided the archaeological sites into three different site types based on their location in the landscape and assumed age. Conditions of consent specified the excavation of at least one site of each type. This study was initiated in an attempt to apply an explicit research agenda within the limits imposed by these consent conditions.

The study area

The study area lies over the northern edge of Abydos Plain. It covers an area of approximately 5x2.5 km commencing at Anderson Point and running south, between South Creek and South West Creek for a distance of approximately 5 km to the access road which runs along the Shay Gap railway line (Figure 1). This area is part of the Fortescue Botanical District, which lies within the Eremaean Botanical Province (Beard 1975). The geology of the Abydos Plain is characterised by Archaean granite on the inland component and Quaternary alluvium closer to the coast (Beard 1975: 50-56). Within the study area are mangrove flats associated with outcrops of exposed calcarenite, known as the Bosscut Formation. This formation of Pleistocene limestone is believed to have been formed from lithified calcareous sand dunes associated with ancient shorelines (Clarke 1975:79). Port Hedland and its surrounding area are defined by three main geomorphic units, the coastal dunes, the coastal flats and the flood plains. The study area is located entirely within the flood plains unit.

The study area is associated with several creeks draining to the coast between the Turner River Catchment and the De Grey River Catchment. A recent geotechnical investigation in Port Hedland harbour (Paling 2002) demonstrated that the port itself is an old river delta that has experienced successive geological events since the Pleistocene. Based on observations during Coffey Geosciences' geotechnical investigation (see Environ 2004 Appendix N), groundwater levels in the study area are largely influenced by tidal variation. At spring tides the majority of the area is underwater, except the south-west corner, which remains dry. The bulk of the archaeological sites were recorded in this section (see Green *et al.* 2006).

Figure 1: Ortho photomap showing the study area near Port Hedland, Western Australia and the location of the excavated shell midden sites.

The topography of the study area can be described as falling into five main landform types:

1. Most of the study area is dominated by low lying unvegetated hyper-saline mud flats with light sandy brown soils;
2. Mangroves fringe these hypersaline flats on the seaward margins and the margins of tidal creeks and estuaries;
3. Some portions consist of sandy hillocks with red sediments (pindan dunes) raised above the low plain of the mangroves sometimes in the vicinity of creeklines and usually populated by small scrub plant species such as saltbush and *Triodia* spp. These portions are generally unaffected by large tidal movements;
4. White sandy dunes raised above the low mangrove plains and mudflats in the vicinity of Anderson Point;
5. Drainage lines and channels associated with the tidal creeks.

Previous archaeological research in the Port Hedland region

A summary of the results of archaeological surveys in the Port Hedland area undertaken on a contractual basis over the past decade is provided in Green *et al.* (2006: 12ff). These surveys have principally been associated with investigations on the Dampier Salt lease and areas to the east of Port Hedland, with Telstra's optic fibre cable route between Port Hedland and South Hedland and with developments proposed by the Water Corporation and Hope Downs Management Services (O'Connor and Quartermaine 1990, Quartermaine 1991, Mattner and Quartermaine 1991, Hook *et al.* 1993, Warren 1994, 1995, 2001, Robinson and Morse 1997, Harris and O'Reilly 2003, Ibbitson 2004, Green *et al.* 2005; see also Hoving and Choo 1998). These surveys have resulted in the identification and registration of a number of midden sites and small stone artefact scatters on the WA Register of Aboriginal Sites (WA Register). These midden sites, like others in the region (see

Clune 2002), tend to be composed predominately of *Anadara granosa* shell with small quantities of *Terebralia* sp. and *Melo* sp.

Warren (2001: 12ff.) summarises the archaeology of the Port Hedland region as it was known at that time. He suggests that scatters of shell material that occur in the area are dominated by *Anadara granosa*, with the largest and densest shell scatters located in areas closest to the coast. Most shell scatters are low-density surface expressions of weathered shells and fragments, and stone artefacts occur irregularly at these sites. He cites a basal radiocarbon date of 3270 ± 70 BP (Wk9131) from the excavation of an *Anadara granosa* dominated shell midden and engraving site complex (WA Register P07335) near Port Hedland (2001: 11), but no further details regarding the excavation are provided. Engravings occur on limestone ridges. The number of engravings diminishes with increased distance from the coast, except in areas where a high number of engravings are associated with the native fig tree (*Ficus platypoda*) and sources of fresh water. A wide variety of figurative and non-figurative engraved motifs was noted, with the greatest variety of motifs occurring closer to the coast. Stone structures made of piles of similarly sized blocks of limestone, which he suggested were probably *thalu* sites, are present in the area. Their location is not confined to the limestone ridges.

This apparent association of engraving and shell midden sites was suggested for Port Hedland by McCarthy, who hypothesised that, given the absence of stone tools from sites in the region, engravings were probably executed using the sharp end of a *Terebralia* sp. shell (1962: 2), noting that some of the shells recorded in association with engravings had the top few centimetres missing. He undertook experiments which indicated that similar engravings could be produced using *Terebralia* sp. shells. McCarthy was the first to record stone arrangements at Port Hedland, suggesting they functioned as *thalu* or increase sites.

Veitch (1995) reports two radiocarbon ages on shell from the surface of a mounded midden site (WA Register P07303) composed predominately of *Anadara granosa* shell with a small amount of *Terebralia* sp. shell. A *Terebralia* sp. shell returned a date of 750 ± 60 BP (Wk4053), while an *Anadara granosa* shell returned a date of 620 ± 60 BP (Wk4053) (Veitch 1995: 13). This site, a shell scatter with sub-mounded midden deposits measuring approximately 250x80 m and located on a limestone ridge, was on the coast adjacent to Finucane Island near Port Hedland immediately adjacent to the study area. Veitch notes that these dates suggest a significantly later period of shell mound accumulation than in other areas of the coastal Pilbara, where shell mounds had previously been thought to have ceased accumulating between 1600 and 1000 years BP (e.g. O'Connor 1999, Veitch 1999, Clune 2002).

Aims and research design for the salvage excavations

The archaeological work described here was guided by objectives in addition to those specified by the conditions of development consent. These are as follows:

1. To characterise the middens in general terms so as to mitigate against the destruction of the large number of archaeological sites for the Port development;
2. To understand when and how the middens were used by Aboriginal people in the past and over what period the sites formed;
3. To understand the differences between the various midden site types identified and the place of each of the site types in the regional prehistoric economy;
4. To establish a basic chronology for *Anadara granosa* midden and shell mound formation in the Port Hedland region, and to consider how this chronology related to the broader regional sequence of midden and shell mound formation on the northwestern Australian coast;
5. To test Green *et al.* (2006)'s three phase model (see further discussion below).

While these research objectives influenced the methodology, to a large extent the time frames for the excavation had been set by negotiations between FMG and the Pilbara Native Title Service (PNTS) which occurred independently of the research design. The principal factor in this regard was the extremely limited nature of the excavations proposed, and the time frame for their completion. Each midden was to be excavated in approximately one day. Although the excavations often took substantially longer (FMGP04-001, for example, taking three days), the limited time allocated meant that we were often only able to excavate one or two 1x1 m controlled 'hand' excavations at each site. In addition to these controlled excavations, mechanical trenches cut through each site were used to obtain a broad view of stratigraphy, to assist with determining where to locate controlled excavations, and to collect additional radiocarbon samples.

The salvage excavations were carried out in two separate field trips in April 2006 by Eureka Archaeological Research and Consulting UWA (Eureka) and Gavin Jackson Pty Ltd (Gavin Jackson P/L) for Anthropos Australis Pty Ltd. *Kariyarra* representatives participated in all salvage excavations.

The excavations

Excavation of each site proceeded according to a standard method. A string line representing the edge of an approx. 50 cm wide trench was laid out across the site so that a continuous trench would dissect the site through its apex, or apparent area of densest archaeological remains. A trench was then cut to approximately 1-1.3 m depth along this string line. The length and depth of these trenches varied according to the stability of the sediments, and we halted when the trenches could no longer be excavated without risk of section collapse, or after a 10 m long section of trench containing no shell had been noted. In general, these continuous trench cuttings exceeded 15 m in length. The spoil was placed alongside the trench, and both the spoil and section were inspected visually, and cleaned back with a trowel. Sketches of sections of the profile were made, and radiocarbon samples collected and mapped on to section drawings.

One or more 1 x 1 metre excavation squares were then laid out. The number of excavation squares was limited by team's instructions to complete the excavation of one site per day. In general, we selected areas that appeared to have the densest concentration of midden. Excavation squares were oriented north-south and their location was mapped using Differential GPS.

Where no stratigraphic layers were discernible, excavations proceeded according to arbitrary excavation units (spits) of 10 cm depth. Where discrete stratigraphic layers and features were noted, they were excavated separately. A 25x25 cm sample which was the full depth of each spit was collected from the northwest corner of each excavation square as a solid soil sample as described by Bowdler (2006: 322-3). All other soil from each spit was collected in a bucket, weighed, and then wet sieved through a nested set of 6 mm and 3 mm screens. Stone artefacts in the sieve were collected and bagged separately. The residue remaining was then bagged and labelled separately for sorting in the laboratory. During the course of the excavation, samples of shell for radiocarbon dating were collected in situ, bagged, labelled and noted on spit sheets. Excavation ceased once sterile layers were reached.

Details of the excavations are listed in Table 1. The excavations at Sites 23, 31 and 59 reached maximum depths of approximately 40 cm below surface. Excavations at the other four sites reached maximum depths of 70-100 cm below surface. Full site descriptions, section drawings and details of the excavations are contained in Harrison (2007).

Site ID	Description	Excavations
FMGP04-001 and FMGP04-002	Mounded shell midden/ earth mound that lies on the north-eastern bank of Anderson Point and is situated on a low, relatively flat sand dune that forms part of a larger undulating dune system. The maximum height of the dune is approximately 1.3 metres above the high tide mark, measuring approximately 505 m (north/south) by 268 m (east/west). Owing to the irregular shape of the site, Green <i>et al</i> (2006: 55) estimated the site to cover a total area of approximately 62,000 m ² . The shell midden is comprised mostly of <i>Anadara granosa</i> , intermixed with a sparse scattering of <i>Terebralia</i> sp. Associated with another identical shell midden, FMGP04-002 which is located immediately to the west and separated by a large mudflat and tidal access point to the north, and a creek to the south and was treated as part of the same site complex.	three 1x1m hand excavations and four mechanical test trenches (two in 001 and two in 002)
FMGP04-013	Mounded shell midden/earth mound situated across the western margins of two low, white, pindan sand dunes. An eroding shell scatter continues onto the adjacent low tidal mudflat zone, which is subject to inundation during high tides. Green <i>et al</i> (2006:92) estimated that the depth of the shell deposit within the dune to be around 10 cm to 15cm. They mapped the extensive shell scatter as covering approximately 178 m (north/south) by 100 m (east/west) of the dune, and estimated its total area to be approximately 7,8000 m ² . A single isolated Basalt core was noted by Green <i>et al</i> (2005:92) on the dune.	a single 1x1m hand excavation and a single mechanical test trench
FMGP04-014	Mounded shell midden/earth mound situated across the western margins of an approximately 1m high white, pindan sand dune. Its eroding shell scatter continues onto the adjacent low tidal mudflat zone, which is subject to inundation during high tides. The site measures approximately 140 m (north/south) by 139 m (east/west), giving a total area of 12,000 m ² . The shell midden and scatter is mainly comprised of <i>Anadara granosa</i> , with smaller amounts of <i>Terebralia</i> sp. and <i>Baler (Melo sp.)</i> .	two 1x1m hand excavations and a single mechanical test trench
FMGP04-023	Band of shell midden approximately 10cm thick topped with pindan dune located immediately adjacent to the east side of a wide branch of South West Creek and immediately south of a smaller tributary of the creek. The site is situated on the north-western corner of a well established, stable, low, orange pindan sand dune, which is being eroded by the combined effects of the two periodically inundated creek lines and a large, well used four-wheel drive track. The site measures approximately 148 m (north/south) by 133 m (east/west), giving an estimated total area of 7,700 m ² (Green <i>et al</i> 2006: 123). The shell midden appears to be comprised entirely of <i>Anadara granosa</i> .	three 1x1m hand excavations and three mechanical test trenches of varying lengths
FMGP04-031	Band of shell approximately 10cm thick topped by a pindan sand dune, situated within a wide expanse of mudflat/flood channel between several well established, stable, low, orange, pindan sand dunes. Green <i>et al</i> (2006: 145) estimated the maximum dimensions as approximately 246 m (north/south) by 196 m (east/west) and owing to the irregular shape, estimated it to cover a total area of approximately 16,000 m ² .	two 1x1m hand excavations and a single 10m long mechanical test trench
FMGP04-059	Band of shell midden approximately 10cm thick topped by a pindan sand dune, located immediately adjacent to a dry branch of South West Creek, situated on the western margin of a low, orange, pindan sand dune. The west side of the dune has been undercut at high tides by the large drainage channel associated with the creek. Distinct shell lenses with visible stratigraphy can be viewed within the bank of the dune. The site measures approximately 77 m (north/south) by 18 m (east/west), giving a total area of approximately 1, 200 m ² . The midden is comprised entirely of <i>Anadara granosa</i> .	two 1x1m hand excavations and a single 10m long mechanical test trench
FMGP04-094	Shell mound located approximately 100m to the west of a tributary of South Creek on a low-lying tidal mudflat which is vegetated with small saltbushes and a single mangrove at the eastern end of the mound. Approximately 60m to the east of the site is a band of dense mangroves associated with South Creek. Mound is approximately 80cm in height and comprised entirely of <i>Anadara granosa</i> . The site measures approximately 24 m (north/south) by 26 m (east/west), giving a total area of approximately 429 m ² . The site is one of several shell mounds that are present on mudflats adjacent to mangroves fringing South West Creek (in the west portion of the study area) and South Creek (in the east portion of the study area).	a single 1x1m hand excavation

Table 1. Archaeological sites sampled during the proposed FMG port and load-out facility Port Hedland salvage excavations

Laboratory Analysis

The excavated material was subjected to various forms of analysis which were designed to characterise the middens and their deposits, and to address the research aims of the project. These laboratory procedures and their results are outlined briefly below.

The 6mm and 3mm sieved samples were manually sorted into the following categories:

- Invertebrate faunal remains, including unmodified and modified shell and crustacea remains;
- Vertebrate faunal remains, including bone, eggshell and otoliths;
- Flaked stone artefacts;
- Plant remains, including charcoal.

The material retained by the 6mm and 3mm sieves was sorted separately. Material from one 1x1m hand excavation was analysed for each site.

Invertebrate faunal remains

Shellfish remains

Shell material was hand sorted into dietary and non-dietary classes, based on size and species. All complete shells of less than 1cm in length were considered non-dietary (see Rowland 1994). All shell was then further divided into sub-categories based on species. The non-dietary sized shells were weighed and counted but eliminated from further analyses which focussed on dietary shell components. Comparative collections from the University of Western Australia were consulted, along with the book *Seashells of Western Australia* (Wells and Bryce 2000) to aid this analysis.

The dominant shell species in all of the seven excavated midden sites was the Ark shell *Anadara granosa* which accounted for over 90% (and in most cases over 98%) of shellfish remains by weight from all of the sites. This mudflat dwelling bivalve is known to have been exploited as a food source throughout northern Australia by Aboriginal people in the past (e.g. Meehan 1982). The second most frequently occurring shell was the dogwhelk *Terebralia palustris*. Within the region *Terebralia* have been recorded as occurring in groups of 10-30 individuals within the muddy substrates of mangrove forests (Le Provost, Semeniuk and Chalmer Environmental Consultants 1980). Small quantities of a number of other shell species were present in some of the other middens. Noteworthy amongst these is Baler shell (*Melo amphora*), which in addition to being eaten were used by Aboriginal people as scoops and water carriers (Meehan 1982: 64), and Giant clam (*Tridacna maxima*), which has been noted by archaeologists on the northwest Australian coast in the manufacture of flaked artefacts in place of stone (Przywolnik 2003). The preferred habitats of the shell species can be seen to group into a series of resource zones which form distinct groups of species with shared habitats (see Table 2).

Scientific name	Common name	Resource zone	1	13	14	23	31	59	94
<i>Terebralia palustris</i>	Dogwhelk	Mangrove	✓	✓	✓	✓	✓	✓	✓
<i>Anadara granosa</i>	Ark shell	Mudflats/intertidal sandy mid littoral	✓	✓	✓	✓	✓	✓	✓
<i>Dosinia juvenilis</i>	Clam			✓		✓			✓
<i>Tellinidae spp.</i>	Tellins			✓	✓				✓
<i>Tridacna maxima</i>	Giant clam	Sub-tidal sandy substrates	✓	✓					
<i>Melo amphora</i>	Baler		✓	✓	✓	✓	✓		✓
<i>Muricidae sp.</i>	Murex	Intertidal rocky shore		✓	✓				
<i>Nerita lineata</i>	Nerite			✓					✓
<i>Botula vagina</i>	Mussel				✓	✓			
<i>Saccostrea cucullata</i>	Oyster		✓	✓	✓	✓			✓

Table 2: Table showing resource zones associated with shellfish species recovered from the seven excavated midden sites

Terebralia shells are found in the study area today within the mangrove itself, and were observed during fieldwork in groups of 10-20 large individuals in the mud amongst mangrove roots at the base of trees. Kerry Robinson (pers. comm. 28th April 2006) stated that the shells are used by

Kariyarra fishermen as burley by crushing the shell and throwing it into the water. The mid-littoral or intertidal zone was noted by Meehan (1982: 59) as the most productive zone for the collection of shell fish by the Anbarra of Arnhem Land. These intertidal areas harbour many edible gastropods and the bulk of the bivalve species, including *Anadara granosa*, which is known to Kariyarra people by the term *yunthu* (Kerry Robinson pers. comm. 9th April 2006). King tides expose sub-tidal sand flats on the coast in which are gathered the sub-tidal Giant clam and Baler species, as well as the large gastropod *Syrinx aruanus*. Although these large shells were noted on the surface of Sites 1 and 2, no excavated examples were uncovered. However, Kerry Robinson (pers. comm. 28th April 2006) stated that the shells, which he referred to by the *Kariyarra* word *nyungu*, are still collected from the sub-littoral sandy areas at times of extremely low tides and from the reef by Aboriginal people today. A number of shell species representing intertidal rocky platform environments, including *Saccostrea cucullata*, *Muricidae* sp. and *Botula vagina*, were also found in small numbers in the analysed material from the seven excavated midden sites. Such environments can be found today on the rocky headland at Port Hedland across the estuary from Anderson Point.

In an attempt to produce data which was able to be compared with the broadest range of midden studies from adjacent regions, shell weights, MNEs and MNIs were calculated for all of the major shell taxon represented in the seven excavated midden sites (see techniques discussed in Bailey 1993, Marshall and Pilgram 1993, Claassen 1998, Mason, Peterson and Tiffany 1998 [and comments], Claassen 2000, and Bowdler 2006). For taxon represented by a small number of individuals, shell weights only were calculated. To do this, shells were sorted within species into whole shells and fragments. For bivalves (eg *Anadara*), left and right hinged whole shells and fragments were counted and weighed separately, as were fragments which could not be identified as belonging to one or other side of the shell as they did not have enough of the umbo remaining to identify them. In the same way, for gastropods (eg *Terebralia*) whole, anterior and posterior parts of shells were counted and weighed separately from unidentifiable broken fragments.

During sorting, it was noted that many of the *Anadara* shells exhibited a particular breakage pattern, where a hole had been punctured through the valve of the shell from the outside. Meehan (1982) records that *Anadara* often did not open on their own once they were cooked, requiring a hard tap on the hinge to open them. She illustrates the resulting breakage pattern which exactly corresponds to that recorded for a large proportion of the excavated shell. This breakage is interpreted as resulting from human predation and the fact that it was noted at all midden sites suggests all can be positively identified as shell middens (as opposed to natural shell deposits or cheniers).

		<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
Site Name	Spit	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)
FMG04001	1	22.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	567.5	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	567.0	19.9	2.2	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	3157.8	81.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
	5	2134.6	246.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7
	6	414.3	33.1	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	5.9
	7	221.8	290.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4
	8	8.3	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	7094.1	695.0	11.9	7.0	2.4	0.0	0.0	0.0	0.0	0.0	41.5
	Total shell weight=7851.9											
Site Name	Spit	<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
FMG04013	1	4507.2	0.0	34.6	22.6	0.0	0.0	0.0	2.0	0.0	0.0	3.9
	2	4125.5	21.2	15.0	0.0	2.4	2.9	0.0	0.0	0.0	0.0	0.0
	3	2216.0	4.0	5.0	0.0	0.9	0.0	0.0	0.0	0.0	2.2	4.6
	4	1396.3	1.9	0.4	0.0	1.5	0.0	2.9	2.2	0.0	0.0	0.7
	5	218.8	0.0	0.0	0.0	0.3	0.0	3.5	1.0	0.0	0.0	0.0
	6	10.1	0.4	0.0	0.0	0.4	0.0	8.1	0.0	0.0	0.0	1.8
	7	4.5	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0
	Total	12478.4	27.4	55.0	22.6	5.4	2.9	20.0	5.2	0.0	2.2	11.0
	Total shell weight=12630.2											
Site Name	Spit	<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
FMG04014	1	994.9	5.7	1.7	0.0	0.7	0.0	0.6	1.3	0.0	0.0	0.7
	2	4333.4	20.6	29.7	0.0	0.0	0.0	3.0	38.3	3.0	0.0	37.5
	3	3416.2	86.4	6.7	0.0	5.9	0.0	1.9	38.1	4.8	0.0	0.0
	4	3125.5	121.4	8.3	0.0	0.6	0.0	2.9	9.9	0.0	0.0	0.0
	5	1814.8	45.7	19.1	0.0	2.3	0.0	8.8	0.0	12.5	0.0	5.5

	6	139.9	9.9	0.0	0.0	0.5	0.7	3.5	1.8	1.2	0.0	0.0
	7	6.7	38.3	0.0	0.0	8.0	0.0	12.9	0.0	0.9	0.0	0.0
	Total	13831.2	328.0	65.6	0.0	18.1	0.7	33.6	89.4	22.4	0.0	43.7
	Total shell weight=14432.7											
Site Name	Spit	<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
FMG04023	1	3027.6	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.1	0.0
	2	11901.7	2.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	313.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	15243.2	3.3	1.7	0.0	2.9	0.0	0.0	0.0	0.0	0.1	0.0
	Total shell weight=15251.1											
Site Name	Spit	<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
FMG04031	1	4043.6	67.7	16.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	117.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	4161.7	67.7	16.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total shell weight=4245.8											
Site Name	Spit	<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
FMG04059	1	219.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	111.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	17079.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	4.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	17415.1	0.3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total shell weight=17415.4											
Site Name	Spit	<i>Anadara granosa</i>	<i>Terebralia palustris</i>	<i>Melo amphora</i>	<i>Tridacna maxima</i>	<i>Saccostrea cucullata</i>	<i>Botula vagina</i>	<i>Tellinidae sp.</i>	<i>Muricidae sp.</i>	<i>Nerita lineata</i>	<i>Dosinia juvenilis</i>	<i>Unidentified</i>
FMG04094	1	8289.5	0.5	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
	2	6510.3	2.4	3.0	0.0	0.0	0.0	2.4	0.0	0.6	0.0	0.0

	3	1130.0	0.0	0.0	0.0	2.7	0.0	0.7	0.0	0.7	0.0	3.1
	4	1741.3	30.0	0.0	0.0	0.3	0.0	2.9	0.0	0.0	2.2	0.0
	5	640.9	0.3	0.0	0.0	0.3	0.0	0.5	0.0	0.5	0.0	0.0
	6	1108.1	6.6	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
	Total	19420.0	39.8	3.0	0.0	3.3	0.0	7.7	0.0	1.9	2.2	3.1
	Total shell weight=19480.9											

Table 3: Shell weights from the 6mm samples by species for each of the analysed test squares from the seven excavated shell midden sites

There was variation between the sites in the density of *Anadara granosa* remains contained within the each arbitrary 10cm excavation unit (see Table 3). The largest shell weights and MNI values for *Anadara granosa* were obtained from individual excavation units from Sites 23 and 59. Overall, the highest shell weights and MNI values for *Anadara granosa* remains were obtained from Sites 94 and 59. With the exception of Site 31, which had comparatively few shellfish overall, there was little variation between overall shell weights and MNI values for *Anadara granosa* shell for the other six excavated midden sites, as shown in Table 4. This suggests that, although variable in form, all sites represent a similar volume of shell accumulation (Figure 3). This has implications for the interpretation of the place of the various site types represented within the regional economy.

Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-001	1	22.9	1.0	2.0	0.0	0.0	0.0
	2	567.5	41.0	89.0	19.1	1.0	1.0
	3	567.0	48.0	99.0	19.9	0.0	10.0
	4	3157.8	212.0	436.0	81.3	0.0	6.0
	5	2134.6	175.0	326.0	246.9	0.0	7.0
	6	414.3	31.0	64.0	33.1	7.0	7.0
	7	221.8	18.0	34.0	290.3	3.0	7.0
	8	8.3	0.0	0.0	4.4	0.0	1.0
	TOTAL	7094.1	526.0	1050.0	695.0	11.0	39.0
Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-013	1	4507.2	312.0	624.0	0.0	0.0	0.0
	2	4125.5	217.0	428.0	21.2	1.0	1.0
	3	2216.0	111.0	219.0	4.0	0.0	0.0
	4	1396.3	72.0	140.0	1.9	0.0	0.0
	5	218.8	13.0	26.0	0.0	0.0	0.0
	6	10.1	1.0	1.0	0.4	0.0	0.0
	7	4.5	0.0	0.0	0.0	0.0	0.0
	TOTAL	12478.4	726.0	1438.0	27.4	1.0	1.0
Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-014	1	994.9	57.0	109.0	5.7	0.0	0.0
	2	4333.4	286.0	544.0	20.6	0.0	0.0
	3	3416.2	197.0	391.0	86.4	3.0	6.0
	4	3125.5	160.0	341.0	121.4	2.0	2.0
	5	1814.8	98.0	193.0	45.7	0.0	1.0
	6	139.9	8.0	15.0	9.9	0.0	0.0
	7	6.7	0.0	1.0	38.3	3.0	3.0
	TOTAL	13831.2	806.0	1594.0	328.0	8.0	12.0
Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-023	1	3027.6	188.0	357.0	0.0	0.0	0.0
	2	11901.7	624.0	1250.0	2.5	1.0	1.0
	3	313.9	27.0	43.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.8	0.0	0.0
	TOTAL	15243.2	839.0	1650.0	3.3	1.0	1.0

Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-031	1	4043.6	274.0	543.0	67.7	3.0	3.0
	2	117.4	8.0	18.0	0.0	0.0	0.0
	3	0.6	0.0	0.0	0.0	0.0	0.0
		4161.7	282.0	561.0	67.7	3.0	3.0
	TOTAL						
Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-059	1	219.6	15.0	26.0	0.0	0.0	0.0
	2	111.8	5.0	10.0	0.0	0.0	0.0
	3	17079.1	1049.0	1976.0	0.0	0.0	0.0
	4	4.7	0.0	0.0	0.3	0.0	0.0
	TOTAL	17415.1	1069.0	2012.0	0.3	0.0	0.0
Site Name	Spit	<i>Anadara granosa</i>			<i>Terebralia palustris</i>		
		Total shell weight (g)	MNI	MNE	Total shell weight (g)	MNI	MNE
FMGP04-094	1	8289.5	500.0	982.0	0.5	0.0	0.0
	2	6510.3	347.0	699.0	2.4	0.0	0.0
	3	1130.0	72.0	135.0	0.0	0.0	0.0
	4	1741.3	85.0	181.0	30.0	0.0	0.0
	5	640.9	35.0	77.0	0.3	0.0	0.0
	6	1108.1	72.0	125.0	6.6	0.0	0.0
	TOTAL	19420.0	1111.0	2199.0	39.8	0.0	0.0

Table 4: a comparison of shell weights, MNI and MNE values for the shellfish species *Anadara granosa* and *Terebralia palustris* for all seven excavated midden sites

Figure 2: Graph showing a comparison of total *Anadara granosa* MNI values for each of the seven excavated shell midden sites

Terebralia palustris shell constituted the next most regularly occurring shellfish species by weight in the seven excavated midden sites (see Table 3). Although it constituted only a fraction of the overall weight of shell fish remains from any of the sites, this is consistent with observed ethnographic gathering of the shell in conjunction with bivalves such as *Anadara granosa* and *Tapes hiantina*. Meehan (1982: 80) notes that while the bivalve *Tapes hiantina* provided the bulk of the shell fish collected by Anbarra people, that a small quantity of gastropods such as *Telesopium* sp. or *Terebralia* sp. were always

collected in conjunction with the bivalves and eaten in small numbers as a sort of 'appetiser'. *Terebralia* occurred in greatest quantities in Sites 1 and 14. Both of these sites had lower layers in which *Terebralia palustris* was high in proportion to *Anadara granosa* (see further discussion of chronology below).

Other shellfish remains recovered in very small quantities included the remains of *Dosinia juvenilis* (clam), *Tellinidae* sp. (Tellins), *Tridacna maxima* (Giant Clam), *Melo amphora* (Baler), *Muricidae* sp. (Murex), *Nerita lineata* (Nerites), *Botula vagina* (Mussels) and *Saccostrea cucullata* (Oyster). The varying quantities of shellfish remains other than *Anadara granosa* which appear to have been collected from different resource zones suggests that the middens could, following Meehan's (1982) typology, be broken into 'processing sites' and 'dinner time camps', which are sites which were primarily concerned with the collection of *Anadara* shells, and 'home base' sites, where a range of resource zones representing the activities of all gender and social groups who come together at the base camp could expect to be found. Sites 1, 13, 14, 23 and 94 are interpreted as 'home base' sites on this basis. Sites 31 and 59 are considered to represent processing sites or dinner time camps. This interpretation is consistent with the analysis of otoliths and flaked stone artefacts discussed below.

Crustacea

Highly fragmented crab shell, most likely belonging to the mangrove dwelling *Scylla* sp. (brown mud crab), and *Uca coactarta flammula* (fiddler crab) was identified small quantities from Sites 13, 14, 23 and 94. In all cases, the shell was so small in size and so highly fragmented, that any further identification other than weighing it was impossible.

Other invertebrate faunal remains

A single fragment of sea urchin was recovered from midden 14 excavation square 1 spit 2. Sea urchin fragments have been noted in other shell middens on the north western Australian coast (e.g. Morse 1993, 1999, Clune 2002).

Vertebrate faunal remains

Bone

In keeping with other excavated shell mounds and shell middens dominated by *Anadara granosa* in the southern Kimberley and Abydos coasts (O'Connor and Sullivan 1994; Clune 2002) few vertebrate faunal remains were recovered from the excavations of the seven shell middens. The bone which was excavated was in such a highly fragmented state that no further identification beyond raw bone weights per spit for each site was attempted. Small fragments of what appear to have been macropod long bones were recovered from Sites 1 and 14. Two pieces of macropod bone were collected from the surface of Site 23 located adjacent to excavation square 1. One of these shows evidence of cut marks and the other appears to have been ground on one edge to form a bone point or bone incisor.

Eggshell

Some fragments of emu eggshell were excavated from the top spit of midden 13. Emus are known to inhabit the hinterland and inland plains of the Pilbara (Clune 2002: 153), and this shell would have had to have been brought into the site to have been deposited there. No other eggshell was excavated from any of the other six excavated midden sites.

Otoliths

A number of otoliths were recovered from the seven excavated midden sites. Otoliths were identified to fauna and species level with reference to collections held at the University of Western Australia and using the AFORO shape analysis software program (Lombarte *et al.* 2006) for otolith identification. In the case of Snapper and Whiting otoliths, an attempt was made to estimate the size of the fish from which the otoliths had been taken with reference to a detailed reference collection of fish otoliths from individual fish of known sizes held at UWA and with reference to McGann (1991).

McGann (1991) undertook a detailed analysis of the otoliths from a series of excavated sites from Shark Bay, Western Australia. Using the method outlined by Casteel (1976), she recorded the size and weight of the otoliths of a number of fish of known size to develop a formula for estimating the live fish length of prehistoric fish remains from Shark Bay. Regression lines and associated formula were developed for Snapper and Whiting which allowed the live fish length to be reconstructed from the length and width of otoliths. Given the close proximity of this study on the southern Pilbara coast, the formulas developed by McGann were used to estimate live fish length and hence develop hypotheses about fishing methods employed by Aboriginal people in the Port Hedland region in this past. Unfortunately, a reference collection and/or formula for estimating the live length of catfish could not be located, so I was unable to estimate catfish lengths.

A total of 23 otoliths from three different fish species were recovered from four of the seven excavated midden sites. No otoliths were recovered from Sites 23, 59 or 94. The three fish species identified were *Lethrinus* sp. (Snapper), *Sillago analis* (Whiting) and *Arius thalassinus* (Giant Salmon Catfish). Snapper inhabit a variety of coastal environments, including coastal reefs and inshore sand beds. Larger fish may also be found offshore on or adjacent to coral reefs. Both Whiting and Salmon catfish tend to inhabit inshore waters and sandy areas adjacent to estuary mouths (Department of Fisheries Western Australia 2006).

Fish otoliths tended to be recovered from those sites which also had a broader range of shellfish species and stone artefacts, suggesting a difference in site function between sites with otoliths, which may represent 'home base' sites, and sites without, which probably represent 'processing sites' or 'dinner time camps' (Meehan 1982). Table 6 is a comparison of the MNIs for the three fish species recovered from the midden sites. It indicates that the otoliths represent the remains of only a small number of individuals-a minimum number of 20 from the four sites. Catfish otoliths were found at all four sites, while whiting and snapper otoliths were only recovered from Sites 13 and 14. These two sites show the most diverse assemblage of terrestrial and marine faunal remains of all of the seven excavated midden sites.

Site	Spit	MNI catfish	MNI Snapper	MNI Whiting	Total
1	1	1	0	0	1
1	4	1	0	0	1
Total		2	0	0	2
13	1	1	0	0	1
13	2	1	0	0	1
13	4	0	1	2	3
Total		2	1	2	5
14	1	0	1	0	1
14	2	1	0	0	1
14	3	1	3	1	5
14	4	1	0	1	2
14	5	0	1	2	3
Total		3	5	4	12
31	1	1	0	0	1
Total		1	0	0	1

Table 5: comparison of MNIs for each fish species and excavation unit at the four sites which contained otoliths

Using the formula developed by McGann (1991), live fish lengths were estimated for whiting and snapper, as shown in Table 7. Although the sample is very small, the wide range of whiting sizes would

suggest a hunting method which is indiscriminate for fish size such as netting or trapping. Bourke (2004) notes ethnographic accounts from Darwin of the netting of the Giant Salmon Catfish in tidal creeks and estuaries. In the case of the snapper otoliths, all derive from adult fish. Adult snapper can be obtained by spearfishing, or, as discussed by McGann (1991: 6.10), through the use of seine or hauling nets. The use of either one or both of these techniques is suggested by the fish remains from the seven excavated Port Hedland shell middens.

Species	Site	Spit	Length (cm)
Whiting	13	4	14
Whiting	13	4	14
Whiting	14	3	30
Whiting	14	4	23
Whiting	14	5	24
Whiting	14	5	23
Whiting	14	5	14
Snapper	14	1	36
Snapper	14	3	36
Snapper	14	3	26
Snapper	14	5	45

Table 6: Estimated live fish lengths from otoliths

Flaked stone artefacts

Like other midden sites from the region (eg Clune 2002), very few flaked stone artefacts were excavated from the seven midden sites. The presence of at least a single stone artefact at the surface of each of the seven sites was noted prior to their excavation. All flaked stone artefacts which were recovered from the 6mm and 3mm sieved fractions were recorded using a standard stone artefact recording form.

Stone artefacts were only recovered from the analysis excavation squares of Sites 1 and 23. The largest proportion (n=21) of the 23 stone artefacts recovered came from Site 23. However, artefacts were located on the surface of all of the seven excavated midden sites, and stone artefacts were noted in some of the excavation squares from the other sites which were not analysed, for example, Site 14 Excavation Square 2. The lack of flaked stone artefacts at midden sites on the Abydos Plain has been noted by other researchers (Clune 2002; Warren 1991).

None of the excavated stone artefacts were retouched, and all of the excavated stone artefacts would be considered to be 'debitage' or flaking debris. However, two backed blades and a burren adze were recovered from the surface of Sites 23 and 1. Full details of the analysis of stone artefacts are contained in Harrison (2007).

Radiocarbon ages

The seven excavated midden sites returned radiocarbon ages ranging between 5350calBP and 50calBP years before present (see Table 7), which include some of the earliest and latest radiocarbon ages associated with *Anadara granosa* dominated middens, shell mounds and earth mounds from northwestern Australia. Site 14 replicates the type sequence from Skew Valley of a shift from *Terebralia palustris* to *Anadara granosa*, but this shift is associated with significantly older radiocarbon ages of between 5250 - 4400calBP, or an uncalibrated date of 4592±133 (Wk19853). Previously, the earliest dates for this shift on the Pilbara coast had been thought to be around 4200 uncalibrated years before present (see further discussion below). FMGP04-014 is interpreted as demonstrating a major hiatus of several thousand years between the lower layers, associated with the shift from *Terebralia* to *Anadara*, and its upper layers, which post date 1000 calBP. All of the other sites post date the shift from *Terebralia* to *Anadara* and are associated with a single phase of occupation and use only.

WK number	Site	Square/ Trench	Spit/Section	Depth b.s. (cm)	Material	Weight (g)	Description	Result (BP)	dC13	Calibrated age range at 68.2% confidence level* (calBP)	Calibrated age range at 95.4% confidence level* (calBP)
19840	FMGP04-001	TRENCH 1	SECTION 1	7	<i>A. granosa</i>	10.1	Top of midden	1586±64	0.034±0.2	1230 - 1070	1280 - 990
19841	FMGP04-001	SQ1	SPIT 3	25	<i>A. granosa</i>	7.02		2110±68	-0.488±0.2	1790 - 1600	1860 - 1520
19842	FMGP04-001	SQ1	SPIT 5	53	<i>A. granosa</i>	10.05		1913±57	0.058±0.2	1530 - 1380	1600 - 1320
19843	FMGP04-001	SQ1	<i>in situ</i>	71	<i>T. palustris</i>	57.25	Basal Top of midden	2099±39	-3.567±0.2	1740 - 1610	1800 - 1560
19844	FMGP04-002	TRENCH 4	SECTION 2	1	<i>A. granosa</i>	12.4		1821±53	-0.66±0.2	1410 - 1290	1500 - 1270
19845	FMGP04-002	TRENCH 4	SECTION 2	30	<i>A. granosa</i>	9.83		2352±57	-0.511±0.2	2050 - 1890	2130 - 1830
19846	FMGP04-002	TRENCH 4	SECTION 2	58	<i>T. palustris</i>	28.43	Basal Top of midden	594±39	-3.477±0.2	290 - 140	320 - 100
20139	FMGP04-013	SQ1	SPIT1	10	<i>A. granosa</i>	9.81		1004±61	-0.503±0.2	634 - 534	680 - 490
19847	FMGP04-013	SQ1	SPIT 7	63	<i>A. granosa</i>	9.8	Basal	1453±98	0.09±0.2	1130 - 900	1230 - 790
19848	FMGP04-014	SQ1	SPIT 1	1	<i>A. granosa</i>	16	Top of upper midden layer	578±44	-1.846±0.2	280 - 140	310 - 60
19849	FMGP04-014	SQ1	SPIT 3	30	<i>A. granosa</i>	12.1	Base of upper midden layer	1604±55	-0.282±0.2	1240 - 1100	1280 - 1030
19850	FMGP04-014	SQ1	SPIT 6	50	<i>Cerithidea reidi</i>	13.5	Top of lower midden layer	4592±133	-5.573±0.2	4980 - 4590	5250 - 4400
20110	FMGP04-014	SQ1	SPIT 7	70-80	<i>T. palustris</i>	26.5	Basal	4865±72	-4.607±0.2	5280 - 5060	5360 - 4920
19851	FMGP04-023	SQ 1	SPIT 2	7	<i>A. granosa</i>	5.93	Top of midden	3126±96	-1.3±0.2	3030 - 2780	3190 - 2720
19852	FMGP04-023	SQ 1	SPIT 3	25	<i>A. granosa</i>	6.12	Base of midden	2981±97	-1.045±0.2	2900 - 2650	3000 - 2450
19853	FMGP04-023	TRENCH 1	<i>in situ</i>	48	<i>A. granosa</i>	10.9	Lowest shell sample	2716±64	-1.239±0.2	2520 - 2320	2670 - 2290
19854	FMGP04-031	SQ 2	SPIT 1	1	<i>A. granosa</i>	12.41	Top of midden	1161±55	-0.158±0.2	760 - 650	850 - 620
19855	FMGP04-031	SQ 2	SPIT 2	30	<i>A. granosa</i>	5.3	Base of midden	1137±86	-0.795±0.2	790 - 620	880 - 540
20138	FMGP04-059	SQ 1	SPIT 2	10-20	<i>A. granosa</i>	29.85	Top of midden	3404±42	-1.804±0.2	3340 - 3220	3390 - 3150
19856	FMGP04-059	SQ 1	SPIT 3	30	<i>A. granosa</i>	9.92	Base of midden	3900±73	-1.722±0.2	3980 - 3760	4090 - 3670
19857	FMGP04-094	SQ 1	SPIT 2	5	<i>A. granosa</i>	11.13	Top of midden	3163±75	-1.622±0.2	3070 - 2850	3170 - 2760
19858	FMGP04-094	SQ 1	SPIT 5	50	<i>A. granosa</i>	18		3041±55	-1.659±0.2	2870 - 2740	2950 - 2710
20140	FMGP04-094	SQ 1	SPIT 6	70	<i>A. granosa</i>	6.01	Base of midden	3329±97	-1.796±0.2	3320 - 3060	3410 - 2910

Table 7: Radiocarbon ages obtained from shell submitted from each of the seven excavated midden sites. *calculated using the Oxcal version 4.0 radiocarbon calibration program (Bronk Ramsey 1995, 2001) using the Marine 04 Calibration curve (Hughen et al 2004) and a ΔR marine correction of 52+/-69 which is a combination of several historic marine shell values from around the west coast of Australia (Fiona Petchey pers comm., January 2007).

Taken together, the radiocarbon dates suggest that all of the sites had a reasonably limited period of formation and use, averaging approximately 600-800 years, but that they were established and abandoned at different times. The graph in Figure 6 shows the oldest and youngest calibrated radiocarbon ages for each of the seven excavated midden sites. The sites form an almost continuous series of occupations of similar lengths of time, dating from between 5400calBP and the present.

Figure 3: graph showing oldest and youngest calibrated radiocarbon ages for each of the excavated midden sites, with the 68.2% level of confidence represented by the solid box plots, and the 95.4% level of confidence by the whiskers. Note two periods of occupation of site FMGP04-014.

A discussion of site morphology

Although all sites were dominated by the remains of the shellfish *Anadara granosa*, the sites showed significant variation in form (see Figures 4-9). Sites 1, 2, 13 and 14 were mounded shell middens or earth mounds. Site 94 was a shell mound. Sites 23, 31 and 59 were scatters of shell associated with an approximately 10cm thick band of dense *Anadara granosa*.

Figure 4: View south across FMGP04-014, a mounded midden or earth mound, showing Excavation Square 2 in foreground and Excavation Square 1 in background

Figure 5: west and north sections of FMGP04-014 Excavation Square 1 showing stratigraphic profile and location of radiocarbon samples

Figure 6: View east across FMGP04-059, a band of shell covered by Pindan dune showing Excavation Square 1 (left, centre) and Square 2 (left, background) and distinct band of shell in dune profile

Figure 7: east and south sections of FMGP04-059 Excavation Square 1 showing stratigraphic profile and location of radiocarbon samples

Figure 8: View north across FMGP04-094, a shell mound, showing Excavation Square 1 and extent of mound following high tide

Figure 9: east and south sections of FMGP04-094 Excavation Square 1 showing stratigraphic profile and location of radiocarbon samples. Note that excavation of FMGP04-094 ceased before sterile layers were reached due to constant inundation with water once water table was reached.

A model to explain the site location and formation of shell scatters and middens within the Survey Area was suggested by Green *et al.* (2006: 355ff). They suggested that the Survey Area is located on a prograding coastline caused by the progressive silting up of the mangrove lined tidal creek systems associated with South Creek and South West Creek. As the creeks and coast line have silted up, older shell midden sites have been stranded and overlain by Aeolian pindan sand dunes. More recent shell midden sites have been established along the new banks of the tidal creeks with this process being progressively repeated as the shore advances. They predicted that the oldest sites would be located in the south of the survey area, with younger sites located in the north closest to the modern shoreline.

These predictions and the associated three-phase model were not verified by the results of the archaeological excavation and analysis; indeed, the results of the archaeological salvage excavations and dating programme would caution against the utility of such broad models in characterising the chronology of shell middens within the Port Hedland region. Nonetheless, the basic premise, that these archaeological sites represent the successive shifting of campsites with the movement of *Anadara* beds, seems broadly plausible. Taking into account Morrison's (2003) discussion of the susceptibility of *Anadara* beds to minor environmental fluctuations, it may be that the major sources of *Anadara* shifted up and down the prograding river delta in a over the past 4500 years, and that site location reflects the changing location of *Anadara* beds themselves. This is borne out by the overlap in the second phase of occupation and site formation of Site 14 with the occupation and use of nearby Site 13. Meehan's (1982) research suggests that Aboriginal people never usually camp very far away from the sources of bivalves (such as *Anadara*) at times when they are more reliant on the source as a staple, for example, during times of ceremonial activity. As others have interpreted similar sites in the region (eg Clune 2002; see also Clune and Harrison this volume), these midden sites may represent the remains of campsites and processing sites focussed on the exploitation of *Anadara*. Their location in the landscape is determined by local environmental factors including local shifts in the location of productive *Anadara* beds.

The evident similarity of the content, *Anadara* shell volume and length of occupation and use of the seven excavated midden sites problematises the divisions which have been suggested between shell mounds, earth mounds (or mounded midden sites), and shell middens occurring as a shallow band of shell overlain by sand dune in the archaeological literature. These sites, particularly shell mounds, have generally been treated separately by archaeologists in northern Australia (e.g. see O'Connor 1999; Veitch 1999; Clune 2002; Bourke 2003, 2004). This study suggests that these sites represent the same broad behavioural signature, modified by different site formation processes. Given the same rate of deposition of shell, shell mounds could be expected to form in environments in which soil is slowly eroded, such as on the margins of mudflats and mangroves which are frequently inundated with spring tides. On the other hand, earth mounds would form given the same rate of shell midden deposition in depositional environments which are protected from erosion by sand dunes formed by wind borne sediments. Shell middens formed by bands of shell might, given the same rate of shell midden deposition, form on surfaces where there is a shift from an erosional to a depositional environment after occupation and use of the shell midden ceases.

Site function and the regional prehistoric economy

The close association of stone cairns (*thalu*) which are believed to have functioned as increase sites, rock art sites and shell middens in the Port Hedland area has been previously noted by McCarthy (1962) and Warren (2001). Meehan (1982: 66) has discussed the correlation between particularly heavy periods of *Anbarra* people's bivalve collection and ceremonial activities, during which time men were involved in ritual preparations and had little time to hunt for food. Clune (2002) has cited Meehan's work in support of the argument that shell mounds on the Abydos Plain were occupied during regular, annual periods when large groups of Aboriginal people lived in a semi-sedentary

fashion immediately after the wet season when resources were abundant and ceremonial activities were undertaken (Clune 2002: 322). The previously noted association between *thalu*, rock art sites and shell middens in the Port Hedland region, and the results of the excavation and analysis presented in this report would seem to support this interpretation of site function.

The focus on shell mounds on the northwestern coast as an archaeologically prominent site type has meant that it has been assumed that shell mounds were somehow different to other types of *Anadara* dominated shell middens on the Pilbara coast. Instead, I suggest that on the basis of the analysis presented here that they should be seen as one of a suite of sites associated with a periodic focus on *Anadara granosa*. While shell mound formation may appear to stop at between 1600 and 1000BP on the Abydos Plain (Clune 2002), there is no evidence that *Anadara* focussed middens and earth mounds stop forming at this time. In the Port Hedland area, this study and previous work by Vietch has demonstrated that *Anadara* dominated earth mounds continued to form during the last 1000 years before present, and possibly as late as 60 calibrated years before present. The end of the period of shell mound formation in northwestern Australia may have more to do with regional shifts in conditions which lead to particular archaeological site formation processes than any changes in economic behaviour by Aboriginal people in the past. Indeed, as Tables 11 and 12 and Figure 13 show, once published radiocarbon ages from the northwestern Australia coast associated with *Anadara granosa* dominated middens and shell mounds are calibrated, they demonstrate no regional hiatuses, but instead a fairly continuous sequence at the regional level. While the Burrup Peninsula does appear to show an absence of *Anadara granosa* dominated middens after c.1600BP, this may be a phenomena of small sample size, or a sub-regional anomaly.

Site name	Date	Material	Reference	Lab Number	Depth b.s.	Site type	Location
Roebourne Gap	830±50	<i>Anadara granosa</i>	Clune 2002	Wk8834	25	midden	Abydos Plain
Roebourne Gap	970±55	<i>Anadara granosa</i>	Clune 2002	Wk8835	35	midden	Abydos Plain
Roebourne Gap	1020±50	<i>Anadara granosa</i>	Clune 2002	Wk8833	surface	midden	Abydos Plain
Clarke's Cave	1470±50	<i>Anadara granosa</i>	Bradshaw 1995	Wk3337	surface	shelter	Abydos Plain
Popes Nose Creek	1530±250	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT102	10-20 (tp1)	midden	Abydos Plain
Nickol River complex	1700±50	<i>Anadara granosa</i>	Bradshaw 1995	Wk3340	surface	midden	Abydos Plain
Popes Nose Creek	1740±320	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT104	10-20(tp5)	midden	Abydos Plain
Cleaverville south	1810±50	<i>Anadara granosa</i>	Clune 2002	Wk8840	surface	midden	Abydos Plain
Popes Nose Creek	2270±250	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT103	70-80(tp4)	midden	Abydos Plain
Anadara mound	2270±50	<i>Anadara granosa</i>	Bradshaw 1992	Wk3343	surface	mound	Abydos Plain
Cape Lambert	2610±185	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT92	surface	midden	Abydos Plain
Cape Lambert	2710±165	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT93	15-18	midden	Abydos Plain
Popes Nose Creek	2870±250	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT101	80-90(tp5)	midden	Abydos Plain
Cape Lambert	2900±135	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT91	15-18	midden	Abydos Plain
Cape Lambert	2930±265	<i>Anadara granosa</i>	Veth and O'Brien 1986	WAIT94	28	midden	Abydos Plain
Nickol 2	3480±60	<i>Anadara granosa</i>	Clune 2002	Wk8836	surface	mound	Abydos Plain
Nickol River complex	4090±50	<i>Anadara granosa</i>	Bradshaw 1995	Wk3343	basal	midden	Abydos Plain
Nickol 2	4160±60	<i>Anadara granosa</i>	Clune 2002	Wk8837	30	mound	Abydos Plain
Nickol 2	4180±60	<i>Anadara granosa</i>	Clune 2002	Wk8838	70	mound	Abydos Plain
Nickol 2	4250±60	<i>Anadara granosa</i>	Clune 2002	Wk8839	110	mound	Abydos Plain
Anadara mound	4270±60	<i>Anadara granosa</i>	Bradshaw 1992	Wk3346	40	mound	Abydos Plain
Anadara mound	6290±50	<i>Terebralia palustris</i>	Bradshaw 1992	Wk3347	60	mound	Abydos Plain
Anadara mound	6510±60	<i>Terebralia palustris</i>	Bradshaw 1992	Wk3348	125	mound	Abydos Plain
Clarke's Cave	7140±170	<i>Terebralia palustris</i>	Bradshaw 1995	Wk3348	120	shelter	Abydos Plain
Hearson Cove	710±80	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1860	surface	midden	Burrup Peninsula
Fish Trap Inlet P2599	1470±90	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1859	surface	midden	Burrup Peninsula
Georges Valley	1810±130	<i>Anadara granosa</i>	Harris 1988	SUA1869	10-20	mound	Burrup Peninsula
Pistol Range	1820±100	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1863		mound	Burrup Peninsula
Tartaruga	1910±90	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1855		midden	Burrup Peninsula
Pistol Range	1960±90	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1862		mound	Burrup Peninsula
Fish Trap Inlet P2585	2590±100	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1865	surface	midden	Burrup Peninsula
Tartaruga	2630±90	<i>Acanthopleura sp.</i>	Vinnicombe 1987	SUA1856		midden	Burrup Peninsula
Fish Trap Inlet P2585	2670±100	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1867	30	midden	Burrup Peninsula
Fish Trap Inlet P2585	2720±100	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1866		midden	Burrup Peninsula
King Bay P1846	2740±80	<i>Anadara granosa</i>	Vinnicombe 1987	SUA1858	0-10	midden	Burrup Peninsula

Skew Valley	2770±80	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1838		mound	Burru Peninsula
Skew Valley	3410±90	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1839		mound	Burru Peninsula
Skew Valley	3540±90	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1843		mound	Burru Peninsula
Skew Valley	3770±90	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1837		mound	Burru Peninsula
Skew Valley	3910±90	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1845		mound	Burru Peninsula
Skew Valley	4150±90	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1834		mound	Burru Peninsula
Skew Valley	4150±80	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1502A		mound	Burru Peninsula
MV 47/112-CS1-12	4230±60	?	O'Connor 1999	Wk2649	basal	midden	Burru Peninsula
Anadara shelter	4240±60	<i>Anadara granosa</i>	Bradshaw 1992	Wk2647	30	shelter	Burru Peninsula
Skew Valley	4290±70	<i>Anadara granosa</i>	Lorblanchet 1977	ANU1502B		mound	Burru Peninsula
Georges Valley	4320±110	<i>Turbo cinereus</i>	Harris 1988	SUA1870	20-30	mound	Burru Peninsula
Georges Valley	4640±110	<i>Turbo cinereus</i>	Harris 1988	SUA1871	50-60	mound	Burru Peninsula
King Bay P2299	4730±100	<i>Turbo cinereus</i>	Vinnicombe 1987	SUA1861	10-15	midden	Burru Peninsula
King Bay P1843	5210±100	<i>Turbo cinereus</i>	Vinnicombe 1987	SUA1868	20-30	midden	Burru Peninsula
Georges Valley	6070±110	<i>Anadara antiquata</i>	Harris 1988	SUA1872	basal	mound	Burru Peninsula
Not-so-secret-shelter	6080±130	<i>Terebralia palustris</i>	Bradshaw 1995	Wk2650	basal	shelter	Burru Peninsula
Skew Valley	6280±100	Gastropod	Lorblanchet 1977	ANU1835B		mound	Burru Peninsula
Anadara shelter	6380±70	<i>Terebralia palustris</i>	Bradshaw 1992	Wk2648	70	shelter	Burru Peninsula
Skew Valley	6600±110	Gastropod	Lorblanchet 1977	ANU1835A		mound	Burru Peninsula
Skew Valley	6620±100	<i>Terebralia palustris</i>	Lorblanchet 1977	ANU1503	80-90	mound	Burru Peninsula
Skew Valley	6960±110	Gastropod	Lorblanchet 1977	ANU1836		mound	Burru Peninsula
Pistol Range	7190±130	<i>Terebralia palustris</i>	Vinnicombe 1987	SUA1864		midden	Burru Peninsula
Idayu	2010±50	<i>Anadara granosa</i>	Veitch 1999	Wk1619	70	mound	North Kimberley
Idayu	2090±50	<i>Tapes hiantina</i>	Veitch 1999	Wk1618	90(basal)	mound	North Kimberley
Goala	2090±50	<i>Tapes hiantina</i>	Veitch 1999	Wk1621	130(basal)	mound	North Kimberley
Wundadjingnari	3130±60	<i>Anadara granosa</i>	Veitch 1999	Wk1620	170(basal)	mound	North Kimberley
Tubridgi 4A	940±60	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2615	surface	midden	Onslow
Tubridgi 2E	1040±70	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2614	surface	midden	Onslow
Tubridgi 2	1300±80	<i>Hyotissa</i> sp.	Veitch and Warren 1992	Wk2610	0-5(tp3)	midden	Onslow
Tubridgi 2 ATP1	2270±70	<i>Hyotissa</i> sp.	Veitch and Warren 1992	Wk2612	0-64	midden	Onslow
Tubridgi 5	2340±80	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2616	surface	midden	Onslow
Tubridgi 9	3450±80	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2625	40.5=42.5(tp4)	midden	Onslow
Tubridgi 8A	3490±70	<i>Hyotissa</i> sp.	Veitch and Warren 1992	Wk2622	surface	midden	Onslow
Tubridgi 8B	3560±80	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2627	surface	midden	Onslow
Tubridgi 9	3830±70	<i>Hyotissa</i> sp.	Veitch and Warren 1992	Wk2629	surface	midden	Onslow
Tubridgi 9	3890±70	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2620	19.5-22.5(tp2)	midden	Onslow

Tubridgi 6	3980±80	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2613	surface	midden	Onslow
Tubridgi 7	4020±70	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2618	25-35(tp1)	midden	Onslow
Tubridgi 9	4040±70	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2626	surface	midden	Onslow
Tubridgi 9	4090±70	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2623	8.5-12.5(tp2)	midden	Onslow
Tubridgi 8B	4110±80	<i>Terebralia</i> sp.	Veitch and Warren 1992	Wk2621	surface	midden	Onslow
Tubridgi 7	4200±70	<i>Anadara granosa</i>	Veitch and Warren 1992	Wk2617	surface	midden	Onslow
Tubridgi 9	4350±90	<i>Terebralia</i> sp.	Veitch and Warren 1992	Wk2624	surface	midden	Onslow
Tubridgi 9	4640±220	<i>Terebralia</i> sp.	Veitch and Warren 1992	Wk2628	46.5-54(tp2)	midden	Onslow
P7303	620±60	<i>Anadara granosa</i>	Veitch 1995	Wk4053	surface	midden	Port Hedland
P7303	750±60	<i>Terebralia</i> sp.	Veitch 1995	Wk4052	surface	midden	Port Hedland
P7335	3270±170	<i>Anadara granosa</i>	Warren 2001	Wk9131	basal	midden	Port Hedland
Mangulagun	1220±60	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	SUA2826	15	mound	South Kimberley
Mangulagun	3640±60	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	SUA2827	basal	mound	South Kimberley
Roebuck Plains 2	3550±70	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	Wk2602	surface	mound	South Kimberley
Sheep Camp	3110±60	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	Wk2663	upper	midden	South Kimberley
Sheep Camp	3070±60	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	Wk2665	middle	midden	South Kimberley
Sheep Camp	2960±110	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	Wk2603	lower	midden	South Kimberley
Thangoo Mound 1	2300±60	<i>Anadara granosa</i>	O'Connor 1999	Wk2661	top 10cm	mound	South Kimberley
Thangoo Mound 1	2380±50	<i>Anadara granosa</i>	O'Connor 1999	Wk2733	basal	mound	South Kimberley
Cockle Well	1520±80	<i>Anadara granosa</i>	O'Connor and Sullivan 1994	Wk2601	surface	mound	South Kimberley
Site 34 Homestead Site	3100±60	<i>Terebralia palustris</i>	O'Connor 1999	Wk2106	surface	midden	South Kimberley
Site 32 Thangoo	1390±70	<i>Barbatia</i> sp.	O'Connor 1999	Wk2106	?	midden	South Kimberley
Site 4	1800±70	<i>Barbatia</i> sp.	O'Connor 1999	Wk2107	100	midden	South Kimberley
Site 20	1700±60	<i>Terebralia</i> sp.	O'Connor 1999	Wk2109	surface	midden	South Kimberley
Site 19	3060±50	<i>Terebralia</i> sp.	O'Connor 1999	Wk2108	surface	midden	South Kimberley

Table 7: Comprehensive list of all previously published radiocarbon ages associated with shell midden sites from northwestern Australia. Data derived from O'Connor (1999) and Clune (2002).

Figure 10: Graph showing oldest and youngest calibrated radiocarbon ages for those *Anadara granosa* dominated middens and shell mounds listed in Table 12, with the 68.2% level of confidence represented by the solid box plots, and the 95.4% level of confidence by the whiskers. Calculated using the Oxcal version 4.0 radiocarbon calibration program (Bronk Ramsey 1995, 2001) using the Marine 04 Calibration curve (Hughen et al 2004) and a ΔR marine correction of 52 ± 69 which is a combination of several historic marine shell values from around the west coast of Australia (Fiona Petchey pers comm., January 2007).

Discussion and Conclusions

Salvage excavation of seven stratified midden sites dominated by *Anadara granosa* shell located immediately south of Port Hedland, WA have returned radiocarbon ages ranging between 5350calBP and 50calBP years before present. These ages include some of the earliest and latest radiocarbon ages associated with *Anadara granosa* dominated middens, shell mounds and earth mounds from northwestern Australia.

Site 14 replicates the type sequence from Skew Valley of a shift from *Terebralia palustris* to *Anadara granosa*, but this shift is associated with significantly older radiocarbon ages of between 5250 - 4400calBP, or an uncalibrated date of 4592 ± 133 (Wk19853). The reasons why this shift may have occurred between 270 and 530 years earlier in this area than in other parts of the coastal Pilbara remains open to debate. However, the answer may reside in the way in which *Anadara* populations are susceptible to localised variations in habitat (Morrison 2003), and that the establishment of *Anadara* beds occurred at different times along the Pilbara coast. These early dates would council against the application of a general clinal model of mid Holocene change northward along the western Australian coast as advocated by O'Connor (1999) at the local level. While this general model seems to be borne out by the bulk of the radiocarbon ages obtained for the north western Australian coast, local variations from the pattern suggest that the processes of environmental change leading to the development of optimum *Anadara* habitats over this period occurred in a patchwork fashion, with much local variation.

Each of the seven sites had a reasonably limited period of formation and use, averaging approximately 600-800 years, but they were established and abandoned at different times. Taken together, they form an almost continuous series of occupations over the last 5000 years. Although all sites were dominated by the remains of the shellfish *Anadara granosa* and appear to represent a similar volume and rate of accumulation of shell per 100 years, the sites showed significant variation in form, manifesting as shell mounds, earth mounds or lenses of shell exposed in dune cuttings. While archaeologists have tended to focus on the large, visually prominent shell mounds as evidence of a focus on *Anadara granosa* during the mid to late Holocene, I have argued that the morphology of such sites is determined not so much by human behaviour but as a result of particular site formation processes, and that all of these sites might be profitably seen as representing similar forms of behaviour in the past. This has implications for the widely cited view that the focus on intensive *Anadara* exploitation in northwestern Australia, and particularly on the Abydos plain, was limited to between 4200 and 1600 BP. Indeed, a discussion of the radiocarbon ages obtained as part of this, as well as other archaeological studies along the Pilbara coast, demonstrates that large, *Anadara granosa* focussed midden sites continued to form until the contact period in northwestern Australia.

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