Research Reports

A small salvage excavation in Windjana Gorge, Kimberley, Western Australia

SUE O'CONNOR, KEN APLIN and
SOPHIE COLLINS

Keywords: Kimberley; desert adaptation; Holocene;
stone artefacts; fauna

Abstract

Windjana Gorge Water Tank Shelter (DIA 12588) is a narrow limestone rockshelter located in Windjana Gorge National Park, Western Australia. Although the site is badly disturbed, test excavation revealed some 45cm of *in situ* deposit down to massive roof-fall. Radiocarbon estimates demonstrate that the shelter was used from at least 7000 calBP into the European contact period. The sediments contain well-preserved faunal remains and stone artefacts. The faunal remains give an insight into Aboriginal economy in an arid region with adjacent fresh water sources.

In 1994 O'Connor and Cathy Stokes test pitted a narrow rockshelter in a limestone outcrop in Windjana Gorge National Park (Figures 1, 2 and 3). The shelter was first recorded in 1988 by Elizabeth Bradshaw and Patricia Vinnicombe during a Department of Aboriginal Sites (DAS, now Department of Indigenous Affairs, DIA) survey, and named the shelter after a large metal tank that had been constructed in it by the Department of Conservation and Land Management (CALM, now Department of Environment and Conservation, DEC), who manage the park (Figure 2). The shelter is located on the south east face of Windjana Gorge and only a few hundred metres off the walking track leading from the car park to the gorge entrance. It contains archaeological deposit and several panels of painted art, although the latter were largely obscured by the tank at the time of the survey.

The DIA site file records the extensive disturbance to the deposit associated with the tank construction, including burial of black PVC piping running from the tank for the full length of the shelter along the dripline. Also noted is a well trodden path from the walking track to the shelter indicating

regular visitation by tourists. O'Connor carried out a small test excavation in July 1994. By then the metal water tank had been removed by CALM just above the concrete base and no longer obscured the paintings. However, the concrete base and black PVC piping were still evident. The primary aim of excavation was to determine if any areas of undisturbed deposit remained and, if so, to salvage a sample of cultural material. The blatant disregard for the cultural and indigenous heritage values of the site shown by CALM, and the evidence of regular tourist visitation, did not bode well for its future management or protection. This view proved to be justified. When O'Connor revisited the site in November 2005 the base of the water tank was buried under large quantities of river gravel and sand, presumably as a misdirected attempt by CALM to restore the condition of the shelter. The DIA site file does not record the authority for, or timing of, these actions but the site file does note that DAS had recommended removal of the concrete base in July 1993.

Figure 1. Location of Windjana Gorge Water Tank Shelter

Figure 2. Plan of Windjana Gorge Water Tank Shelter showing location of test pit.

SO'C, SC: Department of Archaeology and Natural History, Research School of Pacific and Asian Studies, Australian National University, Canberra, ACT 0200, Australia; KA: Australian National Wildlife Collection, CSIRO Division of Sustainable Ecosystems, PO Box 284, Canberra, ACT 2601, Australia

The 50cm square test pit was positioned well inside the dripline (Figure 3) and was excavated in arbitrary spits of approximately 2cm depth (24 spits in total). The volume of sediment removed in each spit was estimated to the nearest 0.5 L by counting the buckets (or fractions) removed. Excavation was discontinued at a maximum depth of ca. 45cm upon reaching rockfall across most of the plan. To continue would have required enlarging the pit into the disturbed area of the floor. All excavated sediment was sieved through nested 6mm and 3mm sieves. Cultural material from the two fractions is combined in the following analysis. Artefact classification follows Hiscock (in press).

Figure 3. Windjana Gorge Water Tank Shelter photographed in 1994, showing the concrete tank base (photograph S. O'Connor).

Stratigraphy and dating

The deposit was sandy throughout and the only visible stratigraphy involved some slight changes in colour (Munsell 10YR 5/2 – 10YR 5/4) and pH (8.0–8.5). Five

radiocarbon dates were obtained on charcoal, three of them by the AMS method, and one AMS date was obtained from a *Celtis* seed (Table 1). The dates span much of the Holocene through to historic times. Flaked bottle glass occurs in most levels down to Spit 8 where an associated date of 90 ± 30 BP was obtained on charcoal. Rapid accumulation of the top 15–20cm of the deposit seems likely, perhaps due to local landscape destabilisation. The alternative interpretation, that the deposit is characterised by a significant degree of vertical mixing, is rejected in view of the general consistency of the age – depth relationship within the radiocarbon dates.

The vertical distribution of most major categories of excavated materials is summarised in Table 2. Values are densities, i.e. quantity (weight or number) of material per unit volume of excavated sediment. Because sediment volume was estimated to the nearest 0.5 L, density estimates carry an average error factor of approximately 5% (± 0.25 L in 5 L). Taking this source of variance into account, we conclude that: 1) quantities of bone do not vary significantly through the deposit; 2) land snails show a systematic increase in abundance from the bottom to the top of the profile; 3) freshwater bivalves are most abundant at the very base of the profile and again, in Spit 9 and above; 4) bird eggshell is most abundant at the base of the profile and again mid-way through the sequence, in Spits 9–14; 5) charcoal values fluctuate greatly but show a systematic decrease from the bottom to the top of the profile; 6) seeds, (mainly *Celtis*), show two peaks, one in Spits 16–22 and the other in Spits 6–9; and 7) stone artefact densities fluctuate markedly by weight but this obscures a marked peak in numbers of (mostly very small) artefacts between Spits 11 and 16 (see below). Three small fragments of ochre were found, one in each of Spits 1 (yellow – 5.06g), 2 (orange – 0.10g), and 3 (yellow – 0.18g). The fragment in Spit 1 has clear striations and has been heavily worked. Tiny quantities of fragmented freshwater crustacean exoskeleton were recovered from most spits.

Sample ID	Lab code	Material	$\delta^{13}\text{C}$	Radiocarbon Age BP	Southern Hemisphere Calibration 2 sigma interval
WG1-A-8	OZD162 (AMS)	charcoal	-25.00*	90 ± 30	2 BP to 74 BP (49.6% of area) 81 BP to 142 BP (34.6% of area)
WG1-A-11	NZA 22269	charcoal	-26.20	1058 ± 30	903 BP to 963 BP (73.2% of area)
WG1-A-12	NZA 22270	charcoal	-26.84	1664 ± 35	1403 BP to 1568 BP (93.6% of area)
WG1-A-16	NZA 18654 (AMS)	<i>Celtis</i> seed	-14.74	4684 ± 40	5282 BP to 5473 BP (99.5% of area)
WG1-A-21	ANU 10786 (AMS)	charcoal	-25.00*	6337 ± 208	6717 BP to 7569 BP (99.5% of area)

Table 1. Windjana Gorge Water Tank Shelter, Radiocarbon estimates. *Assumed. Radiocarbon dates were calibrated using Calib 5.1 beta (Stuiver and Reimer 1993).

Spit	Sediment volume (L)	Bone (g/L)	Bivalve (g/L)	Egg Shell (g/L)	Land Snail (g/L)	Seed (g/L)	Charcoal (g/L)	Stone Artefacts (g/L)	Stone Artefacts (no/L)
1	4.5	3.26	0.19	0.02	41.36	1.09	0.02	4.18	2.22
2	3.0	2.76	0.29	0.06	37.82	0.90	0.01	0.60	2.33
3	5.5	3.02	0.36	0.04	36.91	1.06	0.05	5.65	2.73
4	5.0	2.38	0.36	0.03	33.32	0.87	0.04	0.56	2.20
5	4.0	3.26	0.60	0.02	43.90	0.86	0.11	0.70	1.50
6	5.0	3.72	0.46	0.07	45.22	1.44	0.09	0.02	0.40
7	4.5	3.78	0.34	0.07	42.78	1.44	0.06	4.60	2.44
8	4.0	3.27	0.64	0.05	32.49	1.39	0.05	0.90	3.50
9	4.0	2.53	0.30	0.10	23.69	1.32	0.13	0.68	1.75
10	6.0	3.12	0.10	0.07	23.18	0.90	0.20	1.30	2.50
11	4.0	3.18	0.07	0.11	26.47	0.79	0.09	3.50	4.00
12	5.5	4.27	0.06	0.22	28.81	0.61	0.13	2.64	7.82
13	5.0	4.13	0.12	0.13	20.88	0.42	0.09	0.90	7.20
14	5.0	4.21	0.13	0.19	24.26	0.39	0.10	1.34	10.00
15	5.5	4.08	0.10	0.07	21.69	0.69	0.17	1.25	7.64
16	4.5	4.49	0.10	0.04	27.16	1.06	0.15	1.27	7.33
17	6.0	4.60	0.05	0.09	23.58	0.74	0.14	2.90	3.00
18	6.0	4.26	0.10	0.08	26.05	1.24	0.13	0.18	2.67
19	6.0	4.09	0.03	0.05	37.08	1.61	0.04	6.82	1.50
20	6.5	3.95	0.15	0.06	29.56	1.55	0.08	0.06	1.38
21	5.5	2.87	0.05	0.04	19.82	1.09	0.26	0.15	1.64
22	4.5	3.96	0.11	0.27	17.84	0.72	0.26	0.07	3.11
23	5.5	4.12	0.27	0.14	19.56	0.51	0.00	0.76	2.36
24	4.5	4.16	0.83	0.09	16.41	0.89	0.07	0.04	2.44

Table 2. Windjana Gorge Water Tank Shelter, density of each major category of excavated finds in each spit.

Faunal analysis

Preservation of all organic remains is excellent and we suspect that little has been lost to post-depositional degradation. However, surficial weathering on a small number of bones suggests prolonged exposure to the elements, most likely during breaks in sediment accumulation. The proportion of bone in each spit showing evidence of burning ranges between 2.4% and 12.0% (mean 4.9%). Burning incidence is low across most taxonomic groups (Table 3), including both potential non-human prey species (e.g. small rodents) and human prey remains (e.g. possums, macropodids). In contrast, all categories of reptiles show moderate degrees of burning. Most commonly burnt elements across all groups are phalanges, caudal vertebrae and dentaries, presumably a result of charring of extremities during traditional earth oven cooking.

Many of the small vertebrate bones are relatively unfragmented and this, coupled with the low frequency of burning, suggests that a proportion of the fauna is derived from owl pellets. Two small solutions tubes, located directly above the deposit, are potential roosting sites for owls. Remains of medium-sized and larger mammals (e.g. bandicoots, possums and macropodids), which are clearly not derived from owl pellets, show the same pattern of minimal burning but are highly fragmented. The more frequent burning of small reptile bones marks these as

derived in large part from human activity. The economic significance of reptiles is evident from ethnographic accounts of desert people (e.g. Gould 1991), with women often playing a major role in their acquisition.

Taxonomic representation is relatively uniform through the deposit (Table 3). Large to medium-sized game mammals are scarce. Reptiles make up 30–40% of remains in most spits, while small murids make up between 30–70%, and slightly more on average above Spit 9 than below. Small numbers of frog and bird bones, as yet unidentified, are present throughout. Frogs and small birds are both commonly found in owl pellets and they might be derived from this source. In contrast, the bird eggshell, also from unidentified species (not emu), is more likely derived from human activity. The quantity of eggshell tracks that of stone artefact numbers through the profile, save for a basal spike that is not observed in the artefacts.

The mammal fauna includes species associated with tropical savannah and/or grassland (*Conilurus penicillatus*, *Rattus tunneyi*, *R. villosissimus*, *Pseudomys nanus*, *Isoodon macrourus*, *Macropus agilis*), sandy arid habitats (*Pseudomys* sp. cf. *P. fieldi*, *Isoodon auratus*, *Dasyurus* sp.), rocky gorge habitats (*Zyzomys* spp., *Dasyurus hallucatus*, *Petrogale* spp., *Trichosurus vulpecula*) and areas of cracking clays (*Planigale ingrami*). Overall, the fauna is consistent with the modern range of habitats that lie within the foraging range of both people and owls. Accordingly,

Spit	Goat?	<i>Tachyglossus</i>	<i>Thylacinus</i>	<i>Dasyurus</i> spp.	Small dasyurids	Bandicoots	<i>Trichosurus</i>	<i>Bettongia</i> sp.	Macropodids	Large murids	Small murids	Microbats	<i>Varanus</i>	Small lizards	Snakes	Bird	Chelid turtle	Fish	Frog
1											28		3	2	4	2			1
2					2	1					11		2	1	4				
3	1					1	1		3	1	30		2	1	16	1			2
4					4	1	1		2		23	1	2		6	1			
5					3		1		3		31	1	1	2	4	1			
6		1			2	1			2		43	1	2	4	6	2			1
7					4	2	1				52		1	2	7	1			4
8					2		1		2		34			4	9				3
9					1				4		17		4	2	9	1			
10				1		3			1		27		7	7	26				6
11				1	2	1			2		13		6	5	9	2		1	4
12				1	2	3	4		4	1	26		4	2	2	1			1
13					1				2		27		3	7	5	4			2
14					1	3			5	1	25		2	3	8	1			1
15					1	3		1	7	1	30		5	7	6	2			1
16			1	1	2	1			4		16		4	4	8	1			1
17				1	1	1	1		3		26		7	8	12				
18				1			2		1		18		8	5	13				1
19					1	1					43		7	5	7				1
20						4			1		17		5	8	4	2	1		1
21				1	1				1		14		5	2	5				
22				1					2		15		7	2	6				1
23					3	2			2		14		5	4	3	1			
24					1	1	1		2		13		5	1	5	1	1		
Total	1	1	1	8	34	29	13	1	53	4	593	3	97	88	184	24	2	1	31
Total burnt					1		1		2		1		14	13	12				
% burnt					2.9		7.7		3.8		0.2		14.4	14.8	6.5				

Table 3. Number of individual and burnt specimens (NISP) for all major taxonomic groups identified within the vertebrate bone assemblage.

there is no evidence of major changes in local environments through the Holocene. Within the murid rodent assemblage (Table 4), the two most abundant taxa (*Rattus* spp. and *Leggadina* spp.) are opportunists that generally become locally common only during 'good' seasons i.e. when local rainfall produces a boom in seed production and invertebrate populations. The abundance of these species suggests that owls may have used the site most often during such periods.

The fauna contains two mammal species of special interest. The first is a thylacine (*Thylacinus cynocephalus*), represented by a partial molar in Spit 16. This is one of only a few well-dated *in situ* specimens of this extinct marsupial carnivore from northern Australia. Two fragments dated to the late Pleistocene and mid Holocene were recovered from Widinggarri Shelter 1 in the coastal Kimberley (O'Connor 1999:90). The second is an unidentified large murid rodent, represented by a maxilla lacking teeth from Spit 3. This taxon is better represented in the Carpenter's Gap faunas

and appears to represent a taxon not recorded in historic collections from this region (Aplin, in prep). The mammal fauna will be reported in more detail following completion of faunal analysis from Carpenter's Gap 1, 2 and 3 (McConnell and O'Connor 1999).

A minor component of aquatic fauna is present throughout, with one small fish vertebra in Spit 11 and fragments of freshwater turtle in Spits 20 and 24. The chelid turtle remains are the first record of this group from Windjana Gorge, although several species are found in the Fitzroy River drainage. The present record suggests that they may have disappeared from the gorge in the mid-Holocene. The paucity of fish bone is unlikely to be due to preservation but may be due in part to loss of tiny bones through the sieve. Freshwater bivalve shell is present throughout but is most abundant in the two lowest spits and in Spits 1–9. The crustacean exoskeleton belongs to the cherabin, *Macrobrachium rosenbergii*, a large freshwater prawn found only in northwestern rivers.

Spit	<i>Rattus villosissimus</i>	<i>Rattus tunneyi</i>	<i>Rattus</i> spp.	<i>Leggadina</i> spp.	<i>Pseudomys nanus</i>	<i>Pseudomys</i> sp. c.f. <i>P. fieldi</i>	<i>Pseudomys</i> sp.	<i>Zyzomys argurus</i>	<i>Zyzomys woodwardi</i>	<i>Conilurus penicillatus</i>	Unknown large murid
1	6		18	2	2						
2	2		7				1	1			
3	4		20	4	1			1			1
4	3		17	3							
5	5	1	23				2				
6	8	2	29	2			2				
7	6	3	36	2	2		3				
8	8	1	21	3	1						
9	3		10	3			1				
10	5	1	17	2	1				1		
11	4		8	1							
12	3	1	16	2			4			1	
13	6		20				1				
14	4	2	15	3	1					1	
15	6	1	17	2			3	1		1	
16	4		10				2				
17	4		20	2							
18	3		13	1					1		
19	7	2	29	1	2		2				
20	4		9				3	1			
21	5		6	2			1				
22	2		8			1	4				
23	4		9	1							
24	6		7								

Table 4. NISP for taxonomically identified murine rodents.

Stone artefact analysis

A total of 417 pieces of humanly transported stone were recovered. However 43% of these are shatter or non-diagnostic pieces that were excluded from the attribute analysis. The assemblage is dominated by unretouched flakes (Table 5), measuring, for the most part, less than 10mm. A single quartz core came from Spit 7 and a total of four retouched flakes were recovered. Although seven different raw materials were utilised, quartz dominates

every level, with chert and silcrete featuring to a lesser extent. A small number of glass artefacts were recovered from Spit 8 and above.

The four retouched artefacts can all be loosely described as points (Figure 4). Artefact 302 (Spit 1) is a made on bottle glass. It has continuous retouch along both lateral margins and around the tip. The retouch was by pressure flaking and is primarily unifacial with only one or two scars from the very tip removed from the opposite side. Retouch is much more invasive along the left margin, extending up to 8.1mm from the edge, as compared to 3.5mm from the right margin. Wear analysis was undertaken of both surfaces of the artefact using a combination of low and high magnifications (50–400x). Large numbers of tiny hertzian flakes were visible under low magnification, along with a clear zone of abrasion along the left margin of the unretouched surface. The abraded area emanates from a steeply retouched edge and is triangular in shape, extending a maximum of 2mm from the edge. Abrasion is visible inside flake scars along the margin but does not extend further onto the retouched face. The subtlety of the abrasion suggests use on something quite soft and the triangular shape of the abraded area suggests uneven penetration of the worked material by the cutting edge.

Artefact 303 (Spit 7), is a chert point with continuous retouch along both lateral margins and onto the distal tip. The dorsal surface is almost entirely retouched with the exception of a small area along the platform. Retouch is unifacial except for one scar that crosses the ventral surface. Average length of the dorsal flake scars is 5.3mm. No evidence of wear was detected.

Artefact 47 (Spit 11), a quartz point, has extensive bifacial flaking along both lateral margins and extending up to 8mm from each edge (Figure 4). The size of scars and clear evidence of initiations and terminations, as well as the regularity of scar removals, suggests pressure flaking as the likely method of manufacture. No trace of wear was detected.

Artefact 165 (Spit 17), a small quartz point, exhibited continuous unifacial retouch extending from the distal tip to the platform along both lateral margins. All flake scars originate from the ventral surface and cover the entire dorsal face. Scars are large and steep, with a depth of between 3 and 8mm, and only five scars account for the combined length of both lateral margins. The size and depth of the scars, coupled with a lack of evidence for pressure points,

Artefact Class	Quartz		Chert		Silcrete		Glass		Other		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Unretouched Flake	177	42.5	27	6.5	17	4.1	6	1.4	6	1.4	233	55.9
Retouched	2	0.5	1	0.2		0.0	1	0.2		0.0	4	1.0
Core – Pebble		0.0		0.0		0.0		0.0	1	0.2	1	0.2
Flaked Piece	70	16.8	15	3.6	4	1.0		0.0		0.0	89	21.3
Shatter	86	20.6	2	0.5	1	0.2		0.0	1	0.2	90	21.6
Total	335	80.3	45	10.8	22	5.3	7	1.7	8	1.9	417	100.0

Table 5. Windjana Gorge Water Tank Shelter, artefact class by raw material for the entire excavated assemblage.

Figure 4. Windjana Gorge Water Tank Shelter, stone artefacts with retouch (points).

suggests percussive retouch. Analysis of the entire periphery of this artefact under both low and high magnifications (50x, 200x, 500x) revealed rounding and light polish. The distribution of this polish over all ridges of the entire artefact is characteristic of soil sheen polish.

The predominance of quartz in the assemblage (Table 5) suggests that this material was available locally. Quartz seams have been located by O'Connor on the north side of the gorge, near Carpenter's Gap 1 and other similar sources might be locally present. The ready availability of quartz might explain the lack of retouch, with users generally adopting an expedient approach. Most of the quartz is of reasonable to high quality and was worked by direct, rather than bipolar, percussion. In contrast, chert (10.8%) and silcrete (5.3%), are proportionately the most heavily reduced materials, and flakes of these materials are consistently small. These attributes suggest that chert and silcrete were not locally available.

Within the quartz assemblage, the high number of tertiary

flakes and virtual absence of cores raises questions about the nature and location of the reduction process. Traditionally, these attributes would imply reduction occurring away from the shelter. However, it is also possible that a significant proportion of the smaller tertiary flakes were produced during a more specific reduction activity, possibly the production of points. A comparison of stone artefact densities based on weight and number reveals a specific occupation phase, represented by Spits 11 to 16, during which large numbers of small quartz flakes were deposited. The majority of these are less than 10mm in length, consistent with the size of negative flake scars on the two quartz points recovered from the same levels. Whether or not this reflects a purely local shift in emphasis of activities, or a more general shift towards increased reduction of raw materials during this time, can only be decided by comparison with other excavated sequences in the region.

Discussion

The combined faunal and artefact assemblages indicates that, through the mid- to late Holocene periods, mobile groups were expediently utilising locally available resources from the gorge and its flanking sandy banks, and from the semi-arid to arid areas surrounding the limestone escarpment. The aquatic habitats of the gorge probably provided only small quantities of fish, turtles, crustacea and freshwater bivalves. Indeed, the faunal remains seem to indicate a typical 'desert' adaptation with emphasis on reptiles and medium-sized mammals. Very few larger game animals were brought to the site but whether this accurately depicts actual hunting patterns or merely the differential transport of large prey items is not currently known.

The stone artefacts also indicate expedient use of a readily available quartz source, with more exhaustive utilization of other raw materials obtained from more remote sources. Artefact numbers increase in Spit 16, about 5300 calBP (Calib 5.1 beta, Stuiver and Reimer 1993), after the appearance of the first retouched stone point, perhaps indicating greater incidental production of small flakes associated with point production or retouch. The points include unifacial, marginal and bifacially retouched examples and were made using percussive and pressure flaking techniques. The earliest point at WG Water Tank Shelter appears to predate 5300 cal. BP but the possibility of its being intrusive from above cannot be discounted. The radiocarbon age estimate of 90 $\pm$ 30 BP from Spit 8 is a good approximation for the European contact period in this region and glass artefacts make their first appearance at this level.

Acknowledgements

O'Connor would like to acknowledge the Bunuba Traditional Owners of the Water Tank Shelter and Windjana Gorge who assisted with the fieldwork in 1994. Dr. Madge Schwede is kindly thanked for her assistance.

References

- Gould, R.A. 1991. Arid-land foraging as seen from Australia: Adaptive models and behavioural realities. *Oceania* 62:12-33.
- Hiscock, P. In Press. Looking the other way: A materialist/technological approach to classifying tools and implements, cores and retouched flakes, with examples from Australia. In S. McPherron and J. Lindley (eds), *Tools or Cores? The identification and study of alternative core technology in lithic assemblages*. University of Pennsylvania Museum.
- McConnell, K. and S. O'Connor. 1999. Carpenter's Gap Shelter 1, a case for total recovery. In M-J. Mountain and D. Bowdery (eds), *Taphonomy: the Analysis of Processes from Phytoliths to Megafauna*, pp. 23-34. Canberra: ANH Publications.
- O'Connor, S. 1999. 30,000 Years of Aboriginal Occupation in the Kimberley, Northwest Australia. *Terra Australis* 14.
- Stuiver, M. and P.J. Reimer. 1993. Extended ^{14}C data base and revised CALIB 3.0 ^{14}C Age calibration program. *Radiocarbon* 35(1):215-230.

Patterns of chronological variability in occupation on the coastal margin of Blue Mud Bay

PATRICK FAULKNER

Keywords: Northern Australia, shell mounds, chronology, Holocene, variability

Abstract

This paper presents an analysis of radiocarbon dating of shell mounds and middens in Blue Mud Bay, northern Australia. The aim is to investigate variability in use of the landscape and foraging activity through time. By considering both mounded and non-mounded shell deposits, results indicate that occupation and use of coastal landscapes during the Holocene in this region of northeast Arnhem Land was highly variable, with several overlapping phases of occupation and gaps in site formation. As in some other Australian regions, this implies a discontinuous or non-linear pattern of occupation, one that suggests the late Holocene occupation of coastal Blue Mud Bay may be characterised by variability in the distribution and intensity of foraging behaviour through time and space.

A number of recent studies have demonstrated that detailed investigation of local or regional chronologies can provide insights into potential variability in the intensity and distribution of foraging and use of the landscape (e.g. Attenbrow 2004; Hiscock and Attenbrow 1998; Holdaway *et al.* 2002; Ulm 2006a). As such, our ability to establish secure chronologies at a regional level will ultimately enable us to draw meaningful comparisons at the inter- and intra-regional scales. Recently, several researchers have noted that the chronology of human occupation within any given region cannot be based on individual radiocarbon determinations alone, it is through multiple determinations that landuse patterns may be recognised (Holdaway *et al.* 2002; Ulm 2006a). For that reason, when reconstructing the past in this way, we need to base our interpretations on a pattern based on the accumulation of multiple events (Holdaway *et al.* 2002: 356). Therefore, although there are certain limitations and problems of resolution when interpreting the available radiocarbon chronologies from any given area, by using this kind of approach, we are able to characterise long-term temporal trends, thereby building a picture of occupation. This paper presents the results of recent research in Blue Mud Bay, northeast Arnhem Land (Figure 1), with a specific focus on the chronological patterns of occupation on the Point Blane Peninsula where a large sample of radiocarbon dates (38 dates from 20 sites) was obtained from a cross-section of site types in varying environmental contexts. This approach provides a basis to