[Supplementary material]

Archaeology of the Waiat mysteries on Woeydhul Island in Western Torres Strait

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Methods

Excavation and processing

Test pits were excavated using a trowel and hand shovel, proceeding in arbitrary Excavation Units (XUs) guided by Stratigraphic Units (SUs). XUs averaged 30mm in cultural layers and did not exceed 60mm. Excavated sediments were dry-sieved through a 2.4mm mesh to ensure maximum retention of cultural materials, then wet sieved at a field station established on Mabuyag to facilitate initial sorting by species, also return of all non-cultural materials (including shellfish <10mm in maximum length) to Woeydhul. All such materials were weighed prior to discard, added to weight collected for all sediments (occurring during excavation). Cultural materials and sediment samples were transported to Australian National University for laboratory analysis.

Radiocarbon dating

In situ charcoal, shell and bone samples were prepared for radiocarbon dating at the ANU Research School of Earth Sciences. Where possible, radiocarbon samples targeted intact, dense dugong ribs (pretreated using an ultrafiltration method; Wood *et* *al.* 2014) or shell (pretreated using an acid leach). Based on context and alignment these were assumed to be cultural and were unlikely to be intrusive (horizontally aligned and, with the exception of S-ANU19579, ribs were aligned parallel with adjacent bones). Marine shell samples were collected from young, filter feeding bivalves thus reducing the likelihood of introducing old carbon contamination. Charcoal was microscopically assessed to remove non-tree species and to ensure sample contained diagnostic elements such as vessels, fibres and rays of heartwood, and was pretreated using an acid-base-acid protocol (Wood *et al.* 2016). Radiocarbon dates were calibrated against IntCal13 or Marine13 (Reimer *et al.* 2013) using a ΔR value of 50 ± 47 radiocarbon years (Ulm 2006) in OxCal 4.3 (Bronk Ramsey 2009), where they were also modelled. The model assumed that all dates had a 5 per cent prior probability of being an outlier within the General t-type Outlier Model (Bronk Ramsey 2009), and assumed that the sand layer ended at the same time in each square.

Faunal analysis

Large vertebrate analysis (by SSC and IC) was completed at ANU laboratories using a dugong and turtle reference skeletons from the CSIRO National Research Collection. Remains were identified to the lowest possible taxonomic/ anatomical level, with represented elements, bone surface modification, (cut marks, colouring, burning) and fragmentation recorded. Bone surface modifications, to be reported elsewhere (S.C. Samper Carro *pers. comm*.), were identified at a macroscopic level with a head mounted hand lens (10×) and later evaluated at the microscopic level with a Dino-Lite Edge Digital Microscope AM4815ZT (220×).

Quantitative units considered were number of remains (NR, including identifiable and unidentifiable fragments), the number of identifiable specimens (NISP, identified to taxon), and the minimum number of individuals (MNI, considering portion preserved, side, and ontogenic stage). Prior to this all bones were tested for refits, distinguishing between mechanical refits and articulated elements (Fernández-Laso 2010). For mechanical refits, we have distinguished between pre-depositional (green fracture) and post-depositional/excavation (dry) breakage angles and outlines.

Small vertebrate analysis (DW) was completed using the fishbone reference collection located at the ANU Department of Archaeology and Natural History. Bone identification followed Dye and Longenecker (2004) procedures, focusing on the fivepaired cranial elements (i.e. premaxilla, maxilla, dentary, articular and quadrate) and identifying the five distinctive jawbones as well as additional elements that are distinctive to a particular taxon (e.g. post-cranial bones including Elasmobranchii vertebrae). At this stage weight and NISP counts only have been completed for small vertebrate with further analysis pending.

Shells and shell fragments were identified (ML) using comparative reference collections at the Australian National University. All specimens were identified to the lowest taxonomic level possible. Species names were recorded against current classifications in the World Register for Marine Species. Shell assemblages were quantified by weight (g), Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI). MNI was used as a primary method for quantification—the MNI as a measure, records one repetitive feature per taxon (spires in gastropods and the left valve for bivalves), therefore circumventing issues of inflation due to fragmentation associated with NISP counts (Classen 1998).

Lithic artefact analysis

Analysis of all artefacts was completed by two of us (LN and GVDK) in ANU laboratories. Due to the small size and poor quality material of many artefacts a hand lens, and where necessary microscope, was used.

A conservative methodology was adopted, whereby pieces that were clearly broken, but without diagnostic details were labelled 'consistent with bipolar reduction'. It was observed that this category was consistently associated with other forms of cultural material (including positively identified flaked artefacts), suggesting the majority of these pieces were manufactured during the knapping process. A second category 'attributes BP' included those pieces where bipolar reduction could be clearly identified by attributes such as symmetrical profile, rectilinear morphology with associated bifacial or unifacial scars, series of closely spaced ripples and/ or abrupt step and/ or hinge terminations. Assessment of local geology was completed based on recent research on Mabuyag and surrounding Islands (von Gnielinski 2015).

Results

Table S1. Radiocarbon dates from all squares calibrated against IntCal13 and Marine13 (Reimer *et al.* 2013) in OxCal v.4.3.2 (Bronk Ramsey 2009).

Material	XU	Lab code	Radiocarbon age (BP)	Calibrated age (cal BP, 95% probability)	% yield	δ13C	δ15N	%C	CN
Square B									
Dugong, rib	XU2B	S-ANU64030	1000±24	626–507	3.1	−3.9	5.1	44.6	3.2
Pinctada	XU3A	S-ANU59419	908±25	615–491	89.2	N/A	N/A	N/A	N/A
Dugong, rib	XU3A	S-ANU59821	944±22	631–509	2.4	−5	4.7	43.1	3.2
Pinctada	XU6B	S-ANU59418	1026±23	675–551	90.7	N/A	N/A	N/A	N/A
Asaphis	XU8B	S-ANU59416	1002±25	660–540	90.5	N/A	N/A	N/A	N/A
Dugong rib	XU8B	S-ANU59820	964±29	645–516	3.9				
Pinctada	XU10B	S-ANU59417	1033±28	686–550	89.9	N/A	N/A	N/A	N/A
Dugong rib	XU10B	S-ANU59823	1017±24	672–543	2.6	−3.8	4.5	42.5	3.1
Charcoal	XU13A	S-ANU59816	981±25	871–798 (0.473)	68.5	N/A	N/A	56*	N/A
				939–897 (0.507)					
				953–944 (0.020)					
Charcoal	XU18	S-ANU59814	1182±23	1178–1056 (0.979)	65.2	N/A	N/A	56*	N/A
				1020–1012 (0.021)					
		S-ANU59817	1197±23	1181–1060 (0.995)	65.7	N/A	N/A	56*	N/A

				1218–1215 (0.005)					
Square C									
Dugong bone	XU3B	S-ANU59818	824±23	781–690	1.3				
Square D									
Dugong bone	XU2	S-ANU64031	729±24	423–276	1.9	−5	5.8	45	3.2
Dugong bone	XU3	S-ANU59819	825±23	496–353 (0.978)	2.2				
				347–334 (0.022)					
Charcoal	XU8	S-ANU59813	355±25	400–316 (0.513)	66.5				
				406–402 (0.006)					
				496–422 (0.480)					
Square E									
Shell (Dosinia sp.)	XU2	S-ANU59414	1000±25	659–539	89.6	N/A	N/A	N/A	N/A
Shell (Cardiidae)	XU8	S-ANU59415	1692±30	1353–1199 (0.999)	89.5	N/A	N/A	N/A	N/A
				1191–1190 (0.001)					
Dugong	XU11	S-ANU59812	1908±23	1583–1387	51	N/A	N/A	56*	N/A
Charcoal	XU17	S-ANU59811	156±27	BOMB**	80.8	N/A	N/A	59*	N/A

* %C was measured volumetrically during cryogenic capture of CO_2 gas.

** BOMB carbon refers to addition of ‘artificial’ radiocarbon to the atmosphere as a result of nuclear weapons testing after 1950.

Table S2. Results from the Bayesian model for Woeydhul squares B, C and D assuming that the sand layer ended at the same time in each.

Name	Calibrated date (cal BP)				Modelled date (cal BP)				Convergence
	68% probability range		95% probability range		68% probability range		95% probability range		
	from	to	from	to	from	to	from	to	
Square C									
End XU3B					428	168	428	954	99.2
S-ANU59818	475	360	495	300	471	379	487	297	99.4
Start XU3B					612	399	780	321	99.6
Ê=End of sand unit					829	601	921	557	99.8
Square D									
End XU2					378	193	383	282	98.5
S-ANU64031	392	276	461	233	370	273	417	195	99.1
Transition XU8/XU2					430	319	458	260	99.3
S-ANU59819	476	360	496	301	473	389	484	302	99.4
Start XU8_start of mound					591	396	747	310	99.6

Ê=End of sand unit					829	601	921	557	99.8
Square B									
End XU2b					521	453	528	323	97.5
S-ANU 64030	600	507	639	479	525	479	535	404	99
Transition XU3A/XU2B					529	485	539	431	99.1
S-ANU59821	545	466	614	430	534	492	545	444	98.9
S-ANU59419	523	443	595	363	533	492	543	446	99
Transition XU6B/XU3A					540	498	559	454	98.8
S-ANU59418	615	526	649	495	550	505	575	465	98.7
Transition XU8B/XU6B					559	505	589	471	98.7
S-ANU59820	590	473	627	446	566	508	596	480	98.6
S-ANU59416	600	509	640	480	569	510	596	481	98.6
Transition XU10B/XU8B					583	519	605	484	98.5
S-ANU59823	610	520	645	490	607	535	625	494	98.7
S-ANU59417	619	530	655	495	608	535	630	495	98.8
Transition XU13A/XU10B_start of mound					634	535	716	486	99.1

End of sand unit					829	601	921	557	99.8
S-ANU59816	933	804	954	797	933	830	954	797	99.9
Transition UX18/XU13A					1096	932	1143	846	99.9
S-ANU59817	1162	1081	1182	1060					
S-ANU59814	1172	1065	1179	1011					
Charcoal 18B	1172	1073	1176	1066	1127	1062	1173	1013	99.9
Start XU18					1178	1072	1293	...	99.1

Lithic artefact analyses for squares C, D, E

Square C deposits revealed little cultural material (SOM2). There were 27 lithic fragments (25 Attributes Bipolar (ABP) and two Consistent with Bipolar (CBP)). Quartz dominated, however, three dark volcanic pieces were recovered from XU 1A, 2B and 3A.

Square D contained 77 lithic fragments, including seven flakes, 41 ABP and 11 CBP (SOM2). Quartz dominates (32); however, a range of raw materials were noted including biotite granite (4), ferricrete (6) other siliceous (29), dark volcanic (5) and microgranite (1). Consistent with Square B, significant quantities of artefacts were recorded in deposits immediately below the bone mound (i.e. XUs 5–7) with only 18 fragments above this. Indeed 44 per cent of the total (34 fragments, including all flakes) were recovered beneath XU3. This strongly suggests a discrete phase of human activity, potentially site preparation in advance of mounding activity.

Square E contained 530 lithic fragments including 207 ABP (one core and six flakes) also 343 CBP (SOM2). Upper deposits (Surface – XU3) were associated with 413 fragments, with small quantities of lithic artefacts recovered in three XU's beneath this. Quartz was the dominant raw material, with small quantities of dark volcanic material and granite also noted (primarily in XU4). A comparatively large proportion of crystal quartz (57 in XU3; 9 in XU4; 13 in XU5 and 1 in XU6) and milky quartz (97 in XU3; 10 in XU4; eight in XU5 and one in XU6) was noted. A markedly different (ephemeral) phase of human activity was identified between XU10 and XU17 (54-109cm). While milky quartz was present, quantities were much lower than porphyritic, felsic, volcanic rock (26 in XU10; one in XU11; eight in XU12; three in XU13 and one in XU17). It is likely that the dark, volcanic rock originates from the Badu Granite group or Torres Strait Volcanics (mapped on the neighbouring Aipus and Mabuyag).

Table S3. Stone artefacts excavated from square B. Abbreviations: BP = bipolar; QM = milky quartz; QC = crystal quartz; QS = smokey quartz; DV = dark volcanic; MG = micrograine; F = ferricrete; BG = biotite granite; DI = dark igneous; PFV = porphyritic, felsic, volcanic rock; SG = soft grey unidentified rock; CO = conglomerate.

XU	No. pieces	Material	Flake	Attributes BP	Consistent BP	Nil BP
1	18	7qc, 11qm	1qc, 1qc (core)	5cq, 2qm	9qm	0
2A	21	8qc, 12qm, 1 dv	0	8qc	11qm	1dv, 1qm
2B	20	7qc, 13qm	0	7qc, 2qm	11qm	0
3A	2	2qm	0	0	2qm	0
3B	17	2qc, 14qm 1dv	0	2qc, 11qm	3qm	1dv
4A	14	4qc, 10qm	0	4qc, 2qm	8qm	0
4B	60	25qc, 35qm	0	22qc, 7qm	3qc, 28qm	0
5A	12	2qc, 9qm, 1f	0	2qc, 4qm	5qm	1f
5B	35	10qc, 25qm	0	2qc, 8qm	8qc, 17qm	0
6A	8	2qc, 6qm	0	2qc, 1qm	5qm	0
6B	27	8qc, 19q	0	6qc, 16qm	2qc, 3qm	0
7A	13	2qc, 11qm	1qc,	1qc, 7qm	4qm	0
7B	35	21qc, 14qm	1qc	13qc, 4qm	7qc, 10qm	0
8A	19	5qc, 14qm	1qc	4qc, 6qm	8qm	0
8B	47	1f, 14qc, 31qm	1qc	10qc, 8qm	4qc, 23qm	1f
9A	41	16qc, 25qm		10qc, 9qm	6qc, 16qm	0
9B	54	24qc, 30qm	1qc	18qc, 7qm	5qc, 23qm	0
10A	24	10qc, 14qm	1qc	7qc, 4qm	2qc, 10qm	0
10B	52	1sg, 25qc, 26qm	2qc	18qc, 5qm	5qc, 21qm	1sg
11A	40	1d, 12qc, 27qm	0	11qc, 9qm	1qc, 18qm	1d
11B	45	23qc, 22qm	0	23qc, 7qm	15qm	0
12A	11	11qm	0	5qm	6qm	0
12B	34	7qc, 27qm	0	4qc, 5qm	3qc, 22qm	0
13	42	1os, 15qc, 26qm	1qc, 1qm	11qc, 4qm	3qc, 21qm	1os
14	14	7qc, 7qm	0	6qc, 1qm	1qc, 6qm	0

15	3	3qm	0	3qm	0	0
16	1	1qm	0	1qm	0	0
17	2	2qm	0	2qm	0	0
18	1	1qm	0	0	1qm	
Total	712	712	12	336	356	8

Table S4. Lithic artefacts from square C.

XU	No. pieces	Material	Flake	Attributes BP	Consistent BP	Nil BP
Surface	4	4qm	0	4qm		
1A	4	3qm, 1dv	0	3qm, 1dv		
1B	2	1qc, 1qm	0	1qc, 1qm		
2A	5	3qc, 2qm	0	3qc, 2qm		
2B	3	2qm, 1dv	0	2qm, 1dv		
3A	5	1qc, 3qm, 1dv	0	1qc, 3qm,	1dv	
3B	1	1qc	0	1qc		
4A	2	2qm	0	1qm		1gm
4B	2	2qm	0	1qm	1qm	
Total	28	28		25	2	1

Table S5. Stone artefacts excavated in square D.

XU	No. pieces	Material	Flake	Attributes BP	Consistent BP	Nil BP
2	6	1q, 3bg 2f	0	1q, 2bg	0	1bg, 2f
3	8	4qs, 4qm	0	4qs	0	4qm
4	9	1f, 1bg, 7qs	0	7qs, 1bg	0	1f
5	7	1co, 3bg, 2qs, 1f	1q	1qs, 1bg	0	2bg, 1co, 1f
6	37	7qc, 11qm, 10qs, 4bg, 4f, 1dv	2qc, 2qs	5qc, 2qm, 6qs	5q, 7bi	1qm, 2qs, 4f, 1dv
7	10	2qc, 6qm, 2dv	1q, 1dv	2qc, 4qm	1dv	1qm
8	2	1qm, 1dv	1dv	1qm	0	
9	1	1mg	0	1mg	0	
9B	1	1qc	0	1qc	0	
Total	81	81	8	39	13	21

Table S6. Stone artefacts excavated from square E.

XU	No. pieces	Material	Flake	Attributes BP	Consistent BP	Nil BP
Surface	14	10qc, 4qm		2qm, 7qc	2qm, 3qc	
1	125	73qc, 48qm, 4dv		2dv, 17qm, 44qc,	31qm, 29qc	2dv
2	130	51qc, 79qm		11qm, 32qc	68qm, 19qc	
3	162	4di, 97qm, 60qc, 1f	3qc	1di, 19qm, 32qc	3di, 78qm, 25qc	1f
4	40	1mg, 18dv, 10qm, 9qc, 2f	1mg, 1dv	6dv, 6qc	11dv, 10qm, 3qc	2f
5	21	8qm, 13qc		3qm, 6qc	5qm, 7qc	
6	2	1qm, 1qc		1qc	1qm	
7	0	0				
8	0	0				
9	2	2qm				2qm

10	44	26pfv, 18qm	1pfv	4pfv, 3qm	21pfv, 15qm	
11	3	1pfv, 2qm		1qm	1pfv, 1qm	
12	8	8pfv		2pfv	6pfv	
13	6	3fpv, 3f		1fpv	2fpv	3f
14	3	2qm, 1f			2qm	1f
15	0	0				
16	0	0				
17	1	1pfv	1pfv (core)			
Total:	561	561	7	200	343	11

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