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THE MOYJIL SITE, SOUTH-WEST VICTORIA, AUSTRALIA: PROLOGUE — OF PEOPLE, BIRDS, SHELL AND FIRE

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ABSTRACT: Moyjil (also known as Point Ritchie) is the site of an unusual shell deposit in south-west Victoria showing many characteristics of a midden. Earlier research established an age of 60 ka or older for the shell deposit but could not establish whether humans or animals such as seabirds were responsible for its formation. This paper, the first of six in this special issue, summarises the most recent phase (~10 years) of investigations. The site's age is now fixed as Last Interglacial and following the stage MIS 5e sea-level maximum (i.e. younger than 120–125 ka). Fragmentation and the limited size distribution of the dominant marine shellfish (*Lunella undulata* syn. *Turbo undulatus*) confirm the site as a midden. There is also evidence for fire (charcoal and discoloured and fractured stones) and two hearth-like features, one of which has been archaeologically excavated. None of the evidence collected is able to conclusively demonstrate a human versus animal origin for the site. Significantly, a human origin remains to be disproved. These papers provide the basis for a new phase of research into the possible cultural status of the Moyjil site.

Keywords: Last Interglacial, shell middens, hearths, Point Ritchie, *Lunella undulata*, *Turbo undulatus*, *Larus pacificus*, operculum, OSL, amino acid racemisation

This is the first paper in a series of six in this special issue, which investigates an unusual shell deposit on the west bank of the Hopkins River mouth, at Warrnambool, in south-west Victoria. The site has been the subject of a long-running research project (~10 years) by the current researchers, building on early work by Edmund Gill and others.

Jim Henry, a Warrnambool naturalist and historian, first drew Gill's attention to the shell scatter on West Stack in 1981. Gill subsequently, and in collaboration with the author, commenced a wider investigation into the Point Ritchie (Moyjil) headland area, correlating the West Stack deposit with shells within a sand layer between two calcretes on the headland cliff. He also identified several Last Interglacial (LIG) beach deposits around the headland. The absence of rounding due to abrasion on the West Stack shells contrasted with the extensive rounding of shells of the same species (dominantly *Lunella undulata* syn. *Turbo undulatus*) in the LIG beach deposits. This species also dominates many Holocene Aboriginal middens near rocky coasts in south-eastern Australia. Cementation of the West Stack shells in their sandy matrix suggested an age beyond the Holocene, subsequently confirmed by radiocarbon dating which gave ages interpreted as beyond the limit of the method (>40 ka). Charcoal and terrestrial snails found with the marine shells in the headland sand layer indicated transport of the marine shells inland. These characteristics led Gill to suggest the site was an ancient midden. In May 1986 he organised a workshop to examine the Moyjil site and a second upstream shell deposit (the Hopkins Estuary site) later established to be a natural shell deposit (Gill et al. 1991). The 22 workshop attendees included leading geologists, archaeologists, traditional owners and representatives of the Victorian Archaeological Society. A final summary statement of the workshop agreed the Moyjil site was older than 40,000 years, based on radiocarbon dating; that it was of human origin and thus one of the oldest archaeological sites presently known in Australia; and that it warranted further investigation.

Gill died shortly after the workshop, but the latter provided the incentive for further collaborative work to refine the Moyjil site's age using a range of relatively new techniques (thermoluminescence, amino acid racemisation, uranium/thorium radiometric dating and electron spin resonance). Thermoluminescence (TL) and amino acid racemisation (AAR) suggested an age of 67 ± 10 ka — beyond the limit of the archaeologically accepted time of arrival of modern humans into Australia from Southeast Asia (Prescott & Sherwood 1988; Sherwood et al. 1994). An electron spin resonance study of the shell (Goede 1989) and another TL analysis (Oyston 1996) suggested an even older age corresponding to the early LIG. In 2006 shell speciation and taphonomy were further investigated by Hannah Nair. The lack of water wear on the shells, their fragmented nature and the presence of charcoal and blackened stones, a fish otolith, and crustacean exoskeleton fragments further supported an interpretation that the site was a midden, although it was now recognised that the deposit could have either a human or seabird origin (Nair & Sherwood 2007).

The substantial midden evidence coupled with its potential great age provided a strong incentive to investigate the site more thoroughly to establish how it was formed and to repeat age determinations using techniques developed or refined in the 30 years since the initial work. In this series of six papers we report a suite of studies designed to investigate further the age and origin of the shell deposit. These papers detail stratigraphy, chronology, shell taphonomy, the evidence for fire and the origin of discoloured (blackened) stones, and archaeological excavation of a hearth-like feature. In order to place these studies in context the major conclusions of each study are summarised in this first paper along with recommendations for future research.

SITE DESCRIPTION

The Hopkins River enters the sea at the eastern edge of Warrnambool. On the western side of the river entrance is a cliffed headland over 12 m high and two seaward stacks (Figure 1: East and West Stacks). A scatter of marine shells, stones (some blackened) and sand occurs on the flat surface of West Stack. On the headland a 2–4 m wide bench at ~8 m above sea level sits at the same level as the West Stack surface and hosts similarly discoloured stones and two hearth-like (charcoal and burnt stone) features. Overlying the headland bench and partially burying it is a sand layer up to 2 m thick. Charcoal, marine shells and (rarely) discoloured stones are dispersed within this sand layer. The Aboriginal name for the headland area is Moyjil and it was called Point Ritchie by Europeans. We refer to the shell scatter on West Stack and the headland as the Moyjil site.

STRATIGRAPHY AND AGE OF THE DEPOSIT

Stratigraphic and geomorphic analysis of the cliff below the shell bed reveals at least four calcarenite/palaeosol couplets (units V, T, S and R: Carey et al. 2018, this volume) which we interpret as evidence of at least three interglacial sea-level highstands dating back possibly as much as 500 ka. At Moyjil, units T, S and R occupy a valley or swale in unit V. All have been planated to create the flat surface of West Stack and a headland cliff bench. The flat surface, designated Ground surface alpha (Gsα), supports the shell deposit of West Stack and, on the headland, discoloured stones and a calcarenite (unit Q2) containing isolated shells and charcoal fragments. Optically stimulated

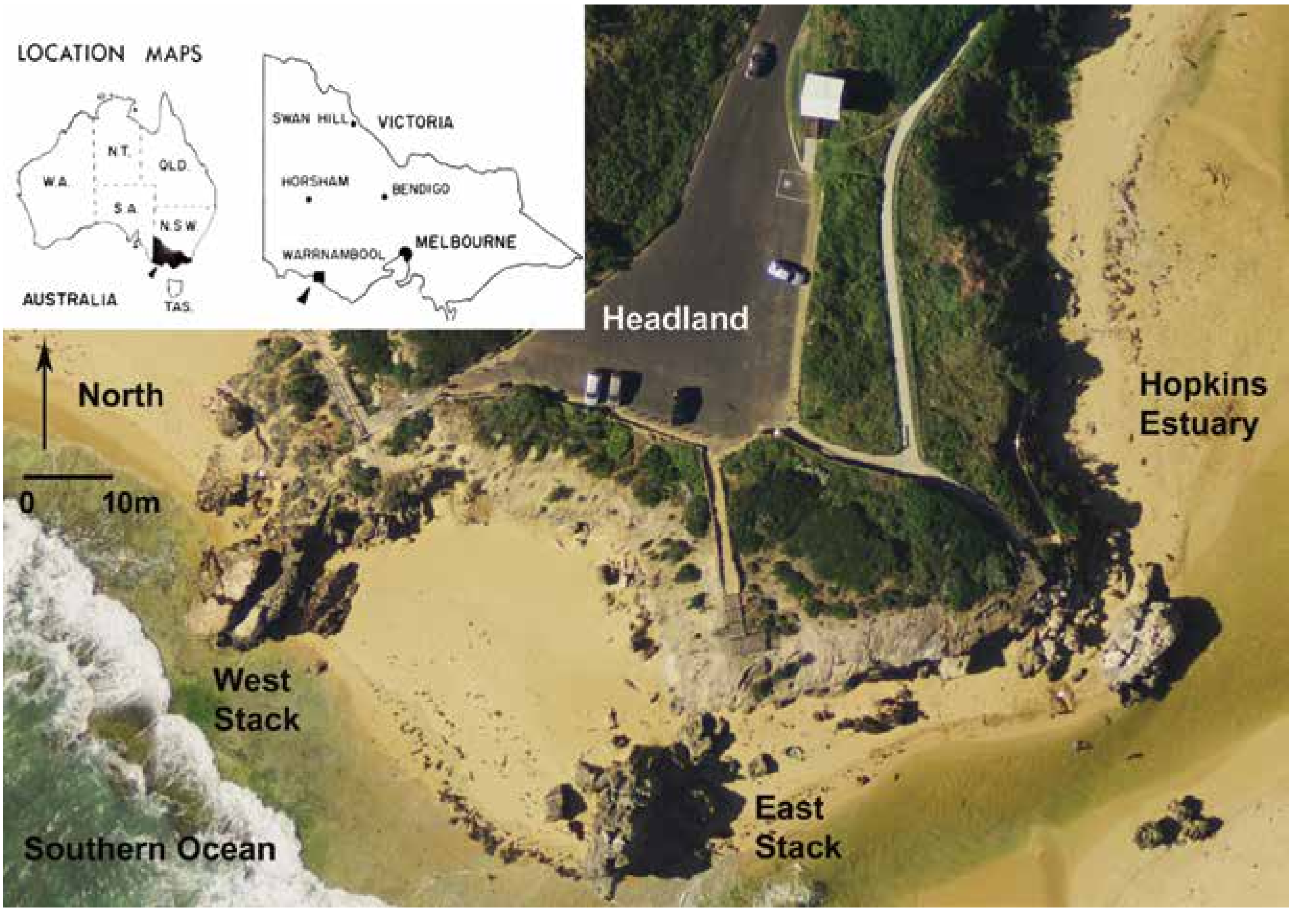

Figure 1: Cliffed headland on the west side of the Hopkins River mouth, Warrnambool. The Moyjil site occurs on the surface of West Stack and along the headland cliff.

luminescence (OSL) analysis yielded an age of 239 ± 17 ka for the unit R sand immediately below Gsα (Sherwood et al. 2018a, this volume) corresponding to a penultimate (Stage 7) highstand. Unit R is rather weakly cemented and its calcrete cap presumably prevented its removal by marine erosion during the LIG sea-level maximum (MIS stage 5e). Hearty et al. (2007) have reconstructed a sea-level history for stage 5e. For most of the period between 118 and 135 ka the sea stood at a level about 2–5 m above present. During this time visored notches were cut on West Stack, East Stack, a nearshore island and the cliff. Hearty et al. (2007) identified a brief interval of a few thousand years around 120 ka when sea level peaked at 6–9 m. Gill and Amin (1975) recognised a beach deposit at 7.5 m at Port Fairy, 20 km west of Warrnambool. At Moyjil a small shell-gravel deposit sits at 5.8–6.1 m on the ridge between West Stack and the headland. Both deposits may have formed during this peak sea level. In any case, sea at this level so close to the present cliff would have had a strong influence on the former cliff top. If sea level reached 8 m it would have overtopped West Stack and the cliff top and stripped them down to calcrete Rcp to form Gsα. There is evidence of this overtopping in the form of potholes on West Stack, and marine abrasion and potholes on two large fallen slabs (Blocks B and F) (Carey et al. 2018, this volume). Even a sea 1–2 m below the cliff top would have created a hostile environment for sediment accumulation and plant growth on its surface.

It is on this bare surface of Gsα that we believe shell accumulation commenced, accompanied by accumulation of blackened stones. OSL of the sand (unit Q2) which buried Gsα reveals a complex history of deposition. Quartz grains in the largely calcareous sand show a broad overdispersion (Sherwood et al. 2018a, this volume). Modelling of this overdispersion using a three-component finite mixing model indicates most of the sand is of LIG age, consistent with the stratigraphic interpretation. There is a significant component of older sand (from Stage 7) suggesting incorporation of this sand as a consequence of mixing from below (bioturbation?) or by mass movement from an upslope source. A younger component of unit Q2 sand (50–60 ka) is believed to represent the time at which a soil calcrete developing on unit Q2 (unit Q2cs) achieved closure, sealing the sand from further turbation.

Re-determination of the amino acid ratios of *Lunella undulata* syn. *Turbo undulatus* shells from unit Q2, as well as first-time determinations for three storm-beach deposits from notches on East Stack and West Stack, confirm they belong to the same LIG aminozone, consistent with the OSL analysis (Sherwood et al. 2018a, this volume).

The West Stack molluscan fauna provides additional evidence of a LIG age. Within the shell assemblage there is a single embedded specimen of *Lunella torquata* syn. *Turbo torquatus*, a warm-water species not found in Holocene shell beds or along the present coast (Nair & Sherwood 2007). Valentine (1965) regarded this species as an index fossil for the LIG in south-west Victoria.

The results derived from the dating techniques are consistent with the stratigraphy. From stratigraphic considerations (Carey et al. 2018, this volume), the most likely time of deposition of unit Q2 is after retreat of the sea from its Stage 5e maximum (i.e. post- ~120 ka; Hearty et al. 2007). Neither OSL nor AAR are able to refine this estimate — in the case of OSL overdispersion precludes sufficient temporal resolution and AAR ratios show a large range even for shells within the same deposit. A retreating sea resulted in dune formation and burial of Gsα with its blackened stones and, on West Stack at least, shells.

One other event is captured by the shell and stone arrangements on West Stack. This is identified as a major disturbance event (called by us the Z event) which shattered calcrete and transported shells and stones (some of the latter discoloured) in a matrix of pinkish sand and mud across Gsα. On West Stack this mixture moved as a debris flow southwards across to and into pothole-like depressions. Crude sorting left coarser stones on the northern part of the stack. On the headland similar sand and mud forms the basal component of unit Q2. The Z event disrupted the assemblage of stones and shell but did not mark the end of shell accumulation (Carey et al. 2018, this volume).

ORIGIN OF MARINE SHELLS

Marine shells occur on Gsα at an elevation of 8.0–8.4 m Australian Height Datum (AHD) on West Stack, and up to 9.5–10 m AHD in the headland's unit Q2 sands. There are few whole shells. Fragments show sharp edges and an absence of water rounding. Their difference from shells of similar age within the LIG storm beach deposits was noted by early investigators (Prescott & Sherwood 1988). Nair and Sherwood (2007) suggested that the Moyjil deposits could be attributed to either humans or animals such as seabirds known to create shell middens. Pacific Gull (*Larus pacificus*) middens resemble the shell deposit on West Stack. Examples in South Australia are dominated by *Lunella undulata* syn. *Turbo undulatus* though molluscs such as abalone and crustacean exoskeleton fragments also occur (Sherwood et al. 2016). Taphonomic analysis of *Lunella* opercula also showed gulls are selective, preferring larger shellfish. Pacific Gulls forage for shellfish and crustaceans on rocky shores at low tide and drop their prey onto rocky surfaces (anvil rocks) to break shells to access the flesh. The process of shell breakage creates sharp-edged fragments and opercula with rim damage mainly concentrated on the edge originally closest to the mollusc's outside body whorl. This is the location where anvil impact damage mostly occurs (Sherwood et al. 2016).

Holocene Aboriginal middens near rocky shores in western Victoria are also commonly dominated by *Lunella undulata* syn. *Turbo undulatus*. Comparison of Aboriginal middens with those of Pacific Gulls shows that people do not display the same degree of size selectivity, with Aboriginal middens frequently containing smaller individuals and smaller species such as *Cominella lineolata* and *Bembicium nanum*. Aboriginal middens also tend to exhibit a much higher proportion of opercula with undamaged rims due to the particular way the shells are broken open with a hammerstone. However, the location of damage on impacted rims, when it occurs, is similar to that of opercula from Pacific Gull middens (Sherwood et al. 2016; Sherwood et al. 2018b, this volume).

There is no significant difference ($P>0.050$) between the West Stack *in situ* (embedded) opercula population and a Moyjil late Holocene Aboriginal midden and two Pacific Gull middens at Point Avoid and Golden Island Lookout in South Australia. The *in situ* population is, however, highly significantly different (i.e. $P<0.01$) from the Cape Duquesne (Victoria) early Holocene Aboriginal midden population. The West Stack population of loose (not *in situ*) opercula is at least highly significantly different ($P<0.01$) from all others except for that of the Golden Island Lookout seabird midden, from which it is not significantly different ($P>0.05$). These and other observations (presence of smaller shellfish species, presence of smaller *L. undulata* individuals, and limited areal distribution of shells) do not allow a confident assignment of the midden deposit to the singular agency of either humans or Pacific Gulls (Sherwood et al. 2018b, this volume).

FIRE EVIDENCE

Presence of fire

Evidence of fire at Moyjil is indicated by the presence of charcoal and implied by the presence of darkened (possibly burnt) stones. Charcoal is preserved as macroscopic pieces (often 1 cm^3 or larger) in lensoidal or horizontal clusters within unit Q2 (Nair & Sherwood 2007). On Gsα, darkened stones show blackening to varying degrees. Some reveal darkened surfaces and when broken show a gradational colour change with depth into the stone. There is a general correspondence between stone size and colour such that larger stones are pale or partially darkened and smaller stones are dark throughout (Bowler et al. 2018, this volume).

Experimental heating of white calcrete in a wood-fuelled campfire of modest size resulted in the calcrete's fragmentation and darkening. After 30–60 minutes the smaller fragments were darkened throughout. Similar results for limestone are reported by other workers (e.g. Gonzales-Gomez et al. 2015).

Magnetic susceptibility (MS) measurements of calcrete samples also show a correlation with stone size and colour (Bowler et al. 2018, this volume). Larger, pale stones have lower MS compared to small dark calcrete stones. Thermal effects on MS due to fire are known (Oldfield & Crowther 2007; Herries & Fisher 2010) and have been ascribed to mineralogical changes in iron-bearing rocks at the temperatures reached during combustion (>700°C — Gonzales-Gomez et al. 2015). Blackening of limestone has been attributed to other circumstances (Miller et al. 2013). Anaerobic deposition of iron minerals during calcrete formation by fungal activity can produce dark rocks with higher magnetic susceptibility. A possible example of such deposition occurs within the palaeosol of unit T in the form of large numbers of small (1–3 cm diameter) sub-angular pebbles quite different in appearance from the stones on Gsα. At Moyjil no occurrence of black calcrete that could serve as a source for the stones on Gsα has been identified.

In order to test further whether the darkening of the calcrete stones could be attributed to heating, three dark stones from the surface of Gsα were subjected to TL analysis (Bowler et al. 2018, this volume). The LIG ages obtained for these stones (93–143 ka), the same as the surface on which they lay, strongly suggest their TL had been reset by heating (i.e. we interpret the TL findings as being due to heating of older calcrete during the LIG).

Controlled use of fire

At Moyjil Bowler observed two apparent fireplaces that he designated Fp1 and Fp2. The first of these was on Gsα embedded within basal sands of unit Q2. It was excavated archaeologically under cultural heritage permit 12/006690 (McNiven et al. 2018, this volume). The second occurs within unit Q2 approximately 50 m east of Fp1 and remains unexcavated.

Fp1, designated Charcoal and Burnt Stone Feature #1 (CBS1) by McNiven et al. (2018, this volume), occupies a roughly circular depression in Gsα. Within the depression is a dark sand containing charcoal and blackened stones, some fractured with pieces still in jigsaw fit. A large flat calcrete stone at the top of CBS1 has a *terra rossa* pebble cemented to its surface. A small piece of similar *terra rossa* is immediately adjacent to the pebble, suggesting thermal spalling (Bowler et al. 2018, this volume).

McNiven et al. (2018, this volume) use a wide range of criteria to test for human versus natural (e.g. bushfire) processes behind the origin of CBS1. Critically, microscopic examination of a sample of 30 charcoal fragments excavated from the feature identified half

(N=16) as possibly to definitely derived from roots. Two charcoal fragments featured minute root hairs suggesting they had been little disturbed during combustion (i.e. *in situ* burning within CBS1). Nearly all identified root specimens appeared to belong to the same taxon. The small sample size did not allow confident conclusions about whether the charcoal originated from *in situ* burning of roots or from root wood brought to CBS1 (McNiven et al. 2018, this volume).

Blackening of calcrete as observed requires its exposure to high temperatures for relatively long periods (>30 minutes at >700°C). Such conditions are unlikely in a wildfire, particularly as heath vegetation was the likely fuel. Terrestrial snails within unit Q2 are found in drier coastal woodland or heath environments (Nair & Sherwood 2007; McNiven et al. 2018, this volume) and rhizomorphs found within unit Q2 are of a diameter (<1–2 cm) suggestive of a shrub rather than a tree community. In addition, the well-developed calcrete Rcp which covers the cliff top would severely hinder root penetration by large trees. We believe the present coastal heathland resembles that existing in the area at the time CBS1 was created. It is also possible that Gsα was a bare stone pavement following the retreat of the LIG sea. Under a heath vegetation or bare stone environment fracturing and/or blackening of stones by wildfire is unlikely (Bowler et al. 2018, this volume; McNiven et al. 2018, this volume).

AN EVALUATION OF THE ARGUMENTS

The unusual shell deposit at Moyjil has been subjected to a degree of scrutiny rare if not unprecedented in Australian archaeology. Its age is now assigned with confidence to the LIG — well beyond the currently accepted ages of the oldest known human sites in Australia and New Guinea (i.e. 45–65 ka; e.g. O'Connell & Allen 2015; Clarkson et al. 2017). For this reason the present researchers have strived to rigorously test the hypothesis of a human origin for the site.

The *L. undulata* shell opercula show clear evidence of size selection and we believe the deposit can be confidently labelled a midden. Whether humans or seabirds were responsible cannot be established confidently from the available evidence. Some features such as the presence of small shellfish species and small *L. undulata* individuals and the topographically limited area of the scatter are not expected in a seabird midden. Against this, the size distribution of *L. undulata* opercula is more similar to that of modern seabird middens than Holocene Aboriginal middens (Sherwood et al. 2018b, this volume).

The fire evidence, including the TL of dark stones, and particularly the evidence of *in situ* fire in CBS1 (and possibly Fp2) is similarly equivocal in terms of human versus natural agency. These combustion features are certainly not part of a seabird midden. Evidence for burnt-root charcoal, especially *in situ* burnt-root charcoal, is consistent with a feature of natural origin. Yet vegetation at the time of shell accumulation was most likely coastal heath with a low wood fuel load unlikely to be capable of creating the intense heat necessary to fracture and blacken stones.

The weight that the reader gives to the various pieces of evidence presented in the following papers will depend on individual knowledge and experience. Within our own research group the extent to which available evidence is currently considered supportive of the human agency hypothesis ranges from 'weak' (McNiven) to 'strong' (Bowler). Importantly, and despite these differences, we all agree that available evidence fails to demonstrate conclusively that the site is of natural origin. A human site of Last Interglacial age (~120 ka) in southern Australia would be of international significance because of its implications for the movement of modern humans out of Africa. We accept that, as a result, the requirement for a high level of confidence in the evidential basis of human agency is necessary. While many may consider the presence of stone artefacts as a minimum for demonstrating human agency, we note that many Aboriginal coastal shell middens in south-eastern Australia do not contain such materials (McNiven et al. 2018, this volume).

The six papers in this volume present the results of the latest phase of long-running research into the potential human origins of the Moyjil site. The degree of uncertainty of our conclusions, coupled with the potential national and international cultural significance of the site, call for another phase of research at Moyjil employing a range of new techniques that will allow better differentiation between human and natural processes of site formation. This work could include further research on differentiating between human and bird middens (Sherwood et al. 2018b, this volume), differentiating between human and natural combustion features (McNiven et al. 2018, this volume), and differentiating between calcrete stones blackened by burning versus other known processes such as mineralisation and organic impregnation (Bowler et al. 2018, this volume). At the very least, Fp2 needs to be excavated archaeologically and analysed using a battery of chemical and micromorphological techniques (Bowler et al. 2018, this volume; McNiven et al. 2018, this volume).

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