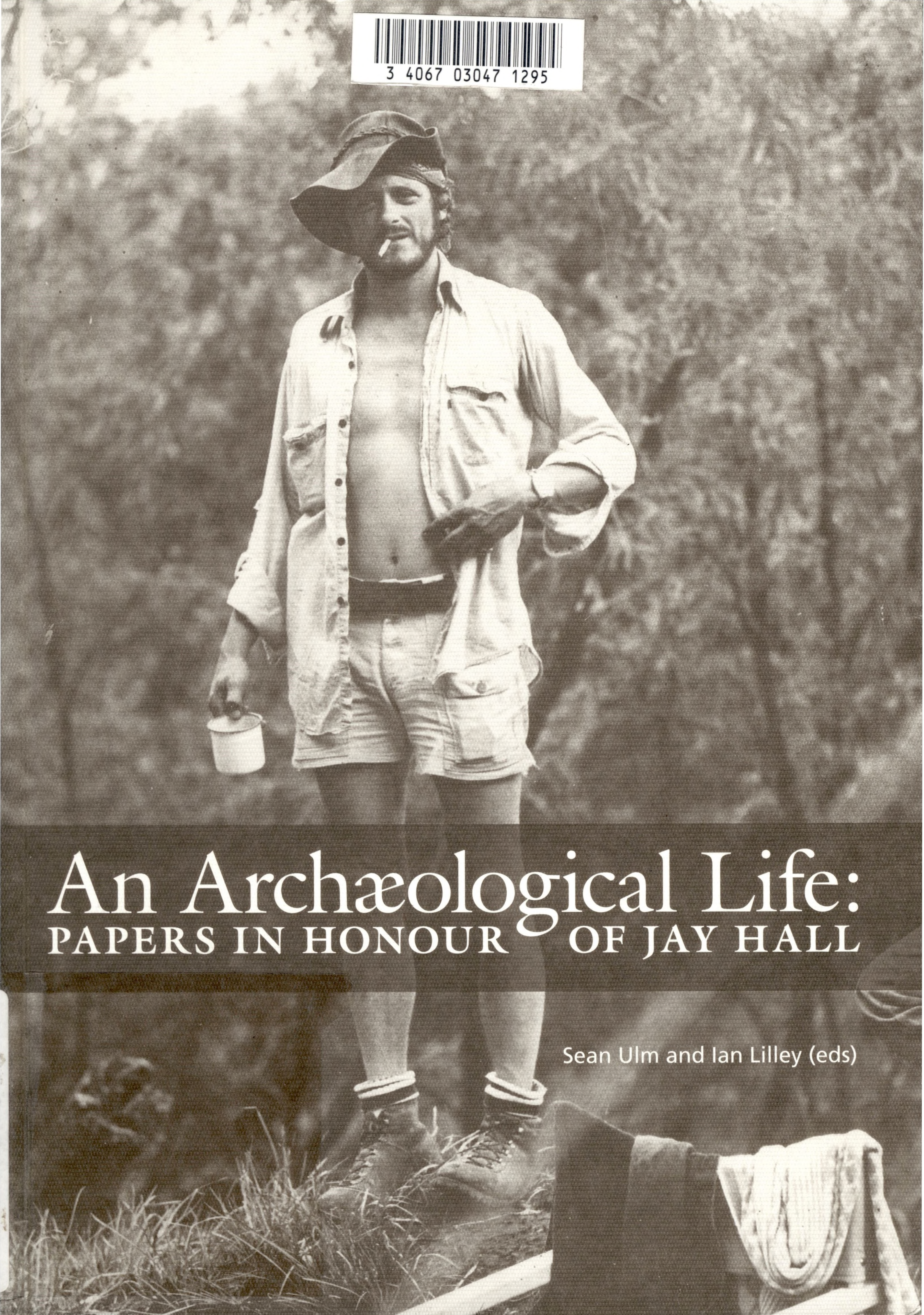

An Archæological Life:
PAPERS IN HONOUR OF JAY HALL

Sean Ulm and Ian Lilley (eds)

In 2007 Associate Professor Jay Hall retires from the University of Queensland after more than 30 years of service to the Australian archaeological community.

Jay's arrival in Australia in June 1976 to begin the archaeology programme in the Department of Anthropology and Sociology at the University of Queensland marked two important events in the history of archaeology in this country. Firstly it provided a local focus for archaeology north of the Tweed River, thus continuing to expand the discipline beyond the dominant Sydney-Canberra axis. Secondly Jay was an important addition to the tiny number of American-trained archaeologists practising in Australia at that time. Indeed, because of Jay's fundamental role in developing the archaeology teaching at UQ, that school became and has remained the most 'American' among Australian archaeology departments in its philosophy and methodology. This, and the four field approach used in UQ, in turn produced several generations of scholars who continue to influence archaeological thinking in this country and beyond. Celebrated as a gifted teacher and a pioneer of Queensland archaeology, Jay leaves a rich legacy of scholarship and achievement across a wide range of archaeological endeavours.

This volume brings together past and present students, colleagues and friends to celebrate Jay's contributions, influences and interests.

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Aboriginal and Torres Strait Islander Studies Unit
The University of Queensland
Brisbane

Front Cover: Jay at Platypus Rockshelter, 1977 (Photograph: Rae Sheridan).

Back Cover: Jay fondling a stone artefact (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1151).

Frontispiece (p.ii): Jay examining bone points at Platypus Rockshelter, July 1981 (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1148).

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Preface

The editors discussed the idea of this festschrift over many years and many glasses of red wine around campfires, in pubs and at social gatherings. We often talked about Jay's impact on archaeology, applied as well as academic, clear in the range of publications and reports that are listed at the end of the volume. We mused, too, about the way that many of Jay's former students, in particular, had gone out onto the archaeological landscape branded with a particular UQ-style of archaeology. We wanted to explore where some of these journeys had ended up through contributions to this volume. The 20 contributions and 31 contributors included in the volume capture some of those journeys in a range of studies ranging from considerations of ritual agency on the Mayan periphery and social interaction in the remote Pacific to reduction sequences in central Australia and bodies under football stadiums.

When Jay announced his impending retirement for mid-2007 we implemented our idea to ask former students and colleagues to contribute to this volume, only to have it come together in the final two months before the official celebrations to mark Jay's retirement on 29 September 2006 ('Jay Day'). For making this project possible we owe a great deal of thanks to the contributors for putting up with our (often unreasonable) demands to turn things around to keep the volume on track. Thanks to all. In particular we thank other members of the 'Jay Day' organising committee – Tam Smith, Jon Prangnell and Gail Robertson – for their support.

Publication of this volume has been made possible through the support of the Aboriginal and Torres Strait Islander Studies Unit at the University of Queensland. We thank Michael Williams for supporting this project from its genesis around the campfire in his country.

For help with tracking down and supplying photographs we thank Jim Allen (La Trobe University), Bryce Barker (University of Southern Queensland), Diana Lilley (Office of Marketing and Communications, University of Queensland), David Madsen (University of Texas), Ian McNiven (Monash University), Rae Sheridan, Renae Weder (Utah Division of State History) and the Department of Anthropology, University of Utah.

For refereeing manuscripts, we thank Bryce Barker, Wendy Beck, Chris Clarkson, Maria Cotter, Daniel Cummins, Judith Field, Richard Fullagar, Peter Grave, Geraldine Mate, Carney Matheson, Ian McNiven, Reagan Moore, Karen Murphy, Stephen Nichols, Dolores Piperno, Jon Prangnell, Jill Reid, Gail Robertson, Richard Robins, Annie Ross, Mike Rowland, Mike Smith, Tam Smith, René Viel and Catherine Westcott.

Antje Noll worked tirelessly to track down obscure references and redraw many of the figures which appear in this volume, the latter task assisted by Nathan Woolford. Jill Reid gave up yet more weekends to help bring yet another long project to completion in the last panicked months. Jill, Antje and Geraldine Mate also proof read parts of the completed manuscript. Jon Prangnell and Tam Smith (University of Queensland Archaeological Services Unit) and Mike Rowland and Karen Murphy (Department of Natural Resources, Mines and Water) cross-checked lists of unpublished reports.

Sean Ulm and Ian Lilley
September 2006

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Jay Hall – From Scatology to Eschatology

Jim Allen

> *I'd like to go back to San Jacinto drainage now and stratify it by natural environmental zones. I'd either survey it all, or I'd sample it by transects or small quadrats. On each site I'd do a controlled surface pickup. And I'd use a Brainerd-Robinson matrix or Pearson's r to define groups of related sites sharing lots of design elements. I'd construct a site typology: towns, villages, hamlets, camps. I'd test one site of each type, the shallow ones by random quadrats and the deep ones by transects. Each site would be excavated by natural levels, and I'd use house floors, storage pits, activity areas, and so on as my units of collection. We'd sample a series of houses for tools, seeds, pollen, and bones, and set up a contingency table to compare them; search for craft areas, to get a handle on specialization and divisions of labour; get age, sex, and burial association on every skeleton, and the context of every ritual item. We'd quantify the data on traded goods, and study the context to see what mechanisms were moving it. A catchment analysis would be performed on each site, using chi-square to see which environmental factors were being selected for. Each level of the hierarchy would be studied by nearest-neighbor method to see what the spacing was, and changes in the pattern over time would be studied with a Markov model to see if we could detect any of the rules.*
>
> The skeptical graduate student in *The Early Mesoamerican Village* (Flannery 1976:372).

I first met Jay at the 1978 Kioloa conference that led to the first Australian Archaeological Association meeting at Falls Creek the following year. He was not presenting a paper himself but I became aware of him from comments he made during the first morning session. I knew he had been appointed to the University of Queensland (UQ) a couple of years earlier and asked Rhys Jones what he did. 'He studies old shit.' 'Don't we all?' I asked. 'No,' said Rhys, 'he studies old SHIT; he's a palaeoscatologist.' Whether it was this exotic specialism or his propensity to sit up late arguing archaeology or his generosity with the Jim Beam (Figure 1), Jay was immediately part of the small but growing coterie of professional archaeologists in Australia.

Figure 1. Jay and Jim at the 1978 Kiola conference (Photograph: Jim Allen).

Jay's arrival in Australia in June 1976 to begin the archaeology programme in the Department of Anthropology and Sociology at UQ (in this paper I ignore a number of generic departmental name changes over the years and use only this designation) marked two important events in the history of archaeology in this country. Firstly it provided a local focus for archaeology north of the Tweed River, thus continuing to expand the discipline beyond the dominant Sydney-Canberra axis (of 62 listed participants at Kioloa only 11 were not from Sydney or Canberra (Johnson 1980)). Secondly Jay was an important addition to the tiny number of American-trained archaeologists practising in Australia at that time (only Dan Witter, Paul Ossa and Jim O'Connell immediately spring to my mind) and he provided a significant check to the influence of what was then called the 'Cambridge connection', an argued dominance of Cambridge-trained archaeologists working in Australia (Murray and White 1981, 1982; cf. Allen and Jones 1983). Indeed, because of Jay's fundamental role in developing the archaeology teaching at UQ, that school became and remained the most 'American' among Australian archaeology departments in its philosophy and methodology. This, and the four field approach used at UQ in turn produced several generations of scholars who continue to influence archaeological thinking in this country. Perhaps most interesting is that few of these became strict processualists (Sean Ulm: *'Jay's students continue to transgress all sorts of traditional disciplinary boundaries and hold amazingly divergent views, often about the same things'*).

Scatological Studies

Jay was born in Maidenhead in the United Kingdom in February 1944, and spent much of his childhood in New Zealand, but did his undergraduate degree at the University of Utah (Figure 2). He toyed with psychology but settled on archaeology, later explaining his choice simply as 'man ain't rat'. He graduated *magna cum laude* in 1970, having written a thesis on the recovery of parasite ova from Great Basin coprolites (or palaeofaeces, as he called the non-silicified forms). He married Alice in the same year. In those days he was Henry Johnson but a friend in Price, Utah, called him H.J. By the time he reached Australia it had shortened to Jay (he still gets John in some places). Jay stayed at the University of Utah and completed an MA in 1972, studying diet and diseases represented in coprolites from the eastern Utah early Fremont site of Clyde's Cavern. Jay's archaeological career in Utah was shaped by the irascible Jesse Jennings, who greatly influenced his archaeological style and ideas. Jay still refers to him affectionately as 'that old curmudgeon'.

Figure 2. Bear River, Utah, c.1970. Back row (L-R): Hamilton Benson IV, Jim Zeidler, Jim Adovasio and Richard Allen. Front row (L-R): Bobby Lee Hosa and Jay (Photograph: Department of Anthropology, University of Utah).

Figure 3. David Rhode and Jay keep on an eye on the backhoe operator removing backdirt from the mouth of Danger Cave, western Utah, USA, 1986 (Photograph: David Madsen).

Jay moved to the University of Chicago to do his PhD, with Leslie G. Freeman, writing a thesis on coprolite samples from the Anasazi pueblo called Antelope House, in the Canyon de Chelly in Arizona (the degree was completed in 1979; 1970s students at UQ recount how he was seldom seen at social functions before his doctoral testamur was paraded one evening in the university staff club, then the social transformation occurred). During his time as a graduate student in Chicago, Jay achieved some notoriety by taking on the French archaeological establishment. Henry de Lumley had claimed that more than 400 human coprolites at the 400,000 year old Terra Amata site in southern France contained pollen grains that indicated seasonal use of the site in spring. Some coprolite experts doubted these claims and samples were sent to Jay and his Youngstown colleague Gary Fry. With the certainty and directness of Kent Flannery's skeptical graduate student, Jay pronounced, 'There is absolutely nothing about these specimens that suggests that they are fossilized excrement', a dismissal that became a quotable quote (e.g. Trevor-Deutsch and Bryant 1978; Tyldesley and Bahn 1983).

Although initiating archaeology courses in the University of Queensland was an important change in direction for Jay, by 1980 he reported that he had put together the 'makings of a coprolite laboratory' on campus (Hall 1980:84) and that while continuing to analyse samples from California he was now working on coprolites from Ken's Cave in Queensland and Devil's Lair from Western Australia, as well as sites in the Solomon Islands.

In 1980 Jay became a visitor in the Prehistory Department in the Research School of Pacific Studies at the Australian National University (ANU), invited by Rhys Jones to analyse 22 supposed human palaeofaeces from the enclosed chamber of the south cave at Rocky Cape. In the event they turned out to be scats from *Sarcophilus harrisii*, the Tasmanian Devil (Hall and Jones 1990). An interesting outcome was that it could be argued that since the devils were preying on human food scraps in the cave, Jones' (1971:589) original prediction that these palaeofaeces could shed light on ancient human diet remained valid, even though the immediate samples were now demonstrated to be non-human in origin.

During the 1980s, although he published a few more papers on palaeoscatology, wider teaching and research responsibilities gradually separated Jay from such specialist studies. But not entirely. In 1980 Jay had examined dog coprolite samples that had been previously prepared by an Auckland MA student.

The samples were from Kohika, a late Maori lake village in New Zealand's Bay of Plenty. A brief report by Jay was included as an appendix in the student's thesis (Williams 1980). More recently he was able to update this work and report the identification of parasite eggs in these coprolites, in a fascinating chapter that demonstrates the ways in which palaeoscatology can inform of prehistoric human diet, site environment, health, seasonality and even chronology. The Kohika coprolites could be shown to be prehistoric because they lacked what are now abundant and widely dispersed pollens from *Pinus* and the narrow-leaved plantain, both European introductions (Irwin *et al*. 2004).

Jay also continued to work in Utah throughout the 1980s, including undertaking excavations with David Madsen at the important site of Danger Cave (Figure 3).

Finally, it would be remiss of me not to point out that Jay's association with palaeoscatology has been the source of endless humour over the years. It was Jay himself who noted that the identification of the Tasmanian Devil as the progenitor of the Rocky Cape scats was the product of exhaustive elimination. But my own favourite concerns Jay's 1980 sojourn in Canberra. Wal Ambrose was building his house at Garran at the time and someone found a cement extrusion from a broken three-hole brick. Rounded at one end and tapered at the other, in size and shape it was the perfect replica of a human faeces. The existence of this 'coprolite' was brought up in conversation at morning tea and Jay immediately expressed interest in seeing it. Put in a plastic bag with a fictitious site, square and layer designation, it was produced at lunch time. At afternoon tea Jay admitted defeat. 'I can't understand it,' Jay said, 'it looks like the person ate nothing but sand.'

Inevitably in the early 1990s when the pop song *Scatman* was high on the charts Jay inherited the epithet from his undergraduates. Despite its appalling lack of metre or rhyme or evident intelligence, some ex-students from that time can still remember the verse:

> I hear you all ask 'bout the meaning of scat.
> Well I'm the professor and all I can tell you is
> While you're still sleepin' the saints are still weepin' cause
> Things you call dead haven't yet had the chance to be born.
> I'm the Scatman (Scatman John 1995).

Queensland, Teaching and the Moreton Region Archaeological Project

Jay was an undergraduate when the Binfords' influential *New Perspectives in Archaeology* was published in 1968. He thus arrived in Australia as a true disciple of the New Archaeology. While to me Jay has remained an unapologetic processualist throughout his professional career, in conversations others have pointed to Jay's increasing readiness in the last decade or two to embrace social explanations. For example, people cite discussions of social fissioning and dolphin commensualism around Moreton Bay (Hall 1999, Hall 2000; Ulm and Hall 1996). In disagreeing I would note simply Jay's own explanation about fissioning. Bowen (1989) had argued that increasing population density on Stradbroke Island resulted in social tensions that led to fissioning – a truly social explanation. Jay (Hall 2000:211) preferred to explain it processually, and even cited Binford to do it: 'adaptation is always a local problem, and selective pressures favoring new cultural forms result from non-equilibrium conditions in the local ecosystem' (Binford 1972:431). For Jay 'the 'Ngugi' simply moved to familiar and relatively vacant land [on Moreton Island] and settled permanently' (Hall 2000:211). Such a move inferred a previous adaptive shift to intensifying marine resource production. Whether or not social tensions were involved was not the important point, for the same reasons as Gordon Childe eschewed religious explanations of past behaviour – they were not encapsulated in the archaeological record. Equally, Jay's appeal to dolphin commensualism was not an idle hypothesis but one based on local ecology and Moreton Bay dolphin behaviour. As Binford had stressed, Jay's interpretation emphasised a local solution to a local problem and one restricted to Moreton and Stradbroke Islands for clear ecological reasons.

Whatever the merits of this debate, processualism was the intellectual background with which Jay moved easily into the Department of Anthropology and Sociology, where linguist Bruce Rigsby had been appointed to the Chair of Anthropology the year before. His colleagues then included the Australian anthropologist Malcolm Calley, anthropological theorist Peter Koepping and ethnologist Peter Lauer.

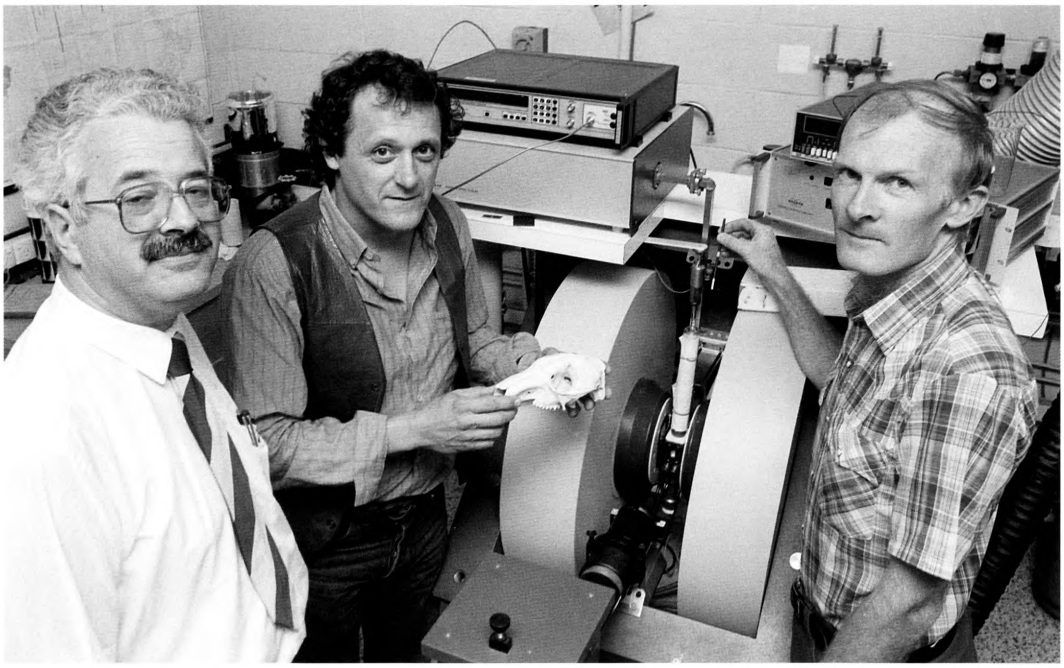

Figure 4. Electron spin resonance (ESR) analysis, May 1988. L-R: Peter Pomery, Jay and David Hunter (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1153).

Jay's responsibility was to develop the archaeology courses. Armed with Phil Phillips' 1955 adage, 'new world archaeology is anthropology or it is nothing', and a copy of Marvin Harris' (1975) *Culture, People, Nature: An Introduction to General Anthropology*, the four field system in UQ suited Jay's philosophy and style. Undergraduates started with a year of general anthropology before specialising in archaeology. The emphasis was on method and practice, and Honours students were encouraged to do laboratory and fieldwork theses over library theses. After 18 months student numbers warranted expansion and Mike Rowland began as a tutor in 1978; shortly after Ian Johnson was appointed as postdoctoral fellow where he introduced students to that brand new research tool, the computer. Jay's hand could be seen in both appointments. In 1983 he initiated courses in biological anthropology, taught by himself and Leonn Satterthwait, who had joined the department in 1981.

Jay's gift as a teacher has been his ability to direct his students into situations where they would learn for themselves. He would take any topical issue and have the students dissect the problem, consider the methodologies and data involved and recombine them to create new understandings (Sean Ulm: '*Jay always steered me to the right questions to ask without telling me the answers, or perhaps even knowing the answers*').

Jay embraced a commitment to building and maintaining a strong department that has continued for 30 years and is as undiminished now as when he started. With his philosophy of archaeology and his own interest in scatology Jay maintained an agenda to develop specialised studies and archaeological science, such as the work on starch grains with Su Davies and Richard Fullagar and his strong support for Tom Loy's residue analyses (Figure 4). This has continued most recently to the appointments of Marshall Weisler and Andy Fairbairn to the academic staff and Chris Clarkson, Carol Lentfer and Jenny Khan to postdoctoral fellowships. But ultimately the important part of these projects and appointments for Jay was passing these skills on to his students and exposing them to the breadth of archaeological science.

Paradoxically, these sorts of research directions continued to separate archaeology at UQ (and elsewhere) from other areas of anthropology. This, coupled with the philosophical and financial constraints that have plagued Australian universities in the last two decades have seen the four field system diminish and Jay has reluctantly contributed to this weakening in his endeavours to shore up archaeological teaching at UQ. While intellectually discomforted by these events and his participation in them, he leaves archaeology at UQ amongst the strongest and healthiest centres for teaching the discipline in Australia.

Jay and I always shared the view that the best way to teach archaeology was to do it. During 1976 he established an informal group of undergraduates, grandiosely named them the Brisbane Archaeological

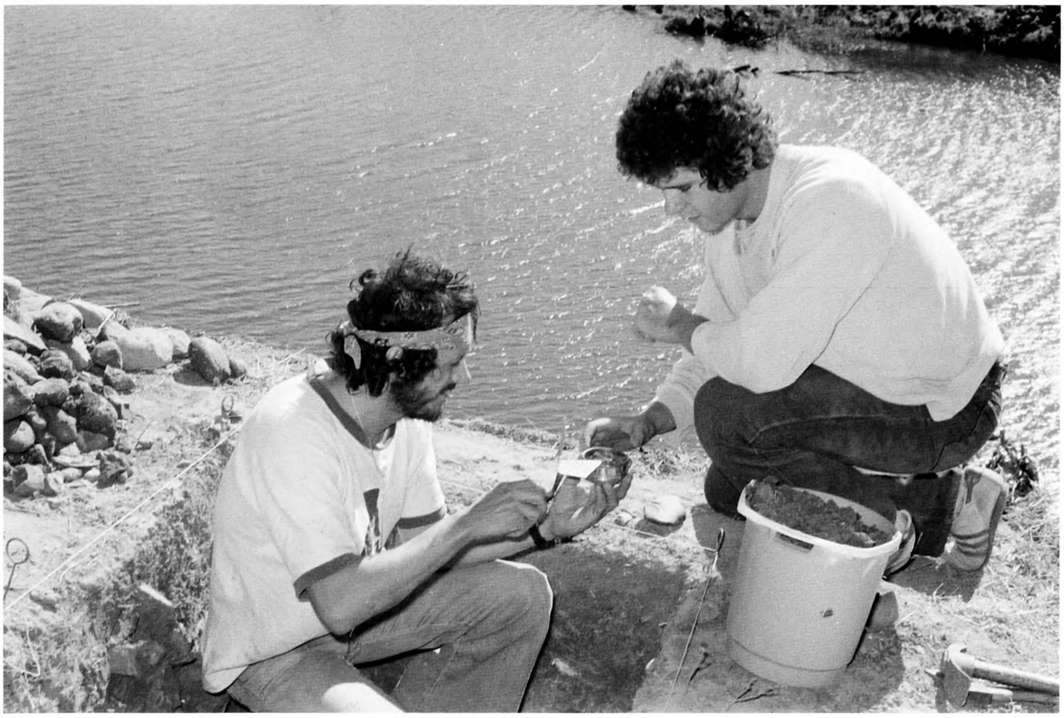

Figure 5. Jay and Ian McNiven undertaking salvage excavations at Platypus Rockshelter, July 1981 (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1147).

Research Group (BARG) and dispatched them to dredge up information – archaeological, environmental, historical and anthropological – that could contribute to a prehistory of the Brisbane region. Every few weeks they would meet at Jay's house to compare notes and drink beer. They discovered that the region had a rich Aboriginal history and a high archaeological potential that was rapidly being threatened by development. Jay claimed this exercise was determined by the meagre availability of research funds and justified it with the Jennings quote that 'archaeology begins in your own backyard' (Hall 1988:2) (Ian Lilley insists that more frequently it was *'archaeology, like charity, begins at home'*). But by mid-1977 BARG had segued into MRAP (Moreton Region Archaeological Project) and with hindsight one can see how Jay's processualism and its appeal to scientific method and hypothesis testing directed him towards defining prehistoric settlement patterns and land-use within the Moreton Region.

Arguably MRAP has been Jay's single most significant contribution to Queensland archaeology and the teaching of archaeology in UQ. It started with a simple but patterned set of aims: to *systematically* locate and record sites and collect data in order to develop a cultural chronology. This in turn would allow the reconstruction of cultural patterning, particularly in subsistence and settlement systems which would lead to the use of these results to address current problems. Three gross environmental zones – offshore islands, the coastal strip known as 'wallum' and the subcoastal zone up to the eastern escarpment – were defined on the bases of biogeography and ethnohistory, but archaeological research within them also depended on logistics and the priorities of salvage. This was 'real world' archaeology where sites for excavation were chosen as much on the imminent threats of sand mining, dam building or airport construction as for the most logical archaeological questions that should be being asked. By mid-1979 the project had its first ARGS funding and by 1980, less than four years after Jay's first archaeology lecture, he could report two completed BA Honours (Draper and Lilley) and the start of two MAs (Lilley and Robins) and three BA Honours (Donoghue, Richardson and Walters). By 1987 Jay could boast the recording of more than 1000 sites in the Moreton Region and the excavation of about 40 of these.

While one of these sites, Wallen Wallen Creek, had been occupied more or less continuously for 20,000 years, no other dated site was older than c.6000 years. Ian McNiven makes the point that at this time schools of archaeology elsewhere in the country would not have undertaken such an intensive examination of mainly late Holocene shell middens; that this was a product of Jay's theoretical armoury. MRAP achieved what it set out to do. It was set up to challenge and counter what was known as 'cowboy'

Figure 6. Jay and students sieving at Platypus Rockshelter, July 1981 (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1145).

Figure 7. The crew from the 1988 excavation season at Bushranger's Cave. Back row (L-R): Bryce Barker, Kathy Frankland, Ian McNiven, Su Davies, Paul McInnes, Fiona Mowatt, Peter Hiscock, Scott Mitchell and Jay. Front row (L-R): Jim Smith and Greg Bowen (Photograph: Bryce Barker).

Figure 8. Jay picks a bone at Platypus Rockshelter, July 1981 (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1148).

archaeology, the sometimes serendipitous exploration of Australian archaeology that had especially characterised the discipline in the 1960s and early 1970s. Importantly, Jay did not set out to replace Australian culture history and functionalism with processualism. In MRAP Jay used all three to begin forging a more distinctive Australian archaeology.

And of course, Jay was at the coal face. With students he began excavating the late Holocene site of Platypus Rockshelter in 1977, an excavation that continued seasonally until 1981 (Figures 5-6, 8). The site was eventually drowned by the Wivenhoe Dam in 1985. As well as substantial papers under his name (Hall *et al.* 1988; Hall and Hiscock 1988; Hiscock and Hall 1988a) the site provided data for theses on stone technology and residues on the stone artefacts and bone points. I understand that as I write, material from the site is again under active study.

In 1982 Jay began work on the early Holocene Bushranger's Cave, some 700m above sea-level in Lamington National Park on the Queensland-New South Wales border (Figure 7). Here Jay documented social and economic reorganisation that intensified in the last 2500 years and saw that the site reflected activities that could be linked to its location at the boundaries of socially linked clans in the ethnographic present (Hall 1986; Hiscock and Hall 1988b). Bushranger's Cave remains the oldest subcoastal site identified by MRAP and again provided a range of data for multiple Honours theses.

The list goes on and is extensive. Jay re-excavated Laila Haglund's Sandstone Point site in the mid-1980s; Minner Dint was one of Jay's early excavations on Moreton Island, as was Toulkerrie on Moreton's southwest coast. This latter excavation led to further excavations by Walters and later Bowen. But perhaps it was the excavations at the new Brisbane airport in 1984 and 1987 (Hall and Lilley 1987) that crystallised Jay's thoughts about past Aboriginal responses to the marine transgression. This site, situated on a palaeo-shoreline some 5km from today's shoreline, was first occupied in the early to mid-Holocene and provided evidence to support Jay's view that the proliferation of middens in the area dating to less than 2000 years showed not so much the intensive late Holocene use of a new environment as a continuous adjustment during periods of rapid environmental change by people who had always used the coast. In Binfordian terms this was a predictable pattern of human adaptation to non-equilibrium conditions in the local ecosystem.

These and others of Jay's Queensland excavations provided data for dozens of theses from BA Honours to PhD and continue to do so today. Many things flowed from MRAP, not the least being that it became a model for similar regional pieces of research, such as McNiven's Cooloola Region Archaeological Project (deliberately chosen for its unfortunate acronym in order to acknowledge Jay's research interest) and to an extent La Trobe's Southern Forests Archaeological Project. I now consider some of the incidental outcomes of Jay's intensive fieldwork at this time.

Field Teaching

When asked, all of Jay's students I've ever talked to identify UQ field trips as the experiences that compelled them to archaeology. Jay's commitment to hands-on archaeology began immediately in 1976 with informal weekend site excursions but MRAP allowed the development of a second year course called Field Archaeology where field training was formalised (Figure 9). Undergraduates would be dragooned to work for students doing BA Honours fieldwork all under the watchful eye of Uncle Jay. Here they learned the meaning of the Hall aphorism 'never let study get in the way of your education'.

Figure 9. Jay with a second year undergraduate class at Cooloola, 1983 (Photograph: Ian J. McNiven).

They learned that fieldwork was fun, but that good archaeology came first. A stickler for detailed notes and records, Jay adopted Jennings' 'FS' field specimen numbering system for every bag that came out of the field (Ian McNiven: *'It used to drive us all nuts!'*). Worse was Roger Miller's 'King of the Road' always Jay's first song when he picked up the guitar at night (Ian Walters (affectionately): *'I came to hate it; it's still seared into my brain'*).

Although keen to develop an Australian archaeology, Jay's persona did not relinquish all of his good ol' boy habits. When you were thirsty you drank beer, when socialising you drank spirits. On one occasion in a bar in Bundaberg Jay asked the barman for a 'B&B' and got a blank look. 'Bourbon and Benedictine,' he explained, and it became the order of the night. Ian McNiven was back there a year later. On the wall a painted sign read, 'B&B, latest drink from the US'.

Jay's field philosophy, work hard and play hard, engendered great coherence and loyalty among his graduate students. Jay created a research environment that taught them that archaeology was not competitive and many of them recall the camaraderie of the graduate student group, the free exchange of ideas, how they helped each other out on fieldwork and how they socialised together. In particular they remember how Jay engineered the 'three part seminar'. Jay would attract all sorts of interesting people from elsewhere to come to talk about their research; the first part would be the formal presentation, then to the University staff club, then somewhere for dinner (Ian McNiven: *'I loved it.'*). Sometimes a fourth part was added until Alice chased them out of the Hall house.

QAR and UQASU

Inevitably, the way Jay steered Queensland archaeology after it was introduced as an academic discipline at UQ resulted in a rapid increase in data. Theses and site reports proliferated and Jay remained mindful of another Jennings admonition that an archaeologist's obligation to his/her discipline is to publish field and laboratory findings as soon as possible. Since much of the new Queensland data was yet to be directed to wider questions of Australian and world prehistory it had little appeal to international journals. Jay bit the bullet and in 1984 the first issue of *Queensland Archaeological Research* (*QAR*) appeared under his editorship. It appeared annually until 1992 and occasionally since then, still with Jay as Editor.

Jay's editorial policy was straightforward. *QAR* had only one requisite. Papers had to be about archaeology in Queensland, a policy that has never varied. In method or theory, papers could appeal to any school of thought, they might be descriptive or analytical, prehistoric or historic. Its pages read like a who's who of Queensland archaeology. Archaeologists represented there include: Barker, Beaton, Campbell, Cribb, David, Flood, Godwin, Gorecki, Hiscock, Horsfall, Huchet, Lauer, Lilley, Loy, McNiven, Morwood, Prangnell, Robins, Ross, Satterthwait, Trezise, Ulm and Walters among many others (including Jay himself on numerous occasions). Few, if any, of this group would not be in Jay's intellectual debt.

QAR is a tribute to Jay's commitment to putting Queensland archaeology on the map, to his students, and to getting the data out there, as Jennings had instructed him to do and as he now continued to instruct his students to do (Ian McNiven: *'QAR was an important vehicle for Jay's postgrads to get our research out there. We deluded ourselves that every paper would become a classic but at least the data got out'*) (I am reminded of a conversation with Roger Green a few years ago, where he remarked that the only 20+ year old papers of his that he saw cited these days were the data papers, so just be patient, Ian!).

At the same time Jay encouraged his students to get their ideas beyond Queensland, both in publishing elsewhere (the contents lists of *Australian Archaeology* are particularly informative in this regard) and always having a coterie of graduate students presenting papers at the Australian Archaeological Association annual meetings. Jay rarely missed a conference and has remained a strong supporter of the Association. He was its Secretary in 1980 and President in 1985.

Paradoxically *QAR* eventually marked a major disappointment for Jay. The last annual volume, Volume 9, appeared in 1992 and it was not until 1996 that Volume 10 appeared. The single reason was that manuscripts had dried up. The world had changed. By the 1990s the innocence of a discipline that had blossomed on the excitement of its own success had been replaced in large part across the country by political infighting, poorly understood but loudly proselytised notions of post-processual theory, and budgetary tightening in universities, especially in the humanities and social sciences. In his 1996 *QAR* editorial Jay lamented the fact that postgraduates 'wanted to publish less substantive overviews in international journals before committing themselves to what they perceived as the 'boring' task of preparing descriptive manuscripts concerning the substance of the archaeological record.' But, aware of the inevitable outcomes of economic rationalism in universities, most students saw that discharging their responsibility to the data had little payoff when competing for a diminishing number of jobs in a discipline being increasingly questioned about its own relevance. Fieldwork, indeed any data-based archaeological research, had grown increasingly unfashionable. Many of the true believers began moving their research offshore.

Like *QAR*, the University of Queensland Archaeological Services Unit (UQASU) was a Jay Hall product of the mid-1980s that developed out of MRAP. Having identified the dangers to the archaeological record posed by the rapidly growing human population in southeast Queensland, the inevitable corollary was that salvage work would not only increase but increase beyond the capacity of the academic archaeologists in Brisbane to accommodate it.

As MRAP took off, not all pieces of necessary salvage were appropriate to student projects so Jay hit upon the idea of the Department of Anthropology and Sociology setting up its own consulting arm. Initially this met with opposition in the Department because people there believed that the pursuits of truth and learning on the one hand and commercialism on the other were incompatible (Ian Lilley: *'The Department went into meltdown over the idea. How times have changed'*). Undeterred, Jay set up a private company called Archaeological Associates with Richard Robins and Ian Lilley. This operated successfully until Lilley left for ANU in 1983, when the business was wound up. Whether or not the success of Archaeological Associates won over the Departmental doubters, UQASU was formed shortly after.

Figure 10. UQASU excavations at the Tower Mill, Wickham Terrace, Brisbane, December 1990. L-R: Daryl Guse, Lord Mayor Sallyanne Atkinson, Jay and Sean Ulm (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1152).

As it developed, UQASU provided new opportunities for postgraduates to broaden their professional training and skills and for undergraduates to get field experience, especially when MRAP slowed down. It provided useful income, and sometimes turned up unexpected information. One night Jay and Ian McNiven met a bloke in a pub while doing a pipeline survey in central Queensland. He claimed to know about Aboriginal artefacts and the conversation turned to bone points. Ian, the fresh young graduate, saw it as a chance to enlighten him on the typology of points – short ones, long ones, double-ended ones, and so on. The man looked somewhat crestfallen. 'I just put all the ones

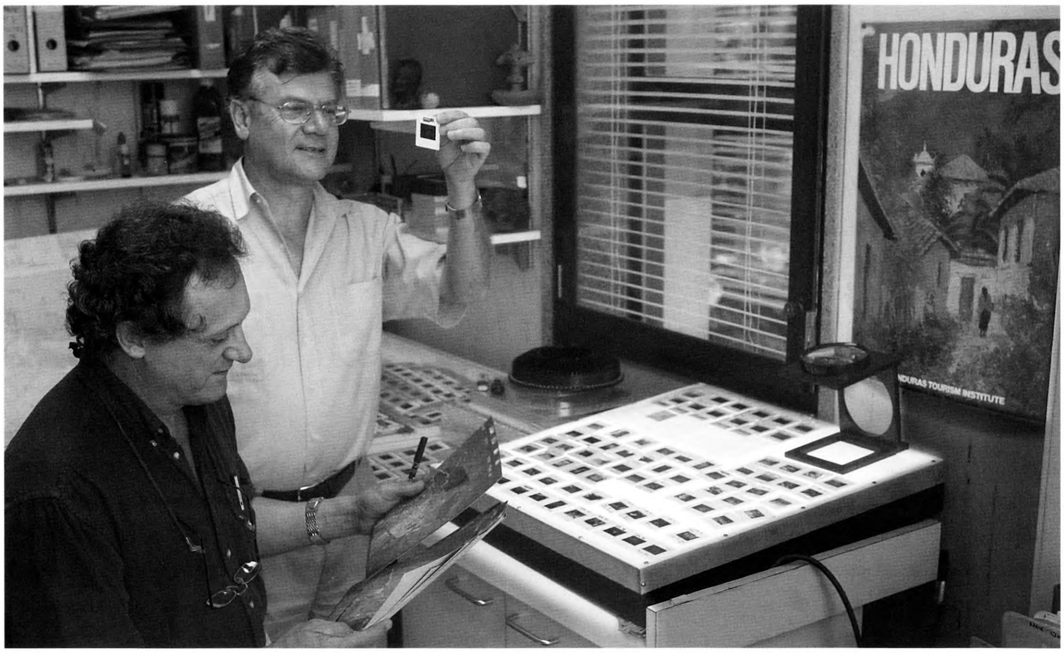

Figure 11. Jay and René Viel examining slides of excavations from Copan, Honduras, December 1997 (Photograph: Office of Marketing and Communications, University of Queensland, 0629-060).

with red parrot feather tassels in one group and the ones with white parrot feather tassels in another,' he said. Once their mouths had closed again, Jay and Ian went off the next day to survey blacksoil plains, but thinking about artefact caches in the nearby mountains (Ian McNiven: *'River terrace stone artefact scatters never looked as mundane as on that day'*).

UQASU remains today a viable and respectable archaeological consulting unit in the University of Queensland (Figure 10).

Copan

After nearly two decades of continuing development, the character and general directions of archaeology at UQ had been well established. Expansion of the teaching staff, particularly with the appointments of Australianists Harry Lourandos and Annie Ross freed Jay from the immediate restraints of teaching Australian courses and supervising an increasing number of graduate students undertaking thesis research in Australian contexts.

Thus Jay encouraged Mesoamericanist René Viel to apply for a UQ re-entry scholarship that he started in the beginning of 1991 (René delights in pointing out that these scholarships were designed specifically for women whose academic careers had been interrupted by family responsibilities). This seems to me to have reflected an urge in Jay to get back into the site formation complexities of house floors, storage pits, activity areas and so on, and in the following Australian summer Jay and Alice visited René at the Honduran site of Copan for the first time. Jay perceived that his Australian experience of stratigraphy, taphonomy and site formation processes provided him with the tools to understand the neglected early phases of settlement at Copan. Jay's change of research direction was sealed. With René, Jay began an investigation into the Mayan Preclassic period at Copan, a project that has yielded a series of important papers and which continues to the present (Figure 11).

As ever, this research drew a consequent response in Jay's teaching and Mesoamerican archaeology was added to the syllabus. Jay also dealt creatively with growing problems with the Field Archaeology course.

TARDIS

The increasingly litigious and bureaucratic theatre of archaeology in Australia in the 1990s, coupled with increasing student numbers, placed increasing pressure on Jay to abandon Field Archaeology. Aboriginal communities grew less willing to have sites used for training, obtaining government permits

Figure 12. Jay makes a fashion statement at the TARDIS site during construction. L-R: Jim Smith, Sue O'Connor, Jon Prangnell and Jay (Photograph: Office of Marketing and Communications, University of Queensland, IMG_1141).

grew more complicated, an increasing number of students had work and family commitments that did not allow for field excursions, universities were growing increasingly edgy about insurance implications for students away from the campus, costs were escalating. Importantly as well, students saw that professional careers in archaeology were no longer limited to Australia and wanted broader learning experiences. However Jay was loathe to abandon the field course. He continued to believe that students learned archaeology not only in the classroom but importantly also in the field, in a group, interacting with the physical data and solving the specific problems of data retrieval, analysis and interpretation.

Jay set about creating TARDIS – Teaching Archaeological Research Discipline In Simulation. Jay, as ever, delighted in the acronym (Figure 12). Of course this one was borrowed and adapted from Dr Who, although I always thought that the original – Time And Relative Dimensions In Space – was equally appropriate for a 25m² site containing elements of the African Lower Palaeolithic, the French Middle Palaeolithic, the Ukrainian Upper Palaeolithic, the Mesoamerican Formative and a generic European Bronze Age, all contained on a Brisbane campus. Students still excavate, analyse and interpret, and especially still take detailed field notes and use the FS recording system for every bag that comes off the site, and, yes, it still drives them nuts, but student numbers have quadrupled.

Largely as a result of the success of TARDIS, in 1999 and 2001 Jay received commendations for teaching excellence in UQ and in 2002 he was awarded the University of Queensland Teaching Excellence Award and the $10,000 prize (Figure 13). However, not content to rest on his laurels, in the last couple of years he and colleagues have begun to develop the application of scientific visualisation technology to archaeological field research records and in 2005 the team received an ARC Special Initiatives grant to continue this work.

Eschatology

The original Greek word, 'ἐσχατος means last, and although eschatology now has an appropriated biblical meaning, my use here is more literal – the study of the last things. I use it to conclude this history by re-emphasising the archaeological philosophy from which Jay has seldom deviated. In his paper with Jones on the Rocky Cape palaeofaeces, Jay recounts how as a young child listening to his grandmother read Defoe's *Adventures of Robinson Crusoe* he was puzzled about how Crusoe could determine the presence of humans on the island from footprints in the sand. The cause and effect relationship eluded him until later when he made footprints in sand and mud and realised how he might infer the prior presence of people and other animals by the ephemeral evidence in the disturbed sand.

Archaeological remains are the last things, the last direct expressions that are extant of past human behaviours. Unlike written records, that by their very nature are meant to convey messages into the

Figure 13. UQ Excellence in Teaching and Learning Awards, Customs House, November 2002. From rear descending stairs: Margaret Shapiro, Debra Henly, Elizabeth Ward, Carole Ferrier, David Radlciffe, Victor Callan, Peter Newcombe, Maree Smith, Jay, Bruce Muirhead, Simon Cool, Ian Cameron and Mehmet Kazil (Photograph: Office of Marketing and Communications, University of Queensland, 4641-020).

future, archaeological evidence does this unwittingly, in almost every case without intentional bias for its future interpretation. While the models and paradigms with which we interpret archaeological data may reflect our own intellectual baggage, the data themselves are almost always bias neutral and by concentrating on the data we can hope to approach the past more objectively.

For Jay this is what archaeology has always been about – embracing the physical reality of the archaeological record and reconstructing past human behaviour from it. Moreover it has always been for Jay a simple eschatological proposition: 'we perceive the entire archaeological record as a kind of death assemblage, whose once living context may be glimpsed through the development of methodology which links our observations with theory' (Hall and Jones 1990:220).

Yes.

Postscript

Hey mate, maybe it's time to spend more time on the dock of the bay with some muddies and a NZ sav blanc? Perhaps we could plan a little foray back to the Rio San Jacinto drainage …? Ian Walters says thanks for all the fish.

Acknowledgements

I have shamelessly plagiarised notes sent me by Sean Ulm, and the three Ians – Lilley, Walters and McNiven. I thank them, Alice Hall, Jack Golson, Tim Murray and René Viel for additional comments. For help in locating and supplying photographs I thank Diana Lilley (Office of Marketing and Communications, University of Queensland), David Madsen (University of Texas), Renae Weder (Utah Division of State History), Bryce Barker (University of Southern Queensland), Ian McNiven (Monash University) and the Department of Anthropology, University of Utah.

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After Clovis: Some Thoughts on the Slow Death of a Paradigm

David Pedler and J.M. Adovasio

Abstract

The discovery in the 1920s of early Native American projectile points in association with now-extinct Ice Age fauna led archaeologists to speculate that North America's first inhabitants were contemporaries with and predators of those fauna. The Clovis point hence became the signature artefact of a lifeway based predominantly on hunting by highly mobile groups of male hunters. By the early 1960s, this perspective had evolved into a well-entrenched dogma of Clovis-First, assuming the status of a 'holy writ' that would face growing challenges from the mid-1970s through the mid-1990s, until finally it was no longer regarded as tenable to any but its most devoted spear carriers. This contribution summarises the historical development of and gradual unravelling of the Clovis-First model, while also presenting some of the diverse implications of a First Americans 'New Testament' that is still being written.

Introduction

At least some of what we are about to say about the life and times of Clovis might strike many readers as at least a little curious, whether they be casual observers of science or interested specialists. Curious, because of the manner in which North American archaeologists have sometimes strayed from the empirical reservation in their ongoing discussion of the provenance, genesis and character of the Clovis archaeological phenomenon and its place in the peopling of the New World. At the outset, we would like to note that we concur with a recent assessment stating that the unfolding of the Clovis phenomenon and the peopling of the New World debate 'has not been North American archaeology's finest hour,' riven as it has been by 'dogmatism, polemic, and rhetoric' (Fedje *et al.* 2004:98). We would also add that it has not been science's best moment either. From the beginning of our attempts to explain what is perhaps the last great prehistoric human migration, there has been enormous pressure to write prematurely the final chapter on the issue, and scientists from various fields at crucial points in the debate succumbed to the temptation to do so. Moreover, every new advance in archaeological technique that held out hope for resolving the issue – notably including radiocarbon dating – only increased this pressure to preserve the phenomenon, and the debunking of pre-Clovis candidate sites further entrenched a line of thought that far too readily became received wisdom.

Fortunately, the analysis and interpretation of Clovis and the peopling of the New World has, over the last decade or so, taken a decided turn for the better. Specifically, a scientific approach to the problem has been reaffirmed across the involved disciplines, and the fanciful, ideological, and perhaps even magico-religious approaches that characterised mid-to-late twentieth century enquiry into Clovis are at the very least on their way to being relegated to the dustbin. We would not argue that the received wisdom of Clovis scholarship has yet been summarily dispatched like the entire North American mammoth herd, as indeed it has continued to survive in vestigial forms (e.g. Fiedel 2005). But the developments of the past two decades, we would argue, have at least led to a fundamental change in attitude, to a reconciliation with the fact that from our present perspective, the elusive final chapter on the peopling of the New World may never be written. In other words, we are suggesting that archaeologists have become more accustomed to and perhaps comfortable with the notion that the timing and manner of the New World's peopling may well remain an open proposition. This may be bad for some careers, egos, and the psychology of previous investment, but we think all would agree that it is a good development for archaeological science.

The history of the Clovis phenomenon, including that of its challenges and retrenchments, is very familiar to many and has been comprehensively documented in numerous excellent overviews (notably including Meltzer 2003, 2005), so we need not burden ourselves with its intricacies for the present purpose. Some salient details will be necessary to frame our discussion, however, so we will briefly describe the Clovis phenomenon and then summarise some of the historical currents that led to the Clovis scholarship of the 1960s and its subsequent re-evaluation. Distilled to its basics, mid-twentieth century scholarship identified Clovis as representing the first inhabitants of North America based on the apparent synchronous ubiquity of the signature Clovis fluted point identified and named in the American Southwest during archaeological excavations of the 1920s and early 1930s. Because Clovis points were found in apparent association with Pleistocene big game animals, especially mammoth, the Paleoindian lifeway was thought to be centered on the systematic predation of now-extinct Ice Age megafauna.

The appearance of radiocarbon dating in 1948, and its subsequent application to Clovis and Folsom sites, initially fixed the ages of these phenomena at c.11,500–11,000 BP and 10,500–10,000 BP, respectively (all dates uncalibrated). Principally based on data obtained from sites in southwestern North America, these dates would undergo some revision and refinement, but the 11,500 BP date for Clovis eventually became the benchmark for the first peopling of the Western Hemisphere. By the late 1960s and early 1970s, Clovis was widely accepted as the New World's founding population and considered the direct ancestor of all other Paleoindian cultures in the New World. Presumed at this point in time to have derived from northeastern Asia, Clovis's initial crossing of the Bering Strait into North America was thought to have occurred c.500 years earlier than the 11,500 BP archaeological manifestation, concurrent with and permitted by the fleeting presence of an ice-free corridor between the Laurentide and Cordilleran ice sheets in the present day northern Interior Plains region of Canada. Following this scenario, the peopling of the entire hemisphere was thought to have occurred within about 1000 years.

Alarmingly, Clovis's widely recognised and distributed, highly visible, and apparently standardised artefacts in association with a relatively tight cluster of radiocarbon dates led archaeologists to posit a single culture with a uniform technology and associated lifeway for North America in its entirety – all without regard to differences in latitude, local environment, site structure, or even non-lithic artefact assemblages. Furthermore, the apparent synchrony between the apparently rapid spread of Clovis and a perceived widespread, contemporaneous extinction of Ice Age megafauna led archaeologists to presume that a causal relationship existed between those extinctions and Clovis. As such, the picture of Clovis was recast as a highly specialised and mobile, rapidly moving hunting culture – analogous to the Magdalenian of France or the Solutrean of Spain's Iberian Peninsula – that played a direct role in a hemisphere-wide population and extinction scenario variously termed the Pleistocene Blitzkrieg or Overkill model (Martin 1967, 1984, 1990; Martin *et al.* 1985).

Hence it came to be that man the Ice Age hunter was reborn in the Americas, and his manifest destiny was cast. Scholarly articles, popular publications and films, murals, dioramas, and other museum displays underwent their own Ice-Age-man blitzkrieg, and commonly came to depict dramatic confrontations between testosterone-saturated, fur-clad, stone-wielding male hunters and formidable, soon-to-be-systematically dispatched Pleistocene beasts. Virtually and conspicuously absent from these admittedly exciting tableaux, however, were non-lithic artefacts, activities unrelated to hunting, and much more significantly, women, children, or the elderly of either sex. This view of late Pleistocene life, in both popular media and archaeological scholarship, on the whole became rather two-dimensional or flat – that is to say oversimplified, incredible, and ultimately predictable.

Myriad culture-historical factors doubtless contributed to the composition of this late Pleistocene just-so story, and time precludes all but a brief accounting of what we believe to be the most salient ones. Obviously critical to this scenario were a number of significant late nineteenth and early twentieth century developments in geological, archaeological and general scientific thought which hastened the gradual falling away of a theological dogma that had either denied or obscured such basic facts as the antiquity of the Earth and humankind. Pioneering scientific works such as Lyell's (1830) *Principles of Geology* and Darwin's (1859) *On the Origin of Species* exerted profound influences on mid-nineteenth century conceptions of antiquity, leading to more critical thinking and intellectually rigorous approaches to humankind during the Pleistocene, which in turn had profound implications for American archaeology and thought concerning the antiquity of humans in the New World. Concomitant with these influences were refinements in the disciplines of geography, cartography, glacial geology, and both geological and archaeological method and theory, all spurred on by the co-occurrence of stone tools with large Pleistocene fauna in high-profile archaeological excavations.

A profoundly influential link between these scientific advances and archaeological thought was provided by amateur palaeoanthropologist Jacques Boucher de Perthes, whose 1837 collection of flaked stone tools from ancient gravels along the Somme River in northern France also identified, in apparent association, the bones of extinct and often clearly large animals. His treatise on the finds, ambitiously entitled *De la création* (Boucher de Perthes 1839-1841), was not well received, nor was his later work, entitled *Antiquités celtiques et antédiluviennes* (Boucher de Perthes 1999 [1849]). But Boucher de Perthes kept on collecting, and his evidence for ancient humans in the Somme Valley was eventually augmented during the mid-1850s by the work of other scholars near Amiens and St Acheul. Gradually, the French and British archaeological communities warmed to Boucher de Perthes' notion that antediluvian humans (or some archaic version thereof) ranged Ice Age Europe at some remote time in the past. In 1859, a delegation of British geologists (including Sir John Evans and Joseph Prestwich), all of whom had been engaged in similar research in England, certified Boucher de Perthes' conclusions and soon thereafter still other discoveries began to mould an image of human antiquity that would soon filter across the Atlantic. Interestingly, a process whereby panels of experts in the field would examine and then pass judgement on controversial archaeological sites would also make its way across the Atlantic and figure largely in the framing and late twentieth century retrenchment of the Clovis phenomenon.

One of the key conduits for the importation of this new archaeological approach was Aleš Hrdlička, a Czech-born naturalised American who left his private medical practice in 1894 at the age of 25 to pursue research in physical anthropology. Hrdlička's research activities ultimately brought him to the attention of Frederic W. Putnam of the American Museum of Natural History, at whose insistence he was to study controversial human remains from the notorious Trenton Gravels locality in New Jersey at the turn of the twentieth century. In 1903, Hrdlička became the head of the newly formed Division of Physical Anthropology in the United States National Museum, where he worked until his retirement in 1941 (Montague 1944; National Anthropological Archives 2005). As founder of the *American Journal of Physical Anthropology* and key player in the formation of the American Association of Physical Anthropologists, Hrdlička came to dominate the field of physical anthropology, serving in numerous very high profile, national and international scholarly organisations. Extremely well-travelled with copious multidisciplinary field experience, Hrdlička early on gained a reputation as a scold and vituperative debunker of what he perceived to be outlandish claims concerning the antiquity of humankind in the New World, for which he set a rather rigid and zealously defended limit of 4000 BP. 'In his manner,' wrote Ashley Montague in Hrdlička obituary, 'Hrdlička tended towards the delivery of ex cathedra judgments in a somewhat pontifical style' (Montague 1944:117), perhaps setting the tone for the debate that would follow.

Hrdlička was not above making his own outlandish claims, however; specifically, in his work entitled *Early Man in South America* (Hrdlička *et al*. 1912), wherein he argued that all indigenous Americans ascribed to a relatively recently arrived, single racial entity based on exterior physical traits. Hrdlička (Hrdlička *et al*.1912) finally concluded that the prehistoric colonisation of the Americas was accomplished over the past 4000–5000 years by a single Mongoloid population originating in Asia and crossing into the New World via the Bering Strait. Hrdlička appears to have held this view until his death (Fagan 2004:39), refusing to yield even to the publication of the Folsom and Clovis discoveries of the late 1920s and early 1930s. And thus, Ice Age man in the New World was supplied a new type of playmate, the alpha male scholar who vanquished his foes in much the same fashion that his Ice Age predecessor vanquished all manner of Ice Age beasts. It would be difficult to overstate Hrdlička's role in this new character in archaeological scholarship. Indeed, as Lavallee (1995:32) notes, 'Hrdlička's authority and prestige were such that, during the 1920s, his propositions acquired the strength of dogma.'

These are some of the intellectual currents, then, that brought to a close what Willey and Sabloff (1993:152-213) call the Classificatory-Descriptive Period (1840-1914) of American archaeological thought and which came to inform the mid-twentieth century practice of American archaeology and our understanding of the Clovis phenomenon. Over this 75 year period, there occurred a growing rigour and scientism in archaeology and the incorporation of other related scholarly disciplines such as geology and physical anthropology. Unfortunately, this trend was also accompanied by a growing confidence in the discipline on the part of Clovis scholars that was almost certainly out of proportion with what was knowable at the time and rather impaired by the dogmatism of scientific committees composed of authoritative, exclusively male, figures.

Other much less evident but even more potent shaping forces were at work, obviously, perhaps the most important being a tyranny of preservation that largely permitted the exclusive recovery of stone tools like the Clovis point from archaeological sites, thus elevating this class of technology to what any ethnographer knows is an undeserved prominence. Another less subtle and far more pernicious force was gender bias. Not at all coincidentally, the early scholars who shaped the 'man the hunter' diorama were men who, given their wont to characterise stone tool making and use as the exclusive province of males, produced a self-reinforcing bias. In a marvel of circularity, male scholars reconstructed Ice Age lifeways based almost exclusively on the one class of tools presumed to have been made by males.

Wrinkles in the Clovis Curtain, and its Unravelling

We do not wish to convey the sense that Clovis scholarship of the mid-twentieth century was the sole province of blinkered, sexist lemming-scholars, as the field is already overpopulated by such *ad hominem* pronouncements. But the perspective gained by hindsight nonetheless provides us with significant insights concerning some of the Clovis-First model's inherent difficulties that might have been apparent to its early advocates had they not been following a tradition of deeply entrenched received wisdom and practice.

Perhaps the most significant warning that something might have been amiss should have been the Clovis-First model's fantastically seamless fit with what was then a very small corpus of supporting data. For indeed, based on data from a relatively small handful of sites, the model explained everything: from late Pleistocene extinctions to a presumed Paleoindian focus on the systematic predation of big game, from a perceived highly mobile lifeway to the population of the entire hemisphere in about 1000 years, from the timing of the ice-free corridor's opening and human entry into North America to the perceived absence of an earlier human presence in the Americas and eastern Beringia. These self-reinforcing explanations were rather eagerly accepted, even in the face of contrary evidence that was rejected because it did not precisely fit the scenario.

Moreover, not only did Clovis-First scholars reject contrary evidence, their model thrived on the rejection of these data, with the result that, as Madsen (2004:2) notes, 'the pervasive acceptance of the Clovis-First model largely stifled the investigation of possible alternative explanations for the antiquity of human settlement in the Americas'. As we have noted elsewhere (Adovasio and Pedler 2004), it has long been apparent that disputed pre-Clovis localities – and even some *bona fide* Clovis sites – have produced technological suites that are profoundly different both from traditional Clovis and each other. This discrepancy was further widened by an ignorance of non-lithic artefacts and the obvious degree of technological (and, presumably, behavioural) diversity among roughly contemporaneous sites that was too great to ascribe to a single, late-arriving progenitor complex, monolithically Clovis. And this point deserves emphasis: Clovis's South American contemporaries, along with what we now know to be its eastern North American predecessors in the hemisphere, evince artefact assemblages and site patterns that bear no similarity to the traditional conception of Clovis.

Various other classes of archaeological data and otherwise inconvenient details about the Clovis-First scenario were also rejected or overlooked during the late 1960s and 1970s. Distilled to essentials, these omissions most prominently included a lack of Clovis points west of the Bering Strait; a similar lack of Clovis point finds in Canada's Interior Plains along the presumed route through the ice-free corridor; and the suggestion that those presumably Clovis-related fluted projectile point forms that had been identified in Alaska and the Interior Plains were in fact younger, which in turn suggested a northern rather than southern migration of the form (Krieger 1954).

Nor were these inconsistencies or problems limited to just the archaeological data available at the time. The human role in Pleistocene extinctions was also wide open to question, specifically because evidence for the predation of extinct Ice Age animals was in fact limited to just a few western sites and their associated Clovis artefacts and mammoth remains. Curiously, a continent-wide phenomenon was posited on these limited data and in the face of conflicting data from eastern North American localities – where artefact associations with mastodon, though present, were sporadic at best if not virtually nonexistent, and analogous associations were documented for absolutely no other extinct species (Griffin 1965; Meltzer 2003). As Grayson and Meltzer (2003:588-589, 591, Table 2, Figure 1) note, only 14 North American archaeological sites demonstrate the predation of extinct megafauna, and the number of species involved is limited only to mammoth (12 sites) or mastodon (two sites) with no evidence of demonstrable kill sites for the remaining 26 extinct genera of North American herbivores. This scenario was further troubled by the fact that only 15 of these now-extinct species persisted on the landscape later than 12,000 years ago – signalling that massive extinctions occurred well before the arrival of the Clovis populations that were presumed to have dispatched them.

In short, the precise admixture of factors leading to these extinctions is presently unknown, and although it is widely thought to have been occasioned by some combination of changing late Pleistocene climate and environments, human predation, and perhaps even disease, we consider it quite improbable that responsibility will ultimately be placed on a single factor – especially the human predation part of the equation. As with the various research avenues that have been explored throughout the course of the Clovis debate, however, the ultimate disposition of this matter should lie in the development and testing of these hypotheses singly to determine whether they succeed or fail on their own merits in explaining late Pleistocene megafaunal extinctions in the New World.

Pre-Clovis Sites and Human Settlement of the New World

The most significant and successful challenge to the Clovis-First model, however, has not been posed by its inherent weaknesses but, rather, by a mounting corpus of direct, physical, archaeological evidence that lends credence to a pre-Clovis presence in the New World. This was not always the case, as is doubtlessly all too well known to many specialists in the field. Indeed, repeated claims for pre-Clovis occupation of North America have been made for over a century and numerous candidate sites have been discredited, usually based on challenges that their constituent artefact assemblages were either of disputable human origin or could not be reliably and precisely associated with undisturbed, radiocarbon dated contexts demonstrably older than 11,500 BP. And although a considerable number of these sites deserved their ultimate rejection as pre-Clovis entities, another class of sites has weathered the challenges (Figure 1), perhaps even enduring a level of scrutiny that otherwise would have brought down some accepted conventional Clovis localities (cf. Fedje *et al.* 2004:98).

The most often cited localities that have led to a general acceptance of pre-Clovis populations are Monte Verde in Chile (Dillehay 1989, 1997, 2000) and Meadowcroft Rockshelter in southwestern Pennsylvania (Adovasio *et al.* 1977a, 1977b, 1979-1980a, 1979-1980b, 1984, 1985, 1988, 1989, 1990, 1992; Adovasio and Page 2002; Adovasio and Pedler 2004, 2005; Carlisle and Adovasio 1982). These two localities have yielded artefacts that are both radically different from conventional Clovis material culture and derived from radiocarbon dated contexts at least 1000–2500 radiocarbon years older than the Clovis-First model's presumed crossing of the Bering Strait.

Although Meadowcroft Rockshelter was discovered and published upon before Monte Verde, this latter locality is considered by many to be the first site to rend the Clovis curtain (Adovasio and Pedler 1997; Gibbons 1997; Meltzer *et al.* 1997). Located in south-central Chile on a tributary stream c.15km northwest of the Gulf of Ancud on Chile's Pacific coast, Monte Verde is much farther away from Beringia than any pre-Clovis site in the hemisphere. Two cultural components have been reported from the site, the earlier (MV-I) which evinces close association between three possible cultural features and a small number of lithic artefacts that are of unquestionable human manufacture. The older of two roughly contemporaneous features associated with this component has yielded a date of 33,370±530 BP, which, if valid, renders this occupation the oldest directly dated human manifestation in the entire New World (Monte Verde's excavators, incidentally, presently reserve judgement on the extent and character of this earlier occupation). Nonetheless, the apparently much later but still pre-Clovis MV-II component, in our view and that of a growing number of scholars (e.g. Fagan 1995; Gowlett 1992; Meltzer 1993, 1995), represents both the oldest definitive evidence of humans in South America and the oldest open-air locality in the New World. This second component is securely dated by a series of over a dozen conventional and accelerator mass spectrometer (AMS) assays to c.13,000 BP and appears to reflect, at the very least, a semi-sedentary, highly generalised utilisation of an environmental setting not radically different from that evidenced in the area today.

Figure 1. Locations of key sites mentioned in this paper.

The later Monte Verde component is a streamside settlement sealed beneath a peat layer that formed after its abandonment. The settlement is bisected by the stream and composed of two clusters of apparent residential structures. In addition to the remains of several vertical posts and other structural elements, in one part of the site the excavators identified a small salt cache (perhaps used in hide tanning), clusters of mastodon (*Cuvieronius* sp.) bone and skin, extensive amounts of worked wood, other plant remains (apparently including medicinal species), and of course stone tools. One of the excavators describes this locus as 'apparently a place where prehistoric inhabitants prepared meat and animal hides, manufactured stone tools, and perhaps cured body ailments' (Dillehay 1987:10).

The utilisation apparently included the year-round exploitation of small game, paleo-llama (*Llama glama glama*), and mastodon (*Mammut americanum*), as well as a wide diversity of plants. Most interestingly, the toolkit is dominated by perishable artefacts with a stone industry that, while clearly of human origin, is truly meagre by conventional standards and bears no resemblance to those from any of the other pre-Clovis sites considered here. Very few of the Monte Verde lithic artefacts are temporally diagnostic in and of themselves and indeed, with exception of the three projectile point fragments with apparent affinities to the El Jobo type (Bryan *et al*. 1978; Cruxent and Rouse 1956), most of the lithic artefact assemblage is remarkable only for its *ad hoc* or expedient character, a very low number of curated tools, and a nearly complete lack of formalisation. Most of the igneous raw materials employed in the production of the MV-II stone toolkit derive from locally abundant fluvioglacial gravels, with less than 15% coming from remote sources. In short, the evidence from Monte Verde suggests an adaptation that could not be more dissimilar from the conventional view of Clovis and, though earlier, can in no way be interpreted as even vaguely ancestral to Clovis.

More than 10,000km north of Monte Verde is Meadowcroft Rockshelter (36WH297), a deeply stratified south-facing rockshelter located on a minor west-flowing tributary of the Ohio River in southwestern Pennsylvania near Pittsburgh. With the publication of its first radiocarbon sequence in 1974, Meadowcroft Rockshelter has become the most controversial North American locality advanced for early occupation of the New World since Abbott's excavation in the Trenton Gravels (cf. Meltzer 1993:43-48). The 11 strata at Meadowcroft have yielded the longest indigenous occupational sequence from eastern North America and one of the longest in the New World. The site's upper strata (Upper IIa-XI) span the entire Holocene with a *terminus ad quem* dating to just before the American Revolutionary War (AD 1775–1783), and its lower culture-bearing strata (Middle and Lower IIa) extend well back into the late Pleistocene.

Applying the most conservative interpretation of the available chronometric data, we conclude that even if only the youngest date from upper middle Stratum IIa is valid, the minimum age for the presence of human populations in this part of Pennsylvania is 12,000–10,600 BP. If the six deepest dates unequivocally associated with cultural material are averaged – a procedure with which we are uncomfortable on statistical terms – then humans were definitely present at the site between 14,555 and 13,955 BP. If the younger date in this range is averaged with the younger of the two dates (19,600±2400 BP and 19,100±810 BP) from the site's lowest culture-bearing stratum (i.e. lower Stratum IIa), it is possible that Meadowcroft's earliest occupation may have occurred c.15,250 BP. It should be noted, however, that these older dates were both obtained from very small, diluted samples, and both are non-AMS assays with high standard deviations.

The lithic artefact assemblage associated with the earliest Meadowcroft populations is relatively small (c.700 specimens) and represented by secondary and tertiary core reduction and biface thinning from the late-stage manufacture and the refurbishing of finished implements. The specimens suggest that an essentially curated lithic toolkit was brought to the site by its earliest inhabitants employing raw materials from far-flung quarries such as Flint Ridge in Ohio, Onondaga chert sources in New York, several Kanawha chert sources in West Virginia, the Pennsylvania jasper quarries well to the east of the site, and local Monongahela chert. This wide-ranging procurement pattern, in turn, suggests that the 'serial quarry scenario' proposed by Custer (1984) may exhibit a truly venerable pedigree in eastern North America or, perhaps less likely, that the region's earliest populations were already part of a far-flung exchange network. While space precludes a comprehensive summary of the earliest Meadowcroft lithic assemblage, it suggests that the site's pre-Clovis first inhabitants employed a technologically standardised and sophisticated, small polyhedral core- and blade-based industry of decidedly Eurasiatic, Upper Paleolithic aspect.

Other pre-Clovis sites have also been discovered at widely separated loci in North America, including Cactus Hill and Saltville in Virginia, Topper in South Carolina, the Nenana Complex sites in Alaska, and a cluster of Chesrow complex sites in southeastern Wisconsin. All of these localities are as old as or significantly older than Clovis and none appears to be related to that entity. Significantly, the lifeways represented on at least two of these sites, Cactus Hill (Johnson 1997; McAvoy and McAvoy 1997; McAvoy *et al*. 2000) and Saltville (McDonald 1996, 2000; McDonald and Kay 1999; Wisner 1996), reflect the same sort of generalised hunting and gathering pattern evidenced at Meadowcroft Rockshelter. Cactus Hill's pre-Clovis component, which lies less than 10cm below its intact Clovis component, is dated by a series of radiocarbon and optically stimulated luminescence (OSL) dates ranging from a suspected hearth dated at 15,070±70 BP to a charcoal concentration beneath a lithic tool cluster dated at 16,670±730 BP. The Chesrow sites mentioned earlier have produced intriguing radiocarbon dates allegedly associated with artefacts and extinct fauna, with assays ranging from as early as 13,470±50 BP (Overstreet *et al*. 1993, 1995) to as late as 12,480±130 BP. On the basis of these dates and associated fauna, and unlike the other sites under discussion, it appears that some of the Chesrow complex sites are at least contemporary with, probably earlier than, and perhaps loosely ancestral to Clovis.

Framing these sites and site complexes as bookends to the north and south are sites of the Nenana complex (e.g. the Dry Creek, Walker Road, Moose Creek and Panguingue Creek sites) and a number of sites in South America (e.g. Lapa do Boquete, Lapa dos Bichos and Grande Abrigo de Santana do Riacho in Brazil; Tagua-Tagua in Chile; Tibitó in Columbia; and Taima-Taima in Venezuela), respectively. Neither of these groups of sites appears to be even vaguely related to Clovis and, in the case of the South American loci, the observed co-occurrence of unifacial and bifacial technologies renders them quite different – and obviously not descendent – from their North American counterparts, Clovis or otherwise.

By our count, it is apparent that at least five sites – and perhaps as many as 20 – are significantly older than Clovis. Moreover, with the notable exception of Meadowcroft and Cactus Hill, which exhibit generally comparable or analogous durable toolkits made from very different raw materials, the technologies represented at all of the other pre-Clovis sites or complexes discussed or mentioned in this paper are significantly different both from each other as well as from Clovis. With this very broad diversity in mind, and especially considering the broadly different levels of investigation undergone at these localities, it is perhaps better to tentatively and loosely label these entities as 'pre-Clovis cultures' rather than consider them as a distinct cultural horizon after the fashion of Clovis.

Beyond Clovis

With the Clovis-First paradigm *in extremis*, if not outright *rigor mortis*, it is certainly appropriate to ask 'what next?' There is no simple answer to this most logical *post mortem* query. However, if we phrase our response in terms of stock questions like who, where, how, and when, potential answers become somewhat easier to frame but in many ways remain frustratingly unsatisfying.

Regarding the issue of 'who' and 'where', it is clear that the makers of Clovis projectile points were not the initial colonists of the New World. Furthermore, despite the near unanimity that the homeland of the first migrants is somewhere in northeastern Asia, we are no more able to specify a geographically more restricted or circumscribed homeland than was possible before the Clovis-First collapse. The results of mtDNA, Y-chromosome, and linguistic research – in concert with the available archaeological data – point inexorably in one general direction, yet presently they do not point to a precise place or places nor to any specific 'donor' populations or archaeological complexes representing the birthplaces or 'parents' of the first New World populations. Even with the ongoing and anticipated refinements of molecular genetic methods, protocols, or calibrations (see Shurr 2002), and despite what surely will be more extensive field research on both sides of the Bering Strait, the 'who' and 'where' questions will not be answered anytime soon and may never be answerable in any but the most general way.

This somewhat depressing observation should not be interpreted as suggesting that additional research will not or should not be done on the 'origins' issue. To the contrary, such research is ongoing in many areas and will doubtlessly continue to provide surprises. Using archaeological, physical anthropological (including both palaeontological and genetic data), linguistic, archaeometric, and other datasets, we may well be able to identify with much greater precision the number, general timing, and character of the sequent population pulses into the New World. Perhaps we will also be able to identify which, if any, of those pulses included the forebears of Clovis and which ones ultimately produced no living progeny. These so-called 'failed migrations' have largely been ignored in the archaeological literature.

Even before the Clovis-First model entered bankruptcy proceedings, questions were raised about the 'how' of the peopling of the New World, specifically concerning the traditional route and generally accepted 'vehicle' for the initial penetration of the Americas. Dogmatic assertions that the first colonists walked here and then travelled exclusively between the forbidding ice sheets to points south was never accepted by skeptical segments of the archaeological community. New research (e.g. Fedje *et al*. 2004) continues to illustrate the improbability of the 'walk through the ice' scenario and is beginning to show the viability of alternative routes and different entry mechanisms. While it is highly likely that some of the first and some of the later arrivals to the New World probably did walk between the waning ice sheets, it is becoming increasingly clear that others did not. Despite the predictable protestations for a lack of evidence, it is obvious to many that the so-called coastal entry route was both usable and used and, furthermore, that such populations as may have participated in this coastal entrada had access to and were intimately familiar with boats and water transportation (Jodry 2005). Future research on the coastal entry route as well as the 'old' interior avenue should also help to elucidate not only issues of entry but, more importantly – at least to us – issues of behaviour and lifestyle.

As many have pointed out, the question 'when' suggests an event with finite chronological boundaries. If such a question is taken literally to mean at what time in uncorrected or calibrated radiocarbon years did the first colonists arrive in the New World, the question is unanswerable. Only a freak discovery beyond the odds of calculation would produce datable evidence of the very first New World personage or population. Even assuming that he, she, or they were discovered and precisely dated, how would or could we ever know they were the first? If, on the other hand, as Meltzer and others have stressed, that the peopling of the New World is a process not an event, then we should ultimately be able to refine our estimates as to when this process began as well as its internal chronology. We say 'estimates' for the same reasons noted above, whether the initiation of a process or a discrete event, palpable proof of 'first' will remain forever elusive.

To be sure, there will continue to be new sites *du jour* which are slightly or, perhaps, very much older than those currently known. The search for and discovery of these sites will continue both in terrestrial and underwater contexts, abetted by geomorphological considerations, and will provide the future grist for countless new peopling benchmarks. Such research will also no doubt spawn the expected host of 'colonisation' models built on this or that calculated rate of movement or demographic expansion (Surovell 2000). We find it curious that burned once and badly by the blitzkrieg hypothesis, some practitioners in the field seem committed to generating even more far-fetched scenarios based in some cases on even flimsier chronological data.

If the answers to who, where, how, and when remain elusive, we have high expectations for a question not posed earlier. Specifically, what were the first migrants to the New World actually doing? What did their behavioural repertoire include or, put most simply, what were their lives like? Data from many of the sites previously cited conclusively indicate that these shadowy figures are far more behaviourally complex and variable than the lithocentric-men-in-fur killing big game animals model would have us believe. As more pre-Clovis sites are excavated – and, more pointedly, as more Clovis-era residential loci like the Gault site (Collins 2002) in Texas are investigated – it is quite likely that we will discover that both Clovis-age and earlier groups are more accurately characterised by a wide variety of subsistence, settlement, and site-use strategies using durable and especially non-durable technologies to implement very different patterns of adaptation.

With the recovery of normally perishable artefacts like basketry, cordage, netting, textiles, sandals, bone, wood, and other non-durable classes of artefacts from early sites, we have gained and will continue to gain insights into all of the 'whats' raised earlier as well as directly related issues such as gender roles and agency in the Americas' remote past. Hopefully, these insights will include some plausible answers to that most fundamental 'what' question, namely the nature of Clovis itself. Though its now abundantly clear that Clovis is not a culture or technocomplex in the sense of Gravettian or Solutrean, we still don't know exactly what it is or was.

Conclusions Writ Small

In preparing this contribution, we discussed how we and many of our colleagues have occasionally used forums like this to offer grand observations and pronouncements, especially concerning what we think we now know, in effect succumbing to the temptation we alluded to at the outset, that of writing the elusive (and perhaps illusory) last chapter. Such temptation can also become stronger with the passing of a pre-eminent paradigm, as does the belief that finally, we have the answer(s). Rather than bathing you in the dubious light of conclusions writ large, however, we have instead elected to offer only a few modest closing thoughts writ small.

The Clovis-First model was one of the most powerful and persistent descriptive models to ever emerge in the history of New World archaeological thought. It was apparently well-grounded archaeologically, bioarchaeologically and linguistically, and for a time quite parsimonious in explaining the arrival, spread, and specialised highly mobile, big-game-focused, stone tool dependent lifestyle of the New World's first inhabitants. Moreover, like many other elegant models in the history of science, it came to be accepted as gospel, not simply by scholars, but the informed public as well. Unfortunately, and again like so many other failed theorems, the Clovis-First model was wrong and fundamentally flawed from the outset. Designed to answer a rather simple set of questions – who, where, how, when and what – in the end, it answered none! Moreover, its tenacity actually inhibited the generation of new answers to these 'old' questions.

The passing of the paradigm has allowed North and South American practitioners to rethink these fundamental questions in ways actually considered heretical a few years ago. While the demise of Clovis-First cannot and will not immediately enhance our knowledge of the earliest Americans, it will provide a milieu in which scholars will be able to operate unimpeded by the fetters of a very narrow mindset long considered inadequate by scholars in Europe or South America. Perhaps the best thing about going beyond Clovis is simply that – the realisation that there is something beyond Clovis. As our colleague Mike Collins (2002) observed, this realisation has led to the most dynamic and exciting period in the history of New World archaeology. To this we add the observation that it is a time so new and so theoretically fluid that to offer any more than this would be too presumptuous even for a field that has been swayed by presumption for almost a century.

Postscript

One of the authors of this contribution (Adovasio) was a colleague and part-time roommate of Jay Hall's at the University of Utah (1968–1970). During that memorable time, we both suffered to varying degrees under the lash of the late Dark Lord of Utah, Jesse D. Jennings, while attempting to master the theory and mechanics of his version of anthropological archaeology. On occasion, thoroughly frustrated by this or that, real or imagined, torment attributed to the Dark Lord's malice, I would often complain to Jay. His usual response to this caterwauling was to admonish me 'not to think too much'. Many years later, I have finally absorbed the wisdom of this remark, and I and my co-author, David Pedler, offer this contribution both in honour of Jay's magnificent career and also as proof positive that at least one of us (Adovasio) has learned not to think too much!

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Mid-Holocene Hunters of Kangaroo Island: The Perspective from Cape du Couedic Rockshelter

Neale Draper

Abstract

Cape du Couedic Rockshelter is perched below the top of a limestone cliff, 80m above a small bay on the southwest coast of Kangaroo Island, South Australia, and was first recorded by Lampert (1981). Archaeological excavations conducted in the mid-1980s by the present author produced a substantial range of faunal remains, stone artefacts, and spatial data relating to Indigenous use of the rockshelter and its environs, when it was occasionally occupied between approximately 7500 and 5500 years before present. This paper summarises a key aspect of the Cape du Couedic research – the analysis of excavated faunal remains from the larger mammals, the Australian Sea Lion (*Neophoca cinerea*), the Kangaroo Island Kangaroo (*Macropus fuliginosus fuliginosus*) and the Tamar Wallaby (*Macropus eugenii*). The faunal analysis was specifically designed to provide evidence about the use of this site and the surrounding landscape by the Indigenous people who inhabited it, and to provide some insights into the hunting, butchering, food-sharing and food-preparation practices used by Kangaroo Islanders in the mid-Holocene. Comparisons with ethnographic data recorded from a wide geographic range of mainland Australian contexts during the last two centuries provide some striking parallels with the Cape du Couedic practices, and suggest a significant and widespread degree of consistency and continuity of these cultural practices from at least the mid-Holocene into the ethnographic present.

Introduction

Kangaroo Island has been separated from the South Australian mainland by the 14km wide Backstairs Passage (Figure 1) since the rising of postglacial seas between 8000 and 9000 years ago according to science (Lampert 1981), or alternatively since the Ngarrindjeri Creation Ancestor Ngurunderi commanded the seas to rise up to trap and drown the passage and his two fleeing wives (Berndt 1940; SA Film Corporation 1987; Tindale MS 1932-1935).

The archaeology and ethnography of Kangaroo Island have occupied a unique place in the story of Australian archaeology and prehistory since research in the 1930s by Tindale, Cooper, and others from the South Australian Museum first began to characterise the fascinating case of a large offshore island with an abundant prehistoric archaeological record (in terms of stone artefacts at least), but without any known historic Aboriginal inhabitants (e.g. Cooper 1943, 1960, 1966, 1968; Tindale 1937, 1957, 1968, 1974, 1981; Tindale and Maegraith 1931). Typological studies of abundant stone artefacts found on the surface around lagoon beds on the island as forest land was cleared for agriculture produced the impression of two distinct stone tool industries on the island – a large tool tradition (the Kartan), and a small tool tradition. These characterisations derive from a sparse archaeological record that lacked any substantive chronology, stratigraphic context, or material evidence other than stone artefacts (e.g. faunal remains) that might flesh out a prehistory for Kangaroo Island. Lampert conducted extensive research on this issue, focused upon finding and investigating undisturbed archaeological sites that might provide a chronological framework and faunal data to provide an interpretative context for this 'Great Kartan Mystery' (Lampert 1972, 1975, 1977, 1981, 1983a, 1983b). Lampert's research provided some chronology for the archaeological record ranging from approximately 16,000 to 3000 years before present, as well as faunal data from Seton Rockshelter

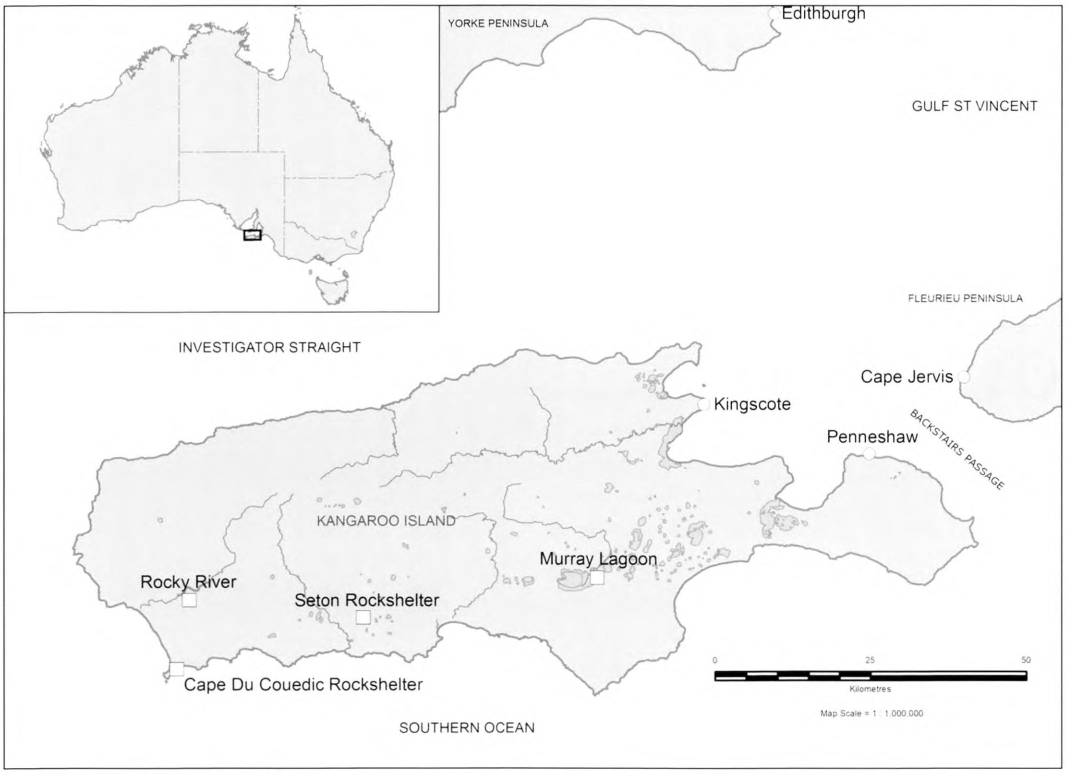

Figure 1. Map showing the location of Cape du Couedic Rockshelter and other recorded archaeological sites on Kangaroo Island, South Australia (Drawing: Andrew Maland).

(Lampert 1981), but did not resolve the 'Kartan Mystery', although the impression of a succession from large tool to small tool industrial traditions remained. Although Lampert's excavations at Seton Rockshelter produced significant faunal remains, the analysis of this material focused on environmental reconstruction, rather than its potential to inform about past human behaviour.

Later excavations at Cape du Couedic Rockshelter and at Rocky River (Draper 1987, 1988, 1991, 1999) have extended the chronology for human occupation to less than 1000 years before present, and have provided evidence of a single, broad-based stone artefact technology on Kangaroo Island that fits more comfortably within the regional archaeological record of the adjacent mainland (Mulvaney and Kamminga 1999:227-228, 335-337). The Cape du Couedic excavations also provide a substantial faunal record for the Aboriginal subsistence economy in the southwest corner of the island from about 7500 to 5500 years ago.

Faunal Evidence from Archaeological Sites on Kangaroo Island

Limited information relating to past Aboriginal subsistence economy on Kangaroo Island may be derived from the locations of the archaeological sites in terms of their resource catchments. Most sites occur on slightly elevated, well-drained land close to freshwater lagoons or streams. The basic campsite requirements of freshwater, firewood and proximity to a food supply are met by this site pattern. These locations would have provided access to water birds and their eggs, a wide variety of plant foods, and any animals which came to drink at these water sources or inhabited the surrounding mallee and eucalypt forests. Murray Lagoon, with its resource-rich wetlands and fringing forest provides an outstanding example, ringed with archaeological sites containing the full range of quartzite and quartz artefacts recorded from the island. Campsites located in the vegetated dunes perched above the cliffs which line the southern and western coastline of Kangaroo Island offer access to shoreline resources such as shellfish and sea lion, as well as a wide variety of other local plant and animal foods. Often in these coastal locations, water sources were limited or only seasonally available (e.g. rock pools or small springs).

In rare cases, there is more direct evidence concerning the food resources used at particular sites. In the coastal sand hills near Pelican Lagoon, Cooper and Condon (1947) reported an eroding campsite with a surface scatter of emu eggshell, at least eight species of marine mollusc shells, and a range of animal bones including the skull of a rat kangaroo (*Potorous platyops* or *P. morgani*):

> All these food remains were scattered thickly on mounds showing traces of fire, together with considerable quantities of quartz flakes and also burnt hearthstones. In close proximity were hammer stones and stone implements, the latter mostly comprising characteristic examples of the Kangaroo Island large hand-chopper, which is almost invariably derived from a water-worn quartzite pebble (Cooper and Condon 1947:66).

The bones and shells were preserved in this site because of the calcareous, partially consolidated sand dune in which the faunal remains were buried. However, when such faunal remains are exposed through erosion, they rapidly decay and disappear. Other campsites preserved within consolidated, calcareous dunes have also been recorded at West Bay, Little West Bay, Cape du Couedic and Pennington Bay. All of these sites have stone artefacts of quartz and quartzite (both large and small), fireplaces and shellfish remains (although no animal bones have been observed in the limited erosion exposures). These alkaline depositional environments favour the preservation of bone and shell, but plant remains are relatively rare.

There are two main excavated faunal assemblages recorded from archaeological excavations on Kangaroo Island, from Seton and Cape du Couedic rockshelters. The deposits within these sandy-floored, limestone rockshelters have preserved the bones of animals, birds and shellfish. In the case of Seton, a relatively small rockshelter (approximately 7m wide and 3m deep), the site also functioned as a *Sarcophilus* (Tasmanian Devil) lair in between human visits (Hope *et al.* 1977; Lampert 1981:103). These animals also contributed to the faunal assemblage in the shelter and probably even reworked some of the bone refuse left by humans. Fortunately there are a number of distinguishing characteristics which identify this carnivore/scavenger activity, including a concentration on small animals, the breakage of bones into small, uniform-sized pieces, tooth marks and an absence of burning. One extinct genus of kangaroo, *Sthenurus*, is represented in the lower occupation layer of the site, and suggests that the local extinction of these animals took place somewhere between 16,000 and 11,000 years ago. The tentative identification of red kangaroo (*Megaleia rufa*) in the early occupation layer would seem to indicate a much drier and more open, grassy landscape during the last glacial maximum, when the island was a plateau, with Seton some 20km inland from the low sea-level coastline. The wide range of mammals, birds, reptiles and molluscs present in the assemblage otherwise reflect the fauna of the surrounding mallee and low sclerophyll forests of more recent times, as well from the nearby freshwater lagoon.

In general, the analysis of faunal remains from the Seton excavations concentrated upon palaeoenvironmental reconstruction (Hope *et al.* 1977; Lampert 1981), and did not investigate the potential evidence regarding human behaviour that might be available from the assemblage.

The Cape du Couedic excavations and analyses were designed to implement a more forensic approach – to use the ethnohistorical, experimental and environmental investigation techniques of a 'middle-range theory' approach to address questions about the patterns of human behaviour that produced the assemblage (e.g. Binford 1979, 1981, 1984). What insights could the faunal remains provide about the use of that site and the resources of the surrounding area by Indigenous hunter-gatherers in the mid-Holocene? What could we learn about the nature and composition of the occasional human occupants of the shelter from the assemblage? Could this information take us beyond the bare bones of tool typologies and provide some insight into the lifestyle of the mysterious, prehistoric inhabitants of Kangaroo Island – how similar to or different from mainland Indigenous people of that time, or even the more recent past, might they have been?

The Evidence from Cape du Couedic Rockshelter

Cape du Couedic Rockshelter has a floor space of approximately 300m², and is located just below the top of 80m high limestone cliffs overlooking a small cove near the southwestern corner of Kangaroo Island (Figures 2-3).

Plant remains have not been preserved in the site apart from pieces of carbonised grass-tree (*Xanthorrhoea* sp.) trunk in many of the fireplaces and cooking pits, and rare leaves and twigs which may have blown in. The introduced *Xanthorrhoea* pieces may have resulted from a number of uses other than simply firewood – resin used as glue and for hafting stone tools (one quartzite cobble 'knife' flake from the earliest occupation level of the site has a preserved resin handle), as a yellow pigment or as

Figure 2. View of Cape du Couedic Rockshelter, at the centre top of the cliff (Photograph: Neale Draper).

an antiseptic (crushed resin), as food (the inner part of the trunk), or as a fragrant inhalant and incense (trunk or leaves). These uses are widely known among South Australian Aboriginal people today.

On the other hand, bone and shell are well preserved in the calcareous sand of the archaeological deposit, particularly in the midden extending along much of the back wall of the shelter, below a low, overhanging rock ledge (Figure 3). The large mammal and shellfish components of the Cape du Couedic faunal assemblage have been analysed in Draper (1991). The small fauna assemblage from Cape du Couedic has been described separately by Langeluddecke (2001). This study revealed that eight foetal and neonatal sea lion pelvic bones had been included in the small fauna collections in error. The additional material does not substantially alter the overall pattern of results from the original analysis, which is focused on the treatment of adult and subadult animals. It should be noted that as well as hunting larger sea lions, the occasional inhabitants of the rockshelter also took pups from the colony.

Faunal analysis of 1830 large mammal bones from the archaeological excavations at the rockshelter included identification of species, anatomical parts, and patterns of breakage, burning, and cut marks on the bones (Draper 1991). These data were interpreted with the assistance of ethnoarchaeological, historical and experimental data in order to link specific faunal procurement and processing techniques with diagnostic archaeological signatures.

The large fauna assemblage from Cape du Couedic Rockshelter consists of food remains discarded by the human occupants of the site within midden deposits, or scattered remains discarded in association with cooking ovens or hearths. The midden deposits along the rear wall of the shelter include bone, stone artefacts and charcoal, contained within a matrix of charcoal and ash-stained sand. Eighty-eight percent of the bones have some degree of burning, and 29% exhibit cut marks. Gnaw marks are very rare on the larger bones, occurring on only eight specimens in the excavated assemblage. These have been identified tentatively as seven instances caused by small animals (e.g. rodents, Dasyurids), and one of human origin. The assemblage of large fauna bone has been only minimally affected by non-human taphonomic agents.

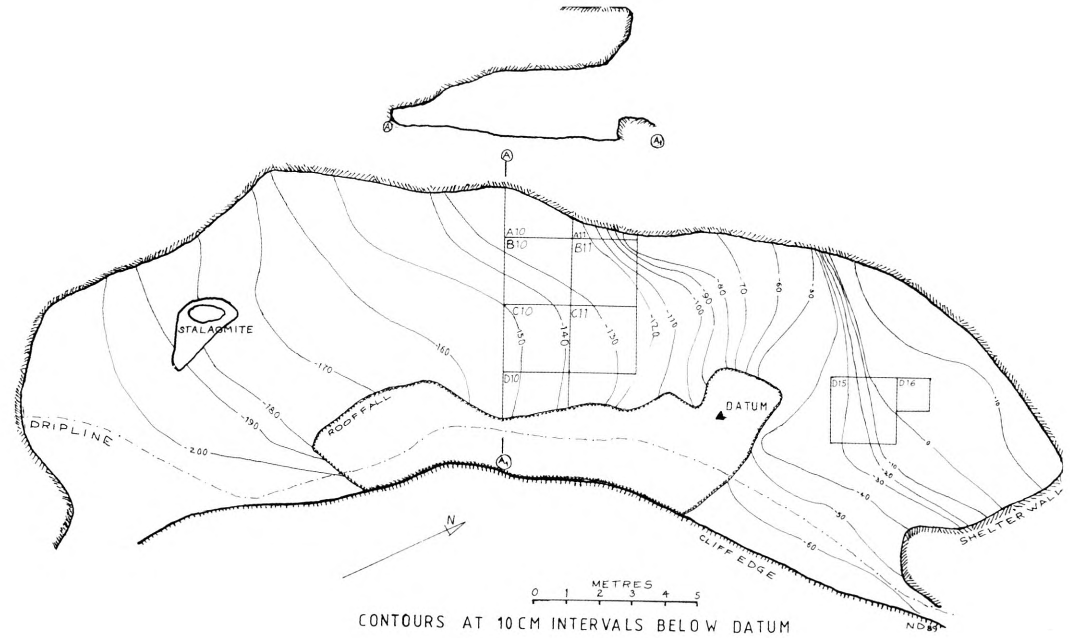

Figure 3. Site plan of Cape du Couedic Rockshelter, showing the location of excavations.

People used this shelter while hunting and collecting food resources along the coastal cliffs, beaches, and adjacent scrubland and forests. This period of use appears to have coincided with the presence of a sea lion (*Neophoca cinerea*) colony at the base of the cliff, at a time when the rising postglacial seas provided a broad beach at the head of the nearby cove. Before 7500 years ago, the shore was further out at the mouth of the cove or beyond, while after about 6000 years ago, the final stage of sea-level rise reduced the beach to a narrow strip of sand and cobbles at the foot of the cliffs. At around this time, the sea lions probably moved to broader beaches and fringing sand dunes further east (such as Seal Bay, where they are found today), and Indigenous use of the rockshelter ceased. The other large fauna represented in the assemblage, kangaroo and Tamar Wallaby, still inhabit the low scrub of the coastal cliff tops and the forests further inland today (this area lies within Flinders Chase, South Australia's earliest National Park). The biology of Kangaroo Island mammals is summarised in Inns *et al.* (1979). The extinct Kangaroo Island Dwarf Emu (*Dromaius baudunianus*) also is present (Morgan and Sutton 1928; Parker 1984), represented by small amounts of burnt bone and egg shell.

Macropods

There are two larger macropods represented in the Cape du Couedic assemblage. The smaller of these species is the Tamar Wallaby (*Macropus eugenii*), with adult males weighing on average 11–12kg. The other species is the large Kangaroo Island Kangaroo (*Macropus fuliginosus fuliginosus*) – a distinct subspecies of the western grey kangaroo, and the largest contemporary kangaroo species – adult males may measure 2.5–3m from nose to tail (Wood Jones 1924:257).

Macropods have a distinctive physiology and, consequently, a distinctive economic anatomy as well. Their forelimbs are relatively small, the rear limbs and hindquarters are very substantial, and the large, thick tail is also a significant source of meat, marrow and sinews that are used traditionally for the manufacture and repair of composite tools and weapons. The economic anatomy of the kangaroo has been described by Hopwood (1981), Hopwood *et al.* (1976) and Tribe and Peel (1963), and is very usefully summarised for archaeological faunal analysis by O'Connell and Marshall (1989).

The faunal analysis focused upon calculation of the minimum number of anatomical elements (MNE) represented in the assemblage, and the minimum animal units (MAU) that this implicates. MAU is a conversion of MNE data into complete 'animal units'. In other words, the MNE count of bones present in an assemblage (e.g. for complete ribs or for proximal humerus) is divided by the number of those

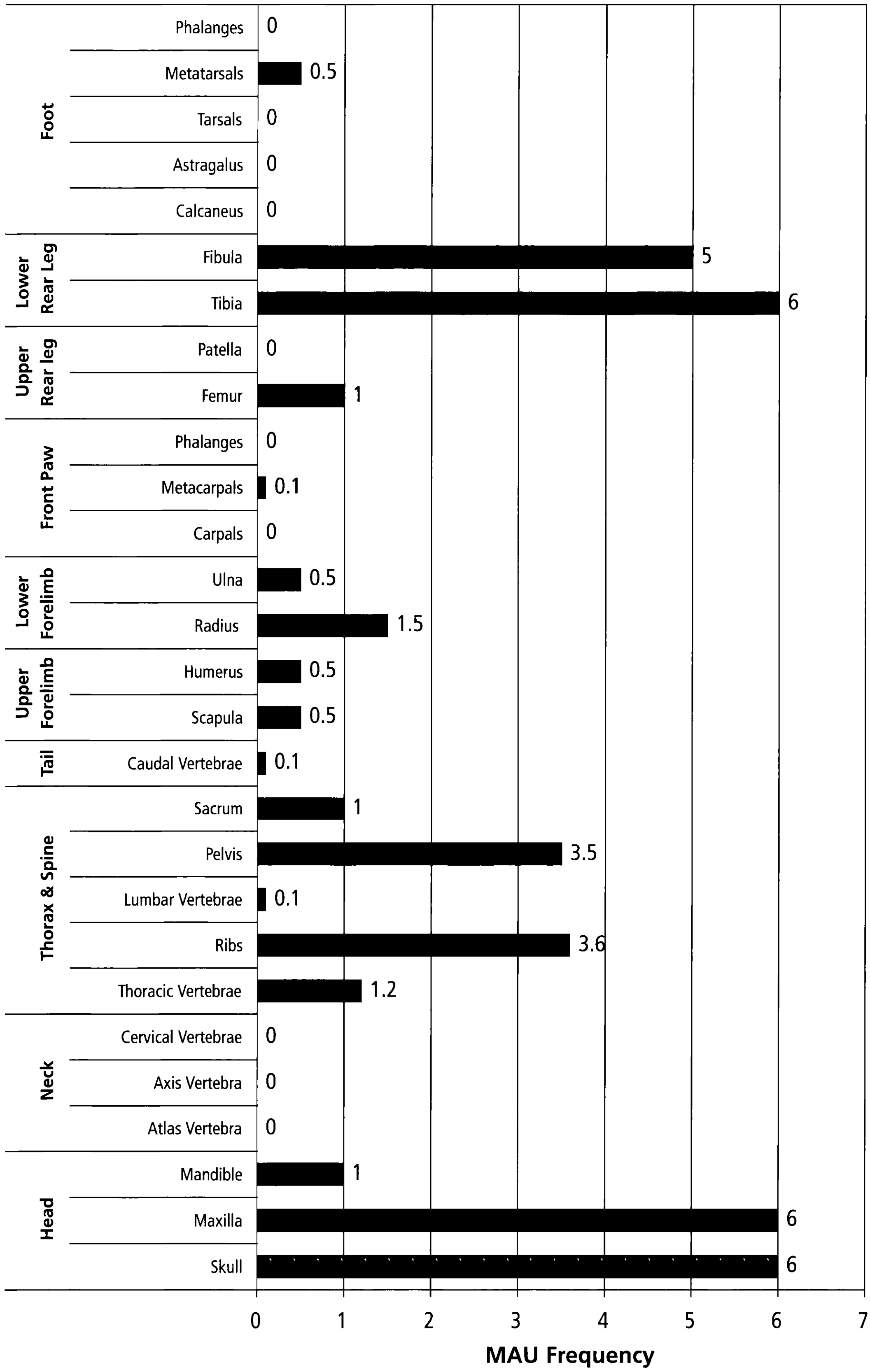

Figure 4. Combined macropod MAU frequencies, Cape du Couedic faunal assemblage.

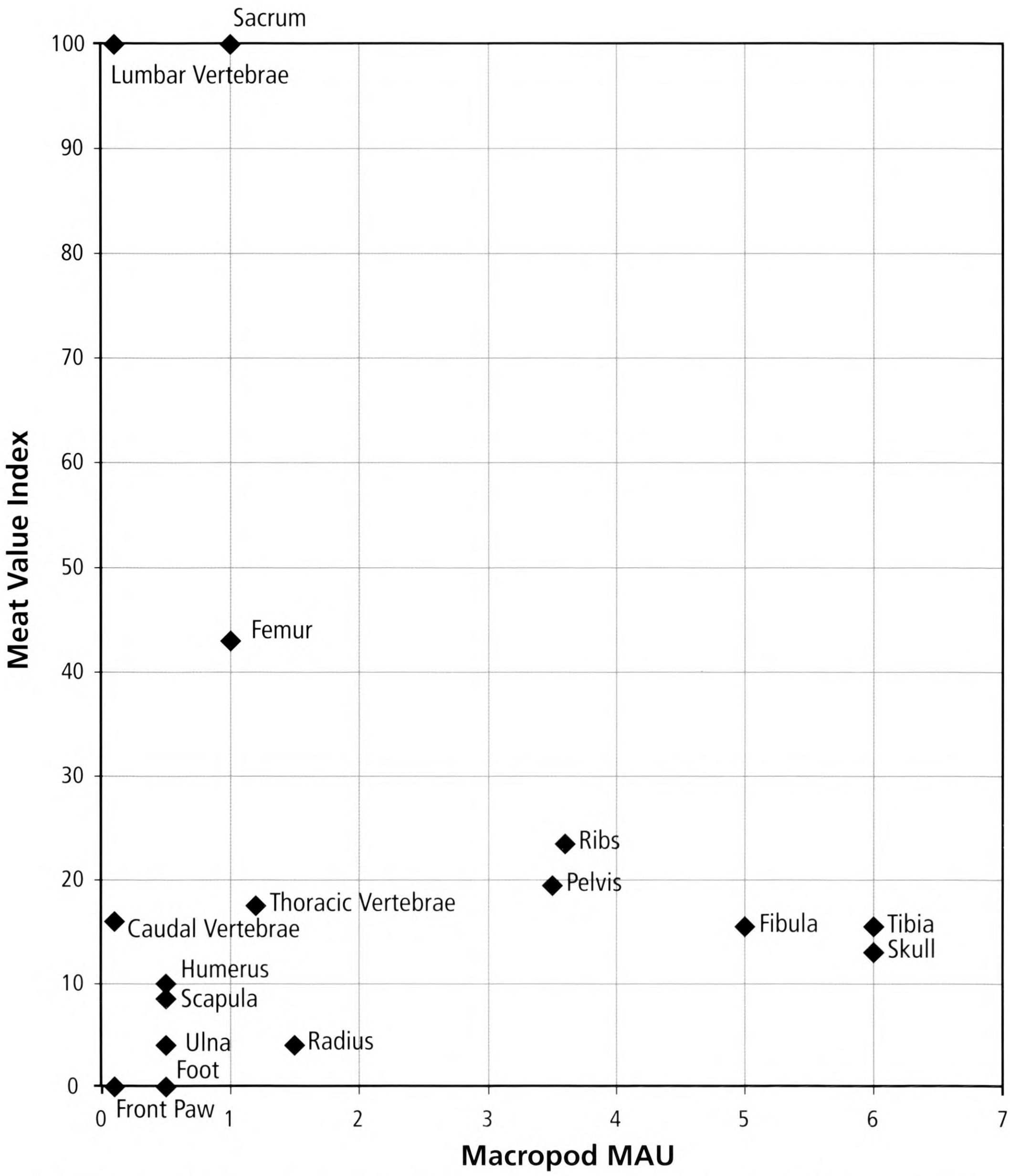

Figure 5. Macropod MAUs from the Cape du Couedic faunal assemblage compared with averaged Red Kangaroo meat utility indices (O'Connell and Marshall 1989).

anatomical parts which occur in a complete animal (26 ribs, 13 on each side; 2 proximal humerii, one on each side).

Macropods were not introduced to the site as complete animal units. Figure 4 shows that although the excavated assemblage has a baseline of at least six animals represented, based on counting heads and lower legs, this is reduced to 3.5 for the ribs and pelvis and less for all remaining anatomical segments, with the tail, feet, front paws, lumbar vertebrae and neck altogether absent. There are additionally 98 indeterminate long bone fragments (leg and forelimb), 22 plate fragments (e.g. skull, scapula) and one phalangeal fragment (foot) – which is consistent with the MAU pattern. Aboriginal hunters usually field-process kangaroo and wallabies – involving some butchering, cooking and consumption – as recorded in ethnographic accounts (e.g. Binford and O'Connell 1984; Gould 1967; McArthur 1960; McCarthy and McArthur 1960; O'Connell and Marshall 1989) and followed in contemporary practice (though the latter is sometimes mitigated by the use of motor vehicles in hunting). Some anatomical parts generally are consumed or discarded at the field-processing site, particularly the lower limbs and tail, and sometimes the intestines. The forearms and paws are often discarded or consumed in the field, as they have relatively little meat, while the tail is considered the most prized portion, and usually is consumed by the hunters. Intestines are heavy and spoil quickly, and so are usually consumed or discarded at this stage as well. The cooked carcass of an adult macropod is frequently butchered into about 9–10 portions for sharing among hunters and their families.

The faunal evidence from Cape du Couedic can be 'fleshed-out' by converting the MAU frequencies on bones to 'economic anatomy' units based on the relative amounts of meat and marrow that they represent. Figure 5 compares these MAU values with an averaged meat utility index based on Red Kangaroo (using data from O'Connell and Marshall 1989). This comparison shows two distinct trends in the Cape du Couedic macropod pattern. Clustered near the origin of the graph are a number of low utility body parts which were seldom if ever introduced to the site – the feet, the entire forelimb, the thoracic vertebrae (without the ribs) and the tail. These are parts that were usually discarded (presumably consumed) in the field. Note that the meat utility index value for caudal vertebrae in Figure 4 is probably too low, given the greater-than-average thickness of the tail of the Kangaroo Island Kangaroo.

The second feature of the graph is the negative curvilinear trend exhibited by the remaining body parts with decreasing meat utility but increasing frequency in the archaeological assemblage. The highest ranking part, the lumbar/sacrum, is rarely introduced into camp. It appears that a considerable portion of each macropod was consumed in the field, including both the lowest and the highest meat utility parts. The second highest meat index value is for the femur. This element is possibly under-represented in the archaeological assemblage owing to smashing bones for marrow processing. There are 98 long bone fragments, which are most likely to be either femur or tibia. However, if this is the case, the articular ends of the femurs must have been very thoroughly processed, as they are quite distinctive even in fragmentary form (e.g. the pelvic ball joint). Like the pelvis and tibia/fibula units, the ribs have a much higher MAU frequency than their meat utility indices would account for, particularly by comparison with the various vertebrae. The same applies to the skull, with the highest contrast of all between MAU value (high) and meat utility (low).

The pattern is further refined by considering the potential contribution of bone marrow, another valuable food source. Figure 6 compares the macropod MAUs with an average marrow index, calculated from data provided by O'Connell and Marshall (1989). With the exception of the femur, which is the second highest-ranked part in each case, this distribution is quite different from the meat index. The consistent selection of the tibia/fibula – and less frequently, the entire rear limb – matches their very high marrow value, and provides a potential explanation for their selection for introduction to the residential site. All other anatomical segments have much lower marrow values, but as shown by the curvilinear trend, their frequency of selection does correspond with this trend (excluding those segments classified as having zero value), suggesting that marrow content may have been a relevant criterion in selection of parts for transport to the site.

The most frequently introduced body part is the skull, which has not registered significantly either on the meat or marrow indices, but the brain is a separate food item that was not included in either of these scales. This gives the skull an additional food value which distinguishes it from other, medium-low meat utility parts, in the same way that the tibia is distinguished by its high marrow content. The choice of these particular elements for regular introduction into camp suggests that these additional food values were significant. Skulls and tibiae were both routinely broken (the high frequency of long bone shaft and plate fragments), which supports the interpretation of processing for marrow and brain extraction. Brain and marrow are both nutritious, easily digested foods – particularly useful for children being weaned or old people with few teeth, or those with special dietary needs, such as nursing mothers or invalids. It is possible that people in at least one of these categories were regularly present at Cape du Couedic, and that they had limited mobility and remained in the vicinity of the rockshelter rather than accompanying the hunters, so that this food was brought back for them.

There is another factor to be considered in relation to macropod processing at Cape du Couedic. Kangaroo Island has significant periods of cold weather, and it is likely that the local Aborigines skinned the macropods they caught, so that the furred hides could be processed for rugs and cloaks. This would affect the processing of the animals, as the skin could not be used as a container for cooking and carrying the meat. How would this practice affect the resulting faunal assemblage? Three historic accounts of kangaroo processing which involves skinning the animals are discussed below. These records were made in the mid-nineteenth century. The first is by a German missionary, Clamor Wilhelm Schurmann, a member of the fledgling European colony based at Adelaide. Only a few months after his arrival in South Australia in 1838, Schurmann accompanied a group of Kaurna people on a kangaroo hunting trip in the bush on the Fleurieu Peninsula (the mainland opposite Kangaroo Island):

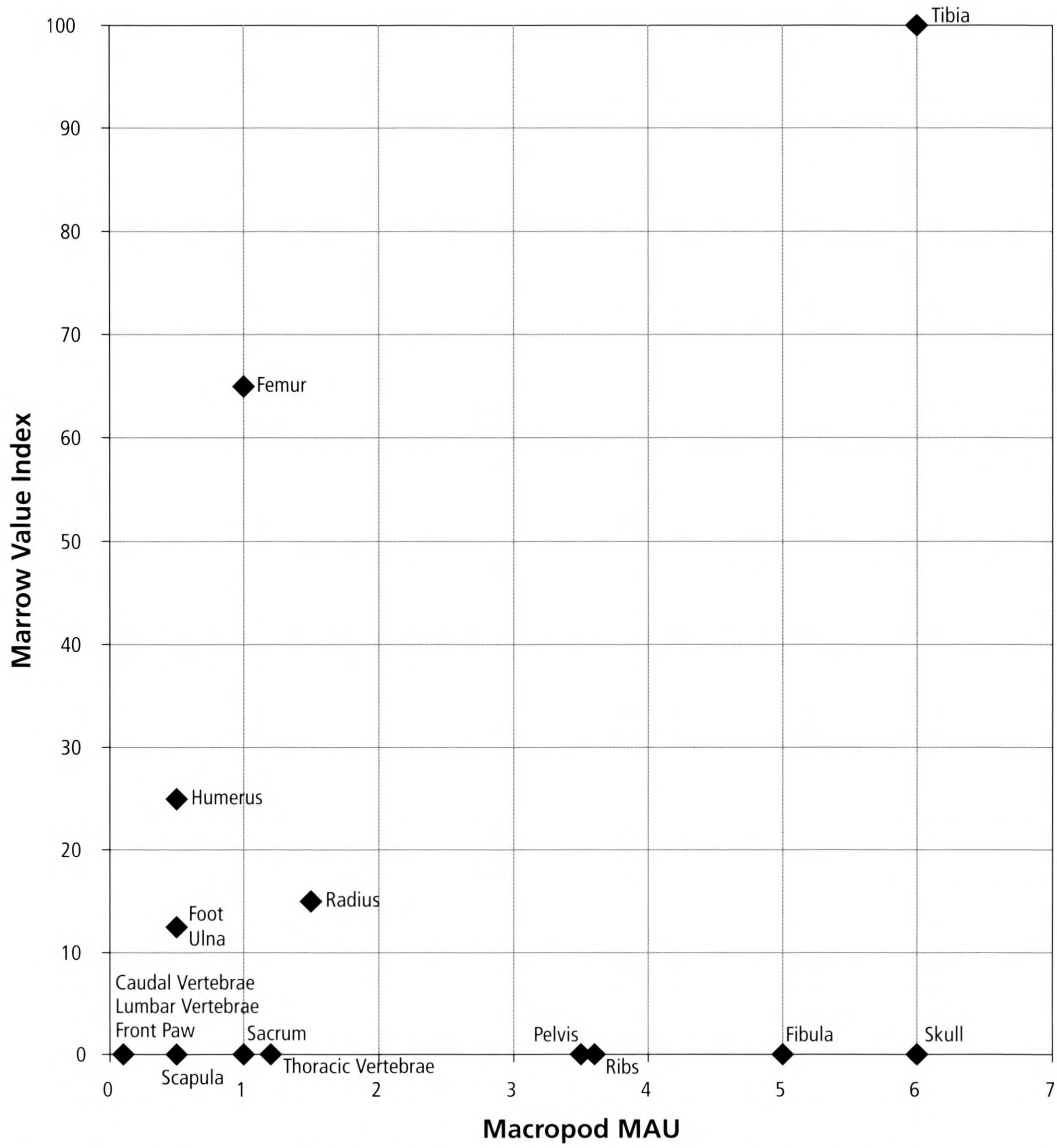

Figure 6. Macropod MAUs from the Cape du Couedic faunal assemblage compared with averaged Red Kangaroo marrow utility indices (O'Connell and Marshall 1989).

The way the natives prepare a kangaroo for eating is remarkable and worth a mention here. As soon as the prey is killed, they choose a place nearby, where wood and stones are available, to stew it. The animal is taken to this place, and the one most skilled begins skinning from the head down to the point of the tail. The tail is cut off and singed over the fire. Another one digs a hole a foot and a half deep [c.46cm]; another one collects stones, another wood. When the hole is dug they make a fire in it, and in this they place stones, which become glowing hot.

By the time the fire has burnt out, the butcher has eviscerated the animal, has cut off the legs and shanks, and made three slits in the thick meat of the legs, while another has cleaned the larger intestine. From the blood, collected in the hollow breast, they made a sausage. After this, they removed the stones from the heat and placed some into the breast and belly, others into the slits of the legs, mixed with the leaves from a small gum tree for seasoning. They laid branches from the same trees in the heat and on the kangaroo. Between the branches on the top, they placed the legs, the tail, and the sausage, as well as the lower parts from the intestines, and covered everything with glowing stones.

Meanwhile, one of them removed a piece of bark from a tree, large enough to cover the kangaroo from head to tail. The space between the bark and the edge of the hole was filled with soil to make it airtight. Now they rest comfortably for half an hour, and then they open up the sealed oven and pull out the cleanest, most magnificent roast.

> The butcher's duty now was to cut up the animal, and in this he was less clean, using the pointed end of a club, then his knife. Very cleverly he cut up the entire animal in about eight to ten pieces. When everyone had eaten his fill, they packed up the rest to share it among the women and children, and some men who didn't take part in the hunt (Schurmann 1987:63-64).

The layers of leafy branches and paperbark provide flavour and help to keep grit out of the meat and to prevent it from drying out too much during cooking (instead of the skin). It also results in more thorough cooking of the meat through a combination of steaming and oven roasting (particularly in the thoroughly prepared example reported by Schurmann, in contrast to minimal cooking time in central Australia). Depending on the plants used, this process often provided a side dish of edible, steamed greens as well. In describing the subsistence economy of the Nauo people of the area around Port Lincoln on Eyre Peninsula (on the South Australian mainland northwest of Kangaroo Island) in the 1840s, Schurmann (1987:226) wrote:

> All kinds of meat and fish are roasted on the fire; large animals, such as kangaroos, are skinned and cut into joints, but the smaller sorts are thrown on the fire without being skinned, unless the natives want to save the fur for cloaks. When the hair is well singed off they are taken from the fire again, and the inside is taken out, and is generally handed over to the women and children.

From the mid-nineteenth century forests around Brisbane in southeast Queensland, Tom Petrie (1975:84-85) observed broadly similar practices, and noted the criteria used to decide on the appropriate processing tactics for different animals. The Turrbul people around Brisbane skinned kangaroos which were considered suitable, but unlike the South Australian examples, they did not joint the animals prior to cooking. These examples all involved field butchering (either before or after cooking) and also partial consumption of the skinned macropods in the field.

Processing activities such as skinning and butchering also tend to leave diagnostic cut marks on the bones. Figure 7 illustrates the distribution and orientations of cut marks on macropod bones from the Cape du Couedic assemblage. The shaded portions are anatomical parts which are rare or absent from the faunal assemblage. Binford (1981) provides a useful discussion of ethnographic, ethnoarchaeological and experimental records related to different methods and strategies of portioning animals during butchering, as well as cut mark and bone breakage 'signatures' related to skinning, dismemberment by cutting and leverage, filleting and marrow cracking. In using this information in the Cape du Couedic faunal analysis, allowances need to be made for the smaller forelimbs and larger rear limbs of macropods, compared to more conventional quadrupeds. In addition, Binford's data relate to large tool, 'chop and break' butchery, which involves distinctive dismemberment strategies and patterns of cut and chop marks (Binford 1981:142-147 notes the use of a throwing stick by an Alyawarra man in 'chop and break' dismemberment of a kangaroo).

Which butchery strategies were used to process the animals represented at Cape du Couedic? From an anatomical viewpoint, the logical sequence of animal processing is: (a) skinning; (b) dismemberment; (c) filleting; and (d) marrow processing (Binford 1981:106) Not all of these stages will be present everywhere, and cooking may be interposed between one or more stages (e.g. if leftover food is reheated). The question of skinning already has been raised above, in connection with ethnographic descriptions and the macropod anatomical part frequencies in the faunal assemblage. Figure 7 records numerous diagonal and transverse cut marks on the upper part of the skull. These cuts are not associated with butchering – for example the severing of the skull from the neck, which would place cut marks further back, on the occipital bone around the margins of the *foranum magnum* (Binford 1981:107). Half of the plate/blade fragments listed also have cut marks. These pieces could be either from the skull or scapula. The cut marks form part of a pattern which includes the diagonal cut marks appearing on each of the few radius and ulna bones introduced to the assemblage, as well as the diagonal and transverse cuts on distal/medial tibia. The macropod lower arm (radius, ulna) receives no butchering attention in any of the ethnographic accounts, because of the low meat value of this segment. The sample of these bones in Cape du Couedic is very small, but the pattern is consistent. The tibia/fibula unit is much better represented – the single example of a transverse cut on a distal fibula is probably associated with dismembering the foot (Binford 1981:119), a ubiquitous Aboriginal practice in the ethnographic present, and inferred at Cape du Couedic from the high frequency of the distal tibia/fibula, and the virtual absence of foot bones in the assemblage. All but one

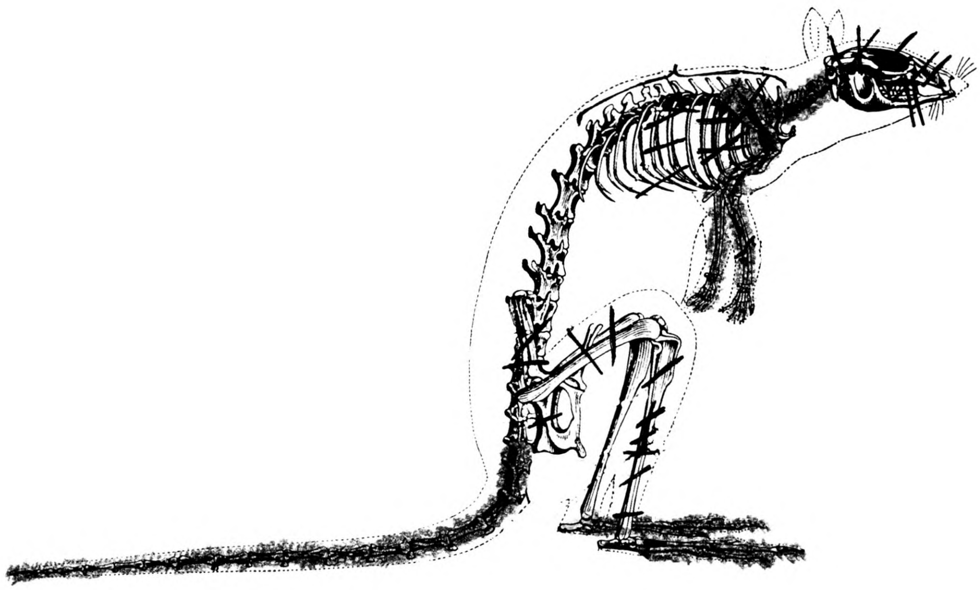

Figure 7. The distribution of cut marks on macropods from the Cape du Couedic faunal assemblage. Shading indicates anatomical parts rarely present or absent from the assemblage. There were also 81 cut marks on long bone fragments, and 11 cuts on plate fragments.

tibia and one fibula have cut marks, and nearly all of these are clustered around the distal/mid-shaft region. These are not dismemberment cuts, and only one bone has a longitudinal cut mark consistent with filleting the meat form the bone (Binford 1981:127, 130-131), or from skinning (Binford 1981:107). The rest of the marks are diagonal or transverse. Their orientations and locations are diagnostic of skinning:

> There are actually very few places on the anatomy where the manipulation of the skin brings the butcher in direct contact with bone. The two places where this is most likely are the lower legs and the head. I have already mentioned that cuts derived from skinning activities have been noted encircling the shafts of lower limb bones. Such cuts have been observed on the lower tibia, the shaft of the metatarsal ... and the phalanges. Analogous placement has been noted on the front leg, the distal segment of the shaft of the radio-cubitus, the metacarpal, and the phalanges. The encircling cut is generally one of the first to be made and is basically the "point of entry" for the skinning of the animal. Subsequent cuts normally originate at such an encircling cut and extend down the medial face of the leg to the body of the animal. Cut marks may result from this action.
>
> The second place where the skin is essentially stretched over bone is on the head. There are several places where one might expect cut marks if the head is in fact skinned out: around the base of the antlers ... or horns, somewhat less commonly around the ears, and around the mouth, particularly in the "chin" area of the mandibles (Binford 1981:107).

In translating this pattern into macropod terms, there are no antlers or horns, but because the pelt is very thin on the head, kangaroo skins are usually removed back from the region of the ears. This is consistent with the cuts on the skull shown in Figure 7. In the example of Aboriginal skinning of a kangaroo on a hunting trip near Adelaide that was recorded by Schurmann, the skinning took place from 'the head down to the point of the tail' (Schurmann 1987:63), the opposite of the process described by Binford. This would not present difficulties, as the skins of macropods have relatively little subcutaneous fat, which is easily peeled off the carcass except for the muscle attachments of the forelimbs and the concentration of fat around the internal organs of the lumbar region (Kamminga 1982:39, 40). Kamminga's experiments in skinning kangaroos resulted in longitudinal and diagonal cuts towards the distal ends of the tibia and fibula in the process of making incisions to open out the pelt. There were also cuts around the forelimbs and diagonal cut marks across the ribs to the sternum (some of the cuts on ribs shown in Figure 7 are consistent with this pattern). Marks on the distal-medial tibia also may be caused when cutting tendons away from the skin at the ends of the hindquarters (Kamminga 1982:31). The evidence for the consistent skinning of these macropods for their furs is convincing.

Most of the remaining cut marks on the Cape du Couedic fauna can be related to dismemberment. The transverse cuts on the medial mandible could relate to either filleting out the tongue from below the jaw, or from butchering the mandible away from the skull on a stiff carcass. In the latter instance, it is likely that the stiffness of the carcass would be the result of a widespread Aboriginal practice of dismembering the carcass after cooking, rather than the alternatives of the carcass being frozen or in an advanced state of *rigor mortis* as described by Binford (1981:109; Gould 1967:53; O'Connell and Marshall 1989:395-396). The transverse or diagonal cut marks on three out of 10 maxillary pieces are consistent with the mandibular cut marks (e.g. Binford 1981:109-110, 1984:104).

Five out of 14 thoracic vertebrae have transverse cut marks. These occur on the cylinders of the vertebrae, and are consistent with rib removal rather than filleting (Binford 1981:111). Binford describes three general categories of cut marks on ribs: (a) transverse cuts at the proximal end (dorsal surface) related to filleting the tenderloin; (b) the distal ends of the ribs cut off, from separating the brisket; and (c) transverse/diagonal cuts on the proximal end (ventral surface) from removing the rib slabs by the 'bend back and chop method' (1981:113). Less than half the macropod ribs have distal ends present. The distal end cut marks (diagonal, transverse) could relate to either separating the brisket from the ribs, or from separating the ribs from the sternum during removal of the rib slabs.

The pelvis is not a frequent anatomical part in the assemblage, but seven out of eight pieces have cut marks. Two of these are complete (that is, a complete left or right side) and the others consist of the ilium and acetabulum (four), an ischium and acetabulum, and an unspecified fragment. It is very likely that the partial bones relate to episodes of splitting the pelvis through the pubic symphysis during dismemberment of the carcass, where the pubis has been broken off the pelvis in the process, as described routinely in the Australian ethnographic examples (Draper 1991:Figure 6.7a). The pattern of transverse and diagonal cuts on the ilium and ischium, generally concentrated around the acetabulum, is typical of dismembering the dislocated proximal femur from the pelvis (Binford 1981:113-114, Figure 4.22, 1984:124-125, Figure 4.13).

The femur is represented only by three partial shafts, each with diagonal and/or transverse cut marks, which might be related to either dismemberment or meat removal. Ninety-five percent of the long bone shaft fragments have diagonal and/or transverse cut marks. As these pieces come mostly from the shaft rather than ends of the long bones, this cut frequency is consistent with the tibia, fibula and femur cut patterns.

Breakage patterns also support the interpretations related to marrow processing, particularly in relation to the thorough fragmentation of tibia and femora at the site. Based on the evidence from parts of the tibia which have survived in recognisable form, these bones were usually cracked by bipolar percussion on an anvil (possibly using the same hammers and anvils used for the bipolar flaking of quartz micro-blade artefacts at the site). This technique is described by Binford (1981:157-158) on the basis of his experience with the Nunamiut in Alaska.

> This is the "on-anvil" technique, where the bone rests on an anvil – commonly one of the large stones surrounding the hearth – and is impacted with a hammer. Bones broken in this manner are seated on the anvil in a stable fashion and do not slip around. Bones commonly seated on the posterior or anterior faces are distal metapodials, distal radio-cubitus, and the distal tibia. These are almost always impacted on the posterior or anterior faces rather than on the lateral or medial faces, as is more common when the bone is held in the hand and impacted with a hammer at an oblique angle to the bone. The latter orientation biases the break in favor of a classic spiral fracture, which if done well will run up the cavity exposing a considerable portion. Impacting on the posterior or anterior faces tends to shatter the bone or produce a complex depressed fracture (common with the radio-cubitus and metapodials) or a complex bipolar fracture more likely with the distal tibia. Removal of the articular ends in this fashion commonly results in an unbroken section of the shaft of the bone in the form of a cylinder (particularly with the femur and tibia), which is then freed of its marrow by pushing the "hot dog" out with a small stick or sometimes a sheep rib bone ... Regardless of whether the hammer-on-bone technique or the on-anvil technique is used, the impacts are still directed at the neck area of the bone just below the articular [sic] ends.

At Cape du Couedic, the proximal tibia have disappeared archaeologically (e.g. disposed in a special place which was not excavated, reduced to unrecognisable fragments, not introduced to the site), but the distal and medial tibia shafts were cracked in the manner described by Binford (1981:161-162; Draper 1991:Figure 6.7b, Figure 6.7c). This pattern is identical to the broken macropod long bone shafts from the Pleistocene lower layers of Devil's Lair in southwest Western Australia illustrated by Dortch (1984:61-62).

Finally, there is a generally high incidence of graded, light-medium burning on the margins of bones (except on the small forelimb sample) as well as examples of charred thoracic vertebrae, ribs, a fibula shaft, and long bone and plate fragments. This pattern also suggests that the animals had been skinned before cooking, which would increase the likelihood of edges and ends of bones burning during cooking. More than that, it also suggests dismembered joints were being cooked rather than entire animals. However, this interpretation cannot be certain, as the burning pattern could also be the result of reheating 'joints' introduced to the site from an animal previously cooked whole in a field oven.

Overall, the different lines of evidence available from the analysis of this mid-Holocene assemblage of macropod bones provides a remarkably consistent picture, and one that also is consistent with the ethnographic pattern of recent and contemporary Aboriginal society.

Sea Lions

The inhabitants of Cape du Couedic rockshelter also hunted the Australian Sea Lion, *Neophoca cinerea*. This species provided a much greater contribution to the diet of the occupants of the rockshelter, with an MAU frequency of 33.4 based on the most frequent anatomical element, lumbar vertebrae.

Sea lions live in colonies, located on beach sands, coastal cliffs and sand dunes. They are not migratory and most spend all year in the vicinity of the colonies (Day *et al.* 1979; Ling and Walker 1979). In wet, cold, and/or windy weather, sea lions often seek shelter away from the shore – and they also climb cliffs. This remarkable capacity for travelling on land as well as in water is a result of the unique anatomy of the sea lion. Among true seals, the rear flippers provide locomotion. However, sea lions have a different functional anatomy (see Figure 8). The forelimbs of fur seals and sea lions have are broad paddles with which the animal 'rows' itself along through the water. The heavily muscled forelimbs are also used for walking and for climbing.

In terms of economic anatomy, this means that the most important meat-bearing parts are the shoulders and forelimbs. This is followed by the lower back and rump, then the thorax and ribs (which surround a large chest cavity). The rear limbs are small, and in terms of their meat yield, may be collectively regarded as a continuation of the trunk. The sea lion has a streamlined profile with a thick neck, and overall, its economic anatomy resembles a vertebrate 'sausage roll' with well-developed forelimbs:

> Seal limbs appear short in comparison with body size and this impression is heightened because the upper segments of the limbs are concealed within the general body contour. The 'armpit' and 'groin' in a seal occur at the level of the wrist and ankle respectively. Furthermore, the bones of the limbs are short and sturdy (Bonner 1989:6).

Apart from its implications for the distribution of edible tissue on the animal, this anatomical design results in the unusual but effective manner in which the sea lion moves on land, including the inland forays and cliff-climbing abilities referred to above:

> Because the locomotion in the water is effected by the fore limbs their hind limbs are less modified. In particular the shank is not bound as rigidly in a posteriorly directed position as in the true seals. This means that a fur seal on land can bring its hind flippers forward and waddle on its heels. Because the limb bones are shortened and the limbs mostly within the body contour, the steps it can take are very short but when really exerting itself a fur seal can break into a gallop, bringing its hind flippers forward simultaneously and covering the ground at a surprizing rate (Bonner 1989:10).

In this way, sea lions and fur seals may sometimes prove dangerous to the hunters. Vanderwal and Horton (1984) relate several historic accounts of Tasmanian Aboriginal men being attacked by fur seals while attempting to kill them with clubs in a colony, sometimes resulting in serious injury to the hunter. Wood Jones (1925:372) considers that intrusion into the 'harem area' during the breeding season or blocking an

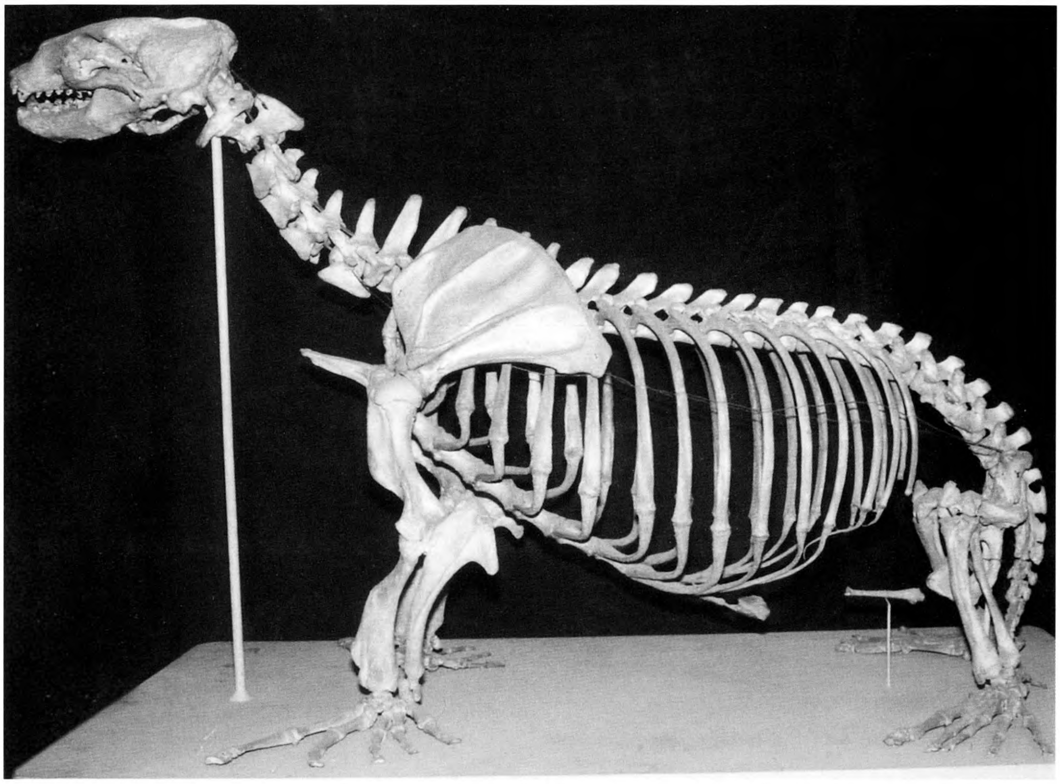

Figure 8. Articulated skeleton of a young adult, male sea lion (South Australian Museum) (Photograph: Neale Draper).

animal's path back to the sea are the 'only two circumstances under which they may become dangerous to one who does not intentionally molest them'. Of course, the point here is that the hunters certainly were 'molesting' them. It would be difficult to successfully spear such animals, as their vital organs are comprehensively protected by closely spaced ribs, a heavily muscled torso and neck, all sheathed in a thick layer of blubber overlain by tough hide. It has been reported that the only hunting technique successfully used on land (as opposed to harpooning) appears to be the use of clubs to bludgeon the animals, usually across the frontal/nasal area, where the bone is relatively thin and not protected by very much 'padding' of muscle or blubber (Vanderwal and Horton 1984:96-98; John Ling, SA Museum, pers. comm., 2006). If the animals were not taken unaware, they could certainly strike back with their powerful tails and flippers, their large canine teeth, and their surprising combination of bulk and speed of movement:

> The adult bull is an animal of great bulk, a total length of ten to twelve feet [c.3–3.7m] is about the average for well grown specimens, and the build, especially about the neck and shoulders, is extremely massive (Wood Jones 1925:364).

On the other hand, the combination of microblade-barbed spears propelled by spear throwers may have been equal to the task, particularly if several hunters worked in unison (certainly equivalent to harpooning), and would have been at least marginally less dangerous than attacking the animals at extremely close range with clubs. Such projectile weapons would have had much greater range, penetrating power, and shock/trauma delivery for hunting these animals than would unbarbed, hand-thrown spears.

The MAU frequencies for each anatomical part are shown in Figure 9. In this bar chart the rear limb is listed directly after the pelvic region, because the sea lion's rear limbs are not separate 'limbs' at all in terms of economic anatomy (as described above), but rather a continuation of the torso, with flippers attached at the end. The forelimbs are more distinct anatomical units, external to the 'body sausage', so that these elements are listed last.

There is a fairly consistent pattern of butchering and consumption in the excavated assemblage. Heads are often introduced (skulls have been mainly smashed into fragments). The axis vertebrae may be the severing point and has a lower frequency. The trunks of the animals are well represented in terms of cervical, thoracic and lumbar vertebrae, the pelvis, and extending through the rear limb (tibia) to the ankle (calcaneus) except for the sacrum and tail. Ribs are under-represented here, suggesting animals were butchered into portions, and that rib slabs were introduced to the site less often than vertebral slabs. The tail area is often missing, including the sacrum, caudal vertebrae and femora. Forelimbs are well represented (consistent with the fact that they are much larger than the rear limbs).

My interpretation of the sea lion pattern is that: (a) this material was introduced to the site from a separate kill/butchery location; (b) body parts were introduced in frequencies roughly proportional to their food value in attached meat and blubber; (c) some marginal parts were invariably abandoned or consumed at the initial processing site (always the flippers and frequently the tail and the ribs); and (d) the head was severed from the neck at the axis vertebra.

There are some relevant ethnographic examples, involving anatomically similar fur seals or dugong. Vanderwal and Horton (1984) summarise historic references by Kelly (1921 cited in Vanderwal and Horton 1984), who writes of fur seal hunting by a group of Aboriginal women at George Rocks, northeast Tasmania. The women cooked their supper by each butchering a shoulder (with forelimb?) from a young seal, and cooked in the open fire (presumably using the skin as a 'dish' for cooking. In processing a number of fur seals for transport to the main camp of their residential group, the women removed and roasted the shoulders and flippers for their own use, while the seal carcasses were returned – otherwise whole – to the camp (Kelly 1921:179 cited in Vanderwal and Horton 1984:98).

In Heinsohn and Marsh (1984:Figure 7), there is a photograph of a dugong being butchered at the water's edge by an Aboriginal hunter. It appears that the head and one forelimb/shoulder have already been removed, and the butcher is in the process of removing the second forelimb package. The photograph shows the carcass lying on its back at the water's edge, a longitudinal cut running from the neck to the beginning of the caudal vertebrae. Here, a deep transverse cut has almost severed the tail from the trunk. Donald Thomson (1934:247-250) describes dugong butchering at Cape York in the late 1920s in considerable detail. The key factors for the current discussion are that initial butchering involved a deep incision down the face and around the upper lips and then a deep cut down the mid-dorsal line of the underside of the body to the tail. In the case study reported by Thomson, the dugong were then butchered into transverse portions (1934:248, Figure 3), the number of shares depending on the number of hunters.

Figure 10 shows the distribution of cut and chop marks on the sea lion bones. They are concentrated mostly on the face, the lower forelimb up to the middle of the humerus, the ribs and occasionally the thoracic vertebrae, and the lower rear limb – tibia, fibula and tarsals. The bones often were chopped through, smashing and crushing the bone along the chopped edges in the process.

The skull has usually been smashed to remove the brain for eating, after roasting the heads. The points of the canine teeth are usually burnt, and the enamel heat-cracked. Cut marks are relatively scarce on most of these pieces, except the nasal area (Draper 1991:Figure 6.17). This is a very uniform butchering blow – perhaps a 'killing blow', but quite possibly a similar, initial step in skinning prior to butchering as recorded by Thomson (1934:247). The largest specimen also exhibits chop marks above and below the eye, and the splitting of the skull longitudinally down its central axis, which is the case for every specimen. The splitting of the skull and smashing of the cranium appears most likely to have occurred to extract the brain.

Thirty percent of thoracic vertebrae have broken (or chopped) processes, and often ends as well. The thoracic vertebrae probably were often damaged during removal of the rib slabs, the ribs being long enough to have possibly required subdivision for cooking and for transport. Fifty-one percent of ribs are cut, and there appears to have been considerable flexibility in rib processing – perhaps owing to the wide range of animal sizes owing to age and gender. The rib slabs were frequently subdivided, apparently sometimes by chopping through them at mid-shaft. Perhaps in these cases, the thoracic vertebrae and proximal ribs were treated as a unit, and the distal ribs and belly sheet as another.

There is a consistent pattern of damage to the proximal end of the femur. These have either the head of the femur or the adjacent part of the proximal end chopped through, and twisted and severed (Draper 1991:Figure 6.19).

The tibia and fibula were usually cut or chopped/broken right on the bodyline around the ankle joint (distal tibia, tarsals) which is attributed to the severing of the rear flippers from the body. The equivalent severing of the flippers from the forelimbs is shown by diagonal chops, cutting diagonally right through the radius and ulna, severing them completely. The ubiquitous 'Kartan' cobble chopper seems the most likely candidate as the preferred butchering tool for large mammals, and several of these tools were recovered in the excavations (Draper 1987).

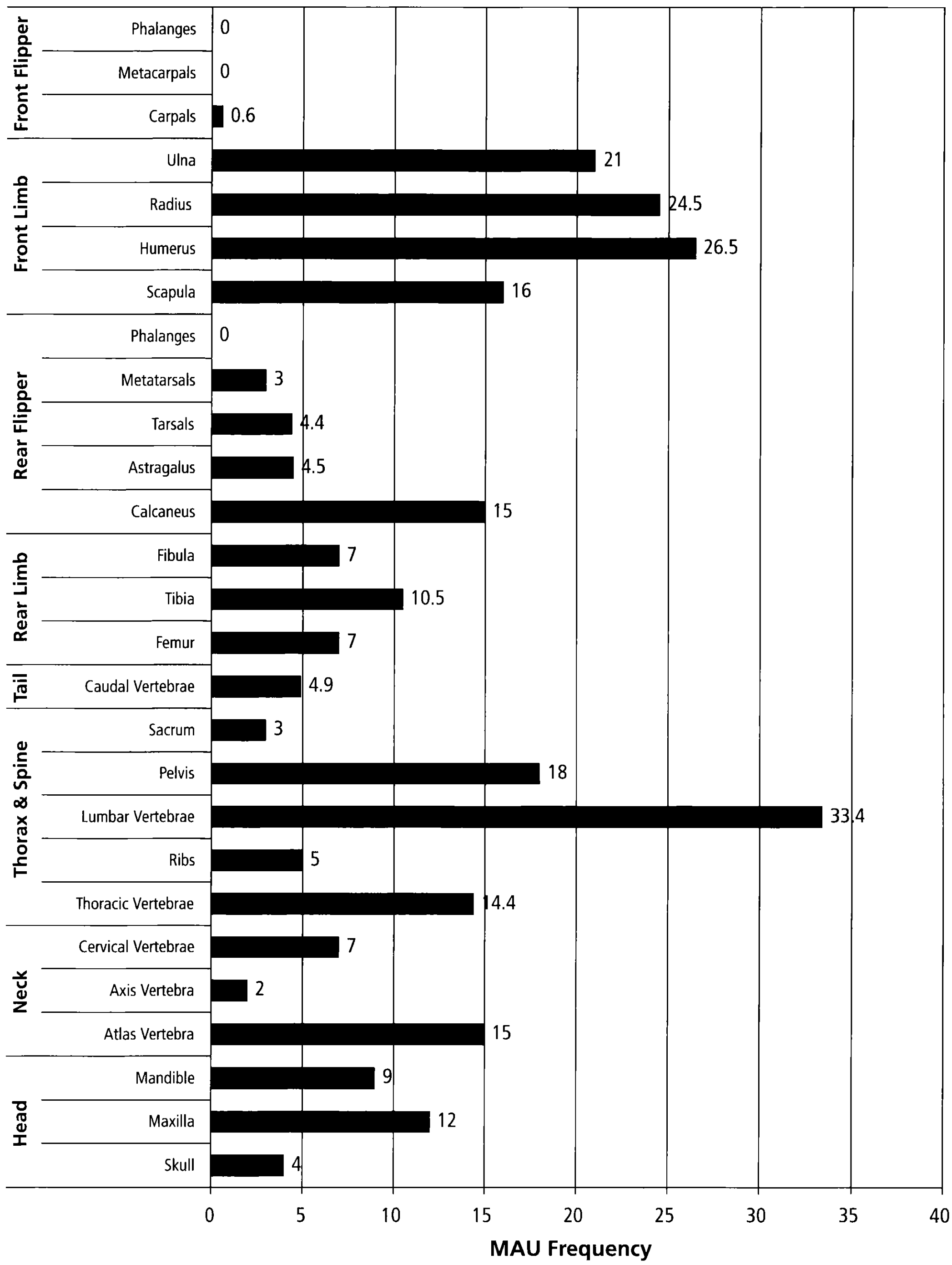

Figure 9. MAU frequencies for sea lion bones in the Cape du Couedic faunal assemblage, summarised by element.

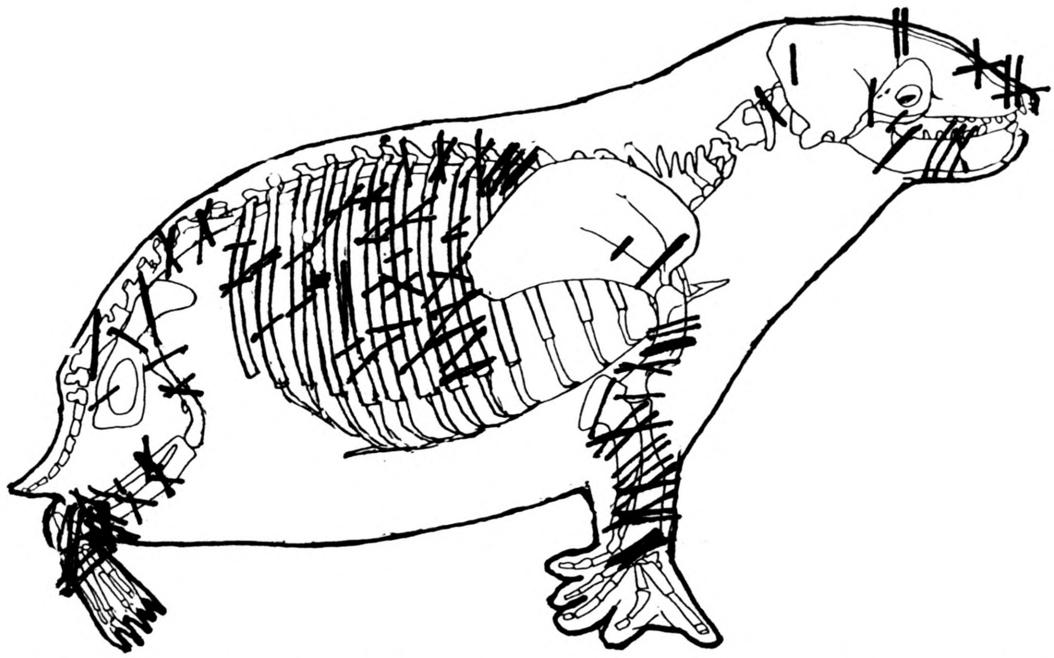

Figure 10. The distribution of cut and chop marks on sea lion bones in the Cape du Couedic faunal assemblage. The most frequent cut marks were on tarsals (rear flipper).

Summary of Faunal Evidence

In summary, parts of sea lions were introduced to the rockshelter much more frequently than macropod parts, and also provided a much greater amount of food than the various small animals, reptiles and birds represented in the faunal assemblage. Consistent with the macropod pattern, the primary butchering and cooking of the sea lions occurred in the field – presumably either on the beach or in a sandy, vegetated area inland of the cliff tops. A consistent pattern of selection was made for anatomical segments to be introduced to the shelter for consumption. The forelimb and the 'saddle' surrounding the lumbar vertebrae were the two segments most frequently introduced. These are the highest food utility parts of the carcass. The butchering pattern, the staging of the processing, and the selection of anatomical parts at each stage, have close parallels with more recent ethnographic and archaeological records of marine mammal processing (fur seals and dugong) in other parts of Aboriginal Australia (cool-temperate Tasmania and tropical north Queensland).

The spatial distribution of the large animal bones in Cape du Couedic Rockshelter represents careful maintenance and regular cleanup of bones from the main, central working area of the site to the midden under the rear ledge. Some stone artefacts, shell, charcoal and ash also were deposited in this midden. Small pieces of bone are more common in the repeatedly used earth oven area at one end of the shelter than in other excavated areas of the rockshelter floor.

Sea lions of all ages and both genders were captured. The frequencies of skeletal parts represented in the excavated assemblage indicate that most of the butchering and cooking, as well as part of the consumption of these animals, was performed outside of the shelter, either on the beach or just inland from the cliff top at the margin of the mallee scrub, where firewood and deeper sand for digging earth ovens were available.

Kangaroo (*M. fuliginosus*) and wallaby (*M. eugenii*) were hunted, and also cooked and partially consumed away from the shelter. From the regular placement of cut marks on the macropod bones that were introduced to the shelter, it is clear that the fur skins were removed for use, probably in the manufacture of cloaks similar to those used on the adjacent mainland in recent times.

There is a regular pattern in the range of skeletal parts of large mammals introduced to the site, referable to regular practices of animal processing and consumption throughout the period when the site was in use. Although the body parts brought back to the camp were generally high meat yielding parts, they were not the highest ranking parts from this perspective. For all large mammals, both the most marginal food value parts (e.g. feet or flippers) as well as the highest food value parts (the lumbar-pelvic 'saddle' of both macropods and sea lions, macropod tails) are rare to absent in the site. For macropods, the parts most regularly introduced were those high in both meat and marrow value, and all long bones have been smashed open on an anvil to extract the marrow. The heads of both macropods and sea lions were regularly introduced – not for their miniscule meat value, but for roasting and extraction and consumption of the brains. There is a definite emphasis on returning these special 'baby' or 'geriatric' foods to the site – highly nutritious, easily masticated and digested foods particularly suited to the dietary needs of pregnant or nursing women, children being weaned, invalids or elderly people with few teeth. These also are the least mobile people in a hunter-gatherer society, and are most likely to have remained at camp for the hunting and foraging parties to return with food. Consequently, this site was most probably occupied by family groups which included less mobile elderly people and/or women with young babies. This interpretation is supported by the wide range of both hunted and gathered foods represented at the site, which suggests that both male and female task groups were operating from the site.

Other gathered foods at the site include a wide range of small mammals, birds, reptiles and rocky shore shellfish. All of these species are present in the vicinity today, with the exception of the Tasmanian Devil, which is only represented in the faunal assemblage by a small number of juvenile jaws. Marine resources such as fish, crayfish and deeper water shellfish, such as abalone, were not exploited for food at this site. Neither were they reported by Cooper and Condon (1947) from the only other coastal site from which faunal remains (apart from shellfish) have been reported. Certainly the Kangaroo Islanders were living fairly high up the food chain, with numerous unexploited food options still available, suggesting an absence of dietary stress at this time. There appears to have been a considerable margin available for the kind of economic intensification which occurred along the heavily populated lower Murray River, lakes, and Coorong during the late Holocene.

Conclusions

The occasional inhabitants of Cape du Couedic Rockshelter on Kangaroo Island in the mid-Holocene are not enigmatic strangers from an unknown cultural tradition. They hunted big game, dealing with it in much the same ways as their counterparts on the mainland in recent times, in terms of field processing, selective transport and sharing of consistent portions of these larger animals, and even the acquisition of warm kangaroo and wallaby skins for the region's cool winters. The patterns in the faunal assemblage implicate family groups rather than male hunting parties as the occasional occupants of the rockshelter. Their stone artefact technology was consistent with this picture, ranging from the use of heavy cobble chopping implements in large game butchering and wood-working, to the use of quartz microblade technology to manufacture composite hunting weapons and hafted tools, indistinguishable from late Holocene assemblages on the adjacent mainland.

These considerations bring us full circle, to the unresolved question of the abandonment of Kangaroo Island by its prehistoric Aboriginal inhabitants, which has exercised Australian archaeology for almost a century. There is no sign in the archaeological record of over-population or of nutritional stress. There is no hint of cultural or technological degradation, or indeed of isolation from the mainstream patterns of Australian prehistory. There is no sign of epidemic disease – in fact, no human skeletal remains at all have been discovered on the island to date, and the burial places and practices of the ancient inhabitants remain a mystery. According to Ngarrindjeri and Kaurna beliefs, this is the island of the dead, inhabited by spirits of the deceased, so that their Elders consider it entirely appropriate for Kangaroo Island to have an archaeological record of hunting and gathering that is unaccompanied any physical remains of the hunters and gatherers (who were spirits, after all). For them, there is no Kartan mystery, and remaining doubts are attributed to the limited, scientific mindsets of anthropologists and archaeologists.

Postscript

Jay Hall's arrival in 1976 as the first 'prehistorian' to lecture in the Department of Anthropology and Sociology at the University of Queensland constituted a major, career-shaping influence on a number of students at the time (as well as many to follow). Those of us who were fascinated by Indigenous Australia, and by the evolution of human culture in general, were exposed to Jay's Kiwi-filtered, Arizona-inspired approach to archaeology as an integrated subfield of anthropology, and of this combined discipline as a science that is as much forensic as social in nature. There was a whole world of human evolutionary history and cultural variability out there to be researched and understood with the assistance of rapidly evolving theory and methods. Before long, my anthropological education was expanding to include the New Archaeology, as well as excavation experience at Platypus Rockshelter and Honours research spanning ethnohistory, archaeology and environmental science focused on Moreton Bay's Indigenous past (Draper 1978).

The approach to anthropology and archaeology that Jay brought to that first generation of UQ students proved irresistible to me, and subsequently I followed his example and went to the United States to pursue my postgraduate education, also in the southwestern United States, at the University of New Mexico in Albuquerque. Nearly four years later, my PhD dissertation supervisor, Lewis Binford, directed me back to Australia to research the Kartan Mystery of Kangaroo Island.

Acknowledgements

Thanks to Andrew Maland (Australian Cultural Heritage Management Pty Ltd) for drawing Figure 1.

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Archaeology and Aboriginal and Torres Strait Islander Studies at the University of Queensland

Ian Lilley

Abstract

This paper discusses the major archaeological research undertaken by the University of Queensland's Aboriginal and Torres Strait Islander Studies Unit over the last decade or so. It describes the long-running Gooreng Gooreng Cultural Heritage Project in coastal central Queensland, a project on Isolation, Insularity and Change in Human Island Populations newly-begun in the Wellesley Islands in the Gulf of Carpentaria, and a developing French-Australian research programme in the Loyalty Islands in New Caledonia.

Introduction

Jay Hall introduced me to archaeology 30 years ago almost to the day when I was writing these words. I was the first of his students in Queensland to front up to his office to say 'I want to be an archaeologist' (and Alice once told me that he arrived home that day saying something like 'I've got one, I've got one!'). Happily for me, he also 'volunteered' me to work as Jim Specht's field assistant in New Britain in 1980, when I was about halfway through my Masters research in southeast Queensland. That kicked me off in Pacific archaeology, the second string to my professional bow. I came and went from the University of Queensland several times after my Masters, leaving to do my PhD at the Australian National University, returning for a postdoctoral fellowship, leaving to teach at the University of Western Australia, and then returning for my present stint. This last differs from earlier instances because I have been working in the Aboriginal and Torres Strait Islander Studies (ATSIS) Unit rather than what is now called the School of Social Science, where Jay has been since we started out all those years ago. The major research I have pursued in the Unit since 1994 is the subject of this chapter. Its inclusion here is apt because Jay taught me much of what I know about doing archaeology, and did the same for Sean Ulm and most of the other archaeologists who have made vital contributions to the projects I discuss. Jay has also always maintained close ties with the ATSIS Unit. This has seen the School of Social Science and the Unit take on a range of joint projects including the supervision of research higher degree students, research publications as well as journal and monograph production, and various conferences and symposia. Jay is thus well and truly implicated in the things we've been getting up to over the last decade or so, and has made a signal contribution to expanding the horizons of staff and students in the Unit as well as the School.

Archaeology in the ATSIS Unit

The University of Queensland's ATSIS Unit ('the Unit') undertakes research and teaching bearing on Indigenous interests and provides academic and pastoral support for the institution's Aboriginal and Torres Strait Islander students. The scope and tone of its activities are guided by the philosophy of the Director, Michael Williams, a senior Gooreng Gooreng man from coastal central Queensland. Since taking up his position in 1992 his abiding concern has been to bring an indigenised approach to the same range of teaching, research and service functions that any mainstream academic department would pursue, while still maintaining its vital student support function. To this end he replaced social workers and counsellors with academic staff who established a full teaching programme and developed a strong international profile in research and professional service at the same time as they supported Indigenous students across the university.

In very recent times new professional student support officers have been engaged to allow the academic staff to cope better with the demands of teaching and especially research and service, as they were in danger of being overwhelmed by their own success. The research effort began with archaeology and cultural heritage but now also includes nationally and internationally recognised work in education, ethnomusicology, literature and the visual arts. Our strength still lies in our original fields of activity, however, and we continue to broaden our horizons geographically as well as intellectually. As will become apparent below, we are now very much engaged with issues of Indigenous cultural and intellectual property and their conceptual and technical impacts on archaeology and heritage management. In some respects it has been quite a journey for me, as I have come to understand that the future of the discipline lies in developing a true mutuality or even hybridity of interests with the descendents of the past peoples whose lives we investigate. In other ways, though, I don't think I have moved very far from some basic principles of professional practice and public outreach that Jay instilled in me long ago, as much by example as anything else.

Gooreng Gooreng Cultural Heritage Project

In 1994 the Unit decided that a multidimensional long-term study of Aboriginal archaeology and cultural heritage in Williams's traditional country would be a good vehicle to advance its budding ambitions in research in a way that contributed to the development of culturally-appropriate research processes. The study included investigations of Gooreng Gooreng language (Jolly 1994) and contemporary social landscapes (Clarkson *et al.* n.d.) as well as archaeological research (e.g. Lilley and Ulm 1995; Lilley *et al.* 1996, 1998, 1999; Ulm 2006, in press), cultural heritage management projects (e.g. Lilley 1995a, 1995b) and the repatriation of cultural property from the study area that is located at the University of Queensland (Ulm and Lilley 1996).

The immediate origins of the project lie in my appointment in late 1994 to develop the Unit's research profile. I was happy to accept the challenge of devising and managing a large-scale multidisciplinary endeavour to implement Williams's visions for Indigenous involvement in university research and research in his traditional country, both of which he sees as a central part of his cultural responsibilities as a senior member of the Gooreng Gooreng and wider Aboriginal communities. I was also happy to 'do the archaeology' as part of the larger enterprise, though I was not convinced that there would be anything of much scientific significance to find, at least at the level necessary to attract the substantial funding we needed to make the university take our ambitions seriously. This was because preliminary assessments of the coastal part of the study area (e.g. Godwin 1990; Rowland 1987), where our investigations were initially targetted, had not revealed anything attention-grabbing.

We persevered nonetheless and our findings in a range of sites dating back to the Pleistocene proved my skepticism was misplaced. Yet that there were any findings at all is only because the significance of the area to Williams and the wider Gooreng Gooreng community prompted him to offer his traditional country as a suitable place for us to start building our research standing. Williams provided a conceptual as well as an empirical foundation for the study in the form of his own postgraduate research (Williams 1981). He maintains a keen academic interest in archaeology (which underpins a long-standing collegial relationship with Jay) as well as the related disciplines included in the project. He also sees the value for his people of building a comprehensive scientific record of Indigenous activity. However, he has always asserted that the Gooreng Gooreng study and the other research activities of the Unit must fit in with Indigenous interests in general and those of his family and language community in particular.

As we have described elsewhere (Lilley and Williams 2005), this means that he has always encouraged extended family members to participate in our fieldwork in Gooreng Gooreng country and to contribute to the body of knowledge being developed. He does this in the light of an Indigenous agenda that

Figure 1. Road Cave, Cania Gorge, central Queensland (Photograph: Sean Ulm).

operates in parallel with the work of archaeologists, anthropologists and the like in the current climate of assertion of Indigenous cultural and intellectual property rights. This agenda sees Aboriginal and Torres Strait Islander people who are in a position to articulate such rights endeavouring to help others to build up their knowledge of Indigenous lives, cultures and histories and to gain the skills and confidence to conceptualise and articulate their concerns and proposals concerning heritage, intellectual property and other matters which affect their lives. In short, this agenda provides pivotal support for the larger project of Indigenous self-determination.

It is for these reasons that, unlike many collaborative projects undertaken in Australia up to that time (see Colley and Bickford 1996:16), where close community involvement and a move from 'prehistoric' towards 'historical' or 'contact' archaeology occurred as the research advanced (and at least in some cases, because material of sufficient age was not found), the present project was devised from the start as a multidimensional effort which integrated Western archaeological/cultural heritage interests with Aboriginal interests. Thus its linguistic, social historical, and archaeological elements all began at roughly the same time. Most important here, the concern to pursue issues of mutual interest and significance meant that as far as the archaeological record would allow, 'prehistoric' and 'historical' archaeology would both be integral to the study from the beginning and would not be conceived of as separate questions.

The archaeological study focused on site survey and excavation, first on the coast around the Town of Seventeen Seventy and then in Cania Gorge some 100km inland on the western edge of Gooreng Gooreng country (Figure 1). Owing to the nature of the evidence that was found, the emphasis until about 1998 was mainly on the pre-European archaeology of the area. On the coast this extends back at least 4000 years and at Cania to at least the Last Glacial Maximum some 18,000 years ago. Importantly for attracting funding from sources habitually focused on mainstream questions, the project was thus able to encompass many of the conventional 'big' issues in Australian archaeology, such as the nature of human adaptation to the extreme aridity which characterised glacial periods in Australia, as well as post-Pleistocene developments, such as the (?non-)appearance of the so-called broad spectrum revolution that in other parts of the world led to agriculture and urbanism and in at least parts of Australia may have led to increasing regionalisation and perhaps other sorts of sociopolitical and economic change.

As work progressed, data relating to the post-European past began to be discovered, linking the archaeology directly with contemporary Gooreng Gooreng social landscapes and the remembered past of living Gooreng Gooreng people. Sean Ulm's doctoral research on the coast allowed him to build an archaeological sequence beginning some 4000 years ago and ending only when the government removed virtually all Gooreng Gooreng people from their traditional land in the early twentieth century. Of particular note has been the discovery of evidence for post-contact cultural continuity in the form of flaked bottle-glass artefacts in places that are not only known to have been frequented by Aboriginal people in the historical period but which also have pre-European components of some antiquity (Ulm in press; Ulm *et al.* 1999). Also intriguing is evidence for increasing regionalisation and perhaps variations in patterns of social identity through time. This evidence is presently in the form of increasing use of local stone sources for artefact manufacture and the geographical restriction of edge-ground stone hatchets of a specific, distinctive lithology to the area historically recorded as the traditional territory of Gooreng Gooreng speakers (Ulm *et al.* 2005).

While work in the inland has established occupation of Pleistocene antiquity (Lilley *et al.* 1998), studies completed at the time of writing had yet to find much material relating to the historical period. This may be because a dam has inundated Cania township and surrounds, which until relatively recently had been the principal focus of activity in the immediate area since the gold rushes of the late nineteenth century. Preliminary analyses of the sparse rock art in the gorge has, however, provided some evidence to support the hypotheses concerning regionalisation and social identity that have been generated by the coastal finds (Chapman 2002).

In the future we will undertake an archaeological and oral-historical study of Williams's family farm in the coastal part of the study area, which was acquired in a land ballot by his grandfather. The aim is to determine the nature of continuities and discontinuities in Aboriginal life between the pre- and post-European periods. This project will to pick up from where Ulm's sequence ends, and thus should help us more firmly integrate Indigenous interests in the recent, remembered past and archaeological concerns with culture contact and cultural change. We want to explore the archaeological dimensions of Williams's deep conviction that although Indigenous groups and communities such as his own have experienced long and sustained non-Indigenous intrusion, to the point where the lifestyle and behaviour of those Indigenous people seem to differ little from 'mainstream Australian culture', his family and a great many like it are passionate about their Aboriginal identity and cultural expression.

The Wellesley Islands

In 2004 the Unit joined an initiative led by Paul Memmott of the University of Queensland's Aboriginal Environments Research Centre to undertake a large-scale interdisciplinary study in the Wellesley Islands in the Gulf of Carpentaria (Figure 2). Also involved are social anthropologist David Trigger, archaeologist Richard Robins, human biologists Neville White and Sheila van Holst Pellekaan, geomorphologist Errol Stock and linguist Nick Evans as well as a number of doctoral and postdoctoral researchers in various fields.

As described elsewhere (Memmott *et al.* 2006), the project will test hypotheses concerning cultural differences between the inhabitants of the North and South Wellesleys in terms of shifts in the relative degree of their isolation and cultural divergence during the Holocene. These two island groups comprise separate cultural-geographic settings that will enable detailed examination of cultural diffusion from a larger-scale mainland cultural complex to geographically-isolated island societies. The idea is to study parallels and divergences in the cultural, genetic and linguistic histories of three distinct cultural groupings of fisher-hunter-gatherers: the mainland Ganggalida, the Lardil and Yangkaal of the North Wellesley Islands, and the Kaiadilt of the South Wellesleys. Despite their similar island environments and the fact that their languages are as closely related as English, Dutch and German, there are some striking cultural and genetic differences between the North and South Wellesley populations. This variation seems to stem from the degree to which populations which were similarly insulated in a geographical sense were differentially isolated in cultural terms. In a wider theoretical framework, our study contributes to debate about cultural reproduction through diffusion and adaptation or rejection of exogenous cultural influences and thus speaks to current concerns about globalisation and the resilience or vulnerability of small-scale societies.

We have chosen to study islands because archaeologists have recognised for some time that evidence concerning the Aboriginal occupation of offshore locations offers intriguing possibilities for better understanding the critical biogeographical and cultural factors necessary for successful and enduring colonisation. Debates about the nature, extent, timing and duration of isolation are central to an understanding of the account of the colonisation and occupation of Aboriginal Australia. While debates about the nature of isolation in arid areas of Australia, particularly as a consequence of late Pleistocene climatic change, are becoming increasingly important (e.g. Smith and Hesse 2005; Veth *et al*. 2005), a good deal of scholarly discussion about isolation has centred on islands (e.g. Jones 1979; Pardoe 1991). At least since the time of Darwin's work on the evolution of Galapagos finches, islands have been considered scientific laboratories where patterns and processes of physical and behavioural change unfold in isolation and so can be studied with much greater control over inputs and outputs than is otherwise possible. It is now known that while insularity does provide researchers with some 'experimental control', cultural change in particular does not occur in isolation except in extreme cases such as Tasmania and Easter Island: island people manipulate their physical insularity to increase or decrease their sociocultural isolation from outside (e.g. Gosden and Pavlides 1994). Understanding how, when and why island people do this will allow us to understand better how people in general manipulate their social environments to control, influence and even reverse larger-scale and often seemingly irresistible flows of people, ideas and things.

One issue of particular interest that has arisen as project preparation has advanced concerns the cultural and intellectual property (IP) rights of the project's various participants. Indigenous IP has been a focus of legal and anthropological attention for some time, especially in relation to copyright and to biological (including human genetic) resources and traditional ecological knowledge (e.g. Anderson 2005; Brown 1998; Janke 1998, 2003), but archaeology has come to the party only lately (Nicholas and Bannister 2004). Anecdotal evidence from international colleagues suggests Australia is at the forefront of developments in this regard, as it is in other aspects of Indigenous/indigenised archaeology and heritage management (Lilley 2000, 2006a). In fact, Michael Williams and I are among a number of Australian investigators on a large international project on Intellectual Property Rights and Archaeology being led by George Nicholas in Canada. At present, though, it seems that while most if not all Australian archaeologists arrive at some form of negotiated understanding with the Indigenous people on whose country they work, basic, 'curiosity-driven' research is unlikely to be the subject of formal, legally-binding IP agreements between researchers and descendent communities. An informal request for information over the AUSARCH-L discussion listserver revealed that with only a couple of exceptions, all colleagues who had finalised such agreements were involved in commercial or other financial arrangements such as cultural heritage consultancies or linkage grants with Indigenous groups as the 'industry partner'.

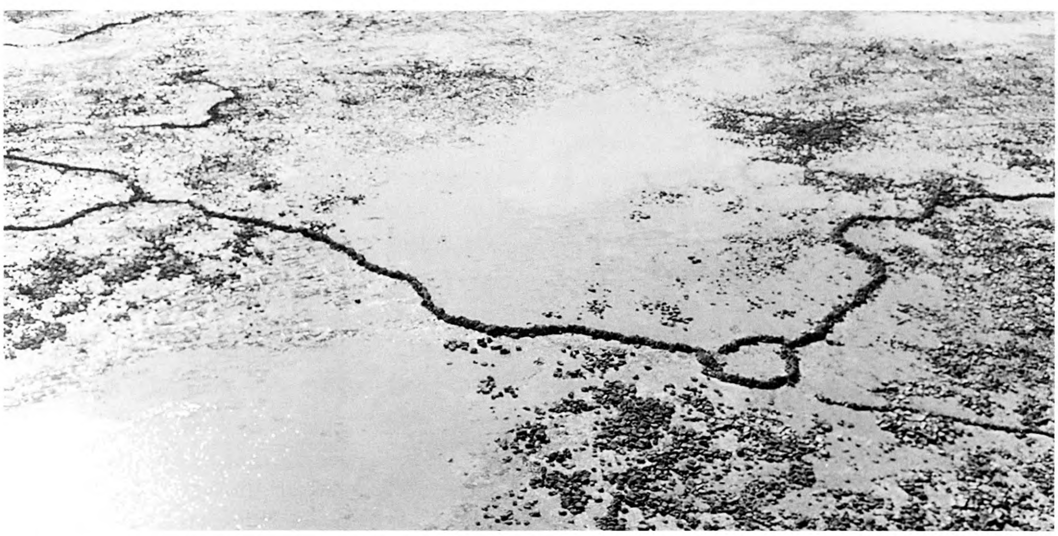

Figure 2. Stone-walled fishtrap complex, Bentinck Island, Wellesley Island Group, southern Gulf of Carpentaria (Photograph: Richard Robins).

In our case at the time of writing something of a related sort seems to be occurring. Our initial negotiations proceeded in a conventional manner, with extended correspondence and numerous community meetings resulting in written consent from representative organisations for the project to proceed, university ethical clearance and so on. Largely owing to the biological aspect of the study, however, some Indigenous community members and their representatives subsequently raised further questions about the proposed research. This led to continued negotiation (very much in train at the time of writing) and a concerted effort on all sides to produce an IP agreement that recognised and protected the IP of all participants, researchers as well as descendent communities.

As this process advanced, it became clear that issues of commercialisation lay at the heart of the questions that had been raised. There has been considerable international attention to such matters, in relation especially to inequitable treatment of Indigenous people in the patenting and commercialisation of their botanical resources and human biological material (cf. Nicholas and Bannister 2004). Indeed, the United Nation's World Intellectual Property Organization (WIPO) established an Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore to deal with these and related questions and in April 2006 announced new funding measures to facilitate its work (WIPO 2006).

In this context it is not surprising that some representatives of the Gulf communities decided to take IP issues to a level higher than hitherto had been anticipated. Yet the sort of research proposed in this instance, the biological work included, is highly unlikely to result in any discoveries with patentable characteristics and/or commercial potential (cf. Nicholas and Bannister 2004). For this reason, representatives of the communities have recently concluded that two agreements should be made rather than one omnibus instrument. The first will be a set of research protocols much like those originally negotiated, which like the larger draft IP agreement were based expressly on the detailed ethical guidelines promulgated by the Australian Institute of Aboriginal and Torres Strait Islander Studies (2000). These protocols will let the research proceed in a reasonably straightforward manner. On the grounds that 'one can never say never' in relation to unexpected scientific results, the second agreement will be specifically concerned with procedures for dealing with results with commercial potential. The latter are covered in the draft IP agreement, as they are in all the agreements discussed with colleagues working elsewhere who responded to my AUSARCH-L enquiry, but in this instance at least it seems that more clarity will be gained by separating commercial and non-commercial interests.

There is a lesson or at least a reminder for the discipline here, and for Indigenous people too, as we move forward. Legal remedies can help provide certainty – and emancipation – where there was none. However, in cases at the boundaries of Western law as presently constituted, where matters of Indigenous cultural and intellectual property are definitely still located, there is a significant risk of dealing inappropriately with the subject matter. Like Indigenous/'traditional' knowledge – now often subsumed as intangible heritage – tangible material heritage, whether archaeological or natural (e.g. biological), may not be best dealt with by Western property law and the way it commodifies phenomena best left uncommodified (Anderson 2005; Nicholas and Bannister 2004; Prott 2005). This means that 'messy' approaches with task-specific instruments such as the ones we are negotiating in the Gulf may be more culturally-appropriate for archaeologists (and other researchers) as well as Indigenous people than neatly-stitched-up legal solutions framed in terms of Western legal conceptions of property and ownership and all they imply about 'exploitation, alienation, and exclusion …' (Prott 2005:226).

Mission: Tiga

The last project I will discuss is being developed with Christophe Sand of the New Caledonian Department of Archaeology in Nouméa and Frédérique Valentin of the National Centre for Scientific Research (CNRS) in Paris. The study concerns the archaeological and contemporary cultural landscapes of Tiga Island, smallest of New Caledonia's Loyalty Islands (Figure 3). The work builds on a three year pilot study that was completed in 2006. Although located overseas and focusing on a very different sort of archaeological record from that in Australia, our overarching objective is to engage with the same issue that provides much of the motivation for the Unit's work on Aboriginal questions. This is the paradox that the scientific success of the discipline in elucidating the dynamics of long-term historical change tends to alienate descendent and especially Indigenous communities with moral and/or legal rights to

Figure 3. Tiga, Loyalty Islands, New Caledonia. L-R: Christophe Sand and Ian Lilley (Photograph: Alison Crowther).

control access to archaeological resources. Such tension arises because community interests in the past normally focus on remembered recent history and are usually framed in terms of continuity with 'ancient traditions' of profound stability. Archaeology's emphasis on change is seen at best to be irrelevant to community concerns and at worst to undermine the authority of tradition and thus threaten the basis of community life (e.g. Sand *et al*. 2006).

I alluded to this issue and its importance at the start of the chapter. There are two reasons why its resolution is critical for the discipline's future. First, disaffected or uninterested descendent communities regularly exercise their rights to restrict access to archaeological resources, slowing and sometimes preventing research. In the Pacific this was most dramatically illustrated by the 10 year ban on research in Vanuatu between 1984 and 1993 (Bedford *et al*. 1998). Second, and much more positively, the process of establishing the mutuality or hybridity of interests required to move beyond the current situation is proving a fertile source of theoretical and methodological innovation (Conkey 2005; Lilley 2005; Lilley and Williams 2005; Sheehan and Lilley in press). To promote continued progress with this matter, our project seeks to forge an understanding of the cultural patrimony of a circumscribed locality in a way that makes sense to local people while still advancing scientific knowledge.

The project's scientific value lies in the substantial boost it is providing to our knowledge of Loyalty Islands and New Caledonian archaeology at a time when research in Vanuatu, the Solomons and other parts of the southwest Pacific is dramatically expanding our knowledge of the region's prehistory (e.g. Bedford 2006; Sheppard and Walter 2006). In this dynamic milieu it is crucial that work in New Caledonia keeps pace if we are to develop a comprehensive understanding of the Pacific's deep human past. The archipelago has long tantalised archaeologists with hints of mystery such as supposedly pre-Lapita 'tumuli' on the Ile des Pins. Even though such conjecture has been discredited by scientific research (Sand 1997), the information now coming to light is no less fascinating in what it is beginning to tell us about

New Caledonia's long-term history and how it compares with the patterns becoming better-defined in neighbouring areas.

Our developing archaeological knowledge of New Caledonia's main island, Grande Terre, makes it clear that the direction and detail of cultural change in New Caledonia differed substantially from that elsewhere in the Pacific. This is most notably the case with the very high level of cultural differentiation that emerged in New Caledonia, something unparalled anywhere in Remote Oceania (e.g. Kirch 2000:147-155). Exploratory findings on the three large islands in the Loyalties suggest that these localities had their own distinctive historical trajectories within the broader currents of New Caledonian prehistory, trajectories which appear to have been formed in at least some measure by interaction within the Loyalties as well as between that island group and Grande Terre (Sand 1998). Previous research also suggests that aspects of the prehistory of Grande Terre were profoundly affected by contacts with the Loyalties. In short, results to date make it plain that an understanding of the archaeological distinctiveness of New Caledonia in the wider Pacific context requires us to get a much better grasp on what distinguished the prehistory of the Loyalty Islands and why.

The Tiga project is complementing this boost to archaeological knowledge through the documentation and analysis of the ways in which people on the island conceptualise and mark culturally-important sites and landscapes today, including sites under archaeological investigation. An innovative methodology being developed in collaboration with the local community to integrate the results of the two parts of the study will provide a model for future phases of the project elsewhere in the Loyalties. As the project proceeds, archaeological results and contemporary Kanak histories and conceptualisations of cultural landscapes will be reconciled through discussions between the professional archaeologists (who include Kanaks from the Loyalties) and local communities. The extent to which a truly melded or hybridised rather than entangled or enmeshed cultural history is feasible can only be determined through negotiation as results from the two different parts of the project become known and can be compared and contrasted.

At this early stage we cannot know exactly where such a process will take us. We intend to go well beyond using oral history to augment archaeological interpretation, though. Our ultimate goal is to achieve a degree of hybridity in archaeological theory, where the cosmopolitan conceptual world of archaeology is adapted to a local context and vice versa. In keeping with a larger concern about effective archaeological communication (Lilley 2005; Sand *et al*. 2006; cf. Watkins 2006), our current thinking takes off from Merry's (2006) discussion of the vernacularisation of transnational ideas in relation to human rights approaches to violence against women. Like the latter, archaeology has been resisted by Indigenous people in many parts of the world as 'an alien, Western import not suited to local normative systems' (Merry 2006:38). Many mainstream archaeologists continue to shy away from native conceptual frameworks for broadly similar reasons (such frameworks being seen as 'alien, non-Western imports …'). If archaeologists are to convince local people of the discipline's worth in their local context, its universalising scientific conceptual apparatus needs to be 'framed and presented in terms of existing cultural norms, values and practices' (Merry 2006:39).

So, too, with Indigenous knowledge being made acceptable in mainstream archaeological practice: it has to be 'framed and presented' in a way that archaeologists can appreciate. 'Framing' here means to 'assign meaning to and interpret relevant events and conditions in ways that are intended to mobilise potential adherents and constituents, to garner bystander support, and to demobilise antagonists' (Snow and Benford 1988:198, cited in Merry 2006:39). Merry (2006:39) describes this whole process as 'indigenization', which she regards as the 'symbolic dimension of vernacularization'. The term applies regardless of whether the recipient population is Indigenous in the sense we would normally use to refer to native populations. Thus the process applies to the translation of native knowledge for archaeological consumption as well as the other way around.

One problem with conventional approaches to vernacularisation/indigenisation is that they aim for 'resonance' on the well-attested grounds that a 'frame needs to be resonant with cultural traditions and narratives to be appealing' (Merry 2006:39). Yet researchers cited by Merry (2006:41) point out that 'resonant discourses are less radical than nonresonant ones … [so] resonance is a costly choice because it may limit the possibility for long-term change'. This is because 'frames' can impose restrictions on who can and cannot speak and what can and cannot be said, thus 'ignoring the continual contestation over meanings, their ambiguity, and their susceptibility to change' (Merry 2006:41, after Steinberg 1999). On this basis, Merry (2006:41-42) supports Steinberg's advocacy of 'a more dialogic analysis that sees the production of meaning as contested, shaped by both group conflict and by the internal dynamics of the discourse itself'. If anything resembles the way archaeology and Indigenous peoples have been working through their differences over the years, this is it! If we recognise rather than avoid this reality we will be better placed to benefit from the intellectual and practical opportunities a dialogic process has to offer.

To take advantage of these insights, vernacularisation/indigenisation can only proceed from one particular end of a continuum in the degree to which 'local cultural forms and practices are incorporated into imported institutions' (Merry 2006:44). The end from which we must launch ourselves is hybridisation, an interactive form of cross-fertilisation 'that merges imported institutions and symbols with local ones, sometimes uneasily' (Merry 2006:48). Merry (2006:48) describes the resulting conceptual hybrids as 'thickly shaped by local institutions and structures'. At the other end, where many past and some contemporary attempts at collaboration remain trapped, lies 'replication'. This is where 'the imported institution remains largely unchanged from its ... prototype ... [and the] adaptation is superficial and primarily decorative' (Merry 2006:44). Replications are only 'thinly adapted to local circumstances' (Merry 2006:48).

Producing workable and mutually-beneficial conceptual hybrids will not be easy for anyone involved. The discipline is still strongly hard-science oriented, despite recent shifts evident in the sorts of papers that appear in places such as the *Journal of Social Archaeology*. Mainstream archaeologists are thus likely to react skeptically to truly 'indigenised' research results. By the same token, the local (and especially the Indigenous) communities with which archaeologists work are likely to remain wary of the discipline over the longer term owing to deep-seated historical grievances and/or the imperatives of contemporary identity politics. We must continue to press forward on such matters, however, if we believe that important issues of mutual interest are at stake (Lilley and Williams 2005).

Conclusion

Archaeologists the world over continue to be exercised by the methodological (as well as social and political) challenges of developing an approach which can integrate Indigenous people's ideas and approaches without sacrificing the advantages of the scientific method. It is critical in this latter respect for archaeologists to appreciate that the benefits flow both ways. This is not just about archaeologists helping Indigenous people understand what the discipline or science more generally can do for them. It is also, to paraphrase President Kennedy, for archaeologists to understand what Indigenous outlooks can do for the discipline. A burgeoning body of work from around the world, in which Australia has achieved a very high profile (see discussion in Lilley 2006b), is demonstrating that the conventional split between history, prehistory and current community interests is theoretically and empirically unsustainable and serves to obscure important processes of cultural continuity and change at the same time that it distances archaeologists from Indigenous and other descendent communities. Elucidation of these processes will result in significant conceptual gains which advance our understanding of the whole of human history as well as help strengthen our ethics and our public outreach.

Postscript

Jay and Alice are some of Cathy and my oldest and closest friends. In fact it's hard to remember a time when they weren't part of our lives. I turned 18 a few months before Jay arrived at UQ in 1976. I very soon found myself working as his research assistant (aka dogsbody) and spent a great deal of time with him in the field, lab and office. That saw me gain access to all sorts of people and things in the university and the profession that I would not normally have had at that stage of a professional career. Someone once said I reminded them of Radar in MASH at that time, and not just because of my height and my glasses. To others it looked different. A while ago I heard that some people used to describe me as 'proto-Jay', an amusing play on 'protégé' that hints I might have modelled myself on him a tad too closely at times. That's undoubtedly true, at least with regard to wearing truly tasteless cowboy shirts, but I still feel very privileged to have been in that position. Thanks for such an extraordinary start, Jay, and for all your support since then!

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An Attack of Nostalgia ... and Other Ways of Seeing the Past

Mike Rowland

Abstract

This paper is a commentry on 'seeing' and understanding the past. The scope is broad and eclectic. Over the last 30 years I have been involved professionally in recording and managing other people's heritage places and structures. In 2004 I was able to attend the 50th Annual Conference of the New Zealand Archaeological Association in New Plymouth; my home town that I left over 35 years ago. The current volume has enabled me to reflect on my personal and professional association with Jay Hall especially from 1977 to 1981. These events provided an opportunity to reflect on ways of seeing the past that range from 'nostalgia' to the 'culture wars'. This pause for reflection has reinforced how important memories and other social values are to the people's heritage we attempt to record and protect. A nostalgic view of the past may provide a useful check on the idea of progress and in this age of globalisation it is proposed that we must become more involved in a range of major current debates incorporating some of the more traditional foci of our discipline(s) such as climate change, resource utilisation, population growth, biodiversity and human diversity.

An Attack of Nostalgia ...

In 1976, New Plymouth celebrated its centennial and Ian Lobb the Chemist thought that on such an occasion people might suffer 'an attack of nostalgia' (Figure 1). Centennials arguably became a significant way of celebrating the past as late as 1851 with Britain's Great Exhibition and appear to be of diminishing importance (McDonald and Méthot 2006). In New Plymouth's centennial papers, 'S.T.' noted how:

> every century or so, people get stricken with the nostalgia bug. They have this strange urge to preserve things; to bring back the past; perhaps in the hope that it might have some bearing on the future (Taranaki Newspapers 1976:16).

References to nostalgia by Mr Lobb and 'S.T.' provided a trigger for me to enquire into ways of seeing, valuing and understanding the past. This enquiry has heightened my understanding of the complex ways in which we view the past and the importance of the past in defining our future. Prehistory, history and heritage are not the past but a (re)presentation of the past. Relevance, accountability and greater involvement in societal issues will therefore continue to be critical to the survival of our discipline(s) in a rapidly changing world. The term 'nostalgia' was used by Johannes Hofer, a German physician, as early as 1678 and until the twentieth century it was confined to a medical usage (Boym 2001:3; Lasch 1991:105-106; Lowenthal 1975:1-3). Boym (2001:41) makes a useful distinction between restorative and reflective nostalgia. Restorative nostalgia is seen as an attempt to rebuild the lost home and patch up memory gaps while reflective nostalgia dwells in longing and loss and the imperfect process of remembrance. Boym (2001:49) sees restorative nostalgia as taking itself seriously, while reflective nostalgia can be ironic and humorous. My discussion focuses on both the restorative and reflective and like Boym (2001:348) part of my interest is to challenge the 'tunnel vision of progress, backtracking, slowing down, looking sideways, meditating on the journey itself'.

Figure 1. The advertisement that triggered the title and themes of this paper (Taranaki Newspapers 1976:16) (Courtesy of *Taranaki Daily News*).

... Remembering the 50s and 60s

I was born in New Plymouth in 1951. A sometimes evocative and comparable picture of growing up in Australia in the 1950s and 60s is provided by Eoin Cameron (2004), who was born in Mt Gambier, also in 1951. Globally the 1950s and 60s saw the end of colonial power in many parts of the world, nationalistic competition expressed in the 'space race', major changes in human rights and race relations and a complex range of threats associated with the so-called 'Cold War'. Nothing characterised the 60s more, however, than a growing awareness of personal and cultural identities. The 50s and 60s were, in many ways, an age of innocence, though full of contradictions. The post-war years in New Zealand have been described by the late Sir Keith Sinclair (1991:288) as 20 years of prosperity, with New Zealanders enjoying one of the highest standards of living in the world. However, there was conflict beneath the surface. The Cold War set up the turbulence of the 1960s and a sense of danger loomed throughout the decade. The paranoia of communism ('reds under the bed') was always apparent. The late 1960s brought recession and opposition to the Vietnam War. New forms of urban protest sprang up including a Maori cultural resurgence and a strong feminist movement. Optimists saw in the growing diversity of lifestyles a new social pattern emerging and yet there were strong elements of continuity with the past (Dunstall 1992:451). An American perspective on the period was not of 'an age of innocence' but of a chronic state of international emergency leading to the erosion of civil liberties and the militarisation of American life (Lasch 1991:25). The 1950s and 1960s have more generally been described by Fukuyama (1999) as the Great Disruption, characterised by increasing levels of crime and social disorder, the decline of families and kinship as a source of social cohesion along with declining levels of trust.

After the 70s

I left New Plymouth in 1970 for Auckland University to study Anthropology and Geography. In 1976, I left Auckland for Armidale and subsequently moved to Brisbane in 1977 after a fortuitous meeting with Jay at a conference in Melbourne which initiated the start of many discussions of the past and future over pizza and wine.

Radical shifts have occurred in New Zealand (as they have in Australia) since my departure in 1976. The long familiar 'cradle to the grave' rights-based welfare state has been replaced by the opposite extreme of a residualist 'safety net' society (Rice 1992:496). There are plenty of doubts about the 'new' New Zealand (e.g. Rice 1992; Simpson 1992). Dalziel (2002:45; see also Saul 2005), in particular, is not impressed with the changes that New Zealand 'dared implement when even Mrs Thatcher would not' and suggests that New Zealand's spell as an 'economic lab rat' has in fact resulted in higher unemployment, lower real incomes and major social problems.

Saul (2004, 2005) has recently analysed the importance of 'the New Zealand experiment' in some detail. He notes that New Zealand as 'the original social democratic model state' did a complete flip in the mid-1980s and attempted to become 'the perfect Globalised nation state'. At the core of this new ideology was the worship of a bright new future coupled with failure in the immediate past. But in the late 1990s, belief came back, and with it New Zealand memories. Thus, the years between 1945 and 1973 no longer seemed such a failure but in fact one of the most successful eras in history for both social reform and economic growth, something to build on, to reform; not something to dismiss. By comparison, New Zealand's globalisation experiment had resulted in New Zealand's national industries being sold off, a declining economy, a stagnant standard of living and high emigration. Saul opines that New Zealand may now be returning towards a more complex and interesting form of positive nationalism, based on the return of the 'public good' (Saul 2004:6-7) or 'social capital' (Fukuyama 1999). Elliot (2002) has argued that Australia has been more selective and a lot more gradual in its approach to reform but Australia has a lot to learn from the 'New Zealand experiment' and I will return to these issues below.

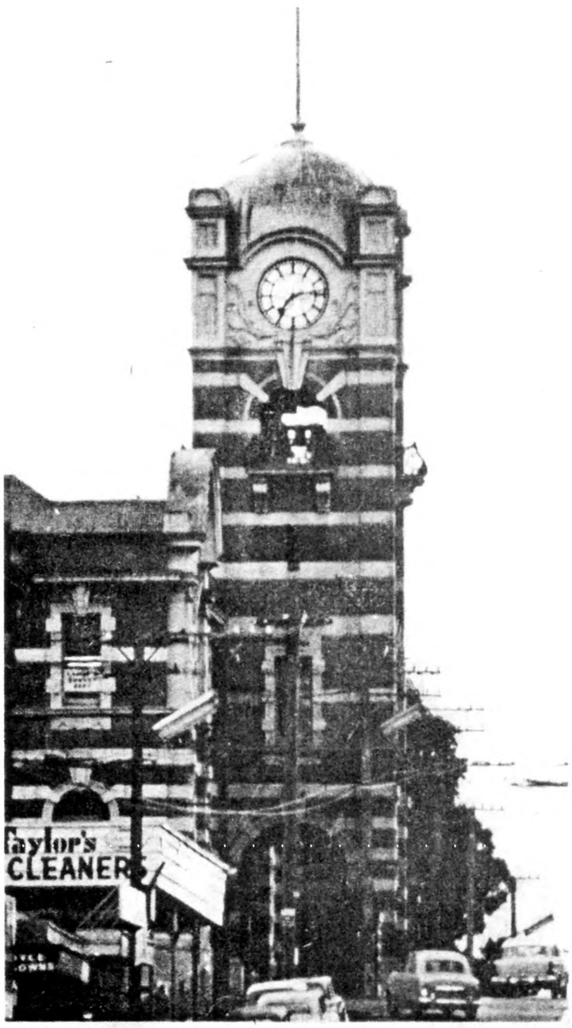
... Remembering New Plymouth

In the following section I briefly outline three aspects of my New Plymouth heritage – the town's Clock Tower, cinemas and Ngamotu Beach – and will then use these as the basis for a discussion of how I (we) perceive and understand the past.

The Clock Tower

The people of New Plymouth began collecting money for a clock tower as early as 1897. An impressive clock tower at the time was thought to give an air of dignity to a city. On 28 November 1905, Sir Joseph Ward, Post-Master General, laid the foundation stone and on 6 July 1908 the long-awaited clock on an impressive 69ft (21m) tower was set in motion (Figure 2). In 1944, the Public Works Department declared the tower an earthquake risk and called for its demolition but for unexplained reasons the tower gained a reprieve until the 1960s.

On 28 January 1964, the tower was again set for demolition. Petitions and lobbying to keep the tower began in earnest. The City Council cooled the controversy in March 1968, by deciding to keep the tower, subject to costs being acceptable. However, moves to get the Council to review the tower's fate resulted in a deadlock, and the issue was blocked by the mayor's casting vote with the result that on 20 April 1969 the tower toppled. Despite the reports of its fragility it proved stubborn and only after a seven-hour labour by the demolition crew did the bricks finally crash to the ground (Anon. 1968, 1985; McGregor 1968a, 1968b, 1968c, 1968d) (Figure 3).



Dominating the city skyline — New Plymouth's clocktower as it was prior to its demolition in 1969.

Figure 2. New Plymouth clock tower prior to its demolition in 1969 (*Daily News* 11 October 1985) (Courtesy of *Taranaki Daily News*).

Figure 3. The clock tower coming down in 1969 (Taranaki Newspapers 1976:35) (Courtesy of *Taranaki Daily News*).

The fate of the clock tower was the first 'heritage issue' that I was involved in. I was in favour of saving the clock tower and can recall being quite emotional about it. In retrospect, however, I can recall no logical reason for this. In fact I suspect I was driven by the emotion of the event rather than by any real understanding of the clock's significance or related issues. Peter Read (1996, also 1999) has written a very compelling book on the feelings generated by a return to childhood places that are unrecognisable, changed or destroyed. He provides poignant stories of a painful process of mourning and grief. Yet I have no real sense of loss at the absence of the old clock tower and in fact my single persistent memory is of the clock's bell ringing out as far away as the suburb of Brooklands on a cool or mostly cold morning, reminding me that I would soon need to be off to school. It was with pleasant surprise, however, that I became aware that the World Soundscape Project has commenced recording a vanishing sonic legacy that includes things as diverse as the clanging of old cash registers to the sound of rocking chairs on wooden floors (Lowenthal 1985:37). I would be impressed if they had recorded the sound of the old clock tower! It is also notable what the clock tower meant to the people of New Plymouth. In July 1983, a public appeal for a new clock tower began. A tower was designed at an estimated value of $268,442.55. A Radio Clockathon, garage sales, special film screening, auctions and mufti days and myriad other activities occurred and the community raised over $70,000. This level of community support must be considered quite extraordinary by any standards. A new but similar clock has replaced the old one (Figure 4).

Figure 4. The new clock tower completed in 1985 (Photograph: Mike Rowland, 1987).

Cinemas

There were four active cinemas in New Plymouth when I was growing up there between 1951 and 1969. Of two earlier theatres, the Theatre Royal was destroyed by fire in 1916 and the other, the Empire Theatre, closed before 1930.

The Regent Theatre opened in February 1916. The theatre was originally a church and the first screenings involved the audience sitting in pews. The building was constructed around the church. Apparently, screenings continued and only stopped for a short time when the church was demolished. The roof was then put on. The theatre shut down in 1964. It remained largely unused until bought by the New Plymouth District Council in 1966 and opened as the Govet-Brewster Art Gallery in 1970.

The Mayfair Theatre (originally called Everybody's) opened in December 1916. It could seat over 300 people. At this stage therefore New Plymouth had three theatres for a population of 8700 people. The theatre ran an International Film Festival from 1980 but declining attendance and the fact that the building was considered an earthquake risk resulted in the building being sold in 1993. A three-cinema complex was planned for the area but a Top Town Cinema 4 complex at the other end of the main street replaced the need.

An Opera House opened in November 1925. It prospered for many years as a venue for live entertainment and later films. However, after World War II, rival attractions, a changing society (and television) resulted in a slump in patronage. Attendances even for films dropped off and the theatre was used only once or twice a week. The building was sold in 1969 because it was losing money. Public support and a number of grants enabled the setting up of an Opera House Trust Board in 1975 and in 1976 a refurbished Opera House was opened by Prime Minister, Robert Muldoon (Taranaki Newspapers 1976:7). The 50th Annual Conference of the New Zealand Archaeological Association at which the themes of this paper were initially developed was held at the Opera House in December 2004. The State Theatre at the opposite end of Devon Street opened in 1935 and could seat 970 people. It was considered an earthquake risk and closed in 1990.

I cannot begin to outline the complex social significance of cinemas in the heritage of small towns but it is a fascinating story. It can be noted that when the State closed in 1990 the usherette had been employed for 19 years, the candy bar attendant for 17 years and the cinemas cashier for 16 years. When the Regent closed in 1964 the projectionist had been working there for over 30 years (de Bueger 1994)! Our own family attendance at the cinema involved a set of rituals too complex to enter into here. I barely recall any of the movies we saw but epics like *The Ten Commandments*, *Sparatacus* and *Ben Hur* do come to mind along with scary ones like Hitchcock's *The Birds* and Stanley Kramer's 1959 version of Neville Shute's *On the Beach* portraying the total destruction of nuclear war. I recall most clearly standing to attention time and time again (though towards 1969 we started to revolt and remained seated, much to the disgust of an older generation) to a scratchy film of Queen Elizabeth on a horse while *God Save the Queen* was played.

I do remember most clearly the black-and-white Cinesound and Movietone newsreels that may have played some part in my 'falling towards Australia'. I can still hear that distinctive voice-over man. By the 1960s television had arrived and Cinesound and Movietone merged in 1970. For those too young to remember, a good feeling for this era can be got from the 1978 Phillip Noyce film *Newsfront*. Although American, the 1971 film *The Last Picture Show* also brilliantly captures the transition involved in the closing of a town's picture show owing to the coming of television. I was delighted to discover that much of Cinetone and Movietone productions survive, some in Sydney and some in Canberra. Recently, UNESCO also honoured Cinesound Movietone productions by adding it to the Australian Memory of the World Register.

I have few significant memories for the architectural values of the cinemas of my youth and I would not be too upset to discover they were no longer there or were not functioning as theatres. I do however retain some great memories associated with these places.

Ngamotu Beach

Many, many summer days were spent at Ngamotu Beach. Sunday picnics with the family were common. My Auntie Jean and Uncle Ralph owned a fish and chip shop just above the Beach and as the sun went down we would get the best fish and chips ever cooked anywhere! The beach was much more attractive than it is today. A pavilion and baches (a New Zealand beach house) were there by the 1920s. There were changing rooms and showers underneath and seating for up to 150 upstairs. I remember in particular the summer Mardi Gras at Ngamotu and the sound of the Shadows playing endlessly at the dodgem cars. I remember the many shows conducted in the Sound Shell and the forbidden adult mysteries of the pavilion. The whole area has been transformed in the 1980s by port development.

When I return to Ngamotu Beach I do experience something of the sense of loss that Peter Read analyses in his book – it is not the attractive place it used to be. But even here it is the memories that are important not the presence or absence of structures. The sounds, sights and smells do come back.

Seeing and Understanding the Past

In researching his book, *The Past is a Foreign Country*, David Lowenthal (1985:xxvi; see also Lowenthal 1997) found that while the past is of universal interest, little research has focused on how people see, value or understand it. In apparent contradiction, however, his dense but encompassing 400-plus pages demonstrate how complex and wide-ranging the issues are. I am able to follow only a few threads of his discussion in this paper.

Wright Morris bluntly exclaimed: 'The past is useless. That explains why it is the past' (cited in Lowenthal 1985:263). Such simplicity would appeal to many. William L. Burton suggested, 'If you do not like the past, change it' and people have often done so, for both good and evil (cited in Lowenthal 1985:263). Others have argued for the 'end of history' (Fukuyama 1992, 1995) in the sense that since liberal democracy as a system of government has conquered all rival ideologies then no further change is likely. Though entertainingly argued, Fukuyama's thesis is hardly persuasive.

An interest in the past, or concern for our 'heritage' as it is glossed today, is relatively recent and is often without adequate definition even in Acts of Parliament. The crux of the heritage debate today however is that heritage can mean many different, even contradictory things to different people (Merriman 2002:547). Lowenthal (1998:7) suggests that heritage is not history, proposing that while history seeks to convince by truth, heritage exaggerates and omits, candidly invents and frankly forgets, and thrives on ignorance and error. But history too is positional; it is dependent upon where one is located in social reality, within society and within global processes (Friedman 1992:194). History then is also in part a mythical construction. Importantly, then, like memory, history and heritage are essentially seen to construct the past rather than reproduce it (e.g. Ballard 2003; Keesing 1989; Trigger 1984). As Tilley (2006:27) has argued we may even produce cultural heritage because unproblematic memory has already been destroyed. What matters, in other words, is not the 'past' but our relationship to it. The Duna people of New Guinea, for example, recount past events and rework them to fit a pattern which predicts current happenings (Haley 1996).

The post-modernist view that the past is culturally constructed in the present in order to serve the needs of the present has implications that are often difficult to articulate and deal with. Some archaeologists seem to go too far when they suggest that we 'should unite in a defence of things, a defence of those subaltern members of the collective that have been silenced and 'othered' by the imperialist social and humanist discourses' (Olsen 2003:100). Sahlins (2003) has astutely noted that post-modernists who deconstruct historical descriptions on the grounds that the 'facts' are constructed in the service of power and domination have been taken aback recently by the use of this view by the political Right. In the particular cases he cites, of global warming and Fijian cannibalism, he demonstrates that doubt among scientists about how to 'see' these events has been used by the Right to deny their existence. There are many similar examples that could be drawn from the history/heritage arena.

The Sokal affair has demonstrated that post-modernism produced a more radical relativism than was ever envisaged (Boghossian 1996; Sokal 1996). While intense debate continues on its definitions and values (Jenkins 2000; Zagorin 1999, 2000), critics have seen it as 'remarkably dim-witted' (Eagleton 2003:16), and an 'intellectual Disneyland … writing obfuscatory and opaque prose heavily littered with references to the Parisian oracles of the moment' (Oldmeadow 1992:61, 64). Some simply take the view that it is over (Confino 2000). Post-modernism has not dominated the Australian academy though it can be found in various places (Henderson 1998) and the parallel processual/post-processual debate arguably has had only limited impact on Australian archaeology (Burke *et al.* 1994:18; du Cros 2002:35-40).

I have two, among many, concerns with a post-modernist view of the past. The first is well articulated by Broome (1994:74-77) when he argues that guilt about events in the past is inappropriate, since we did not inhabit the past. Any guilt we might feel should be reserved for present injustices to Aboriginal people. Aboriginal people of the past deserve to be portrayed as the culturally alive and complex humans they were, not stereotyped and diminished as frontier victims before European firepower. Secondly, the emphasis on the 'otherness' of Aboriginal people is also inappropriate when it separates them from the dominant settler society (e.g. Lattas 1990; Riddet 1995). In its most common form, that of the 'noble savage', it can have many negative impacts (Rowland 2004). A most useful insight into this issue is provided by the Aboriginal scholar Francis Peters-Little (2003:36) in reference to the portrayal of Aboriginal people in the medium of film:

> I am mostly concerned that the outcome of too many rigorous ethical protocols and cultural guidelines which are meant to protect Aboriginal 'moral fitness and standards' run the risk of manipulating film-makers to produce sanitised versions of Aboriginal culture, thus distorting the very culture they purport to protect.

I can therefore not accept a view that science is some hegemonic tool of Western imperialism that cannot operate in the modern world. Equally, however, if a variety of reconstructions of the past may suit our (or others') present situation, who would wish to deny their validity. Perhaps we should however always apply the famous Samuel Johnson kick test: As Boswell (1949:292) reports, Johnson once rebutted a complicated proof of the non-existence of physical reality by kicking a large stone and saying, 'I refute it *thus!*'

From Nostalgia …

Between memory and history lies the breeding ground of myth and myths are a fundamental component of human thought. Distinctions between myth, history and heritage are therefore often blurred and myth is generally built on a nostalgic view of the past (Yelvington 2002). Nostalgia has played an important but irregular role in defining an Australian national identity (e.g. Waterhouse 2000) and in forgetting unwanted aspects of the past (e.g. Byrne 1996-7). Nostalgia has a major role in modern advertising (Muehling and Sprott 2004) and is seen as a protest against economic rationalisation and globalism (Ybema 2004:829). The past often seems a better place in the face of apparent decline and disintegration, either from without or from within (Lowenthal 1997:xiii). Nostalgia for the past was felt in the 1940s because of a danger from without. Currently it relates to apparent dangers from within. Fundamental changes are occurring within the structure of societies and old values and standards are being replaced by new. For some this may be challenging, but for many it is clearly confusing, threatening and dispiriting. As many see it, the 'crisis of modernity' remains unresolved. Remembering produces a comforting narrative of the past and an earlier self, through eliminating conflict and tension, and smoothing out disquieting contradictions (Samuel and Thompson 1990:16). The past is thus 'positively evaluated' (Lasch 1991:110-112). We should therefore not be surprised when contemporary Africans express nostalgia for the colonial past when they are excluded from the promises of modernity (Bissell 2005) or that Central and Eastern Europeans express nostalgia for communist rule when democracy has not lived up to its promises (Boym 2001; Ekman and Linde 2005). Equally we should not anticipate that nostalgia for the past is inevitable. Myles Lalor, an Australian Aborigine, for example, refused nostalgia for the birthplace from which he had been displaced, in favour of a cosmopolitanism that asserts that there are always other places where life – even Aboriginal life – can go on (Beckett 1996:313).

Robert Hewison (1987:43, 139-140; see also Lowenthal 1997:248) has argued that a nostalgic view of the past has resulted in an abandonment of critical thinking and turned history into heritage or bogus history that we obsessively preserve. He proposes the need for a critical dialogue between past and present which must not be left to a professional minority. Instead he calls for a collaborative process shared by an open community that accepts both conflict and change and calls for a fierce spirit of renewal. However, an alternative view has been intensively explored by Christopher Lasch in his book *The True and Only Heaven* (1991). While he sees dangers in nostalgic reverie he suggests it remains true that nostalgia can be a positive force in our lives. The idea of progress in Western civilisation has reached the level of a cliché so that nostalgia may provide a critique of the assumption that we are moving along a path which is inevitability good, or that contemporary values are necessarily better than those upheld by our ancestors. The more emphatically the modern age insists on its own wisdom, experience, and maturity, the more appealing allegedly simple, unsophisticated times appear. Thus nostalgia has also become a term of political abuse. In societies that cling to the dogma of progress, no other term is more effective in deflating ideological opponents. Those who deplore nostalgia attribute its appeal to a crisis of nerve, an inability to face up to the realities of modern life (Lasch 1991; see also Koehne 1995; Tannock 1995). Others have coined the term 'postalgia' for organisations longing for a paradise yet to come (Ybema 2004:826).

... to the Culture Wars

History and heritage have today become an important part of a debate about our national identity labelled the 'history' or 'culture' wars (e.g. Bonnell and Crotty 2004); a subdiscipline war also rages between Australian Studies and Australian Cultural Studies (e.g. Marks de Marques 2005; Turner 1996). The journalist Paul Kelly (2003) asserts that in Australia the political war over our past began on 27 February 1992, when Paul Keating delivered his 'one nation' economic manifesto. He notes that while the history wars can be destructive they depict a nation that cares more than ever about its history. He also argues that the history wars will not end until we transcend both the 'trumphalist' and 'black armband' (see Blainey 1993) stereotypes of our history. New Zealand has its own history wars centring on the National History Museum and over deliberations of the Waitangi tribunal (Phillips 1996).

The intensity of the debate over our past is certainly more than a battle, skirmish, or academic argument (e.g. Attwood 2005; Connor 2005; Curthoys and Docker 2006; Hirst 2005; Macintyre and Clark 2003). This is apparent, for example, in the responses to Keith Windschuttle's (2002) book arguing that frontier massacres of Aborigines were not a defining characteristic of the Australian experience. David Flint thought Windschuttle's work 'a truly magisterial study' (Flint 2003:88) while Robert Manne thought it 'so ignorant, so polemical and so pitiless a book' (Manne 2003a:11). More generally, Robert Manne has been described as 'an intellectual undertaker. His dour, grim, accusatory and utterly humourless observations are presented with an impregnable sense of certainty' (Sheehan 2003:48). Manne (2003b) in response thinks a number of people were 'underwhelmed' by Sheehan's first book *Among the Barbarians: The Dividing of Australia* (Sheehan 1998) and that his second book, *The Electronic Whorehouse* 'is a book of exhausting polemical excitement without a central theme'.

Further examples of the history wars include Windshuttle's (2001:11) attack on the Australian National Museum which he see as a 'repository of nothing more than the intellectual poverty of the tertiary-educated middle class of the post-Vietnam war era' that 'panders to the same currently fashionable interest groups of women, ethnics and indigenes'. Davison (2003:8-9) views such hostility to the Museum's interpretation of contact history as inseparable from the government's stance on issues of Aboriginal reconciliation, native title, stolen children and the like. The critics in turn portray the Museum's curators and historical advisors as members of the 'new class', pushing their own radical 'post-modernist' political agenda against the will of the silent majority of Australians whose taxes they are spending. The Indigenous first director of the Museum, Dawn Casey, has eloquently defended the Museum suggesting Australia desperately needs places for intelligent dissent and debate (Casey 2003, 2006). However, her contract was not renewed by the Howard government!

One of the most insightful comments on the 'history wars' again has been put by an Aboriginal scholar who sees academics being dragged in and forced to 'lock horns in a media designated area, which fans the results into flames of its own purpose' and suggests we are still a country that 'must deal with its past, and through that process provide a platform where both black and white can walk together to a shared future of hope, prosperity and equality' (Maynard 2003:139, 144).

Discussion and Conclusions

In concluding I return firstly to 'S.T.''s 1976 view of the past. 'S.T.' believed that we needed to preserve things (in New Plymouth) that would allow people after us to know:

> that there really were such things as quarter-acre sections, single-storey houses; that grass used to grow on lawns; and that, when the weather was fine, you could actually see Mt Egmont. And that out to sea (in which people could actually swim) there was only one oil-producing platform – and even that was only half completed (Taranaki Newspapers 1976:16).

'S.T.', clearly had a deep concern for negative things that have not yet (and are unlikely to) eventuate, but this is not unusual. We tend to underestimate the impacts of change and modernity on people and are therefore often confounded by their nostalgia for the past. The 50s and 60s will undoubtedly continue as partly imaginary places of stability and security, shaped by doubts about who we are and by fears about an uncertain future. In Australia, nationalism during the 1950s created the historical myth of modern Australia being the culmination of a continuous tradition of proud, egalitarian, independent-minded Anglo-Celtic mateship. This national identity excluded from the narrative the role of women, glossed over the racism of the outback and ignored the ethnic and cultural diversity of Australia. In Australia, at least, a return to the 50s might be a return to positive 'family values' but it might also be a return to a 'wogless', White Australia (Duruz 1999:250) and in some cases extremist politics, such as Hansonism (e.g. Barcan 1998). Similar contradictions would face New Zealand. Nevertheless a nostalgic view of the past need not be negative but rather 'one element in a more holistic approach to the past; one that accords legitimacy to individual and group memory and mythos alongside professional and institutional history-making' (Trotter 1999:26). Few modern institutions are immune from feelings of nostalgia. The previous collegial model of universities, for example, is seen as preferable to the mangerialistic model emphasising, among other things, accountability, efficiency, cost effectiveness, markertisation and quality assessment (McKnight 2005:32-36; Ylijoki 2005:557).

At a more practical level, we might be critical of heritage managers of the recent past for favouring 'crown jewel' structures but we must be aware that new fashions suffuse our own efforts. We need a heritage that conforms with and is useful to the present. The public heritage of any society should reflect a cultural past as little falsified as professionals can make it, but also one that connects fruitfully with its inheritors, a legacy they will wish both to enjoy and to hand down to their descendants with their own alterations and additions. Heritage interpretation is thus an exercise in relevance as well as accuracy, in credibility as well as truth (Lowenthal 1986).

In Australia, cultural heritage significance has generally been measured in terms of archaeological and architectural values and this remains entrenched in most cultural heritage legislation and charters in Australia. There are now calls for a more holistic approach giving social significance a greater focus (e.g. Byrne *et al.* 2001; Davison 1991; English 2002; James 1993; Johnston 1992; Watkins 2004). Australian archaeologists and historians have more recently engaged with Aboriginal people in the development of the archaeology of contact, community archaeology, and 'shared heritages' in a move to bridge the gap between the timeless/authentic Aborigine of the past and the real concerns of contemporary Aboriginal people (e.g. Brady *et al.* 2003; Clarke 2002; Greer *et al.* 2002; Harrison 2004; Head and Fullager 1997; Johnston and Buckley 2001; Lilley 2000; Lydon and Ireland 2005; McBryde 1995; Murray 2004; Torrence and Clarke 2000; see also papers in Harrison and Williamson 2002). However, first there is a need for an integrated, holistic approach to heritage legislation and management across Australia (Schulthorpe 2005) which unfortunately appears less likely than ever (e.g. James 1993). In America, as recently as 2004 'federally-subsidized scientists' (archaeologists and anthropologists) were seen as standing in the way of Indian law and human rights (Fine-Dare 2005:177). For Australia, Thorley (2001) has similar concerns and considers it doubtful that wider recognition of Indigenous perspectives will be sufficient to resolve underlying conflicts of value. My own view is that the works cited above have gone a long way to resolving conflicts but continuing debates are to be expected and should be celebrated rather than avoided.

I have been more self-indulgent in this paper than I would normally be. I have perhaps touched on too many issues in too little depth and made too great a leap between an advert on nostalgia and the culture wars. The fact that I was able to 're-see' my hometown after 35 years and subsequently reflect on my early professional and personal contact with Jay has however stimulated in me an awareness of just how complex our understanding and use of the past can be. I am not suggesting that objects, sites or places and the archaeological or architectural values of such places are not important but do stress the importance of social values. I have suggested that a nostalgic view of the past is not necessarily bad if it allows a check on the excesses of the concept of progress. My emphasis on nostalgia and criticisms of post-modernism should not be interpreted as a neo-conservative approach to research and scholarship. I am however persuaded by McKnight's (2005) and others' (e.g. Huntington 1998; Schudson 2005) views that society is, if not 'sliding towards disaster', at least not changing for the better. I am also persuaded by McKnight's (2005:142) view that while globalisation with its emphasis on free markets has been seen as primarily an economic event, its cultural impacts are arguably more dramatic. Also, based on a growing scientific literature that human nature exists, we should begin to develop a new humanism which is not Left or Right in the political spectrum (McKnight 2005). This requires that we should first identify what was valuable in the old politics. It is here that anthropologists, archaeologists and cultural heritage managers should engage in the broader debates.

Views of the past, be they nostalgic or otherwise, have become entangled in Australia (and New Zealand) in questions concerning the very nature of society. If we can deal with an apparent trend to conservatism or neo-liberalism in society (e.g. Anderson 2005; Catley 2005) and 'intelligent design' (Wilson 2005), understand the benefits of globalisation (e.g. Friedman 2005) or its eminent demise (Saul 2005), move beyond some simplistic post-modern rhetoric (e.g. Eagleton 2003), find out what people really think of the past and how it can be made relevant to them (e.g. Hamilton and Ashton 2003; Rosenzweig and Thelen 1998) and continue to develop our relationship with indigenous communities, then archaeology and heritage have a major contribution to make in defining the nature of society.

As Diamond (2005:525; see also Butzer 1996) has stressed, archaeologists have played an enormously significant role in revealing the relationship between people and environment. It is an important role that we can continue to play. We need to engage, as Diamond has recognised, in issues of climate change, resource utilisation, population growth and impacts on biodiversity all of which are relevant to the current human condition. Further, theories of liberalism and socialism share a notion of unending progress based on the accumulation of material goods while indigenous societies more generally have a conservative notion of stewardship of the environment (McKnight 2005:101-102; but see Rowland 2004). Both Saul (2005) and McKnight (2005) believe there is a move away from globalisation back to a more positive nationalism and the potential for a new humanism. Anthropologists/archaeologists also have a substantial role to play in contributing to these debates as they focus on the study of human diversity.

The world has changed dramatically since I (and Jay) began my (our) adventures in archaeology. Globalisation and its broad promises seem to have been overwhelmed by conservatism if not basic fundamentalism, something we would not have anticipated in the 1960s and 70s. In this rapidly changing world it will not pay to be churlish, defensive or dismissive. Archaeologists must engage in a wide range of modern debates and in this respect I think the traditional principles of history, geography and anthropology/archaeology will have much to contribute.

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Of Fairy Rings and Telegraph Poles: The Importance of Accounting for Evidence of Absence in Archaeological Surveys

Richard Robins and Cheryl Swanson

Abstract

The use of probability sampling in archaeology survey design is slowly gaining acceptance in Australian archaeological practice, although its strengths and weaknesses are not fully understood, and its potential is yet to be fully exploited. Archaeological surveys concentrate on finding evidence, and the role of absence of evidence is ignored, although it may be critical for meaningful interpretation. However, the use of the site concept requires careful consideration if absence of evidence is to be effectively incorporated into surveys. This paper considers these issues using a case study from southwest Queensland.

Introduction

In a critical appraisal of a paper claiming to demonstrate that in 'England', there was a correlation between the spatial distribution of bracken fern (*Pteris*) and soil pH of 5.6 or more, Ashby (1936) suggested the apparent association was instead an accident of sampling. The fern has a circular outgrowing habit, commonly referred to as a 'fairy ring'. Ashby pointed out that the cause of the association was not a preference of *Pteris* for soils of a particular pH, but that high pH values were more frequent on the sandy soils on which *Pteris* grew. The distribution of *Pteris* was associated with sandy soils and not pH. He pointed out that the 'the distribution of telegraph poles on these soils would also show an optimum pH at 5.6' (Ashby 1936:232). Therefore, Ashby argued the distribution of bracken was controlled by soil type rather than pH. The failure to arrive at the correct conclusion was due to sampling error. Soil acidity should have been measured where bracken was absent as well as present.

This lesson has been well learned by natural scientists. Sampling designs that ensure collection of evidence of absence as well as presence to ensure the proper identification of cause are commonplace in the literature relating to sampling. Green (1979:26) for example states that:

> To test whether a condition has an effect, collect samples both where the condition is present and where the condition is absent but all else is the same. An effect can only be demonstrated by comparison with a control.

The importance of establishing evidence of absence is not commonly discussed in archaeological survey design. While some archaeological texts point out the importance of collecting evidence of absence in archaeological surveys (e.g. Renfrew and Bahn 2000; Thomas 1979:283), or accounting for absence in analysis of the results (e.g. Lilley 1985; Robins 1983), it is still a neglected and misunderstood aspect of archaeological survey design and implementation. Its importance remains unrealised. For example, when discussing what he terms 'negative evidence', Thomas (1979:283) states that:

> In addition to telling the archaeologist what activities did take place, the data must likewise indicate those activities that did not occur in a particular area or lifezone. It is a relatively simple matter, for example, to determine the presence of pinon harvesting sites within the pinon-juniper zone, but the archaeologist should also determine that such sites did do not occur (1) near a river, (2) on the sagebrush-covered flatlands, or (3) on the high mountain peaks.

However, this comment could be interpreted as the self-evident outcome of any survey, and thus it fails to underscore the importance of identifying negative evidence.

In this paper the term 'evidence of absence' is used in preference to negative evidence. The concept of negative can imply less than zero, and is therefore an inappropriate term when discussing artefact densities or archaeological sites. An alternative meaning is something lacking positive attributes. However, establishing evidence of absence is as critical to the interpretation of spatial patterning as that of establishing presence. In this sense, therefore, evidence of absence is also a positive attribute. For these reasons we regard evidence of absence as the more appropriate term.

Certainly, establishing evidence of absence during surface surveys in a systematic manner similar to that of establishing evidence of presence is a practice that is rarely implemented in Australian archaeology. Jay Hall was one of the first in Australia to recognise the importance (and good sense) in using probabilistic random sampling strategies for archaeological surveys, and encouraged a number of students to use this approach in the early 1980s for projects relating to the Moreton Region Archaeological Project (e.g. Lilley 1985; McNiven 1985; Robins 1983). Smith's (1982) Plumbago survey is the only other example from this time or before. However, such surveys have historically not been a common feature of Australian archaeology in either academic research (Attenbrow 1987; Robins 1983) or in cultural heritage management. While there is a growing recognition of the need to undertake surveys using random samples, and it is becoming a more recognised approach (e.g. Burke and Smith 2004), less common is recognition of the need to implement probabilistic random sample survey strategies to establish absence in a systematic and comparable way to that of presence. It is only through the use of random sampling, however, that 'an effect can be ... demonstrated by comparison with a control' (Green 1979:26). This is particularly relevant for those circumstances where identification of causal relationships between human behaviour and the environment or post-depositional factors need to be established.

Establishing evidence of absence in a structured way also has important implications for survey design and the use of the site concept. By focusing on the presence of evidence only, use of the site concept may hinder attempts to explain patterns in the archaeological record and identify relationships between the archaeology and environmental/post-depositional factors. Non-site archaeology is a more effective strategy than site surveys to obtain evidence of both absence and presence.

The term non-site archaeology was introduced by Thomas (1975) while undertaking the Reese River Ecological Project to test archaeological models based on Julian Steward's ethnography of the Shoshonean of the Great Basin (Thomas 1973). Thomas (1975:62) advocated an approach that regarded:

> the cultural item (the artefact, feature, manuport, individual flake, or whatever) as the minimal unit, and ignore traditional sites altogether.

Our viewpoint does not deny the usefulness of the site concept as an analytical tool in some circumstances. We argue that the critical issue for archaeologists is to identify an appropriate approach for the problem at hand. A site-based approach might not be the most appropriate one where there is a need to record absence as well as presence. This case study will assist archaeologists to understand issues relating to the selection of appropriate survey methodologies and methods. We illustrate our case using data obtained from the results of a non-site survey undertaken by one of the authors (RR) in the vicinity of the Currawinya Lakes, southwest Queensland, Australia, between 1988 and 1990. The broad aim of that survey was to determine if a non-site approach could be used to identify and explain patterning in the archaeological record of an area of arid Australia using approaches developed by David Thomas (1975) and Robert Foley (1981a, 1981b).

The Study Area

The study area embraced 655km² within the pastoral property Kilcowera Station and Currawinya National Park (then Currawinya Station). It is located approximately 30km northwest of the Queensland/New South Wales border town of Hungerford. The town of Cunnamulla is 150km to the northeast and the town of Thargomindah 115km to the northwest. The anastomising channels of the Paroo River are approximately 25km to the east (Figure 1). The study area is on the eastern edge of the Australian arid zone (Winkworth and Thomas 1974:3), with subtropical hot to extreme, very dry summers and mild to warm, dry winters (Bureau of Meteorology 1989). It falls within the mulga (*Acacia aneura*) biogeographic system described as 'predominantly flat or gently undulating plains with mulga dominated vegetation communities' (Stanton and Morgan 1977:3).

An extensive lake system dominates the geophysical character of the area. Lake Numalla, a freshwater lake, both feeds, and is fed by, the Paroo River system, which in turn flows into the Darling River 200km to the south. Lake Wyara is the sink for a small local drainage system and consequently is saline. There are numerous semi-permanent and ephemeral lakes, waterholes and claypans throughout the study area that provide habitats for a large and varied bird life. The major environmental systems are dune fields in the east and dissected residuals in the west.

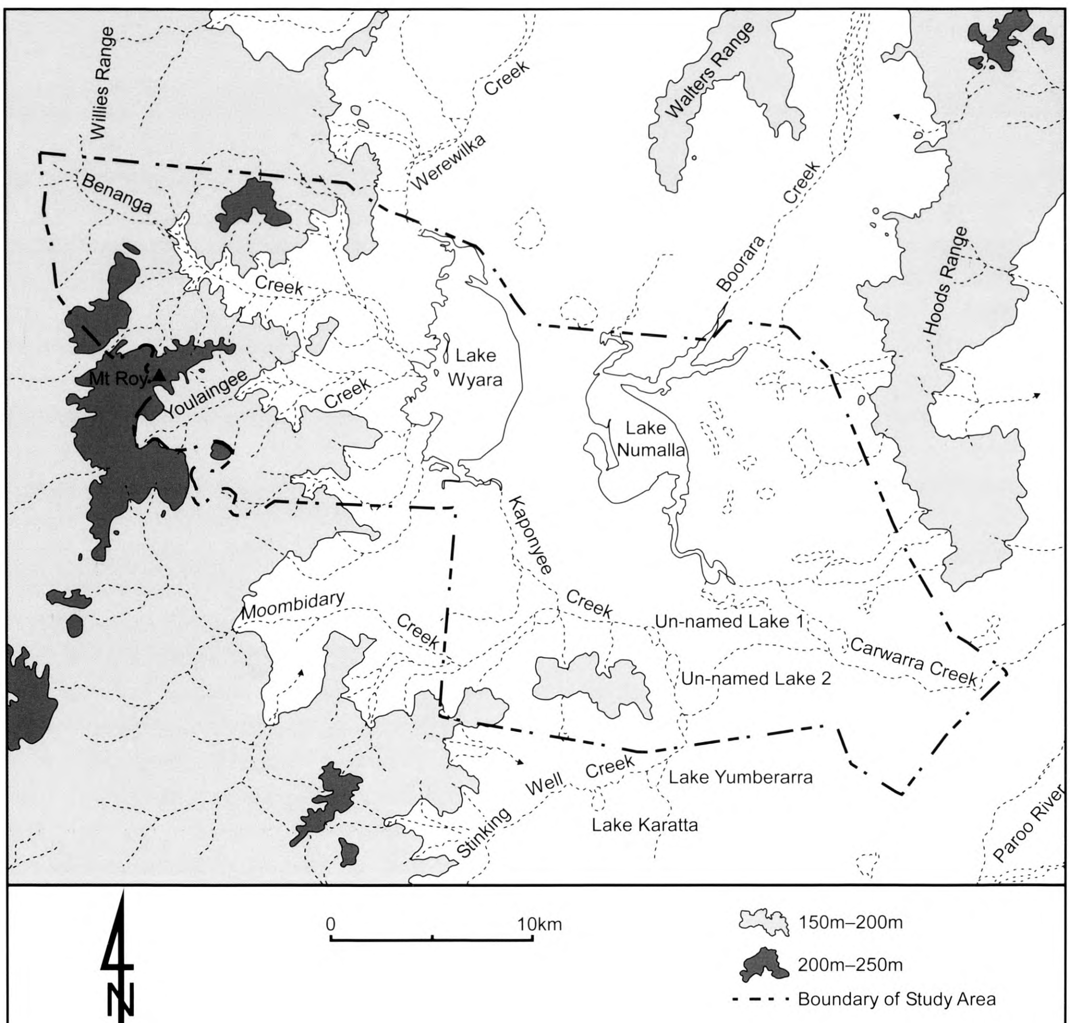

Figure 1. Location of study area.

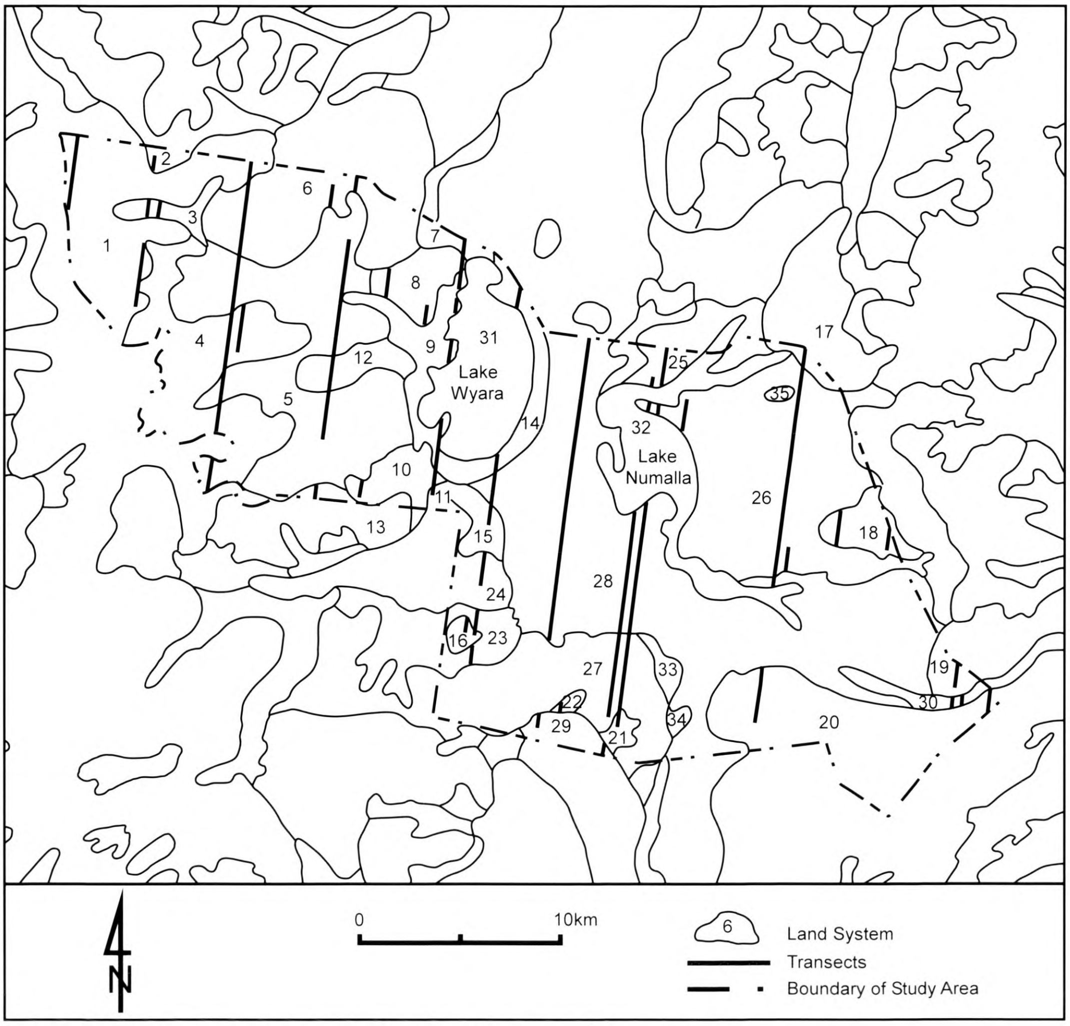

Figure 2. Stratified systematic transect sample of study area.

Survey Description

The details of the survey have been discussed elsewhere (Robins 1994, 1998) and only a brief description is given here. Thirty-five land systems were identified within the study area after Dawson (1974) and Dawson and Boyland (1974). Each land system was given a unique number. The study area was divided into a series of 50m wide north-south transects that intersected a baseline at right angles. A 1% random sample was then selected for each land system (Figure 2).

In all, 132km of transect were planned. The identified transects were then used as corridors within which recording took place. At set intervals along each transect 20m x 20m quadrats were laid out. A minimum of two quadrats was surveyed for each land system; one at the start and one at the end of each transect. Using this method, 525 quadrats were surveyed.

Thirty-five fields of data relating to archaeological and environmental factors for each quadrat were recorded. The location of the quadrat, its environmental context and relationship to key elements in the landscape, factors that affected both the recording and condition of the quadrat, and minimal data about the artefacts, if they were present, were noted. If no artefacts were in the quadrat then only the first 22 fields were filled in. Artefact types, numbers, size and raw material for each quadrat were recorded on a separate sheet.

Six thousand and thirty-seven artefacts were recorded from 214 of the quadrats. The frequency of artefacts in these quadrats varied from 1 to 700, with a mean of 28.2. On the basis of a crude extrapolation from the results of this survey, approximately 151 million artefacts will be found differentially scattered across the study area, with a mean density of approximately 26,000 artefacts/km². Of the quadrats with artefacts, 3% (n=14) contained 100 or more artefacts, and these had a combined total of 4360 artefacts or 72% of the total number recorded. Sixty-three quadrats (12%) contained between one and 10 artefacts each. However, the combined total of these quadrats was only 180 artefacts or 3% of the total. The predominant artefact type was the flake, which accounted for 60% (n=3618) of all the artefacts recorded. Other types with relatively high representation were cores (8.7%; n=28), of which 56% were multiplatform cores, retouched flakes which accounted for 11% (n=661) and snapped flakes for another 3.4% (n=206). Formal tool types were poorly represented. Seventeen tulas, two unifacial points, three pirri points, 10 asymmetrical backed blades, one edge-ground axe, two hammerstones, three grindstones and three (unrelated) topstones were recorded.

Establishing the Case

For the purposes of our argument, we will classify a site as any quadrat with one or more artefacts. Aspects of three hypotheses designed to identify broad patterns of association are illustrated using histograms. They are based on the assumption that amount of discard is proportional to the preference for use. These were not the only hypotheses tested by the survey, and the histograms do not represent the full test of the hypotheses, but they suffice for the purposes of this argument.

Two interpretations are presented based on the same dataset. The first is presented as a simulation of a conventional probabilistic random site survey that examines only evidence of presence. Significance, where it is established, is through comparison with the null hypothesis. Comparisons were made between site characteristics, such as type of erosion, or site location associations, such as distance to permanent water, using contingency table analysis. The null hypothesis being tested is that there is no difference in the number of quadrats associated with types of features (i.e. that each feature or association had the same likelihood of being associated with artefacts as any other feature or association in the specific comparison). For example, in the case of erosion, we assume that evidence of erosion due to wind was as likely to be present as evidence of erosion due to wash or gullying.

To accommodate the sparseness of some cells in the contingency table analyses, the exact χ^2 distribution was used and all analyses performed using the StatXact statistical programme. The 0.05 level of significance was used throughout. In addition, Monte Carlo methods, a form of repeated sampling of the table data, based on 10,000 repeat samples were used to obtain an unbiased estimate of the true P value (Mehta and Patel 1997). This approach was used for both datasets.

Interpretation 1

Hypothesis 1

The observed distribution of artefacts can be attributed to the recording conditions, particularly ground cover, or type of erosion.

Figure 3 presents vegetation cover comparisons for quadrats with artefacts. The majority of quadrats had some form of vegetation cover, with the greatest percentage of quadrats containing between 1% and 25% cover. As ground cover increased the frequency of artefacts recorded decreased. There is a highly significant relationship (P=<0.001) between lack of ground cover and number of artefacts, indicating the possibility that the results of the survey may be highly skewed by lack of visibility.

Figure 4 presents a comparison of erosion types. Some form of erosion occurred in 78% of the quadrats. Of the erosion types recorded, wash was the most frequent contributor with 46.3% of quadrats affected, a statistically significant over-representation (P=<0.001), while mass movement is significantly under-represented (χ^2=19.21, df=1, P=<0.0001). This suggests that erosion, particularly wash, plays a significant role in exposing artefacts.

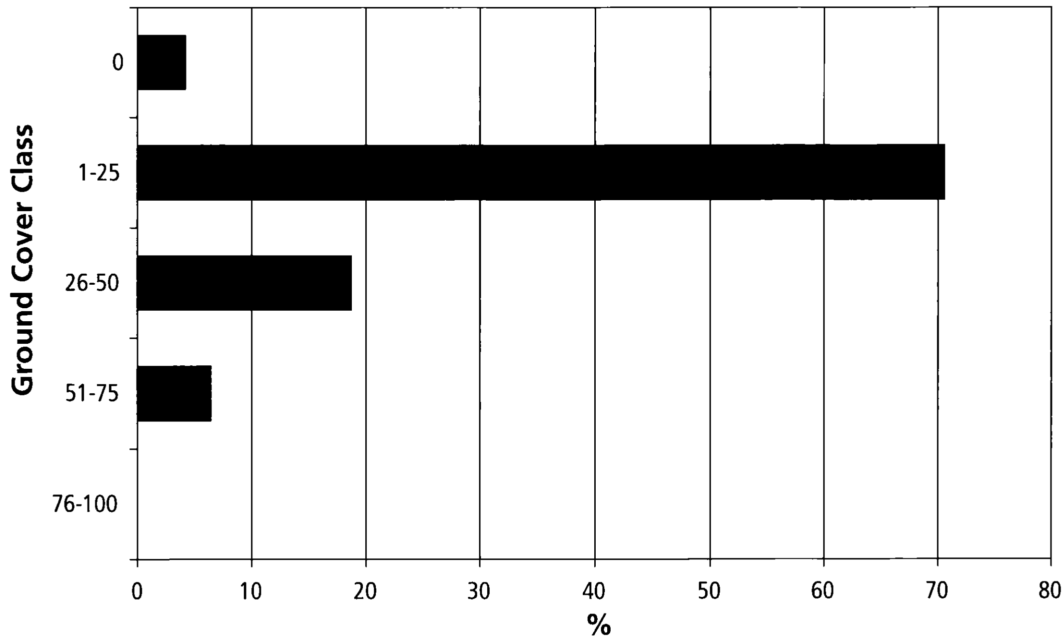

Figure 3. Vegetation cover comparison for quadrats with artefacts.

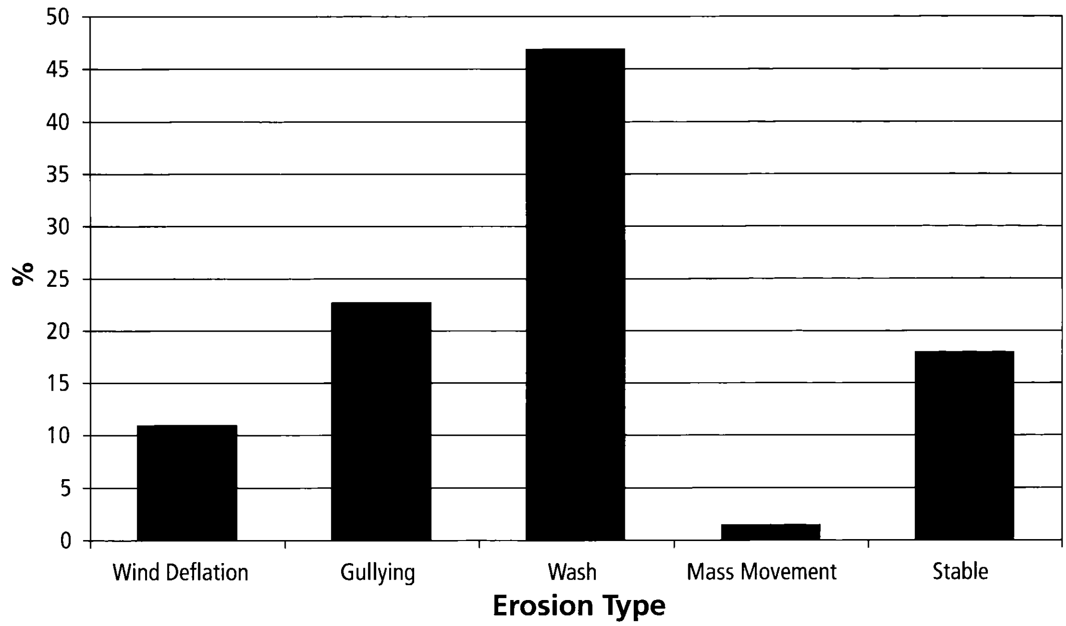

Figure 4. Comparison of erosion types for quadrats with artefacts.

Hypothesis 2

The type of, and proximity to, flakeable stone will affect the character of the artefact assemblage in three ways:

- *preference for particular types of raw material;*
- *preference for a particular size of raw material; and,*
- *a reduction in the percentage of flakes and cores with cortex the further from a stone source.*

The only stone raw material type found in the study area is silcrete which can be obtained from three sources: outcrops, gibber surfaces or creek cobbles. Of these, gibber surfaces were the closest raw material source to artefacts in more than 60% of the quadrats (Figure 5). There is a clear preference for gibber surfaces (χ^2=23.92, df=1, P=<0.001) over silcrete outcrops or creek cobbles. Creek cobbles are significantly under-represented (χ^2=15.99, df=1, P=<0.001). This association suggests that gibber surfaces were the preferred stone source.

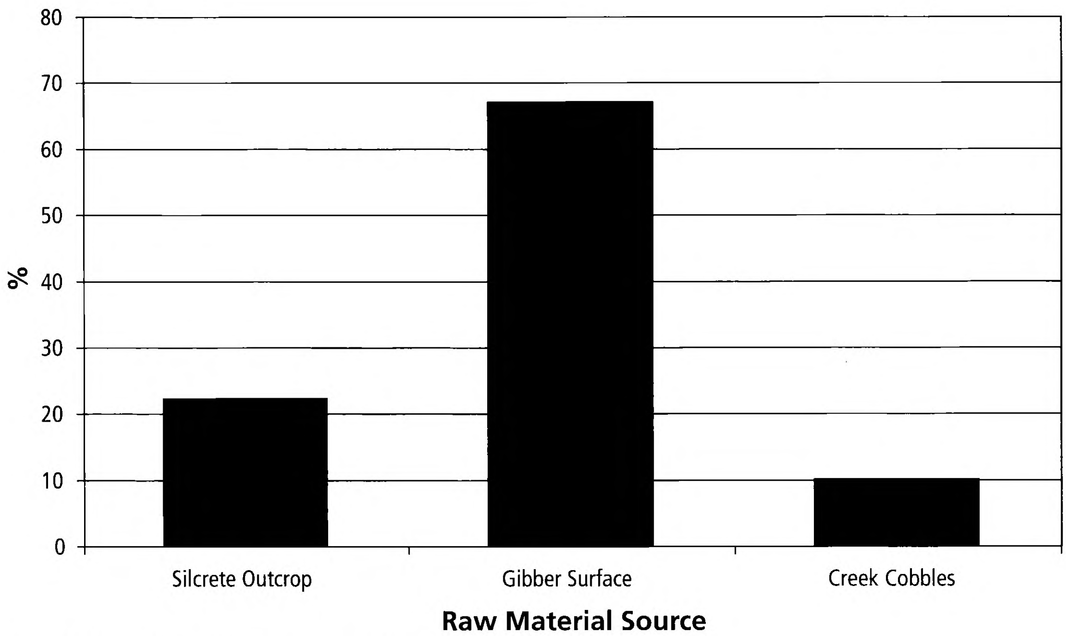

Figure 5. Comparison of closest raw material source for quadrats with artefacts.

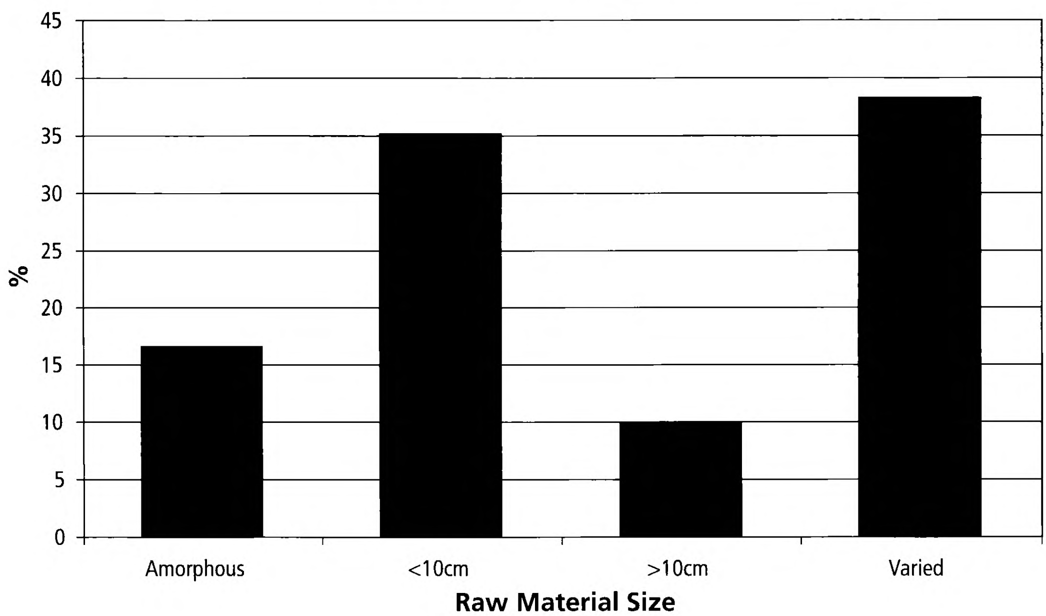

Figure 6. Comparison of closest raw material size for quadrats with artefacts.

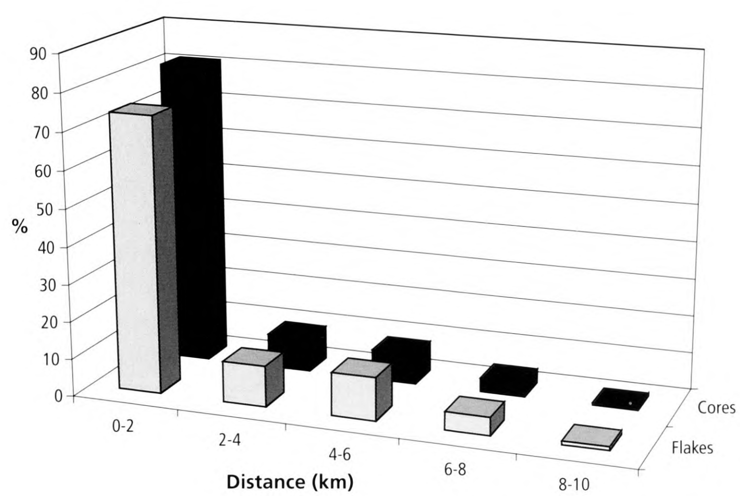

Figure 7. Percentage of flakes and cores with cortex with distance from a stone source.

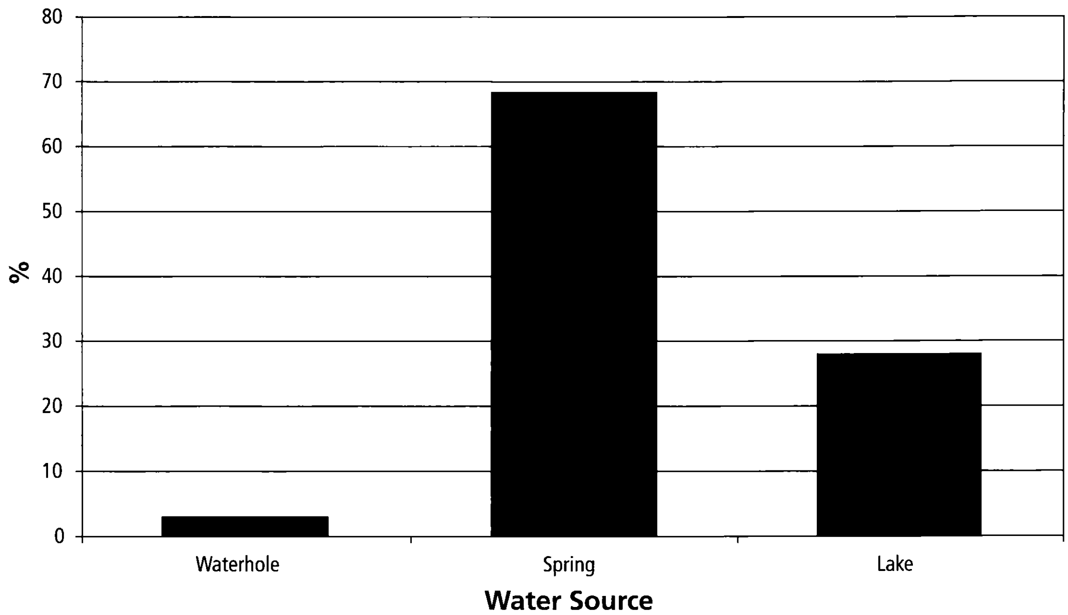

Figure 8. Mean distance to a permanent water source for quadrats with artefacts.

Considerable variation in raw material size was noted. Of the four classes of raw material size, <10cm and the varied were more frequent with approximate equal representation. Amorphous (a term used to describe rock outcrops) was significantly under-represented (χ^2=24.44, df=1, P=<0.001) (Figure 6). This indicates a preference for sources with smaller stones. There is also a clear decline in the percentage of flakes and cores with cortex associated with increasing distance from a stone source (Figure 7).

Hypothesis 3

The distribution of artefacts will reflect access to potable water sources. There will be:

- *no preference for types of temporary water source; and,*
- *a preference for springs over lakes and waterholes as permanent water sources owing to their greater reliability and more even distribution across the study area.*

The mean distance to a temporary water source for quadrats with artefacts was 200m. There is a clear preference for claypans, creekbeds and gullies, all of which are statistically over-represented. Springs are not represented at all, indicating a preference for all other sources of temporary water before springs. There is clear preference for types of temporary water sources.

When distance to permanent water sources is considered, the role of springs is reversed. Figure 8 illustrates the relationship between artefact distribution and permanent temporary water sources. Sixty-two percent of quadrats with artefacts are closer to a spring than to any other source of permanent water (χ^2=25.33, df=1, P=<0.001), a significant over-representation. Lakes are the closest source of permanent water for 36% of quadrats with artefacts and waterholes for 2% of such quadrats, the latter being significantly under-represented (χ^2=30.49, df=1, P=<0.001). There is a clear and significant preference for springs over any other source of permanent water.

Summary

Despite the potential bias owing to ground cover, we can summarise the results by stating that: wash is a significant factor affecting sites and potentially revealing archaeological material; that gibber surfaces are the predominant nearest stone source; and that varied and <10cm are the preferred raw material size. The percentage of cortex on cores and flakes diminishes with distance from the nearest stone source. There is a clear preference for gullies, claypans and creekbeds for temporary water and a strong preference for springs over permanent water.

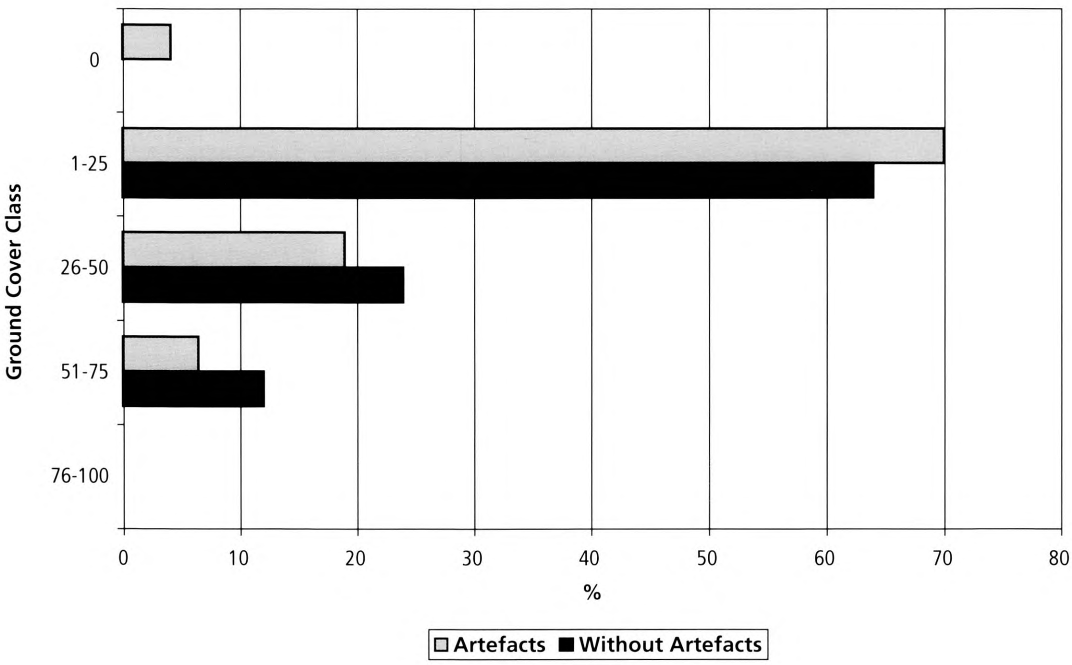

Figure 9. Quadrat comparison for ground cover class.

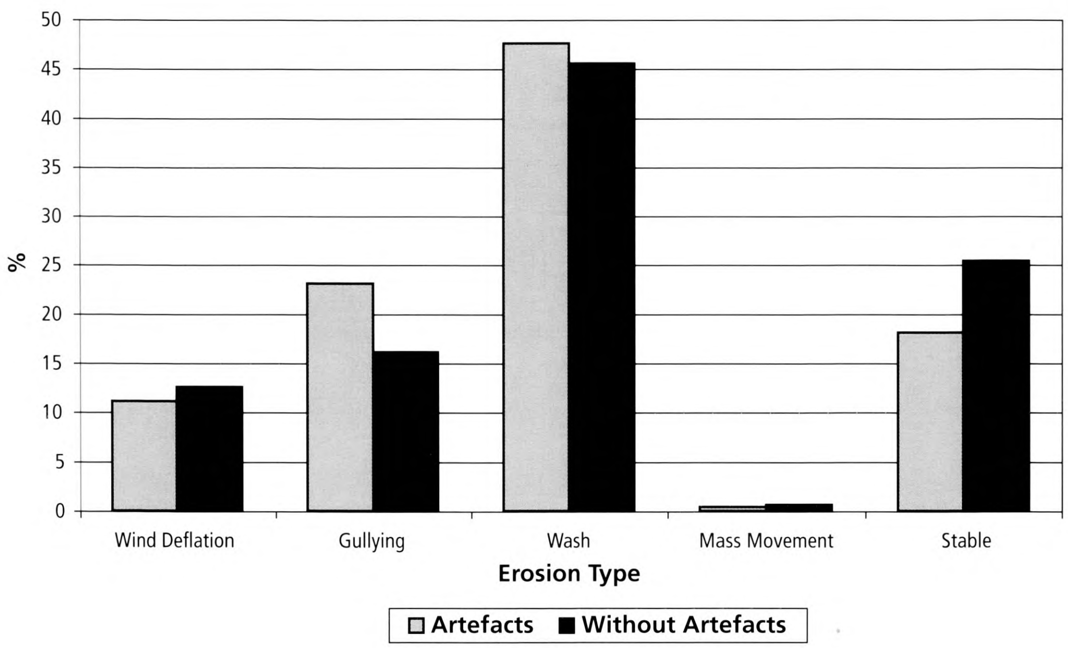

Figure 10. Quadrat comparison for erosion types.

Interpretation 2

If the data from the quadrats where there were no artefacts (an absence of evidence) are considered a different interpretation emerges. Here, significance is established by comparing the frequency of artefact occurrence with the frequency of artefact absence amongst quadrats. The null hypothesis in this instance is that there is no difference in the likelihood of a quadrat with artefacts being identified compared with that of a quadrat without artefacts.

Hypothesis 1

Figure 9 presents a vegetation cover comparison between quadrats with artefacts and quadrats without artefacts. The majority of quadrats had some form of vegetation cover, with the greatest percentage occurring in the 1% and 25% category. As ground cover increased, the frequency of artefacts recorded diminished, however, the representation of quadrats with artefacts and those without artefacts remains approximately equal across all categories. This equivalence suggests that the decrease in artefact numbers cannot be attributed simply to increased ground cover restricting observation.

Some form of erosion occurred in 78% of the quadrats, and Figure 10 presents a comparison of erosion types between quadrats with and without artefacts. Of the erosion types recorded, wash was the major contributor with 46.3% of quadrats affected. Although wash was the most common erosion type, quadrats with artefacts are represented only marginally (2%) more than quadrats without artefacts in this type. The largest difference (7%) between frequencies of quadrats with and without artefacts occurs with gullying. With such a low overall difference between quadrats with and without artefacts, type or extent of erosion can not be regarded as factors that are biasing the observation of sites.

Hypothesis 2

Of the sources of raw material, gibber surfaces were the closest source for over 60% of the quadrats (Figure 11). Quadrats closest to gibber surfaces with artefacts have the same relative frequency as quadrats closest to gibber surfaces without artefacts. Quadrats closest to silcrete outcrops and quadrats closest to creek cobbles have approximately the same representation, although quadrats closest to silcrete outcrops are over-represented by quadrats with artefacts and quadrats closest to creek cobbles are under-represented by quadrats with artefacts. Neither of the frequency differences in these comparisons (outcrops: χ^2=1.19, df=1, P=0.27; creek cobbles: χ^2= 3.18, df=1, P=0.07) is significant, thus it is evident that there is no preference for raw material types.

Of the four classes of raw material size shown in Figure 12, the <10cm and varied classes are nearly equally represented and both more frequent than the amorphous and >10cm classes. Although quadrats with artefacts are under-represented in both of these classes, the differences in frequencies between quadrats with and without artefacts are not significant (<10cm: χ^2=0.76, df=1, P=0.38; varied: χ^2=0.56, df=1, P=0.67). Quadrats where the closest silcrete source is >10cm comprise 10% of the sample, with equal frequencies of quadrats with and without artefacts. Although the quadrats with artefacts in the amorphous category are represented by only 13% of cases, the comparison with quadrats without artefacts is a near significant trend (χ^2=2.32, df=1, P=0.13) (Figure 12). The data indicate that there is no preference for particular types of raw material and there is only a slight preference of the amorphous (outcrop) category.

There is a clear decrease in the frequencies of quadrats with flakes and quadrats with cores with cortex associated with increasing distance from a stone source (Figure 7). There is a clear reduction in the percentage of flakes and cores with increasing distance from a stone source.

Hypothesis 3

The dominant temporary water sources were claypans (49%), gullies (20%) and creekbeds (21%). Quadrats with gullies and quadrats with creekbeds as the closest source of temporary water were both over-represented by quadrats with artefacts, however, this over-representation was only a near significant trend (gully: χ^2=3.53, df=1, P=0.06; creekbed: χ^2=1.84, df=1, P=0.18). For quadrats with claypans as the closest source of water, quadrats with artefacts were significantly under-represented (χ^2=1.84, df=1, P=0.002).

Claypans are such a common feature in the study area that it is simply not possible to be more than 20m from a claypan for large parts of the area (Figure 13). The fact that artefacts were found near a small proportion of claypans possibly indicates a preference for those with particular characteristics. However, the characteristics of claypans were not investigated for this study and it remains a matter for future investigation. Waterholes, lakes and depressions had only a minor representation (< 5%). Springs were not represented at all.

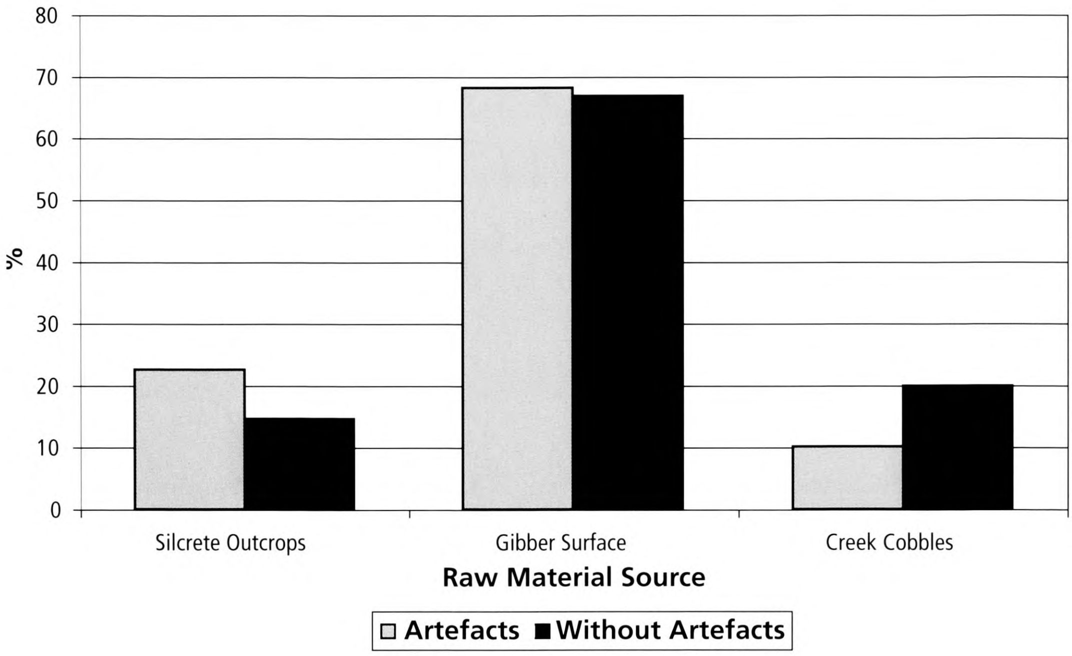

Figure 11. Quadrat comparison for raw material source.

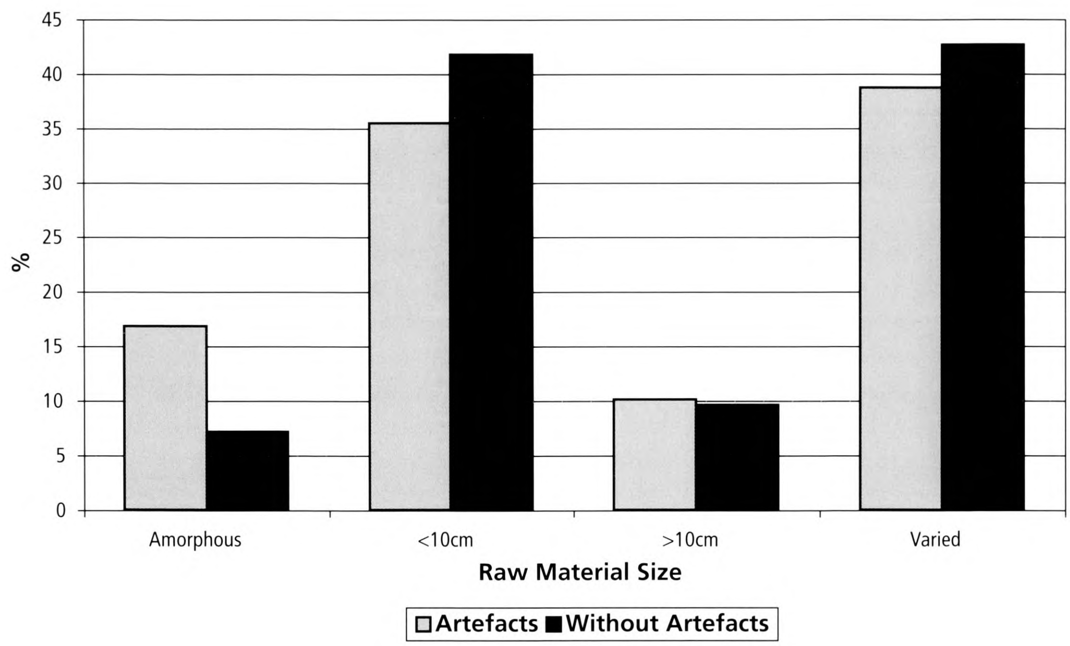

Figure 12. Quadrat comparison for raw material size.

When distance to permanent water sources is considered, the role of springs is reversed. Sixty-two percent of quadrats are closer to a spring than any other source of permanent water. Lakes are the closest source of permanent water for 36% of quadrats and waterholes for 2% of quadrats. Quadrats closest to springs are over-represented by quadrats with artefacts, while quadrats closest to lakes are under-represented by quadrats with artefacts. However, these relative frequencies are only near significant (springs: χ^2=2.89, df=1, P=0.09; lakes: χ^2=3.21, df=1, P=0.07), which would appear to be relatively weak support for the hypothesis that there is a preference for springs over lakes.

Figure 13. Distribution of lunettes and claypans in the Currawinya sand plain.

Summary

The conclusions drawn from this interpretation of the results are radically different from the first. Ground cover is not a biasing factor. Wash is not significant, but gullying is; gibber is not the preferred raw material source – there is no preferred source. Instead of the <10cm and the varied raw material sizes being significant, as had been the case in the first interpretation, the amorphous category was revealed to be significant. The percentage of cortex of cores and flakes diminishes with distance from the nearest stone source. Claypans with artefacts are under-represented instead of over-represented and there was only weak preference for springs over other permanent sources of water.

Discussion

This study was based on field methods that were comprehensively planned and consistently applied. The collection of the data was undertaken in a rigorous, systematic manner with checks and safeguards, and the data tested using a variety of statistical methods. Nevertheless, the interpretation of the results would have been fatally flawed had the evidence of absence not been recorded in a systematic way, and had not been incorporated into the statistical analyses. Comparison of the two datasets clearly illustrates that interpretations where absence of evidence is collected can be quite different compared with interpretations when absence of evidence is not collected. If the demonstration of relationships between multiple, spatial (in this case environmental) variables and the archaeological evidence does not include equal consideration of the absence of evidence, then subsequent interpretation will be meaningless.

These results have implications for the design and implementation of archaeological spatial surveys. We are not advocating that all spatial surveys must be probability surveys. Archaeologists are now well versed in the issues of sampling and representativeness, and there is a range of survey design choices that can be made to suit most questions and conditions (e.g. Bintliff and Snodgrass 1988; Dunnell 1992; Dunnell and Dancy 1983; Ebert 1992; Foley 1978, 1981a, 1981b; Shaffer 1997; Thomas 1975). Data obtained through non-probability sampling can be used to describe the relationship of the archaeological evidence (or sites), to environmental features or factors. Description of relationships, however, is not demonstration of a causal link. If causal explanations relating the archaeological evidence to particular environmental characteristics are sought, then evidence of absence must be collected in an unbiased and comparative way, that is, through the use of some form of probability sampling. If, however, the aim of the survey is to locate types of evidence for the purpose of inter-site or intra-site comparison, then collection of evidence of absence may be irrelevant.

This issue is particularly pertinent when the spatial survey design is based on the concept of the site. The issue of the site has been explored at length in the literature (e.g Dunnell 1992; Dunnell and Dancey 1983; Ebert 1992; Feder 1997; Gallant 1986; Plog *et al*. 1982; Renfrew and Bahn 2000; Robins 1994, 1998; Thomas 1975; Thomas and Bettinger 1976) and it is not our intention to further add to these discussions. We simply note that if the concept of the site is used in spatial surveys to explain relationships between observed discard and putative environmental factors, particular issues of method and methodological import relating to survey design need to be considered.

However, if a site approach is used to achieve the objective of identifying and explaining patterning in the spatial evidence, some accommodation in survey design is needed to effectively incorporate data relating to the absence of evidence into the analysis. If the objective of the site survey is to find sites and explain their relationship to the environment, some account has to be made of the relationship of those areas that do not contain sites to the same environmental factors as those that do. There is thus a need to devise an approach that relates areas of a similar size both with and without sites, to the same environmental variables.

If a random sampling strategy is to be used there are a number of ways that this could be done. One way would be to generate a number of random points in each sample unit that are at least equal in area and number to the sites recorded, and measure the relationship to the same environmental variables as were recorded for the sites. Use of this method allows for flexibility in sample unit size, and can accommodate a variety of sampling strategies. However, it is inherently cumbersome because it requires two surveys, or two phases: a site recording phase and a recording phase where sites are absent, but all else remains the same. A more effective alternative is to eschew the notion of sites altogether and undertake a non-site survey with small sampling units that limit intra-quadrat variability. Such an approach would also avoid the complications of site definition and the attendant biases it can create.

Conclusion

Accounting for the absence of evidence is rarely done in archaeological site surveys in Australia. It is no small irony that if archaeologists undertake probability surveys to provide more scientific rigour to their results, yet assume relationships to be self-evident and ignore the role of absence of evidence, that attempt at rigour is lost. However, accounting for the absence of evidence is fundamental if the intention of the survey is to explain patterning in the landscape in terms of the relationship between human discard behaviour and environmental and post-depositional factors. The strength of association can only be tested if the evidence of absence is considered. The difficulties of accommodating the recording of evidence of absence for comparative purposes are exacerbated if the site concept is used in such surveys. Archaeologists need to determine at the outset if the aim of the survey requires the gathering of evidence of absence. Solutions to some questions may not require it and a site approach may be the best way to achieve answers. However, if reference to environmental factors is considered necessary to explain aspects of depositional and post-depositional patterning in the landscape, absence of evidence is required. In such cases a site-based approach may limit or hinder interpretation.

In reality, a single strategy is unlikely to resolve all the questions that arise during a spatial survey. A more productive approach may be to devise a multi-staged survey strategy that uses different approached to address different problems. To accept this approach, the idea of undertaking surveys to test rigidly-formulated models (often based on ethnographic reconstructions) has to be eschewed in favour of a more flexible, staged approach that addresses new questions that arise from the results of previous phases. There is no reason why non-site and site approaches cannot be combined, and why for some surveys gathering absence of evidence is critical and for others it is not. However, for any approach to be effective, recognition of its strengths and limitations needs to be recognised and the role of evidence of absence understood.

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Sa Huynh and Cham in Vietnam: Implications of Maritime Economies

Ian Walters

Abstract

This paper is about the Sa Huynh culture of Iron Age Vietnam, and its relationship with the state level society known as Champa, which appears to have succeeded it in time while overlapping it in spatial distribution. The paper examines what Sa Huynh actually consists of, and what aspects it might or might not have shared with Champa and Cham culture. Archaeological evidence for Sa Huynh is reviewed, and possible developmental pathways are explored. It is concluded that Sa Huynh is a diverse cultural complex, still rather poorly understood archaeologically. It is suggested that an examination of maritime economies may shed important light on these issues.

Introduction

This paper examines relationships between the late prehistoric Iron Age Sa Huynh culture and the Cham civilisation in Vietnam. My broad field of enquiry lies within an historical overview of the relationship between these cultures: to examine the question of whether Cham culture of the AD period grew out of the Sa Huynh culture or displaced it. A major debate in Vietnamese archaeology centres on the question: Did the Cham state develop out of Sa Huynh culture, or did the Cham come from overseas, replacing Sa Huynh people and hence their culture?

This leads to other questions: Did Sa Huynh develop from earlier contexts or was it too intrusive? Was Sa Huynh the result of settlement by Austronesian speakers from island Southeast Asia? Or did Sa Huynh develop indigenously in Vietnam and did it grow historically into the Cham culture alongside incoming influences of material culture (glass beads, jars), language (Austronesian, Sanskrit), religious attributes (Hinduism, Buddhism) and other elements of belief systems (cremation)?

Glover *et al.* (1996:167) report that French archaeologists rejected any connection between Sa Huynh and Cham:

> They realised that the Cham were clearly related to Austronesian speakers in Indonesia, particularly to the peoples of West Kalimantan and Aceh in North Sumatra and were thought to have been recent immigrants to Vietnam having come under Indian cultural influence further west.

However, Peter Bellwood (1978), from as early as *Man's Conquest of the Pacific*, claimed the presence of jar burials were suggestive of the fact that the Sa Huynh 'may be partly associated with Austronesian Chamic settlement' (Bellwood 1978:191).

Some see Sa Huynh as intrusive. Higham (1996:307) argued that the rarity of bronzes in the earlier culture is 'most easily understood if the Sa Huynh cemeteries represent intrusive groups from island Southeast Asia'. This implies a cultural distance from the relatively nearby high Bronze Age cultures such as Dong Son to the north.

My paper is essentially concerned with these questions. But the aim is more specific: to review what is known of the Sa Huynh, and see where that might lead us in attempting to answer the broader questions. For if we are to explore the possibilities of Sa Huynh Cham evolution, we must be clear about what Sa Huynh represents. What emerges is that we do not yet understand Sa Huynh all that well. The paper argues for the need to determine key variables for examining it and the transition in detail. Trade and exchange have already been suggested (Walters 2000), and here I add variables concerned with maritime subsistence economies. I also examine some relatively new and/or little known findings of Vietnamese researchers about the Sa Huynh in an attempt to demonstrate its complexity and diversity.

Champa

The kingdom of Champa was situated in central Vietnam (Figure 1), stretching along the coast. The Cham spoke an Austronesian language, or languages. Chamic languages have their closest affinities with island Southeast Asia. There was diversity within the mandala (Higham 1989) or state of Champa, and also this culture came heavily under the influence of Hinduism and Buddhism. However, as Bellwood (1985:139) reminds us, for all that, the Cham remained Cham: and they were certainly more often divided than united (Jacques 1986:333). The various spheres of influence which comprised the Cham region spent much energy at loggerheads with each other. The Cham capitals 'were widely separated settlements on different parts of the coast, which appeared to take it in turn to be hegemon, each hegemony being known to the Chinese by a different name; the control of any one over the others may well have been very weak' (Mabbett 1986:292).

Nevertheless, the Cham established a great kingdom and reigned central Vietnam for over a thousand years before being defeated by the southward expanding Vietnamese in the fifteenth century AD (Coedes 1962, 1968; Majumdar 1985; Sharma 1992; Sox 1972; Tran Ky Phuong 1993). Their origins are thought to be in the AD period. A Buddhist inscription which 'stems from an Indian-style ruler in the southern part of the area of Cham settlement' dates to about the second century AD (Mabbett 1986:294). Around the seventh century they became predominantly Hinduised in their religion (Bellwood 1985:137-138) and adopted Sanskrit as a temple and literary upper class language. It is at this time that 'really tangible Indianised kingdoms with divine rulers and magnificent Hindu or Buddhist monuments begin to appear' in the region (Bellwood 1985:138). Monumental construction begins and the brick towers of central Vietnam (e.g. Bellwood 1985:139) are built in the same design as those in central Java.

The Cham built one such large capital at Indrapura, now known in Vietnamese as Tra Kieu, and a significant religious centre just down the road from there at a place now called My Son. Their mandala abutted the southern boundary of the Han Chinese empire for much of their tenure. The Han had conquered the Vietnamese and colonised their homeland also for about a thousand years. The Han were finally defeated by the Vietnamese in AD 939, whereupon the latter people established their own state which they immediately sought to expand. They turned southward and set to with the Cham, waging war and conducting a protracted period of uncomfortable neighbourly relations for several hundred years. On more than one occasion, following Vietnamese sackings, Cham refugees fled to places like Indonesia where their friends and trading partners in other Hinduised kingdoms granted them refuge. Finally in the fifteenth century the Cham empire was defeated in a major fashion, many of their sites burned and pillaged, and the Cham king made his exit, his court taking exile in Java. Some Cham also fled to Cambodia and Melaka in present day Malaysia.

Many ordinary Cham had nowhere to go, and like all defeated citizenry in such times, they had to stay behind and adapt to the new regime. They managed to hold a territory together until 1832 when the Vietnamese Emperor finally put an end to it, annexing the area. They remain in Vietnam as a minority people. They have moved southward and today, though there are remnants in central Vietnam, they tend to live mainly from about Nha Trang in southern coastal Vietnam southward to the Mekong Delta, with a presence in Ho Chi Minh City.

Grand architecture, sculpture and high relief carving were created in abundance in ancient Champa. Many of the figures of Hindu cosmology, such as Ganeshas, Asparas, Lord Shiva and holy linga remain prominent in Cham archaeological sites and in museum collections. Bronze and terracotta were common media. Many bracelets, necklaces and headdresses have been recovered, some made from gold and silver. Bodies were cremated, a very different characteristic from the remainder of archaeological Vietnam. According to Chinese records, in some cases the Cham placed their dead in urns and consigned these to the sea (Bellwood 1978:87).

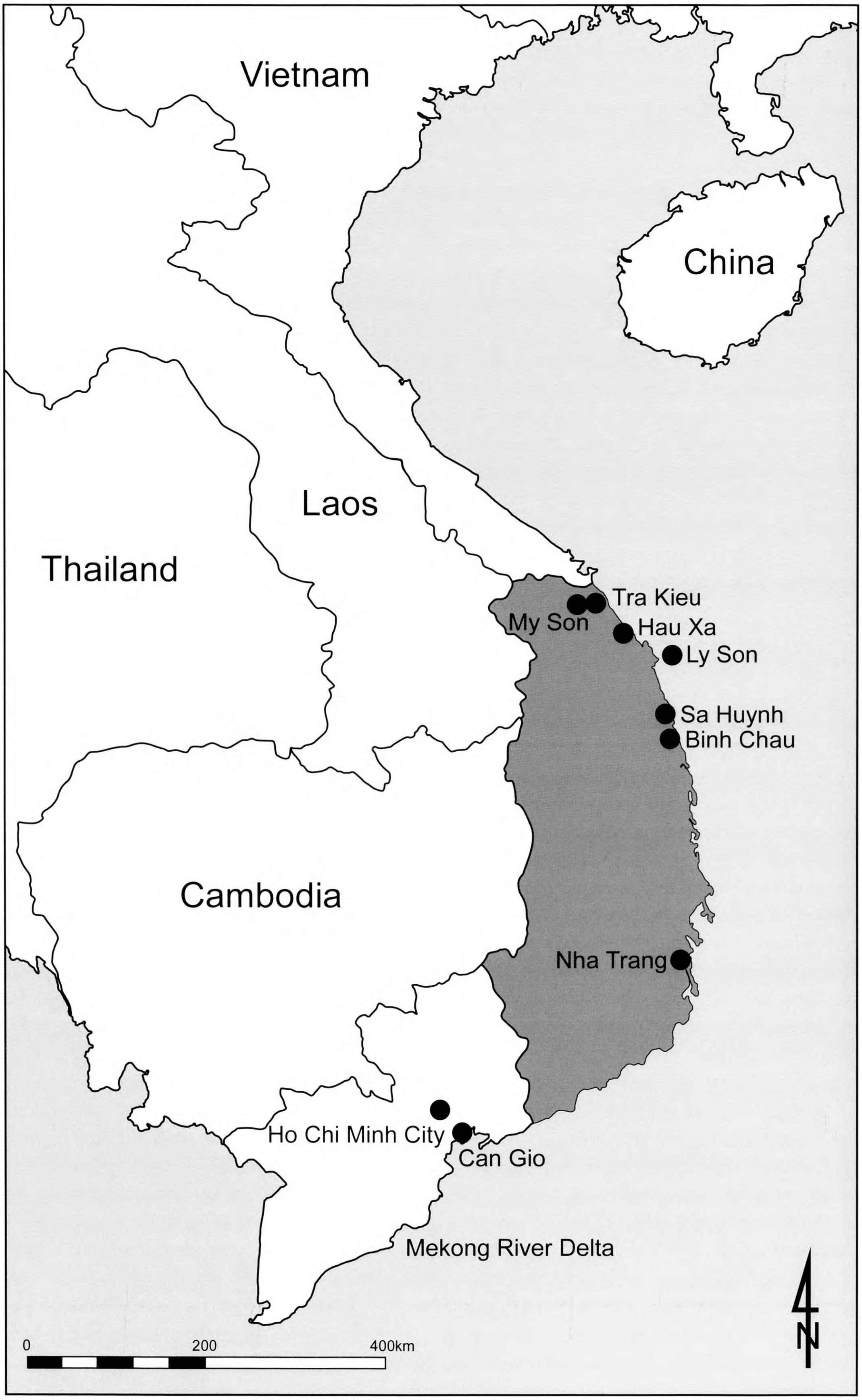

Figure 1. Vietnam region showing overlapping distribution of Sa Huynh and Champa (shaded).

Sa Huynh

Along the littoral of central Vietnam in 1909, M. Vinet, a French customs official, encountered a collection of urns containing cremated human remains and a range of grave goods near the village of Sa Huynh, on what is now the central coast of Vietnam (Figure 1). It was examined by two amateur archaeologists and by the professional Henri Parmentier. In excavations 120 large burial jars were unearthed over an area 80m x 50m.

In 1923 the site was further excavated by another Frenchman, Labarre, whose materials were described in a publication by Parmentier in 1924. In the jars were pottery, glass, bronze and iron artefacts (Ngo Si Hong 1991:1). In 1934 the French archaeologist Colani worked there, recovering 242 more jar burials. In 1939 the Swedish archaeologist Janse located 80 more.

In the 1960s and 1970s other new sites were found and attributed to what was now being called Sa Huynh culture. It was seen as early Iron Age (Ngo Si Hong 1991:2). Since 1975 over 50 Sa Huynh sites have been recorded in Vietnam, several being excavated on a large scale. From the mouth of the Mekong River area in Ho Chi Minh City's eastern rural satellites, distribution extends to the southern boundaries of northern Vietnam. Jars apart, key Sa Huynh markers are jade and glass bicephalous pendants and earrings with slits and projections called *linglingo*.

From 2500 BP onwards sites with iron working appear in Vietnam. There is evidence for centralisation, increased social ranking and chiefdoms. Material culture takes on some important attributes such as chiefly burials in boat coffins, and, reflecting Indian trading contact, glass beads become prevalent as grave goods and decorations.

At the Sa Huynh period sites in Can Gio District of Ho Chi Minh City large cemeteries of jar burials have been unearthed. Though attributed to a new so-called Can Gio Culture, these sites appear to be part of the Sa Huynh complex. Giong Ca Vo, one of the sites, has revealed 301 jar burials, 238 of which contained human remains (Dang Van Thang and Vu Quoc Hien 1997:31). The burials are associated with grave goods including pottery of Sa Huynh type (Dang Van Thang and Vu Quoc Hien 1997:36), and most importantly, the bicephalous ear pendants usually identified as Sa Huynh cultural markers (Dang Van Thang and Vu Quoc Hien 1997).

A radiocarbon date from 1.5m below the surface, in the 'jar burial layer', of 2480±50 BP, uncalibrated, was obtained by Dang Van Thang and Vu Quoc Hien (1997:37). An unusual feature of the jars, for Vietnam, was that they contained so many human skeletons (Dang Van Thang and Vu Quoc Hien 1997:35). According to the excavators, these had been 'interred in a squatting position without secondary burial' (Dang Van Thang and Vu Quoc Hien 1997:35).

Sa Huynh to Cham

Sa Huynh and Cham sites stand out from the remainder of the Indochinese sites in both space and material culture. Their spatial distribution is a good fit: essentially they occupied the same area of central Vietnam (Figure 1). Sa Huynh and Cham sites also share two key cultural markers: the practice of cremation and use of large jars for consigning the dead. Also, the sites contain iron and glass.

Cremation is an unusual burial practice in Southeast Asia, as are burials in large jars, often involving the interment of cremated skeletal remains. Jar burials are found in northeast Thailand during what Higham (1989) refers to as his General Periods A, B, C. But these Thai artefacts were used only for infants and they did not involve cremation. Jar burials are also found on the Plain of Jars in upland Laos. These involve cremation, but they are in a vastly different region from coastal Vietnam, and are separated from the maritimes by upland country and mountain ranges, making communication at that time not easy.

In the Vietnamese Hoabinhian period from the late Pleistocene through to the early middle Holocene, interment takes the form of flexed, crouched or squat burials. These are also common in Indochinese coastal hunting sites in the middle Holocene, with some extended burials being found. Extended burials are the common type in all the big cemeteries encountered on the Khorat Plateau of northern Thailand and on the Thai coast during the expansion of domestic communities (Higham 1989).

There is a suggestion from historical linguistics that where languages arrive or intrude in a geographical space, people arrive or intrude. If languages do move into new areas because the people bearing them move, and if this is so for Vietnam in the later pre-Christian period, this strengthens the case for Sa Huynh and Cham being historically and culturally linked. The Cham were speakers of an Austronesian language. Sa Huynh people then may also have been Austronesian language speakers. At least that's one prediction. A second contradictory prediction is that there were two intrusions: first Sa Huynh, and later Cham.

Many Vietnamese archaeologists posit a continuous evolution from one intrusion. They suggest that the singularity of urn cremations together with Austronesian languages implies that Sa Huynh marks the establishment of a beachhead by these Austronesians who, by their vigorous trading involvement then drove development into the Cham state. For example, the 'jar burial custom of Sa Huynh people was also continued in early Cham population [sic]' (Ngo Si Hong 1991:13).

In his assessment, Ngo Si Hong (1996:32-33) suggested there is a continuity of ceramic forms through the Sa Huynh and into the Cham period. As well this continuity between Sa Huynh and Cham in material culture is evident for iron tools, glass articles and ovoid sepulchral jars (Ngo Si Hong 1996:40):

> In the distribution area of the Sa Huynh Culture many sites belonging to Pre-Sa Huynh Culture and Early Champa have also been found. It was very important to say that, in my opinion, from Pre-Sa Huynh Culture to Sa Huynh Culture, that was a continuous process of cultural development from late Neolithic to Early Iron Age. And from late Sa Huynh Culture to early Cham culture, it was also a continuous process of cultural development in the same region (Ngo Si Hong 1991:2).

Solheim wrote in the 1970s on the Sa Huynh Kalanay pottery tradition, relating this complex of Vietnamese and Philippine pottery design to Austronesian-speaking people he called Nusantao (Ngo Si Hong 1991:2). Sa Huynh material culture was being moved around quite a large area of Vietnam, as well as offshore to the Philippines and Thailand, and perhaps other places as well. Stone four-lug earrings are found in sites such as Phong Nguyen in northern Vietnam (Ngo Si Hong 1991:9). Pottery with nipple handles, comb-point impressed designs in zigzag lines, with red, black and white colouring, forms of 'elaborate bronze implements' characteristic of Sa Huynh assemblages, have been found throughout a wide area of Hoa Loc, Dong Nai, Thanh Hoa, Nghe Tinh, Binh Chau and Bau Trom (Ngo Si Hong 1991:9-10).

In addition, Sa Huynh sites were taking incoming material cultures from neighbouring groups on the mainland, and offshore. Bronze artefacts from north Vietnam have been found in Sa Huynh contexts, and bronze implements and weapons usually associated with the famous Dong Son culture of the north, have been found in Sa Huynh sites (Ngo Si Hong 1991:10). There is even a Dong Son bronze drum recorded from a Sa Huynh site (Ngo Si Hong 1991:10). This all led Ngo Si Hong (1991:11) to believe that:

> during the Metal Age in Southeast Asia, trade played a major role in cultural relations and also in the cultural evolution of Southeast Asia. The presence of Sa Huynh cultural features in many areas of distribution of other cultures and in opposite, the existence of different features of the Southeast Asian cultures in the Sa Huynh Culture were due to movements of trade peoples by land and maritime ways. Through trade, cultural contacts and relations between different groups of trade peoples were developed. They have exchanged not only productions but also techniques, customs and others.

Ngo Si Hong (1991:12) claimed there 'was a continuous process of cultural development from the Late Sa Huynh Culture to the Early Cham and to the Late Cham Culture'. In the Early Cham layer at Tra Kieu for example,

> we can see many characteristics of the Sa Huynh Culture. Common pottery belongs to the Sa Huynh Pottery tradition. This pottery tradition continuously developed also in the late Cham cultural layer in Tra Kieu. The use of red and black colours for the decoration on pottery as was continued in Cham cultural layers [sic]. Common pottery in Cham layers lacks refinement. The mixed ratio of sand is high. Techniques of decoration on pottery are also similar with those in the Late Sa Huynh Culture: cord-marking incisings, painting. Forms of pottery of the early Cham layer in Tra Kieu are close to Sa Huynh pottery forms (Ngo Si Hong 1991:12).

The 'late Sa Huynh site' of Hau Xa in Quang Nam-Da Nang revealed two cultural layers (Ngo Si Hong 1991:13). The lower layer 'belongs to the late Sa Huynh stage' while the 'upper layer belongs to the early Cham culture' (Ngo Si Hong 1991:13). In the lower deposit at Hau Xa 'Chinese coins (late Han) were found in the Sa Huynh cultural layer' (Ngo Si Hong 1991:13). This led him to conclude the Sa Huynh layer 'probably has a relative date of the first century BC to the first century AD', meaning by implication the early Cham layer 'probably belongs to the time of I–II centuries AD' [sic] (Ngo Si Hong 1991:13).

Others disagree with developmental evolution. For example, Diep Dinh Hoa (1997), in a review of pottery traditions in Vietnam, was not at all convinced of a continuity of tradition. According to Diep Dihn Hoa (1997:95), 'Cham culture did not developed [sic] directly from Sa Huynh culture'. Yamagata Mariko (1997) gave an account of excavations at the important Cham site of Tra Kieu. She was only able to detail fragments of one solitary 'shallow bowl' which 'could typologically relate to pottery from the late Sa Huynh period' (Yamagata Mariko 1997:179).

There are 'Indian cultural features' at Tra Kieu, such as 'well-refined pottery' of a red colour on which are found a decorative motif of the face of a 'mythical beast' (Ngo Si Hong 1991:13). There is also the other very important find in the 1993 excavation: that of a single dark grey sherd of what was identified as a fragment of 'an Indo-Roman Rouletted Ware bowl, a ceramic type well known from sites such as Arikamedu in eastern India, dating to between the 3rd century BC and 1st century AD' (Glover *et al.* 1996:170). The calibrated date from the basal level of the 1993 Tra Kieu pit at Buu Chau Hill, from close to this fragment, of '380 - 1 BC' is 'compatible with the known age of this pottery' (Glover *et al.* 1996:172).

This implies onset of Indian cultural influence, such as might be expected with, say, the adoption of Indian influenced religious beliefs or worldview. However, glass beads from the subcontinent and other markers of international trade such as the double-headed ear pendants suggest an earlier Indian trading presence on the coast of Indochina. Indian vessels or vessels crewed by Indians may have been bringing these trade items to the entrepôts of the Vietnamese coast in the first millennium BC. Alternatively it may be that much of the offshore trade in earrings and other items can be attributed to Austronesians plying between the archipelagos of Indonesia, Malaysia and the Philippines, and the mainland. Perhaps the early Cham layers mark not the arrival of Austronesians in mainland Southeast Asia, but the serious Indianising of their ritual and cosmological practices and beliefs.

Ngo Si Hong (1991:14) saw the 'expansion of Indian Culture' as being 'intensive' on a 'large scale' during the first and second centuries AD. So 'Early Cham (or Latest Sa Huynh)' can be seen as being 'influenced by progressive Indian cultural features, mainly by religion and architecture' (Ngo Si Hong 1991:14). As early as the third century AD there are records of 'kings being incarnations of Shiva' in Southeast Asia, and of Cham kings adopting the suffix varman as they did in the Khmer kingdom (Murray 1996:63-65). In addition, Ngo Si Hong (1991:13) makes the point that the 'custom of cremation was a practice in Early Cham', behaviour being 'clearly influenced from India'.

Taylor (1983) interpreted the written records as suggesting this also. According to him, 'by the late 180s' Han influence in this part of the world 'was largely nominal' (Taylor 1983:69). By AD 192 the 'post-Han order emerged rather quickly in the south and was remarkably stable' (Taylor 1983:70). Upper-class Han immigrants 'maintained a formal acknowledgment of Chinese civilization', but

> Han-Viet society as a whole turned toward Buddhist influences arriving by sea from India. Thus, in the late second century, Indian civilization became an attractive alternative to the ebbing Han tide, inspiring Lin-i kingship and Vietnamese Buddhism (Taylor 1983:70).

At this time there was 'a large number of Indians and Central Asians' in what is now southern China and northern Vietnam 'for reasons of commerce and religion' (Taylor 1983:80). For the 'Kushana Empire of northern India was stimulating trade and the spread of Buddhism to all parts of Asia' (Taylor 1983:80).

New discoveries at Xom Oc

Vu Cong Quy (1991) has argued for regional variants of Sa Huynh. Pham Thi Ninh (1998) reported an example of this diversity. She excavated a site on Ly Son Island, Xom Oc, in central Vietnam. This was a large site situated on a sand dune, and appears to have the composition of a shell midden. The cultural layer was 110–150cm thick, composed of shells in matrix. The faunal remains included the molluscs *Tridacna* and *Turbo* among others, bones of fish and other animals. The excavators located seven graves, but only two had clearly defined remains. The first was a 'pottery jar burial with a lid' in the form of a high footed bowl, and was a 'secondary burial of child's bones' (Pham Thi Ninh 1998:2). The other was a 'rectangular grave' containing the bones of two adults (Pham Thi Ninh 1998:2). In her judgment it 'is possible to say that this' allowed attribution of a 'fairly perfect burial' to Sa Huynh 'for the first time' (Pham Thi Ninh 1998:3).

Pottery at the site was decorated with 'red and graphite black painted bands' with an incised motif (Pham Thi Ninh 1998:3). There were 'carinated pots, carinated vessels, bowls, plates' at least some of which appear to have been incised and had 'characteristics of the Sa Huynh Culture' (Pham Thi Ninh 1998:4). In the uppermost 70cm of the deposit the Sa Huynh pottery was *in situ* together with 'Han pottery, with impressed small square shapes and early Champa pottery' (Pham Thi Ninh 1998:4). These identifications are made despite the fact that it 'is very difficult to distinguish between early Champa pottery and late Sa Huynh pottery' (Pham Thi Ninh 1998:4).

There were also 'stone adzes and hoes' and at the left elbow of one of the skeletons, a bronze arrow of the style found in another Sa Huynh site, Binh Chau, which itself is dated to 2500 BP (Pham Thi Ninh 1998:3). Xom Oc also revealed 'a lot of ornaments made of shells such as earrings, bracelets, beads' as well as shell 'chisels and scrapers' (Pham Thi Ninh 1998:4).

The finds were interpreted as characteristic of the Sa Huynh culture but 'closely connected with the marine ecosystem' (Pham Thi Ninh 1998:5). The pottery finds allowed her to infer 'proof for the long-term settlement' of the place, and that consequently culture and society in the area could be been as developing 'constantly without interruption' (Pham Thi Ninh 1998:4).

But the most important implication of the site has to be the new attributes it introduces into the suite of usually accepted Sa Huynh characteristics. Firstly, it is an offshore island site. While the original find at Sa Huynh itself was in coastal sand dunes, this adds another, slightly different, possibly Austronesian dimension to that. The site is a shell midden, much like any other coastal shell midden in Vietnam or elsewhere in the maritimes of this region. That too, in itself is not absolutely new, as sites like the original Sa Huynh site may have also been associated with shell middens. But it strengthens the presence of that form of site, and ensures its place in the range of maritime forms taken by what are considered to be Sa Huynh assemblages. Thirdly, the site contains a jar burial of a child. Fourthly, the site contains a bronze arrow. Finally and most importantly, the site contains extended burials, a new attribute of Sa Huynh sites.

Oddly, the site was not chronometrically dated. No mention was made of charcoal, but there are abundant bone and shell remains available for dating. The Vietnamese have thus far relied on similarities of artefact morphology to date the site to the 3000–2500 range, amenable to Sa Huynh classification.

Important also are the absences at Xom Oc of what would normally be considered Sa Huynh features. Apart from the one small jar with the child's remains, there are no jar burials. Jars with children's bones in them are a feature of a range of cemetery situations in Indochina and elsewhere, but the large jar burials usually defined as a cultural marker of Sa Huynh have – apart from the new Can Gio discoveries – not contained human remains. They do hold quantities of burial goods, and the graves at Xom Oc appear to have these. At Xom Oc there are no iron artefacts. There are also no glass, carnelian, jade or nephrite artefacts, earrings, pendants or beads.

Sa Huynh is Diverse and Variable

In sum then, Sa Huynh seems to consist of a diverse range of assemblages. It is complex and variable, and certainly not monolithic or uniform. The most positive and agreed upon attribute appears to be geographical range. There is a loose agreement on the time range, with the generalisation being from 2500 BP through to the first or second centuries AD – with surprisingly few actual dated layers or assemblages available (Table 1). The key characteristics which are taken to define the culture are iron artefacts, large sepulchral jars, *linglingo* and double-headed earrings or pendants, but some or all of these are missing in as many sites as they are present. The classically typical Sa Huynh sites tend to be burial grounds with jars and grave goods, but there are many other site types as well. In addition, the key material culture markers are items found at the same period throughout the insular maritime

Table 1. Some features of Sa Huynh and Champa.

Culture	Dates	Places	Material Culture	Comments
Champa	AD 15C			Sacked by Vietnamese
	AD 7C		Brick towers; monuments	
	AD 2C		Buddhist inscription	
	380-1 BCE	Tra Kieu	Indo-Roman ceramic	Mixtures of Sa Huynh, Han, Cham
Sa Huynh	2480±50 BP	Can Gio	Burial Jars	Can Gio has human remains in jars Can Gio rich in glass, precious stone earrings, pendants
	c.2500 BP	Xom Oc		Xom Oc has 1 child in burial jar Xom has no iron glass earrings pendants

Austronesian trading area, from Thailand to the Philippines and south to the Indonesian archipelago. Other important pieces of material culture involve items often found accompanying iron in Southeast Asia: imports from India such as glass and pottery.

The diverse Sa Huynh archaeology needs to be seen to represent a vast cultural complex. Within its diversity exceptions seem to be the rule. There are key markers, but they are not found exhaustively, and oddities and absences occur all over (see Table 1). My own reviewer's hunch (dare I raise it to the status of an hypothesis?), based on this relatively new evidence, is to support writers like Peter Bellwood, Ngo Si Hong and Charles Higham: that there was an Austronesian-speaking migration onto the mainland of central coastal Vietnam about 2500 BP, Sa Huynh came about, eventually developing *in situ* into Champa. Presumably from 2500 BP onwards, local inhabitants, whoever they were, became incorporated into the immigrant society to help produce Sa Huynh. All this contributed to the diversity in site types and contents we now witness. Hunch continued: Sa Huynh cannot be understood as one thing, one phenomenon, one culture. In the early AD period, as Han influence waned, and Buddhist and Hindu influences became prominent, at least one dominant faction or hegemon of a diverse Sa Huynh moved on culturally to become Champa.

Another thing is starkly clear, and even though archaeologically obvious, is surprisingly not usually mentioned or discussed. It is this: whoever the people were who gave us this Sa Huynh complex, they were not Vietnamese. Yes, today the Sa Huynh is a claimed component of the pasts of Vietnam and the Vietnamese, and a vital and high profile component at that. It is considered an important phenomenon in the past of Vietnam and the Vietnamese. Sa Huynh artefacts and the Sa Huynh story are proudly exhibited in museums, websites and literature as part of the triumphal past of Vietnam. But back then the geographical distribution of Sa Huynh sites was in an area separated from the Vietnamese, who at that time still occupied the area north of the Sa Huynh Cham perimeter. Only after the Cham were defeated in the fifteenth century did lasting southern migration occur and the place become Vietnamese.

Much more work is needed on Sa Huynh, exploring and defining the limits of its complexity and diversity, seeing which if any of its attributes can be identified as contributing to Cham origins. What other phenomena can be examined to help throw light on this? For example, what can be said about Sa Huynh and Cham maritime subsistence economies? For while they practised trade and exchange with Indianised states or mandalas elsewhere, particularly in island Southeast Asia, and were practitioners of agriculture living in feudal peasant hierarchical societies, they were maritime peoples despite that.

Ngo Si Hong (1996:41) said 'the economy of Sa Huynh inhabitants was based on sea fishing and rice planting in the coastal plains'. Yet as Higham (1996:307) has also said 'we know virtually nothing of the subsistence base of the Sa Huynh people'. Sea fishing it might have been, but we don't know the details. Very little is known about the coastal economies of much of the Vietnamese peninsula during the Holocene. This is made into a most interesting problem if, to straight maritime economic analysis for Indochina, is added the dimension of what role such economies played in the intrusion and development of Sa Huynh and the onset of Champa. This would go hand-in-hand with the development of mandalas or even states there and elsewhere in Indochina, and have interesting implications for that general phenomenon.

In turn come questions such as: What role maritime resource gathering played in augmenting rice and other crop agriculture? What role did it have in local and international trade (intermandalic trade)? Were maritime economies intensified in any way over time during these developments? What is the spatial patterning of maritime resource sites in relation to other key sites and material culture markers?

L'homme du poisson revisits ancient skills! Jay Hall has called me many things over the years, but such was his first tag on me. During the early 1980s as the man of fish, I developed skills very few archaeologists would ever want or envy: I spent so many hours poring over them that I came to see otoliths in my mixed veges; I could pick out mullet vertebrae in the patterns on my lounge room curtains. Damn me if those skills didn't come creeping back one hot humid day amidst the musty collections in a creaky old rundown repository in the Vietnamese capital.

My initial examinations at the Institute of Archaeology in Hanoi revealed a number of common Indo-Pacific fish and shellfish species known from previous work I had done all those years ago in Australia (e.g. Walters 1987a, 1987b, 1989, 1992a, 1992b). Could that past come back to haunt me and be of some use after all? Who would imagine? Future cooperative work analysing maritime faunal remains would surely add another important dimension to our knowledge about transitions to mandalas in Indochina generally, about the origins of the Cham, and the role of Sa Huynh in particular.

Conclusion

Sa Huynh is far too diverse to talk about as a simplistic entity when discussing possible Sa Huynh to Cham evolution or developmental pathways. There must be more effort given to understanding what this vast complex called Sa Huynh consists of. Only then can we look at what particular continuities may or may not be present in the development of Ancient Champa. Arrivals of Hinduism and Buddhism and things like Indian pottery and glass are vital in that regard as time and cultural markers. But we need to know what sort of developments were going on in the economy of this diverse Iron Age coastal complex that may have led to a form of organisation amenable to things like kingship and a royal court. As both Sa Huynh and Cham were to a large extent maritime focused, it seems sensible to begin there, looking to maritime subsistence and economy for indications of development or change. Maybe an opportunity for another *l'homme du poisson*.

Postscript

Jay Hall might be tickled to know that many years after vowing never to look at another fish bone – not even if removed from some delicious mouthful of South China Sea Perch – that I would be caught one day studying, with genuine curiosity, archaeological fish remains in a musty old institution in Vietnam. Dare to revisit the past! Talk about riding a bike – will I never get to forget a fish bone? Goodness, the stuff bad dreams are made of …

Acknowledgements

This book is a celebration of the academic life of Henry Johnson Hall, and I appreciate the invitation to contribute a paper. For the start Jay gave me in archaeology I remain eternally grateful. Cheers mate, and thanks for all the fish. On the paper itself, discussions over the years with Nguyen Kim Dung helped my learning about Sa Huynh and Vietnamese archaeology. Pham Thi Ninh provided me with a copy of her unpublished conference paper. Ian Lilley made helpful editorial suggestions and Nathan Woolford and Antje Noll prepared Figure 1.

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Process or Planning?: Depicting and Understanding the Variability in Australian Core Reduction

Peter Hiscock

Abstract

Normative depictions of reduction created by unquantified studies of core classifications often lead analysts to infer rigid, linear sequences. Normative depictions of core reduction enable, perhaps even encourage, some researchers to believe that they are observing design. This proposition is evaluated using quantitative measurements of refitted sequences of core reduction from the Gulf of Carpentaria. The results demonstrate that cores were discarded at similar sizes and shapes even though they began the reduction process in radically different states, and conversely, cobbles of similar sizes and shapes produced distinctly different discarded cores. The inability to predict outcomes in any simple way is a product of the contingency of the complex process of knapping. The existence of situationally-determined (or evoked) shifts in knapping behaviour and artefact morphology may confound inferences about all phases of the manufacturing process based on a simple analysis of end products. This conclusion emphasises the importance of not only studying process rather than static discard products, but also the need to examine the nature and magnitude of variation in reduction rather than developing normative depictions of knapping processes with the presumption that core morphologies reflect predetermined plans in some simple way.

Introduction

For millennia, many of the central problems in Western intellectual life have been embedded in questions about whether or not versions of Platonic/Aristotelian essentialism assist or hinder our understanding of the world. In many scientific disciplines debates about the viability of essentialism have already been resolved in favour of non-essentialist models, such as the adoption of Darwinism and population-based definitions of species in modern biology. In European studies of human history the transition from models grounded in scriptural views of the world, depicting the creation of humanity in accordance with a divinely prepared plan, to evolutionary models depicting undirected change in response to alterations in circumstance, is a further example of tensions about the value of essentialist thinking. Curiously, the treatment of artefact manufacture in archaeological analyses retains many essentialist perspectives. For example, the presumption that the outcomes of fracturing rock were the goals of the knapper, that knappers undertook flaking in accordance with well-defined and predetermined plans, that mental plans resulted in specific implement forms that were designed to be optimal for particular functions, that specimens in each implement class are morphologically distinct from specimens of others classes, and that the distinction between different categories of implements can be traced back through the manufacturing process to their origin, are ultimately all propositions built on essentialist foundations. Although empirical demonstrations of the falseness of such propositions exist in specific cases, these essentialist viewpoints are still frequently employed as the theoretical framework for archaeological analyses, as though somehow the refutation of their universality could be ignored.

This was the situation when, as a young researcher puzzled by the mechanical application of a largely untested and implausible set of principles, I set out in search of opportunities to explore stoneworking technologies and the possibilities for developing less typological and more interesting, non-essentialist depictions of them. This quest formed part of my doctoral research, carried out with Jay Hall at the University of Queensland. In those still pioneering days of the early 1980s my exploration focused on archaeological surveys and analyses of artefact assemblages in a then remote area of the Gulf of Carpentaria in tropical semi-arid northern Australia, where I analysed cores made from a material called greywacke. Evidence about the knapping that made those cores is discussed in this paper, as an example of the kinds of inferences that become feasible when the yoke of conventional archaeological classification is lifted. Two issues are explored here. Firstly, some of the difficulties that exist in employing normative, unquantified classifications of cores as a way to reconstruct technological process are described, as are more powerful alternative methods. Secondly, it is useful to be aware that such static unquantified classifications of cores may be insensitive methods with which to discuss propositions concerning the standardisation of ancient knapping behaviours and the interpretation of archaeological debris as a signature that rigid plans had been held by the prehistoric knappers, and operated to make aimed-at end products. By developing more sophisticated depictions of the archaeological debris, in which the dynamic nature of knapping and the complexity of the discard of artefacts are recognised and simple linear narratives are not imposed, this paper shows that it is possible for archaeologists to focus more on the process of human behaviour than on the plans some archaeologists have imagined they can recognise in the mind of those ancient people.

Page Creek Quarries

In the semi-arid plain immediately south of the Gulf of Carpentaria, a series of refitted knapping floors at quarries bisected by Page Creek reveal the progressive modification of cores. In this area an extensive flood plain has local relief up to 100m in the form of hills and mesas. A steep, rocky ridge protrudes from the flood plain, and runs roughly west to east for a distance of 3km. Covered by a thin mantle of siltstone and greywacke cobbles and blocks, the ridge has artefact scatters indicating that quarrying took place where cobbles of suitable quality and form were found. Two localities containing the debris of concentrated knapping were recorded on this ridge. The first, called Page Creek Quarry 1, has a scatter of artefacts covering an area of 9350m^2, with artefact densities varying from 0.25/m^2 to 39/m^2 and averaging 7/m^2. A short distance to the east, Page Creek Quarry 2 is positioned on the crest and flank of the ridge, as indicated by a scatter of chipped artefacts at low densities, averaging 0.5/m^2.

Quarried material ranges from greywacke through silty greywacke to tuffaceous siltstone but is here all grouped under the term 'greywacke'. The rock is a dark, vivid green-grey or blue-grey with brown or yellow flecks, but the surface of many artefacts has been weathered to a light grey. Cortex is sometimes thin (1–3mm), but more often it is thick, in some cases more than 1cm. Thick cortex is typically rough and dull, and is generally cream in colour. Thin-section examination reveals that the greywacke consists of angular and subrounded quartz grains, chalcedony grains and particles of plagioclase in varying proportions. Grain size varies but is generally less than 0.2mm.

Greywacke responds distinctively during knapping, and has different characteristics to the other kinds of flakeable sedimentary rocks found elsewhere in the region. Mechanical qualities of Page Creek greywacke can be described using measurements of compressive strength and modulus of elasticity (data provided by M. Domanski). Figure 1 illustrates the relationship of these two characteristics for samples of greywacke and for the only other frequently used lithic material in the region, a banded chert. Compressive strength and modulus of elasticity values for greywacke are lower than for chert, indicating that greywacke is markedly less stiff than chert. Thus, while less force was required to initiate fractures in greywacke than in chert, the lower elasticity and stiffness of the material made fracture in greywacke less controllable. As a result of the relative inelasticity, platform shattering and step terminations occur frequently on greywacke. Properties of greywacke suit it to the production of large, thick flakes.

Greywacke occurs as rounded and subrounded cobbles and boulders and as angular slabs. At the Page Creek quarries cobble size is relatively uniform, averaging 5337cm^3 in volume. While specimens examined in thin-section were homogeneous in grain size, many cobbles contained distinct weathered cracks running parallel to the long axis. Although greywacke fractures well, flakes struck across these cracks are likely to be truncated, and consequently directing blows down the long axis is the most mechanically viable knapping strategy.

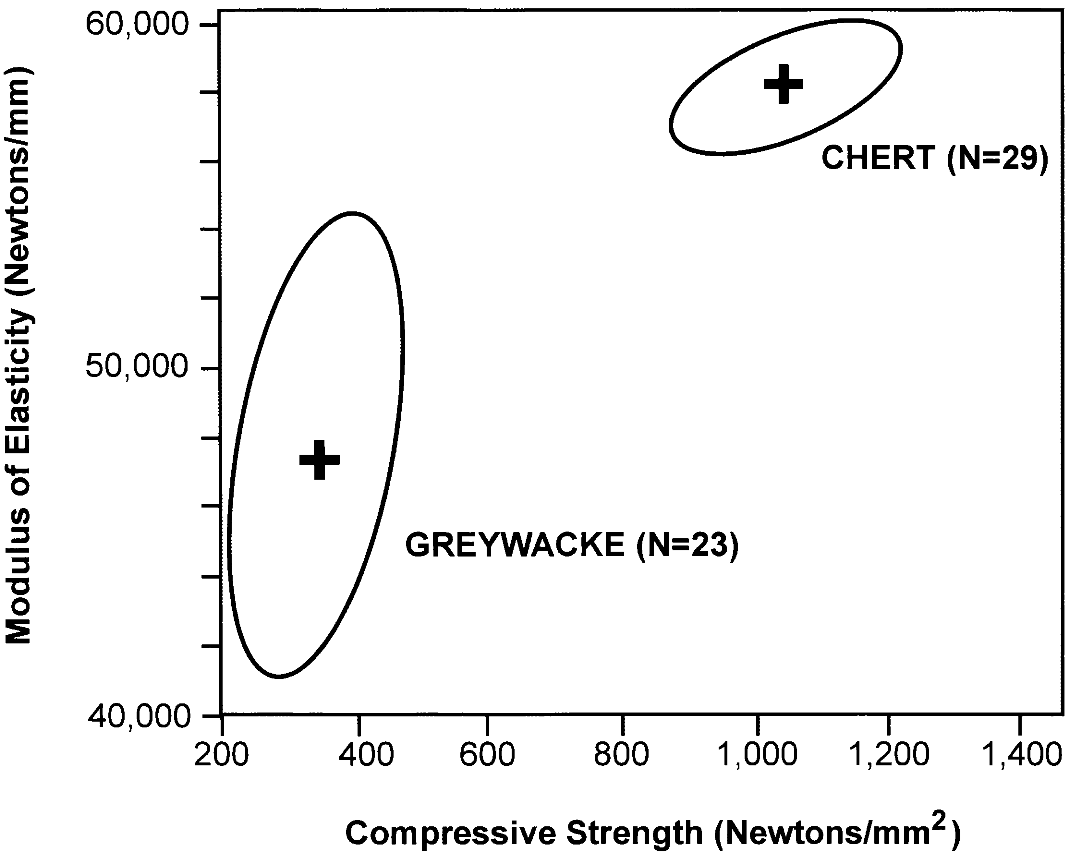

Figure 1. Mechanical characteristics of Page Creek greywacke compared to chert from the same region. Crosses represent the mean value, while ellipses represent the standard deviation.

The antiquity of quarrying and knapping at the Page Creek sites is uncertain. Rockshelter sites less than 30km to the south contain greywacke artefacts in levels older than 20,000 BP, but the exact source of this material has not been established (see Hiscock, P. 1988 Prehistoric Settlement Patterns and Artefact Manufacture at Lawn Hill, Northwest Queensland, PhD thesis, University of Queensland, Brisbane). Variation in the flaked surface of artefacts, ranging from thickly patinated grey to unpatinated dark rock, suggests that quarrying took place over an extended period perhaps covering the late Pleistocene as well as the Holocene.

Reduction at Page Creek Quarries

At Page Creek the cobbles of greywacke were large and rounded, and prehistoric knappers often removed large numbers of flakes in each reduction sequence. The amount of reduction on each cobble can be roughly estimated from the flake:core ratio of 30:1; although interpretation of this ratio is complicated by the possibility that cores and/or flakes have been added to or removed from the assemblage. Refitting provides a more reliable basis for estimating the length of reduction (i.e. number of flakes) carried out on each cobble. Interpretations of the extent and sequence of reduction at the Page Creek quarries have therefore been based on refitting flakes and cores. Five distinct knapping floors were identified on the two Page Creek quarries, each represented by a spatially isolated concentration of artefacts. All artefacts in these knapping floors were collected and subjected to a refitting analysis. The result was the reconstruction of conjoined sequences that represent the flaking of nine different cobbles.

These reconstructed reduction sequences can be described in detail. Even missing flakes, indicated by gaps in the refitted cobble, could be counted and have characteristics measured, including an estimate of weight based on the volume of missing material. This enabled estimates of the original weight of the cobble, and of the amount of stone removed from the cores. Prior to the initiation of knapping these cobbles varied dramatically in size, from 1.5kg to 8kg. Extent of reduction also varied between cobbles. The weight of rock removed during reduction varied from 734g to 7.5kg. The number of flakes removed varied between cobbles, from 11 to 47. Much of the variation in the extent of reduction appears to reflect two major problems faced by people knapping these cobbles:

- the establishment of a suitable platform; and
- maintenance of the core faces in an appropriate state when the removal of large flakes from this greywacke had a high likelihood of generating step terminations that would leave a large mass at the base of the core.

Reduction of all nine refitted cobbles, and all other cores observed on the quarries, involved striking flakes by hard hammer direct percussion, down the long axis of the cobble. Production of a platform was usually accomplished by striking one or two large flakes. Very little choice was available for the position of initial blows because most of the cobble surface was covered with cortex more that 1cm thick. Cobbles selected for reduction had one or more surfaces with relatively thin (<3mm) cortex that was subtly distinguishable from cortex covering the rest of the cobble; the thinner cortex appears hard and smooth. Prehistoric knappers regularly applied their first blows to those surfaces, typically removing large flakes across the short axis of the cobble to yield conchoidal surfaces that could serve as a platform. The number of flakes subsequently struck from the platform was clearly related to the flatness of the surface created by the initial large flakes. If the flakes setting up a platform terminated abruptly or produced undulating surfaces, the capacity to reduce the core was often greatly limited.

Cross-sections through reconstructed cobbles reveal this process of flake removal, and the problems of core shape that threatened to prevent further reduction (Figure 2). The undulation in the platform surface shown in Figure 2c created a barrier to extended reduction and the core was abandoned after only 11 flakes were removed. In contrast the gently curving platform surface depicted in Figure 2a imposed no major problem for reduction, and 46 flakes were struck from the cobble.

Once a platform was established the main threat to continued reduction was the production of abrupt terminations on the core face. To remove such terminations, and thereby prolong reduction, knappers varied the location of blows in five ways. In order of the frequency of application these procedures were:

- Striking the platform to the side of step terminated scars.
- Striking further from the core edge.
- Removing platform overhang.
- Production of outrepasse terminations.
- Initiation of a second platform positioned to remove the base of the core.

Since all five procedures are displayed in a single refitted sequence we can infer that they were probably known to and used by all knappers who worked at the quarry, but each procedure was employed only in suitable circumstances.

This inference leads to an obvious but intriguing conclusion, namely that the archaeological manifestation of a stoneworking technology reflects the circumstances confronting the knapper, and may not therefore represent merely the unfolding of a plan held in the mind of the knapper. One way to understand this reduction process might be described as follows. Knappers possess a repertoire of strategies and techniques they can employ to rectify emerging difficulties with the artefact being worked. Any problem that arises can be prevented or solved by the application of only a limited portion of this repertoire, and so the emergence of a given problem in the reduction of one nodule is likely to elicit from the knapper behaviour that might not otherwise occur. Moreover, a knapper may have more than one viable response to particular problems. Choosing one response rather than another may affect the size and shape of the resulting core and create circumstances in which different problems emerge which in turn will require their own particular solutions. The result is that the patterns of two reduction sequences can diverge as the cumulative effects of context dependent problem-solving alters core morphology. The implication for an understanding of ancient stone working is that a variety of technological procedures may be applied by knappers within a single 'technology'. As a result of the application of different procedures in subtly different contexts there can be multiple archaeological manifestations of one technology. Consequently, classifications of archaeological debris, such as cores, into multiple categories that record morphological differences between specimens need not be describing different reduction trajectories or different manufacturing goals. In so far

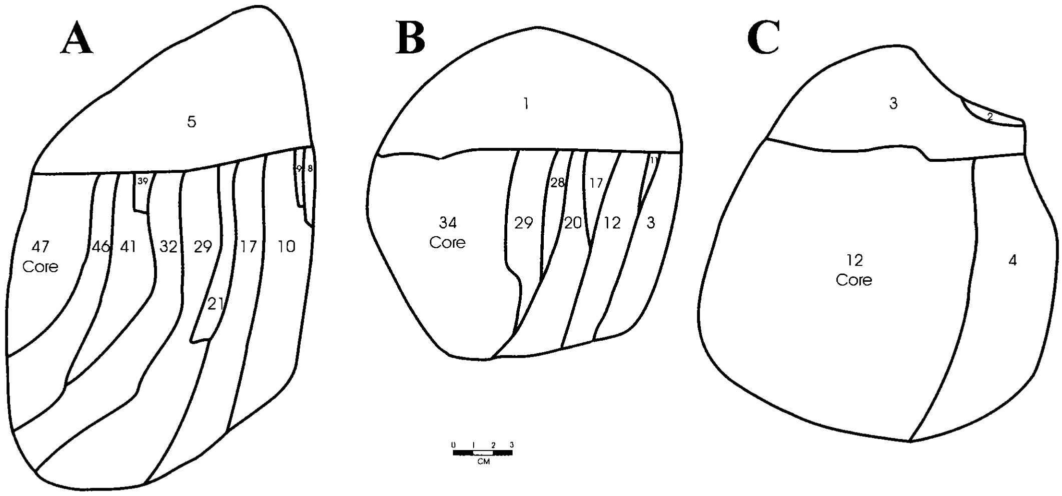

Figure 2. Cross-sections through three cobbles from Page Creek Quarry 1. Numbers identify the order of flake removal, from the first flake struck from the cobble to the last flake and the core.

as the material results of core reduction reflect mental phenomenon, the cores and flakes produced from knapping each cobble might be considered to be cumulative consequences of multiple choices to apply elements of their technical repertoire – choices which are not realistically depicted as part of a fixed plan, but which emerge in the context of a complex and dynamic interaction between the nature of the material, the alteration of the core morphology during knapping, the onset of mechanical problems for continued reduction, and the economic and social circumstances of the knapper.

Given the complexity of these dynamic interactions their measurement on archaeological specimens is difficult. The approach employed must be suited to the specific situations being investigated, rather than searching for a universally applicable methodology, and in this study the selection and impact of problem-solving procedures during knapping, and the way their application causes the pattern of reduction to differ between cores, was measured in two ways, each dependent on reconstructing cores through conjoining and quantifying the changing configuration of flakes and cores.

Measuring the Onset of Problems

Creation of abrupt terminations on the core face potentially reduces the capacity to continue reduction. A description of the timing and magnitude of these alterations to the core face can assist our understanding of the knapper's struggle to control core shape. Refitting provided the opportunity to measure the changing rate and severity of abrupt terminations through the sequence of reduction. Figure 3 illustrates the abundance of abrupt terminations at different points in the reduction process for one cobble. Two patterns are apparent. Firstly, after the platform was created and cortex stripped from the core face, thereby creating a pattern of scars, a series of blows regularly produced feather terminations (Figure 3a). These flakes were comparatively thick, with expanding lateral margins, but had feather terminations because they ran the entire length of the core. As the mass of the core decreased, and thin flakes were often removed from a flat core face, there was a gradual but consistent, seemingly inexorable, increase in the proportion of flakes with abrupt terminations. The directionality of this trend, sustained over a sequence of 30 flakes, suggests that the knapper would have been aware of the gradual emergence of unsuitable features on the core face, but was unable to prevent the continuing production of these terminations. The continued reduction suggests that either feather terminations were not an essential requirement of flakes being produced and/or the knappers were prepared to continue investing energy despite the ongoing difficulties. A second pattern existed within this trend of increasing abrupt terminations (Figure 3b). During the final stages of core reduction, step terminations were very frequently produced. The onset of this high frequency production of step terminations was extremely sudden, and marked the transition of core size and morphology to a state in which production of feather terminated flakes was extremely difficult. One consequence of this trend was that the frequent step terminations at the end of the reduction sequence produced cores with protruding mass near the bottom of the core. This was a common pattern emerging in the reduction of cores at Page Creek.

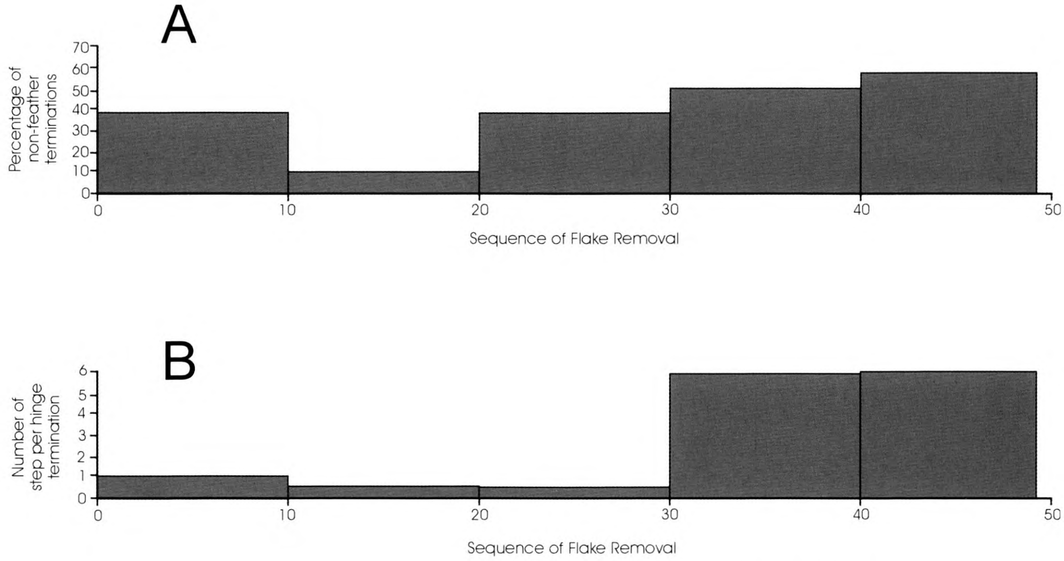

Figure 3. Histograms revealing the variation in flake termination frequencies during the reduction of one cobble, measured by (a) the frequency of non-feather terminations and (b) the ratio of step:hinge terminations.

Tracing the Reduction Process

The knapper's success in maintaining the core face free from abrupt terminations can be evaluated by measuring the stability of core shape through the reduction process. A simple index of core shape, constructed as area of the platform surface divided by cross-sectional area of the base of the core, was used to evaluate the degree to which abrupt terminations have caused the core base to protrude. Values less than one represent a protruding core base, while values much greater than one indicate a contracting core shape with acute platform angles. Smaller values imply increasingly greater problems for continuation of flaking from the existing platform.

Examination of the core shape index for 30 cores recorded at Page Creek Quarry 1 reveals a distinct relationship between the weight of cores when discarded and their shape (Figure 4). This relationship can be expressed in a number of ways. One way is to note the inverse pattern of observations. For core shape values higher than one, core weights are 1kg or less; whereas for core shapes less than one many cores were discarded when they were still substantially heavier than 1kg. A Lowess curve fitted to 80% of observations illustrates the tendency to higher weights at discard with lower core shape indices (Figure 4).

Another way to understand size/shape relationships on these cores is to examine the thresholds that appear to mark points at which specimens are likely to be abandoned. Two thresholds are suggested. One is simply core weight: if cores have been reduced to 450–600g they are discarded at that size irrespective of core shape. This value is called the 'core weight threshold' (Figure 4). The other factor obviously linked to core abandonment is the extent to which the base of the core protrudes beyond the platform. Designated the 'core shape threshold' in Figure 4, this value (approximately described by the equation *core weight*= -14.4+26.19**shape index*) characterises the relationship between core size and shape which represents the limits of reduction for the prehistoric knappers at Page Creek. Together these two inferred thresholds probably mark the boundaries of viable reduction using the techniques and strategies described above. Note the way that many of the recorded cores lay along the inferred thresholds, indicating that these are zones of morphology and size in which discard is much more likely. Although the regularity of specimen size, core shape and negative flake scar size and configuration close to each threshold might be interpreted as reflecting two different forms of core reduction, the quantitative data presented in Figure 4 show continuous variation in these features. Furthermore, the regularity of cores at the point in the reduction process when they were discarded might suggest that they had a common history of reduction, but the uniformity of core form when discarded is a poor measurement of the uniformity of reduction.

Figure 4, plotting 30 abandoned cores, reveals the pattern of discard but does little to explore the process by which cores reach those final states. Questions concerning the uniformity of core reduction at and immediately prior to the moment of discard can be answered by examining these data, but to comprehend the variation of reduction throughout the knapping process further information is

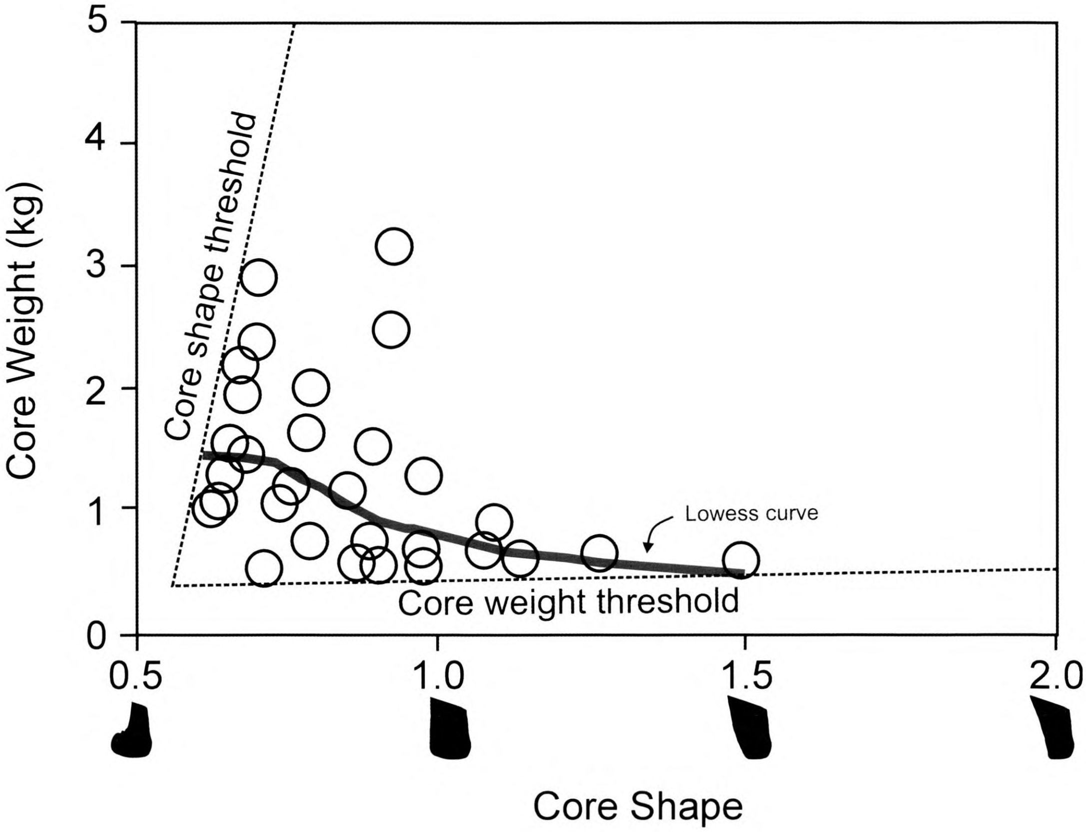

Figure 4. A scatterplot of weights and shapes for cores recorded at Page Creek, showing inferred discard thresholds.

necessary. This additional information can be found in the nine refitted cobbles, where conjoining allows core shape and weight to be calculated for not only the start and end of the manufacturing process, but also *for all points during* each reduction sequence. By measuring the reconstructed cores at different stages in their manufacturing history it is possible to examine the changing relationships between mass and shape as reduction continues. Figure 5 plots the changes in the weight and shape index of these nine cores throughout their reduction. By charting the entire history of core reduction in this way several patterns are revealed.

The general trend that can be observed is that as reduction proceeded the shape of the core increasingly altered towards relatively smaller platforms, and large bases. This trend reveals that on most cobbles the knapper was unable to maintain core shape. Where core shape attained values less than 0.9–1, the specimen was typically abandoned at the core shape threshold when it was still well above the minimum size to which cores with other shapes could be reduced.

However, while following a single strategy the reduction of these cobbles was varied. For example, the direction of change in core shape differs between cobbles, most showing a decline in the shape index during the manufacturing sequence, but some display a slight increase in the index with reduction. Even within the reduction history of a single cobble there are modifications in the direction of change in core morphology. Two of the refitted cobbles show a dramatic reversal in core shape late in the sequence of flake removal. Other cobbles show minimal alterations in core shape despite the reduction of substantial amounts of material. These differences represent the contrast between those reduction sequences in which there was a dynamic instability in core morphology and those that reveal the knapper removed flakes while keeping the core morphology in a stable state.

One potentially revealing pattern visible in Figure 5 is that prior to discard of many cores their morphology and size often changed parallel to one of the discard thresholds during the removal of a number of flakes. This reflects the emergence of abundant problematic features, such as multiple step terminations, late in the reduction sequence, and suggests that during the terminal stage of flaking many cores knappers often struggle to maintain or correct core morphology before eventually abandoning the object. The amount of reduction carried out while a core was located on a discard threshold may in the future be used as a measure of the effort knappers put into persevering with the specimen.

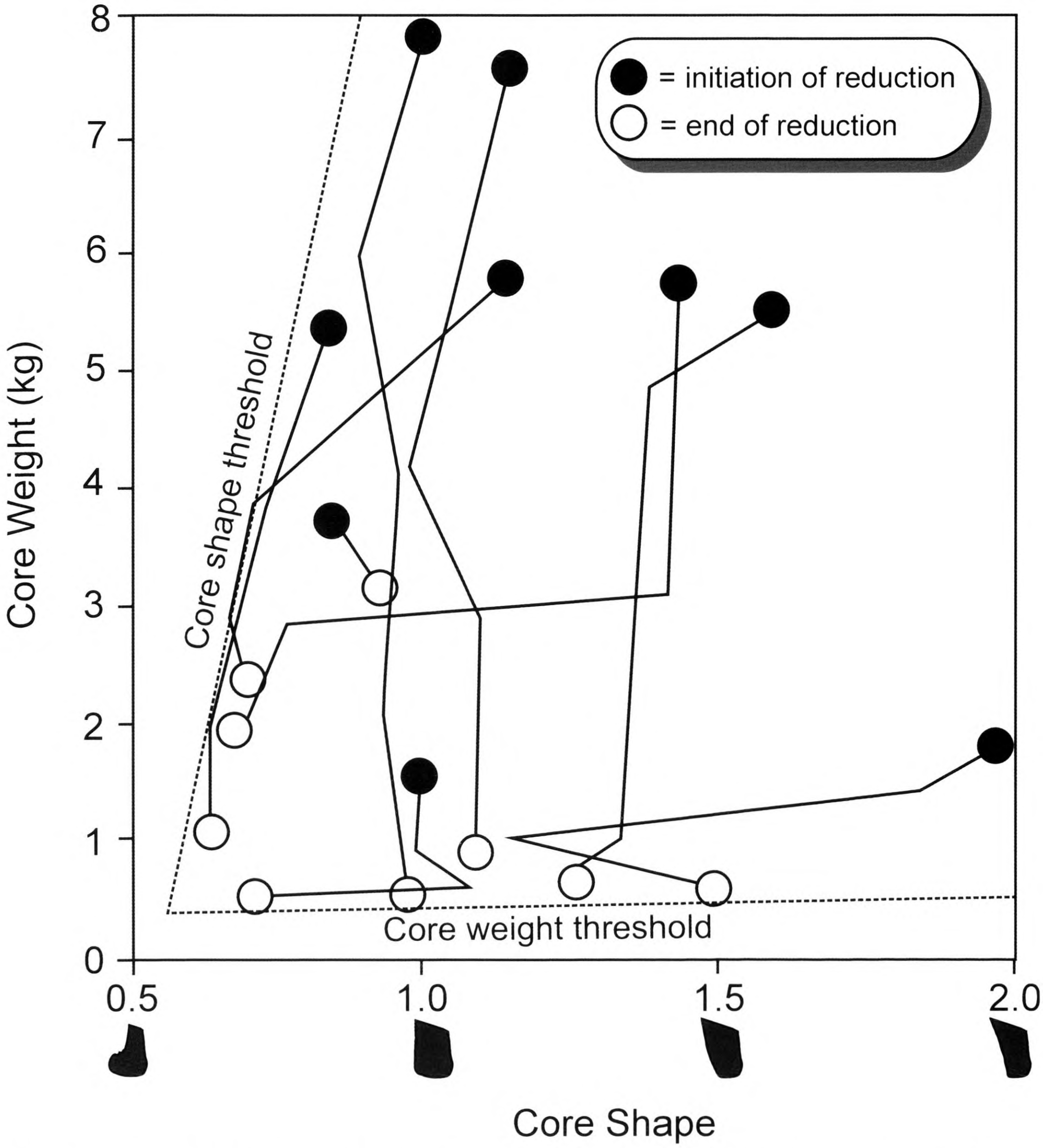

Figure 5. A scatterplot of weights and shapes for refitted cobbles, showing weight and shape of each core at different points during its reduction. Solid circles represent the core at the start of reduction, hollow circles represent the discarded core, and connecting lines trace the changes in shape and size during reduction.

More significantly, the variation between cobbles in the direction of alteration to core morphology during reduction reveals that at Page Creek there was no necessary relationship between the initial and terminal core morphology. Cores were discarded at similar sizes and shapes even though they began the reduction process in radically different states; conversely, cobbles of similar sizes and shapes produced distinctly different discarded cores. The inability to predict outcomes in any simple way is a product of the contingency of the complex process of knapping. Particular events in flake removal, such as the production of an undulating platform at the beginning of core reduction, or an outrepasse or step termination in the final stages of reduction, may alter the direction and ultimately the outcome of the flaking, perhaps eliciting knapping actions that would not otherwise have been employed. The existence of these situationally-determined (or evoked) shifts in knapping behaviour and artefact morphology may confound inferences about all phases of the manufacturing process based on a simple analysis of end products. This conclusion emphasises the importance of not only studying process rather than static discard products, but also the need to examine the nature and magnitude of variation in reduction rather than developing normative depictions of knapping processes with the presumption that core morphologies reflect predetermined plans in some simple way.

Discussion and Conclusion

None of the inferences outlined here, or the conclusions to which they point, is likely to be as accurately inferred without refitting and quantitative measurements of the resulting conjoins. This paper exhibits the advantage of developing analytical approaches that integrate refitting with techniques such as attribute analyses, and which facilitate the quantitative depiction of trends that are revealed by refitting. By employing refitting studies within a composite analytical framework the power of conjoining can be exploited in studies of the variability that exists in past production systems and their articulation within regional systems of manufacturing and artefact use.

The indispensable contribution of refitting to a sophisticated depiction of technological process is illustrated by the case study presented here. In conjunction with quantitative measurements of changing core morphology the use of refitting yielded an image of the dynamic and responsive nature of knapping at Page Creek. Normative classifications of cores are inevitably less sensitive to the multiple interactions between core and knapper and the contingent pathways that reduction can take, for a number of reasons. By definition, normative classifications ignore variability in reduction and lend themselves to images of linear trajectories. This penchant is encouraged and reinforced by the static, or at least temporally limited, information available from cores alone; an issue discussed below. Applying unquantified core classifications to archaeological assemblages, even in an attempt to study technological process, is likely to generate representations of regular and relatively rigid patterns of reduction that tend to follow linear trajectories and in which intermediates or trajectory-crossing reduction sequences are difficult to identify. Descriptions of this kind of standardised and linear reduction process, based on core classifications alone, should raise questions about whether the ancient knapping was in fact this rigid and unvarying, or whether perceived standardisation reflects the insensitivity of the archaeological method. Furthermore, this issue about the effect of the analytical approach on the understanding of core reduction should also raise questions about the value of comparing subjective core classification-based depictions of reduction processes with more sensitive quantified, refitting analyses. If the former analytical approaches typically yield impressions of regular and rigid patterns of reduction, while the latter kinds of analyses demonstrate more variable and flexible reduction sequences, archaeologists should be alerted to the impact of the normative nature of many core classifications on the perception of variability.

In comparison with refitting studies, core classifications can force analysts to focus their attention on the final part of the core reduction. One reason for this focus is simply that in many circumstances the removal of flakes from a core obliterates evidence for earlier knapping of the object, and what remains to be examined on a discarded core is often the evidence for later phases of knapping. When the reduction of cores was extended the absence of information can be pronounced, and when cores were frequently discarded at particular dimensions or morphologies the diversity of early phases of reduction can be difficult to observe. These are conditions in which uniformity of discarded core morphology may be a poor indicator of the diversity of core reduction. By contrast, refitting provides a capacity to reconstruct and measure the sizes and shapes not only of the discarded core but also of those cores at earlier stages in their reduction history.

Normative depictions of reduction emerging from unquantified studies of core classifications often lead analysts to infer rigid, linear sequences, for the reasons already discussed. One implication of these linear, normative depictions is that they enable, perhaps even encourage, some researchers to believe that they are observing design. When the reconstruction of prehistoric knapping presents an image of a standard knapping process, leading to a standardised product, archaeologists have often been unable to resist the temptation to think that they are observing a manufacturing process strongly regulated by a very detailed, preconceived template that reflects the desire of the knapper to obtain the objects recovered archaeologically. Such a conclusion may reproduce the imperatives of goal-oriented, mentalist, essentialist classifications, but they need not be the most realistic or sophisticated depiction of ancient knapping behaviours.

As described above, one issue arising for inferences of intentionality must be the degree to which the perceived directionality and uniformity of manufacturing is merely imposed on the archaeological record by the application of insensitive methods. Findings presented in this paper exemplify the kinds of complexity and variation in the knapping process that can be measured with appropriate analytical techniques. Characteristics of abandoned cores at Page Creek did not reveal the range of manufacturing processes that had been applied to them during early stages in their reduction, and it was only the extensive flake refitting that enable all phases of reduction to be measured. Documented variation between cobbles, in the direction core morphology was altered during reduction, showed that at these knapping floors there was no simple or necessary relationship between the initial and terminal core morphology. Cores were discarded at similar sizes and shapes even though they began the reduction process in radically different states; conversely, cobbles of similar sizes and shapes produced distinctly different cores.

This non-linear and irregular pattern of the progress of each cobble, from the start to the end of the reduction process, is not conformable with the expectations of many researchers that knapping usually involves the application of a design to create 'aimed at' results. To explain away this kind of non-linear pattern as an aberration, a rare example where knappers were uncaring or incapable, is perhaps appealing for researchers of the mentalist persuasion; but such an argument should not be based on an untested assumption that normative classifications are able to measure reduction variability. There are many alternatives to the idea that past knappers held fixed mental images of a sequence of knapping that makes a desired end product. An alternative described in this study is that knapping did not simply involve the imposition of a preconceived pattern on the rocks being flaked but instead knapping was a dynamic interaction between the person and the material they modified. This view sees core reduction as a complex activity in which the individual knapper possessed a repertoire of knapping actions and applied portions of that repertoire as the reduction proceeds, but that the manifested actions applied were selected in response to the condition of the core. This is the sense in which it is possible to describe core reduction as a series of knapping problems that elicit responses from the knapper. Such a process is contingent rather than imposed; the actions elicited from the knapper will vary with circumstance, and hence can account for observed differences in the work of one knapper in different situations, differences between knappers, differences between groups of knappers, and so on. Variation in core reduction may also reflect the larger context in which knapping takes place: the biological, economic, social circumstances, mediated through the mechanics and economics of the rocks being worked. This notion returns me to the point that the evaluation of variation is a necessary trait in the development of more sophisticated views of archaeological artefact assemblages, and that models of fixed designs being reproduced as material patterns have not been powerful ways to depict the diversity of phenomena we can observe archaeologically. Finally, data presented here illustrate why it is imprudent to conclude that the regular size and morphology of discarded cores, or implements for that matter, should automatically be interpreted as indicating the operation of a 'plan'; selective discard of cores with specific characteristics (close to thresholds) can create regularity in archaeological assemblages even when the knapping processes display variability and/or non-linearity. The legacy of essentialist thinking has been to encourage past archaeologists to develop normative depictions of prehistoric knapping and to explain those norms by reference to a plan, but it may be more interesting to measure the variation in archaeological assemblages and to explore the implications of that variability for our understanding of technological structure.

Postscript

This research was undertaken in the early 1980s, at Jay Hall's department at the University of Queensland. His department was the obvious choice of an academic context for research of this kind: an attempt to break from the conventions of Australian archaeology. At that time Jay's department was not only the sole foothold of processual archaeology in the landscape of Australian undergraduate teaching, but also the site of an interesting group of researchers. Jay had attracted research students such as Ian Walters and Ian Lilley who were busily exploring optimality models and statistical hypothesis testing. This was an intellectual context that was, for me, a liberating opportunity; and in retrospect it was an exciting and productive period in Australian archaeology. I thank Jay for the experience and for his friendship over the years.

Late Moves on *Donax*: Aboriginal Marine Specialisation in Southeast Queensland over the Last 6000 years

Ian J. McNiven

Abstract

For 30 years Jay Hall energised a regional archaeological research tradition that has seen southeast Queensland become the best documented coastal area in Australia. A clear pattern has emerged of active Aboriginal engagement with the region's diverse plant and marine animal resources for 6000 years. An important part of this pattern is a major increase in shell midden establishment and use during the last 1000 years. This increase is associated with fissioning and the creation of new and separate coastal groups that placed extra production demands on marginal resources. My paper takes a closer look at this late millennial phenomenon, where it emerges that much of the site increase is accounted for by the addition of *Donax deltoides* (surf beach) middens to the archaeological record of the last 1000 years (including the contact period). In an attempt to historicise a local Aboriginal view that surf beaches were marginal 'back beaches', I argue that *Donax* middens are a signature product of the fissioning and intensification process. Significantly, these late moves on *Donax* and associated settlement-subsistence arrangements provided Aboriginal people of the nineteenth century with opportunities to establish coastal dune/surf beaches as refuges to escape the devastating effects of European colonial invasion.

Introduction

Research at the *Donax*-dominated Minner Dint site on Moreton Island in 1978 was the first midden excavation by Jay Hall in southeast Queensland (Hall 1980). As fate would have it, I spent much of my field research time in the 1980s excavating layers of *Donax deltoides* shells (often referred to locally as 'pipi', 'wong' or 'eugarie') within sand dunes backing surf beaches along the Cooloola coast, southeast Queensland (e.g. McNiven 1990). The attraction of these sites was both their tantalising ephemeral nature (many sites representing thin layers of shell and short-term Aboriginal encampments) and equally curious clustered patterning along seemingly homogeneous beaches. For introducing me to the academic challenges of such sites and coastal dune archaeology in general I owe a great deal to Jay Hall. It was also Jay who introduced me to the notion that fieldwork should be fun, not simply for the sake of hedonism but also for practical reasons of providing a highly sociable and amiable context for others in your team who had volunteered their services for what was often hard and demanding work in stiflingly hot conditions. Academically, Jay instilled in me, as he did in all his students of the 1980s, the fruits of processual archaeology energised by the prophetical writings of Lewis Binford. While in more recent years I have moved conceptually into more treacherous waters whipped up by post-processual winds, key and enduring dimensions of Binford's work that Jay instilled in me were the 'regional approach', sampling strategies, and the strategic importance of all site types across a landscape, both large and small.

After extensive research recording and excavating shell middens along surf beaches and along the banks of estuaries, I decided that the nicest place to camp was surf beaches. These beaches were after all what made southeast Queensland, and places like the Gold Coast and Fraser Island, internationally famous and tourist meccas. Why would the relative attractiveness of surf beaches have been any different for Aboriginal people? Despite my representation, two questions always played on my mind. First, if surf beaches were so attractive to Aboriginal peoples in the past, why were there so few 'historical' images of Aboriginal people using surf beach resources in Australia? It seemed incongruous that one of the only images of Aboriginal people collecting *Donax deltoides* along the entire east coast of Australia was a photograph in the early twentieth century set up by Thomas Dick at Tacking Point Beach, northern New South Wales (see McBryde 1985:Figure 9.9). Second, if surf beaches were so attractive why did nearly all *Donax* middens date only to the last 1000 years when marine resources have been available locally for 6000 years since the end of the marine transgression?

The greatest challenge to my surf beach representation came from another one of my teachers: the late Aunty Olga Miller of Fraser Island. Aunty Olga was a senior Elder of the Butchulla (Badtjala) people of Fraser Island and the adjacent mainland coast. In the context of recording hundreds of large and small *Donax* middens along the east (surf beach) coast of Fraser Island in the 1990s (McNiven 1998), Aunty Olga would ask me how things were progressing with my work along the 'back beach'. This designation for the east coast was used by Aunty Olga at the '1975 Fraser Island Environmental Inquiry' (FIEI 1975:3093; see also Miller 1998:31), while another Fraser Island Elder – Isaac Owens – referred to this coast as the 'outside beach' (Owens 1975). Curious to know what was meant by 'back beach', Aunty Olga explained to me that while the east coast was the focus of activity on Fraser Island today, for Butchulla people in the past it was of secondary importance relative to the richness and cultural significance of the focal resource, residential, ceremonial and sacred areas of the estuarine west coast of the island and Great Sandy Strait (see Miller 1998). In 1975, Aunty Olga noted that in contrast to the 'inner beach' (west coast of Fraser Island), the 'back beach was for picnics and holiday life' (FIEI 1975:3094, 3107). Yet such marginality seemed at odds with the extensive *Donax* middens found along Fraser Island's east coast (Lauer 1979; McNiven 1998) and along the surf beaches of many other parts of southeast Queensland such as Cooloola (McNiven 1985) and Moreton Island (Robins 1984a). In this paper I attempt to historicise Aunty Olga's notion of the 'back beach' as an expression of the late establishment of *Donax* middens in the context of 6000 years of marine specialisation in southeast Queensland.

Coastal Southeast Queensland: Setting the Parameters

Study Area

For the purposes of this paper, and in keeping with Morwood (1987), Ulm and Hall (1996) and Mulvaney and Kamminga (1999:283), coastal southeast Queensland is defined as the area stretching from Bundaberg and Fraser Island in the north to Coolangatta in the south near the New South Wales border. Terrestrially, it takes in the coastal lowlands ('wallum') ecosystem (Coaldrake 1961) and is dominated geomorphologically by sandy soils, high parabolic dune systems and large dune islands (Coaldrake 1962; Thompson 1975).

'Seafood Supermarket'

In his foundational paper 'Sitting on the crop of the bay', Jay Hall (1982:80) laid down what I consider to be a 'basic principle' pertinent to all understandings of long-term Aboriginal occupation of coastal southeast Queensland – the coastal lowlands ('wallum'), dominated by nutrient-poor sandy soils and a terrestrial mammal resource base of low diversity (especially medium- to large-sized mammals) and low abundance (e.g. Dwyer *et al*. 1979), was in marked contrast to the adjacent 'seafood supermarket'. But the coastal lowlands were rich in freshwater, birds and plant foods (particularly swamp plants such as the fern *Blechnum indicum*, a local staple often referred to as bungwall). Thus, the marginality of the terrestrial environment for hunter-gatherers was mainly in terms of mammals, a factor compensated for by a rich marine environment. Thus, as a package, coastal southeast Queensland was a rich environment for hunter-gatherers focusing on terrestrial (plants) and marine (animals) food resources.

Key to understanding the development of marine specialisation in southeast Queensland is the antiquity of the 'seafood supermarket'. In the context of Moreton Bay, Flood (1984:130) concluded that the 'Postglacial Marine Transgression ceased approximately 6000-6500 years ago'. This view accords with more recent evidence from north Queensland for a Holocene standstill at c.5500 BP (c.6300 years ago) that persisted until c.3700 BP (c.4000 years ago) when sea-levels began to fall towards present levels (Larcombe *et al.* 1995). That marine habitats capable of supporting a range of food resources were part of the newly formed southeast Queensland coastline is confirmed by ^{14}C dating of natural deposits with *Anadara trapezia* shells back to 6240±125 BP (c.6700 years ago) (Flood 1981:21) and corals dated back to at least 6000 years ago (Hekel *et al.* 1979). Alfredson (1983:83, 1984; see also Nolan 1986:31) rightly notes that the ancient coral finds reveal the long-term existence of habitats conducive to 'good fishing'. So how does archaeological evidence match up with the 6000 year history of marine resources?

Midden Establishment and Use: Trends Over 6000 Years

Hall and Hiscock (1988:Figure 2), Ulm and Hall (1996:Figure 4) and Hall (1999:Figure 3) make a clear and strong case that coastal southeast Queensland site numbers increase through time, with a major increase taking place during the last 1000 years. However, the dataset of Ulm and Hall (1996) included midden and non-midden sites, and sites without basal or near basal dates. As such, it is difficult to gauge a true picture of establishment trends for shell middens. To circumvent this problem I created my own dataset restricted to southeast Queensland middens with basal or near basal dates. For the most part these sites are also excavated sites. Exceptions are two sites on Fraser Island where Peter Lauer collected shell samples from the base of shell layers eroding from dune sections (i.e. Corroboree Beach 796/54 and Poyungan Valley 217/15) and Teewah Creek 112 (Cooloola) which was excavated and dated to the nineteenth century owing to the presence of metal artefacts (no radiocarbon dates available for site) (see McNiven 1990).

As rightly pointed out by Ulm and Hall (1996:50), southeast Queensland archaeology (like all parts of Australia) is characterised by a 'dearth of sites with termination dates'. That is, most archaeologists obtain radiocarbon dates for basal or near basal cultural deposits, perhaps a date from the middle of the deposit, and rarely for final occupation of the site. Ulm and Hall (1996:50) in their chronological trend survey made the 'assumption ... that sites were occupied to the present if there are no major stratigraphic disconformities to suggest otherwise'. They suggested that this methodological approach 'tends to inflate the number of recently-occupied sites, but given the coarse scale of analyses, this bias probably has little effect on broad trends'. While I concur with these sentiments, the inflation of recent site numbers might be problematic given a key aim of my paper is to explore trends of the last 1000 years. As such, I have taken a more conservative approach and only extrapolate site occupation spans beyond available ^{14}C chronology and up to a notional AD 1900 (50 BP) if 'contact' materials are present in the upper levels of sites. Only one site falls within this category: Toulkerrie 1 (e.g. clay tobacco pipe bowl) (Hall 1984:68).

Twelve sites in the Ulm and Hall (1996) dataset have been excluded from my dataset because of (1) lack of a basal or near basal midden date (St Helena Island and One Tree), (2) lack of readily available data on the context of associated radiocarbon date/s (i.e. Corroboree Beach 799/54, Deception Bay Sites 1 to 5, Cribb Island, Spitfire Creek, Aranarawai Beach Ridge II), and/or (3) absence of faunal remains (i.e. Kings Bore Sandblow Site 97). Older radiocarbon dates for levels beneath midden layers in sites are also excluded (i.e. Teewah Beach Site 26, Toulkerrie 2, Polka Point, Wallen Wallen Creek Site). While it is acknowledged that marine faunal remains may have once existed in these submidden levels, such an assumption is too speculative for the strict guidelines set for construction of my dataset. My resulting dataset contains 86 radiocarbon dates from 39 sites (Figure 1). In contrast, the dataset of Ulm and Hall (1996:49) contained 128 radiocarbon dates from 57 'coastal' and 'subcoastal' sites.

My graphic presentation of site chronological data differs to that of Ulm and Hall (1996:Figure 4) and Hall (1999:Figure 3) but follows Morwood (1987:Figure 4). The *temporal duration* of each site was constructed using the chronological span of individual radiocarbon dates (taken as the temporal span of the highest probability calibrated age range at one-sigma). In some cases, individual spans of a number of dates overlap to form a single larger span. The temporal span of 'modern' radiocarbon dates and 'contact' materials is presented notionally as 50–150 cal BP (i.e. nineteenth century AD). Radiocarbon dates were calibrated using Calib 5.0.2 (Stuiver and Reimer 1993; Stuiver *et al.* 2005) and the

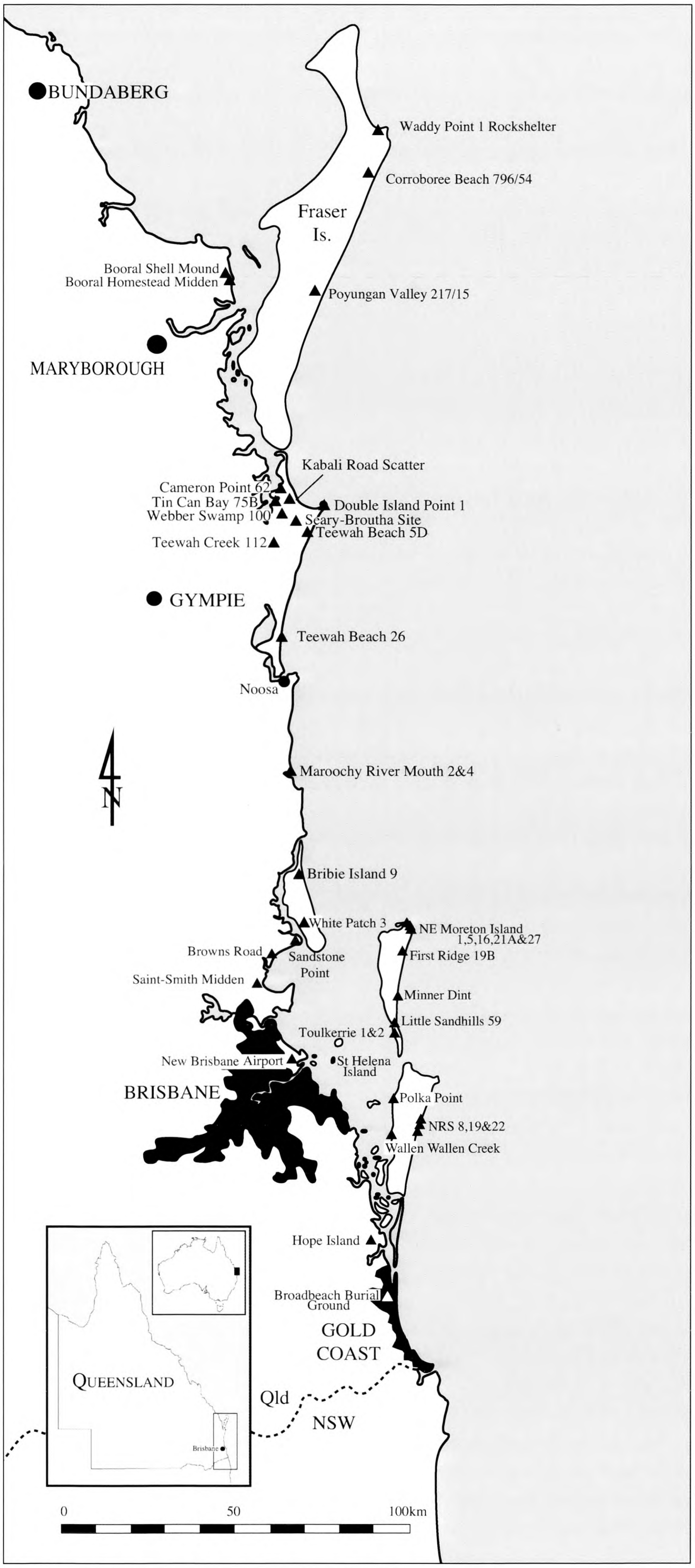

Figure 1. Archaeological sites included in the study dataset.

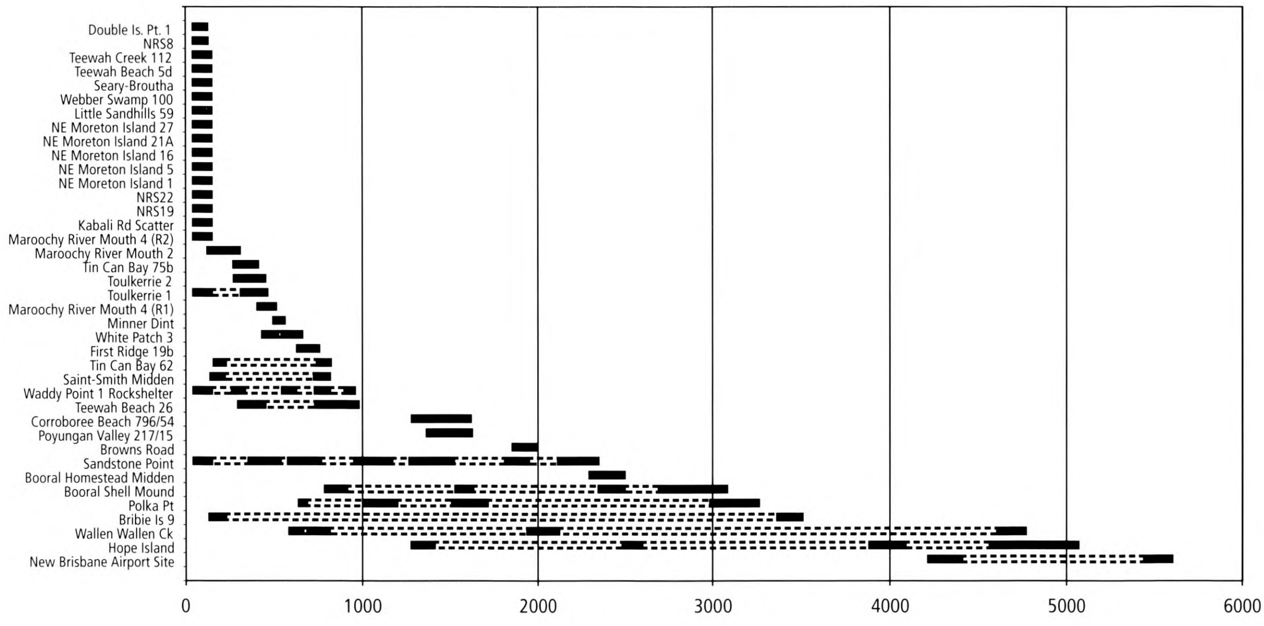

Figure 2. Temporal duration of dated coastal middens sites in southeast Queensland (solid bars= one-sigma span of radiocarbon dates, dotted bars= interpolated occupation continuities between dates).

Southern Hemisphere calibration dataset (McCormac *et al.* 2004). Shell dates were calibrated using the marine calibration dataset (Hughen *et al.* 2004) with a ΔR value of +10±7 following Ulm (2002a). Elsewhere in this paper, calibrated dates expressed as 'years ago' (i.e. calendar years before 2006) represent approximates based upon the midpoint of the highest probability one-sigma calibrated age range rounded to the nearest 50 years. As such, all dates expressed as 'years ago' should be prefixed with *circa*.

Figure 2 presents the temporal duration of each of the 39 middens in the dataset positioned in chronological order based on the oldest radiocarbon date for each site. It is evident that even with this conservative dataset, a clear trend extends for a major increase in middens used during the last 1000 years with a suite of sites with 'modern'/contact dates indicating a secondary and dramatic increase taking place during the nineteenth century AD.

This pattern of major increase in the last 1000 years is represented also in Figure 3 where the number of middens used for each 1000 year period increases steadily each millennium from 6000 to 1000 years ago and then increases nearly fourfold moving from 1000 to 2000 years ago into the last 1000 years. In other words, the number of middens occupied within the last 1000 years is 16 times that occupied 5000–6000 years ago.

Ulm and Hall (1996:52) observe that their data reveal a 'dramatic increase in the number of coastal sites established' in the last 1000 years. This pattern is well borne out in Figure 3 where the number of new middens established per 1000 years between 6000 and 1000 years ago ranges between one and three, but increases dramatically to 28 middens in the last 1000 years. In other words, the rate of midden establishment for the last 1000 years is nearly 13 times the average rate for the previous five millennia. Even if the 16 'modern'/contact sites are excluded from analysis, the rate of midden development for the last 1000 years remains nearly six times the average rate for the previous five millennia (see also Ulm and Hall 1996:52).

Key implications to be drawn from the chronological trends in middens are:

- Aboriginal people were using marine resources in coastal southeast Queensland by at least 5600 years ago, soon after the end of the marine transgression 6000–6500 years ago (Hall and Hiscock 1988; McNiven 1991a; Ulm 1995; Ulm and Hall 1996). Further research is required to determine whether or not the possible 1000 year time lag between these two dates is real and meaningful.
- Increased midden numbers of the last 1000 years is not an artefact of preservation (Ulm 1995:95; Ulm and Hall 1996).

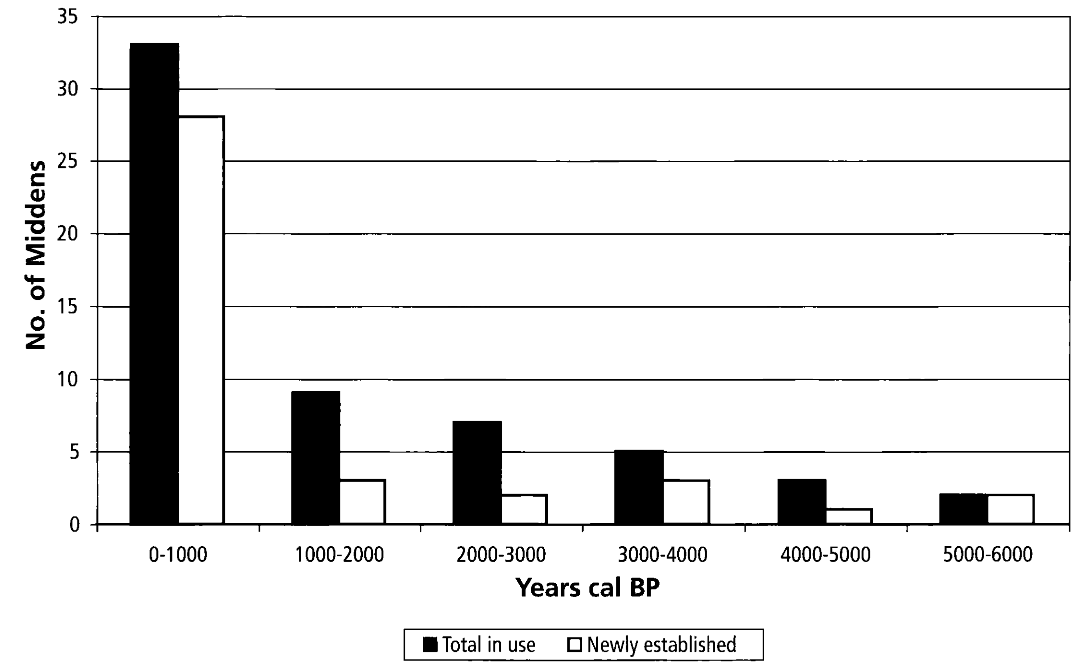

Figure 3. Number of midden sites used and established in southeast Queensland over the last 6000 years.

- Increased site establishment in the last 1000 years is not associated with any concomitant major increase in marine bioproduction (McNiven 1991a; Ulm and Hall 1996).
- While 'there is no simple relationship between number of sites and number of people (e.g. Ross 1981), the general increase in the number of dated sites through time suggests expansion in the general magnitude of occupation of the region' (Ulm 1995:63; see also Ulm and Hall 1996:52).
- The major expansion in marine resource use and associated midden establishment in the last 1000 years provides compelling evidence in support of Walters' (1989; see also Nolan 1986) contention for concomitant social changes within Aboriginal society which have been linked with fissioning and the creation of new and separate residential coastal groups (Hall and Bowen 1989; Hall and Hiscock 1988; McNiven 1990, 1991a, 1999).

In terms of the dramatic increase in midden numbers for the last 1000 years, Ulm (1995:95) asks '[w]hether or not this relates to changes in the use of marine resources'. The remainder of this paper addresses this key question – first in terms of the chronology of use of major categories of marine resources (shellfish, dugong, turtle, whales, crustaceans and fish), and second in terms of the chronology of surf beach (*Donax*) middens versus estuarine middens.

Chronological Trends in Use of Different Marine Resources

Excavations at more than 50 shell middens across southeast Queensland reveal that of the dozen or so middens that exhibit terrestrial faunal remains, all are in small amounts and all reveal a minor dietary contribution of terrestrial animals compared to marine animals. For example, only 0.6g of terrestrial animal bone was recovered from the 13 middens I excavated across Cooloola (McNiven 1990, 1991a). All available ethnographic and archaeological information reveals that when Aboriginal peoples used the coastal strip of southeast Queensland they were marine specialists in terms of animal protein.

Shellfish

Nineteenth and twentieth century ethnographic information for Moreton Bay (e.g. Colliver and Woolston 1975:95; Draper 1980:134; Petrie 1980:74-75; Ross and Members of the Quandamooka Aboriginal Land Council 1996) and Fraser Island (e.g. Devitt 1979:76-77; Foley 1994:12-13) indicates shellfish gathering was and remains a well-established practice of Aboriginal people of southeast

Queensland. As seen in Figure 2, the earliest available evidence for Aboriginal use of marine resources in southeast Queensland is the New Brisbane Airport Site with fragments of estuarine shellfish dating from 4830±110 BP (5600 years ago) (Hall 1999:174; Ulm and Hall 1996:61). The fragmented 'oyster' and 'cockle' shells recovered from the New Brisbane Airport Site reveal minor evidence for shellfishing in estuarine environments by Moreton Bay's earliest inhabitants. The first substantial evidence for elaborate and extensive shellfishing comes from the lower levels of Hope Island midden dated back to at least 4350±220 BP (4900 years ago). This dated Excavation Unit (XU17) featured cockles (*Anadara* sp.) (MNI=39), oysters (*Saccostrea* sp.) (MNI=64), and whelks (*Pyrazus* sp.) (MNI=3) (Walters *et al.* 1987:Table 2). These same three species are key species within recent estuarine middens across other parts of southeast Queensland (e.g. Crooks 1982; McNiven 1991b; Nolan 1986), including the <1500 year old levels of the Hope Island site. As such, the Bay's earliest shellfishers were just as competent at estuarine shellfishing as their descendents were in recent times. Furthermore, recovery of a *Donax deltoides* shell in XU16 indicates the existence and use (albeit minor) of surf beach resources nearly 5000 years ago (Walters *et al.* 1987:Table 2).

Dugong

Nineteenth and twentieth century ethnographic information for Moreton Bay (e.g. Colliver and Woolston 1975:94-95; Draper 1980:132-133; Marsh *et al.* 2002:128; Petrie 1980:67-69) and Fraser Island (e.g. Devitt 1979:77; Lauer 1977:17) indicates dugong hunting was and remains a well-established practice. The major method of capturing the marine mammals was nets or spears, in contrast to harpoons used by Aboriginal people along the central and north Queensland coasts (e.g. Barker 2004; Thomson 1934). Yet archaeological evidence for dugong hunting in southeast Queensland tends to be meagre (Table 1). The earliest available evidence is from Wallen Wallen Creek where Neal and Stock (1986:619, Figure 2) imply that fragments of dugong bone have been found from 4290±90 BP (4750 years ago) through to levels dating to within the last 1000 years. Wallen Wallen Creek provides the earliest known date for Aboriginal dugong hunting along the Queensland coast. This antiquity is corroborated by 1900–2700 year old dugong bones recovered from the Mort Creek Site Complex located south of Gladstone on the central Queensland coast (Ulm 2004:165). Furthermore, the oldest known date for Aboriginal hunting of dugong in Australia comes from Shea's Creek, Botany Bay, New South Wales, where one of the dugong ribs associated with stone artefacts has been dated to 5520±70 BP (5950 years ago) (Haworth *et al.* 2004). Clearly, the earliest users of the central east coast of Australia at the end of the marine transgression had developed technologies, including immobilisation devices (nets and/or spears/harpoons) and possibly canoes to hunt dugongs. Hall and Robins (1984:89) posit that 'dugong bone is interesting in that it appears quite late in the archaeological record ... [which] leads us to speculate that they may be fairly recent migrants into the bay'. Certainly most dugong bones have been recovered from contexts <2000 years old (Table 1). However, the Wallen Wallen Creek evidence indicates dugongs have been around the bay for at least 4000–5000 years.

Table 1. Dugong bones from excavated middens, southeast Queensland.

Site	Age	Reference
Wallen Wallen Creek, North Stradbroke Island	Last 4000-5000 years	Neal and Stock 1986
Polka Point, North Stradbroke Island	<2000 years ago	Neal 1989
Toulkerrie 2, Moreton Island	<2000 and most likely <1000 years ago	Hall and Bowen 1989:16
Toulkerrie 1, Moreton Island	<500 years ago	Hall 1984:72
Little Sandhills, Moreton Island	'modern'	Robins 1984b:57
St Helena Island	Possibly post-contact	Alfredson 1984:4
Sandstone Point	Late Holocene	Crooks 1982:31, 39

Table 2. Marine turtle bones from excavated middens, southeast Queensland.

Site	Age	Reference
Waddy Point 1, Fraser Island	c.650-850 years ago	McNiven unpublished data
Toulkerrie 1, Moreton Island	<500 years ago	Hall 1984:72
St Helena Island	Late Holocene	Alfredson 1984:4
Cascade Gardens	No dates	Haglund-Calley and Quinnell 1973

Turtle

Nineteenth and twentieth century ethnographic information for Moreton Bay (e.g. Colliver and Woolston 1975:96; Draper 1980:133; Petrie 1980:82-83) and Fraser Island (e.g. Devitt 1979:77; Foley 1994:20) indicates marine turtle hunting was and remains an established practice of Aboriginal people of southeast Queensland. The major method of capturing the marine reptiles was by hand or with nets. As with dugongs, archaeological evidence for marine turtle hunting in southeast Queensland is meagre, with marine turtle bone having been excavated from only four sites in the region (Table 2). Of the two sites with associative dates for turtle remains (Waddy Point 1 Rockshelter and Toulkerrie 1), both are restricted to the last 1000 years. This recent antiquity may simply be a function of limited research given that along the central Queensland coast 2500–2700 year old marine turtle bones have been recovered from Mort Creek Site Complex located south of Gladstone (Ulm 2004:165) while Border Island 1 rockshelter in the Whitsunday Islands reveals 6000–7000 year old turtle bones (Barker 2004:113).

Whale

Few written records document whale consumption by southeast Queensland Aboriginal people. A rare reference comes from the Fraser Island region and was published in 1874:

> The carcase of a black whale is lying stranded on the flats near Stewart Island, in Great Sandy Strait, and is causing great excitement among the Aboriginal tribes, who seem to be preparing for a grand gathering in honour of the luscious event ... The blacks have already carried off the flippers and tail, and unless some enterprising whitefellow speedily comes to the rescue of the not inconsiderable amount of oil that the creature may be expected to yield, will probably make speedy work of all the more valuable portions (Anon. 1874:2).

The only archaeological evidence to date for whale consumption in coastal southeast Queensland comes from Toulkerrie on the southern end of Moreton Island where Hall and Bowen (1989:16) report a single piece of 'cetacean' bone dating to within the last 500 years. Recovery of a c.2000 year old whale (Odontoceti) tooth from Nara Inlet 1 rockshelter in the Whitsunday Islands of central Queensland (Barker 2004:79) suggests whale consumption in southern Queensland dates to before 500 years ago. While no evidence exists for pre-European contact Aboriginal peoples of Australia hunting larger whales (e.g. humpbacks) (e.g. Clarke 2001), exploitation of dugongs indicates that small whales of comparable size would have been within technological reach for thousands of years.

Crustaceans

Nineteenth and twentieth century ethnographic information for Moreton Bay (e.g. Colliver and Woolston 1975:95; Draper 1980:133; Petrie 1980:74) and Fraser Island (e.g. Devitt 1979:77; Foley 1994:20) reveals crustaceans (specifically crabs) were and continue to be part of the diet of Aboriginal people of southeast Queensland. Archaeological evidence for crustacean consumption is meagre and all is restricted to crab, with mud crab (*Scylla serrata*) and sand crab (*Portunis pelagicus*) the only identifiable species (Table 3). The earliest evidence comes from Booral Shell Mound on the mainland opposite Fraser Island dated back to a little over 3000 years ago (Frankland 1990). Ulm (2004:130, 133, 409) reports 3500–4000 year old mud crab shell from Seven Mile Creek Mound just south of Gladstone while similar remains dating back to 9000 years ago have been recovered from Nara Inlet 1 rockshelter in the Whitsunday Islands (Barker

Table 3. Crustacean exoskeleton from excavated middens, southeast Queensland.

Site	Age	Taxa	Reference
Booral Shell Mound	c.900-3000 years ago	Mud crab; Sand crab	Frankland 1990:57
Waddy Point 1, Fraser Island	<900 years ago	Crab	McNiven *et al.* 2002:Appendix A
Toulkerrie 1, Moreton Island	<500 years ago	Mud crab	Hall 1984:68
Sandstone Point	Late Holocene	Mud crab; Sand crab	Nolan 1986:63, 65
St Helena Island	Late Holocene	Mud crab	Alfredson 1984:5

2004:77-78). As such, it is likely that crustaceans have been part of the southern Queensland Aboriginal menu since sea-level stabilisation 6000–6500 years ago.

Fish

Nineteenth and twentieth century ethnographic information for Moreton Bay (e.g. Colliver and Woolston 1975:95; Draper 1980:131-132; Petrie 1980:69-74), Cooloola (McNiven 1992:13) and Fraser Island (e.g. Devitt 1979:76; Foley 1994:20; Lauer 1977:17) indicates Aboriginal people of southeast Queensland were and remain expert fishers. Fish were speared or caught in nets and stone-walled tidal fishtraps; fishhooks being unknown for the region until European contact (Walters 1988). The earliest available evidence for Aboriginal fishing in southeast Queensland is the New Brisbane Airport Site where fragments of fish bone were found in association with estuarine shellfish dating from 4830±110 BP (5600 years ago) (Hall 1999:174; Ulm and Hall 1996:61). The next earliest evidence comes from Booral Shell Mound on the mainland opposite Fraser Island where numerous fish bones have been found in all levels dated a little over 3000 to 900 years ago (Frankland 1990; see also Bowen 1998). Fish bones have also been found back to 3000 years at Wallen Wallen Creek (Ulm 2002b:88) which implies they are missing from the earlier bone assemblage dated 3000 to nearly 5000 years ago. Of the remaining 18 radiometrically-dated sites with fish bone in coastal southeast Queensland, all date to the last 2500 years and 15 date to within the last 1000 years (Ulm 2002b; Walters 1989). Thus, 70% of sites with fish bone are less than 1000 years old. While Walters' model for the late Holocene development of a fishery has been critiqued on a number of fronts (e.g. McNiven 1991a; Ulm 2002b; cf. Walters 1992, 2001), the fact remains that most fish bones in southeast Queensland archaeological sites date to the last 1000 years.

Summary

The last 1000 years sees major increases in shellfishing and fishing, and possibly concomitant increases in dugong and turtle hunting. Increased food production can be linked to demographic expansions (associated with fissioning and increased coastal residency) and the need to feed more people. Thus, on a broad scale the available evidence suggests that increased midden numbers of the last 1000 years was associated with quantitative and not qualitative changes in marine resource use. However, one food resource increases so dramatically in use during the last 1000 years that it could be considered representing a qualitative change – *Donax deltoides*.

Late Moves on *Donax*

Shell middens in southeast Queensland can be divided into two major types – open surf beach middens and estuarine middens. Open surf beach middens are dominated by *Donax deltoides*, a bivalve available within beach sands exposed at low tide. Estuarine middens, as the name implies, are adjacent to quieter waters of bays and inlets, particularly areas of mangrove forest. Key shellfish species are oysters (*Saccostrea glomerata*), cockle (*Anadara trapezia*), and club whelk (*Pyrazus ebeninus*). Chronological trends for surf beach and estuarine middens are found in Figure 4. Immediately apparent is the restricted timeframe of surf beach (*Donax*) middens to the last 1500 years in contrast to estuarine middens that span the last 5600 years. When these data are expressed as establishment rates per 1000 years, it is apparent that most of the dramatic increase in middens in southeast Queensland during the last

1000 years is accounted for by surf beach middens (Figure 5). Indeed, the rate of surf beach midden establishment during the last 1000 years is 2.5 times that for estuarine middens.

Set within the context of estuarine midden increases, it is apparent that the increase in surf beach resource use (viz. shellfish) was part of a broader historical process of coastal intensification taking place across coastal southeast Queensland within the last 1000 years. Clearly, the entry of *Donax* middens into the archaeological record of southeast Queensland 1500 years ago and their dramatic increase within the last 1000 years was not a case of incorporation of a newly-available resource into local subsistence regimes. The Hope Island site reveals that *Donax* has been used in the region for nearly 5000 years. As such, the *Donax* midden phenomenon of the last 1500 years is a case of massive increased use of a previously known but little used resource. Increased use of *Donax* shellfish in the last 1000 years by long-term surf beach users is also demonstrated nicely at Teewah Beach Site 26 where after 4500 years of occupation, Aboriginal people suddenly and dramatically began using *Donax* around 900 years ago to the extent that a dense shell midden deposit formed.

Donax as a Marginal Resource

Elsewhere I have argued that the sudden incorporation of *Donax* into Teewah Beach Site 26 was part of a broader process of socio-political change across the Great Sandy Region (Cooloola and Fraser Island) such that increased residency (local population increase) placed major demands on local resources (e.g. food and tool stone), including previously little-used, lower ranking (marginal) resources such as *Donax* (McNiven 1991a, 1999). In terms of southeast Queensland archaeology, I hypothesise that *Donax* shell beds were for the most part a little-used marginal resource until the last 1000 years when population increase created extra subsistence demands on marine resources. Importantly, I would add that *Donax* would not have lost its status as a lower quality food resource simply because of increased use.

That *Donax* was a lower quality and relatively less desired marine resource is revealed also by middens located in areas close to both surf beaches and estuarine areas. For example, along a survey transect located equidistant along a narrow c.2km wide peninsula flanked by Rainbow Beach and Tin Can Bay, northern Cooloola, only 1% of the 12,000 midden shell fragments counted were *Donax*, the remainder being estuarine shells (McNiven 1985:28). Similarly, middens at the mouth of the Maroochy River comprised >98% estuarine shellfish despite the close proximity of the ocean surf beach (McNiven 1989). This pattern has also been documented more recently on Bribie Island by Tam Smith (1992, 2003). In 1989 I concluded:

> It appears that major ocean beach shellfish (i.e. pipi) exploitation only occurred in contexts far removed from estuarine environments. These differences strongly suggest that in coastal southeast Queensland during the late Holocene, estuarine habitats exerted greater subsistence 'pull' on shellfish gathering than ocean beach habitats (see Jochim 1976), probably because of the greater productivity and diversity of potentially edible shellfish in estuarine environments (McNiven 1989:47).

Perhaps these views on the lower subsistence ranking of *Donax* go someway to understanding Aunty Olga's comment on the marginal status of the east coast of Fraser Island as a 'back beach'.

Donax Middens: Post-Contact Intensification and Coastal Refuges

Shell middens in southeast Queensland have implications for the broader applicability of Lourandos' (1983:92) notion that the 'process' of 'intensification' documented archaeologically for the last 3500 years in southeastern Australia was 'nipped in the bud by the coming of the Europeans' (cf. Allen 1997). But is it possible to document continuity in the process of 'intensification' into the post-contact era, albeit as a response to European invasion? A significant dimension of the dramatic increase in *Donax* middens of the last 1000 years is that most (70%) of this increase (14 of the 20 sites) is represented by 'modern'/post-contact sites. If these recent middens are discounted, the number of newly established middens for the last 1000 years is identical for estuarine (n=6) and surf beach (n=6) middens. Yet the rate of establishment of 'modern'/post-contact surf beach middens (n=14) is seven times greater than the

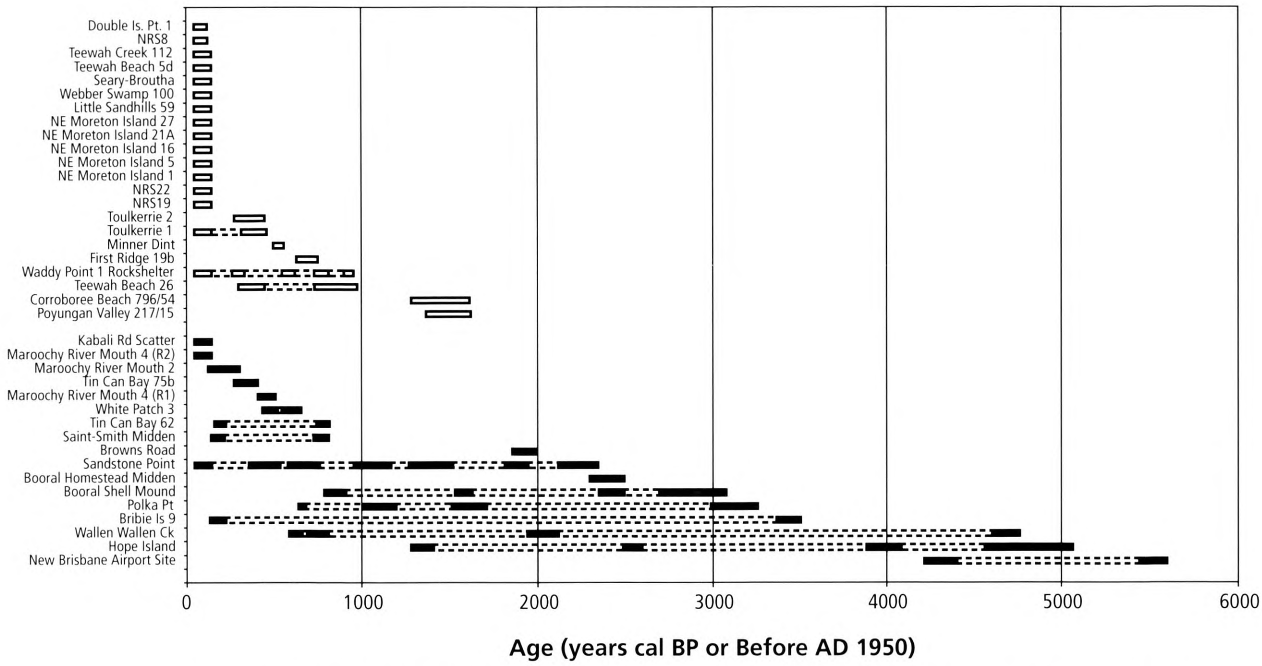

Figure 4. Temporal duration of dated coastal middens sites in southeast Queensland (solid bars= estuarine middens; white bars= surf beach middens; dotted bars= interpolated occupation continuities between dates).

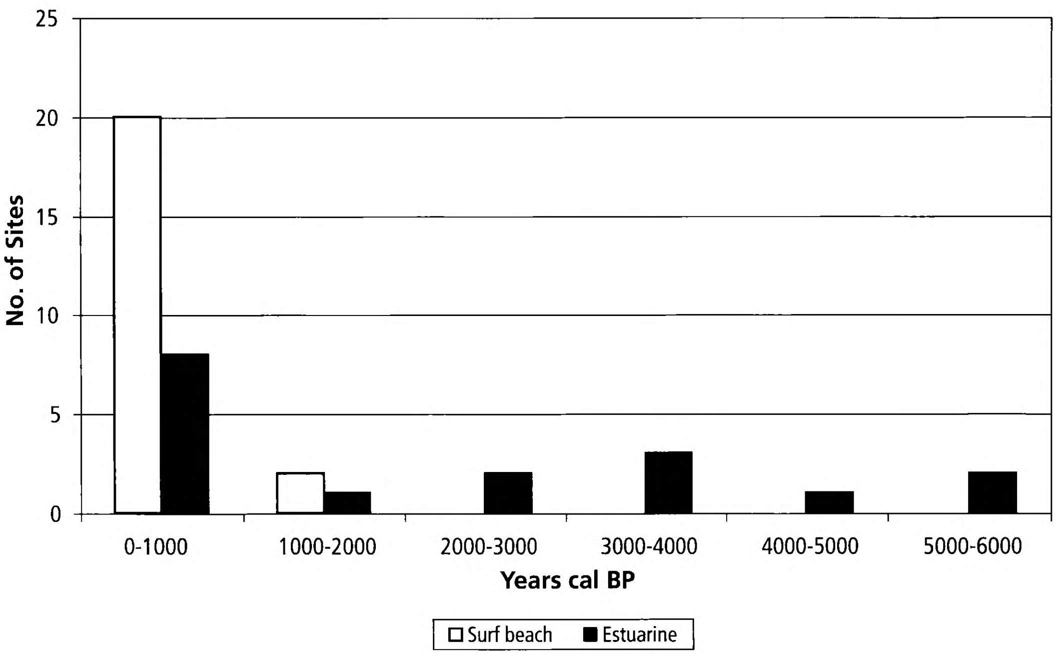

Figure 5. Number of new middens established over the last 6000 years.

rate of establishment of 'modern'/post-contact estuarine middens (n=2). While the representativeness of these data remain to be demonstrated, it is possible that across certain parts of southeast Queensland, Aboriginal post-contact settlement-subsistence arrangements were focused paradoxically more on marginal surf beaches compared to richer estuarine areas.

These post-contact middens reveal that 'traditional' Aboriginal settlement-subsistence practices continued well into the early years of European invasion and settlement of their lands during the nineteenth century. Indeed, the shell midden evidence indicates an intensification of marine settlement and subsistence during this period. In a paper on settlement and subsistence activities along Tin Can Bay, Cooloola, I noted that the increase in shellfishing activities c.100–200 years ago represented a 'secondary augmentation of human activity'; the primary augmentation commencing around 900 years ago (McNiven 1991b:103). I saw this 'secondary augmentation' as a response to European invasion of hinterland regions whereby coastal areas such as Cooloola that were little impacted by Europeans were established as 'refuges' by Aboriginal people 'to escape slaughter'. For Cooloola, the post-contact intensification of settlement and subsistence included estuarine and surf beach contexts. Thus this secondary intensification was an extension of intensification activities initiated around 1000 years ago. Indeed it is somewhat fortuitous that terrestrial marginality of the coastal lowlands in places such as Cooloola and Fraser, Bribie, Moreton and North Stradbroke Islands, worked in favour of Aboriginal people during the nineteenth century. That is, while European terrestrially-based economic systems (agriculture and pastoralism) were generally ill-equipped for such environments, developments in marine specialisation over the past 1000 years equipped Aboriginal people for intensified residential occupation of these lowland coastal environments.

Conclusion

The midden archaeological record of southeast Queensland is the best documented for any coastal region of Australia. Apart from myself, numerous archaeologists over the past quarter of a century have devoted significant parts of their lives in the form of thesis research to understand the long-term Aboriginal history of this region – Gillian Alfredson, Greg Bowen, Jill Crooks, Kathy Frankland, Rob Neal, Anna Nolan, Richard Robins, Tam Smith, Sean Ulm and Ian Walters – and in all cases we have been students of Jay Hall. Jay not only fostered the generation of a wide selection of archaeological data and ideas, but also created a journal – *Queensland Archaeological Research* – where such data and ideas could be published and made available for all to know, digest, discuss and debate. Having available this variety of data and ideas is healthy for the discipline as it establishes checks and balances as each new wave of researchers scrutinises, critiques and builds on previous research.

In terms of future research, a key issue that requires further attention is intensification of Aboriginal occupation of the coast during the last 1000 years. While I believe my 'localisation', 'fissioning' and 'regionalisation' model is on the right track (McNiven 1989, 1990, 1999), considerably more excavation effort needs to be directed towards middens of the last 1000 years to better test the structure and broader applicability of the model. Furthermore, these changes need to be explored more widely as most middens along the Queensland coast also date to the last 1000 years (Ulm and Reid 2000; cf. McNiven 2006). And this paper has added an extra dimension to the issue of late Holocene intensification by putting the focus on the 'secondary augmentation' of middens in the post-contact era. Despite considerable archaeological research in the region, the post-contact coastal archaeology of southeast Queensland remains poorly developed. In this paper I have attempted to show that this recent archaeological record is not fundamentally different from the pre-contact archaeological record but an elaboration of it. This view connects seamlessly all of the coastal archaeological record of southeast Queensland to contemporary Aboriginal people of the region and beseeches the development of partnership research endeavours (e.g. Ross and Coghill 2000; McNiven *et al*. 2002) in our collective pursuit of what Aunty Olga kept referring to as the region's 'hidden history'.

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Diatoms and Sponge Spicules as Indicators of Contamination on Utilised Backed Artefacts from Turtle Rock, Central Queensland Highlands

Gail Robertson

Abstract

An integrated residue and use-wear analysis of the backed artefact component of the stone assemblage at Turtle Rock revealed the presence of aquatic plant residues on a significant number of the artefacts. Since these were often associated with used edges and other, non-diagnostic, plant remains, the most obvious inference was that the tools had been used to harvest aquatic plants, possibly the common reed (*Phragmites* spp.) or bulrush (*Typha* spp.). Ethnographic evidence for the use of reeds for subsistence and craft activities in the recent past provided support for the archaeological evidence. However, further research into the post-excavation history of the artefacts indicated that the excavated deposits had been wet-sieved in a nearby waterhole. Thus, visible plant and other residues from a freshwater environment, which could point to use of the artefacts for harvesting reeds or other aquatic plants, could also be the result of post-excavation contamination. Ambiguities in the analytical results created by wet-sieving prevented clear inferences for artefact use at the site. The implication of these findings for the residue and use-wear analyst is that access to site reports and accurate information on excavation, post-excavation and curation procedures are crucial for informed interpretation of archaeological residues on artefacts.

Introduction

This paper discusses the significance of the presence of diatom and sponge residues on a significant number of backed artefacts from Turtle Rock, a rockshelter in the Central Queensland Highlands. An integrated residue and use-wear analysis of 21 backed artefacts from the site was undertaken as part of a research project which addressed the question of backed artefact use in eastern Australia during the mid-to-late Holocene through an analysis of artefacts from six different sites (Robertson 2005). While 18 of the artefacts at Turtle Rock gave clear indications of use and the remaining three exhibited slight evidence of use in the form of use-wear, 12 artefacts were unable to be assigned to a specific task. The presence of aquatic plant residues, including freshwater diatoms and sponge spicules, on a significant number of the artefacts, often in association with used edges and other, non-diagnostic, plant remains, suggested many of the tools had been used to harvest aquatic plants, possibly the common reed (*Phragmites* spp.) or bulrush (*Typha* spp.). However, further research into the post-excavation history of the artefacts indicated that the excavated deposits had been wet-sieved in a nearby waterhole. This treatment introduced ambiguities into the interpretation of the results.

In archaeological lithic research, residue and use-wear analyses are commonly subsumed under the umbrella of 'functional studies' along with technological analyses. Historically, use-wear analysis was accepted as a 'scientific' method of determining tool function long before residue analysis achieved recognition. The techniques used in residue and use-wear studies are logically complementary in that both employ microscopy to examine an artefact surface for evidence of past use, and both provide information (albeit different types) about the material worked and the way in which the tool was manipulated. Each method has its limitations, but combined evidence from the different approaches allows greater confidence in the resulting inferences. In essence, residue analysis consists of observation and identification of organic and inorganic residues on artefacts while use-wear analysis verifies that residues are task related by identifying associated traces of wear. Use-wear also determines the mode of action or function of the tool. Comparison with the evidence of known activities allows inferences about tool use, where use indicates 'the minimal instance of behaviour directed towards completion of a task' (Schiffer 1979:19). Both techniques are therefore grounded in replicative experimentation.

Residues and wear associated with all periods after artefact discard may be considered contaminants, and differentiation of these from use-related residues and use-wear are incorporated into the analytical technique. Sources of contamination include environmental and cultural events before and during burial and often, recovery and post-excavation procedures. Wear features after discard are discussed below in relation to non-use-wear. Those events prior to excavation generally relate to burial in sediment, although discard into a refuse pit or hearth also occur. Contaminant residues from the burial period could (and often do) include microscopic fungi, plant rootlets, insects and their eggs and webs, sediments with accompanying components, usually plant materials including pollens, spores, starch grains and phytoliths, faecal spherulites and soil minerals.

Post-excavation contamination becomes an issue when procedures are not fully documented or are unavailable to the analyst. Procedures generally include recovery of artefacts, which requires handling and/or on-site sieving of deposits; labelling and bagging; transport; further cleaning; other analyses; storage; and, occasionally, display. Common sources of contamination are handling of artefacts without gloves causing incidental transfer of food, skin, grease, blood and other materials; wet-sieving of deposits on site which can add algae and other water-borne contaminants; labelling of artefacts with black or other ink, often with white paint to highlight the provenance; bagging of multiple artefacts in a single bag causing transfer of residues; bagging of artefacts with inserted cardboard labels which add cellulose fibres; storage in cardboard boxes with cotton or paper cushioning, also sources of cellulose fibres. Some contaminants such as ink labels are macroscopically obvious, while others only become clear during analysis. A combined residue and use-wear analysis is however a methodologically sound approach to resolving the issue of non-use-related residues.

Method

The techniques of residue and use-wear analysis were chosen because they have demonstrated their combined effectiveness as a means of inferring task association and function in archaeological material, and because they are essentially non-destructive. In combination with the use of powerful optical microscopes for observation, the techniques rely on access to a comprehensive comparative reference collection assembled during the course of the project by the author and colleagues in the Archaeological Science Laboratory, School of Social Science, University of Queensland, and also on published data.

As a component of this research, tables were created to reflect anticipated residues and use-wear associated with various hypothesised tasks such as butchery, hunting, bone-working, skin-working, wood-working, general plant processing and also ceremonial or decorative activities. These tables were employed to make inferences on the use of backed artefacts at Turtle Rock.

Residue Analysis

Residue analysis is the study of organic and inorganic materials left adhering to artefacts as a result of Locard's 'exchange principle', which states that material is always transferred from one to the other when two objects come into contact (Briuer 1976:478). The term 'residue analysis' in this discussion refers to the methodology associated with the identification and interpretation of archaeological residues. Although residues on stone artefacts are the focus of this study, residue analysis is employed in a growing number of areas of archaeological research including the study of pottery, glass, coprolites and archaeological soils. On stone tools, residues may be from several different sources. They may be culturally derived, for example as the result of association with some task or as part of the manufacturing process (i.e. hafting and/or tool decoration). They may also arise incidentally from some other activity, or they may be due to taphonomic factors and result from the post-depositional environment or post-excavation processes. An essential part of residue analysis is the exclusion of the non-cultural elements present on an artefact.

The types of diagnostic organic and inorganic residues potentially associated with excavated stone artefacts are generally subdivided into plant and animal residues, although included in the section on plant residues are several organisms such as algae, diatoms and sponges, which are not plants but which have traditionally been described by botanists. Typical plant residues are cellulose (amorphous, tissues and fibres), sap, resin, starch grains, raphides and druses, each with specific characteristics which generally allow their microscopic identification (for identification characteristics see Franceschi and Horner 1980:381; Fullagar 1986:176; Gunning and Steer 1975:117; Horner and Wagner 1995:56; Langenheim 2003:46; Raven *et al.* 1999; Robertson 2005:54-85). Table 1, based on a review of the literature and the results of replicative experiments, illustrates the residues typically associated with various hypothesised tasks.

Residues associated with exposure of artefacts to a freshwater environment are typically sponges, freshwater diatoms and other algae. Their description and microscopic identification, including their differentiation from possible use-related residues, is a significant component of this study and their specific characteristics are discussed in more detail below.

Sponges

Most sponges are marine but they are also found in permanent and semi-permanent fresh or brackish water, and in Australia are present in most inland waters (Racek 1969:304). Sponges are immobile sac-shaped organisms with limited differentiation of tissues into organs, but with a body wall perforated by pore canals (Jones 1956:85). 'The body tissues ... are supported by a series of slender siliceous rods or spicules' (Williams 1980:35). The spicules are of two types, skeletal or dermal, of varying shapes and sizes. In Australia, all freshwater sponges belong to the Family Spongillidae (Williams 1980:32). Australian sponges usually reproduce asexually, releasing a large number of small spheres (<1mm diameter) which also have a layer of siliceous spicules. These spicules may be either straight or curved and cylindrical, or with terminal discs (Williams 1980:35). Thus some sponge spicules have a similar elongate morphology (including pointed tip) to raphides (Figure 1), although many Australian species have tubercles or minute spines on their surface with only a few completely smooth specimens (Racek 1969). Sponge spicules are generally siliceous and therefore should not exhibit birefringence in cross-polarised light. However, this feature is

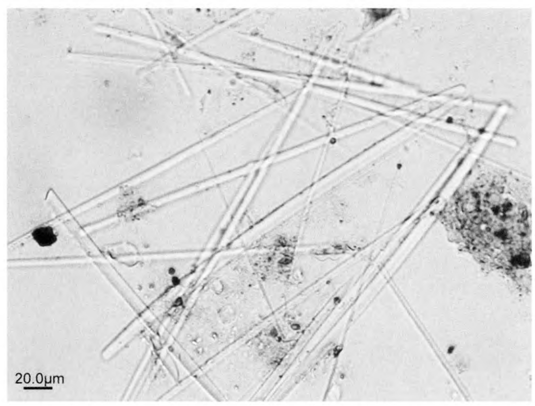

Figure 1. Sponge spicules from *Tedania* sp. measuring c.8µm in diameter and 200µm in length (x500) (Photograph: Gail Robertson).

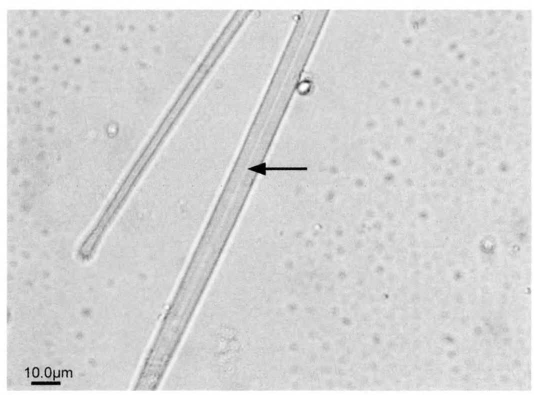

Figure 2. Axial filaments (arrow) on sponge spicules from *Tedania* sp. (x1000) (Photograph: Gail Robertson).

Table 1. Residue criteria for hypothesised task associations and functions. * = residues usually associated with this task.

Task Association		Description of Functions	Residues
Primary Animal Processing	Butchery	Cutting skin and disarticulating bone, removing meat from bone.	Blood*, red blood cells*, proteinaceous film*, fibrous collagen*, muscle tissue, other connective tissue (collagen), fat, vivianite, hair, feather (Fullagar 1986:172-191, 1992; Loy 1994a).
	Hunting	Spearing, stabbing – animal, reptile, bird.	Blood*, proteinaceous film*, tissue fragments*, collagen, hair, scales, feather, hafting resin (Kooyman *et al.* 1992; Loy 1994a).
Bone-Working	Primary Stage	Cutting and scraping of flesh, sinew and periosteum before drying.	Blood*, bone collagen* (sheet – periosteum, fibrils), bone fragments, connective tissue (collagen), fat and oil droplets, vivianite (Fullagar 1986:172-191; Loy 1994a).
	Secondary Stage	Cleaning of periosteum by scraping or cutting, smoothing and shaping/ modifying bone.	Sheet collagen* (periosteum), collagen fibrils*, bone fragments, granular bone collagen, proteinaceous film*, vivianite (Fullagar 1986:172-191; Loy 1994a).
	Tertiary Stage	Working dry bone, engraving, smoothing/polishing, boring or piercing, possibly sawing, adding fine detail, possibly decorating with ochre.	Granular bone collagen*, sheet collagen, bone fragments, ochre*, vivianite (Fullagar 1986:172-191; Loy 1994a).
Skin-Working	Primary Stage (wet)	Separation of skin, removal of adhering fats and tissue, piercing and trimming.	Collagen fibres*, connective tissue (collagen)*, proteinaceous film*, vivianite, blood, lipids, hair (Anderson 1980; Loy 1994a).
	Secondary Stage (dry)	Possible scraping or scoring to soften skin, piercing or awling, cutting to shape.	Collagen sheets*, collagen fibres*, proteinaceous film (Fullagar 1986:172-191; Loy 1994a).
Wood-Working	Wood-Working	Scraping, chopping, cutting, engraving, adzing.	Woody plant tissue*, cellulose*, plant cells visible in tissue, cellulose fibres*, resin, plant sap or exudate*, bordered pits, cells with helical wall-thickening, charcoal, charred sap/resin (Anderson 1980; Hardy and Garufi 1998; Loy 1994a).
Plant Processing	General Plant-Working	Cutting, shredding, removing bark (scraping).	Plant tissue*, amorphous cellulose fragments*, fibres, resins, sap or exudate*, small starch grains*, chlorophyll, phytoliths (Briuer 1976).
	Starchy Plants and Seeds	Scraping, chopping, cutting.	Starch grains*, cooked starch, plant tissue*, raphides, amorphous cellulose, plant fibres*, phytoliths (Briuer 1976; Fullagar 1992; Loy 1994b).
Ceremonial and Decoration	Ritual Scarification	'Crimping' or cutting to form cicatrices on the body.	Blood/human*, connective tissue, lipids/fats, vivianite (Tom Loy, School of Social Science, University of Queensland, pers. comm., 1997).
	Other	Decorating churinga or other object or body.	Ochre, feathers, blood, muscovite mica or none (Akerman *et al.* 2002).

much more distinct in specimens on slides where transmitted light is employed than on an artefact using incident brightfield cross-polarised illumination (Alison Crowther, School of Social Science, University of Queensland, pers. comm., 2005). The spicules also have a characteristic central core or axial canal which may be visible microscopically at least on broken or fragmented specimens (Figure 2).

Diatoms and other Algae

Algae are photosynthetic organisms existing in a variety of habitats, including marine and freshwater, but also extreme environments such as snow and ice, and hot springs. They are extremely ancient in evolutionary terms, occurring in the fossil record dating to approximately three billion years ago, and they vary in structure from small, unicellular forms such as plankton to complex multicellular forms which may be either filamentous or flat sheets of cells. Algae are primary producers of organic matter and also supply oxygen for other aquatic organisms. Diatoms are unicellular algae with a highly differentiated cell wall containing large amounts of silicon dioxide (Round *et al.* 1990:1). They are composed of two parts called valves which are linked by a girdle, and there are two basic forms, pennate and centric. They exist in both marine and freshwater environments, and in the latter are generally found in still or gently flowing water. The presence on an artefact of diatoms and other algae in association with plant fibres, starch grains and appropriate use-wear features may be taken to infer use on aquatic plants such as reeds, including *Typha* spp. Diatoms are identifiable microscopically because of their bilateral symmetry and their highly ornate skeleton and, as they are siliceous, they do not exhibit birefringence (Round *et al.* 1990).

Use-Wear Analysis

Use-wear analysis comprises a series of techniques for obtaining functional information from stone tools to augment that available from conventional morphological and technological approaches. Information is obtained by studying 'the effects of the utilisation process on the tool itself' (Odell 2004:135). It is defined as 'the study of tool functions by examining modifications to the edges and surfaces of stone tools' (Fullagar 1986:9). Since such modifications may be cultural or taphonomic, use-wear analysis has two components: it is a method of defining or describing wear features attributable to cultural factors, that is, tool-use; and a means of interpreting function. The major forms of use-wear observed were edge-rounding, edge-fracturing, striations, lineation and abrasive smoothing and polish (see Robertson 2005 for definitions of these terms with reference to Fullagar 1986 and Kamminga 1982). Use-wear analysis, in this study, was employed primarily to locate used edges and to determine the mode of action of a tool. The more complex wear patterns associated with sustained use which are described in Table 2 were not consistently identified.

The potential for confusion of use-wear with non-use-related wear features is a major methodological issue. All tools will have been subjected to non-use-wear usually from a number of different sources during their life histories, and unless this is identified as such or at least recognised as a possibility, any functional interpretation based on use-wear analysis alone is likely to be questionable. A number of researchers have attempted to address the problem through experimentation (see Burroni *et al.* 2002 for detail), but Hurcombe (1992:71) has adopted an interesting methodological approach to the issue by employing Schiffer's (1972) separation of archaeological and systemic contexts as a basis for constructing a table of phases in the life history of a tool which might produce non-use-wear (see Robertson 2005:28, Table 2.1). This framework allows consideration of the various types of potential wear patterns and also the possibility of identifying at least some of them (Hurcombe 1992:71). Hurcombe (1992:71-78) provides an excellent discussion of numerous sources of non-use modifications and accidental damage to lithic artefacts within this framework, although only a few of these were considered relevant to my research. These included some manufacturing techniques such as abrasion and retouch, 'bag-wear', and accidental damage owing to trampling by either human or animal agency (see Kamminga 1982:7-8; McNiven 1993;Vaughan 1985:23). Other taphonomic factors to be considered are soil processes, including patination which is caused by soil chemicals, soil movement causing friction, and the detrimental effects of exposure to wind, heat and water (Burroni *et al.* 2002). The site context of the artefacts should indicate which, if any, of these issues need to be accounted

Table 2. Use-wear criteria for hypothesised task associations and functions.

Task Association		Description of Functions	Use-Wear
Primary Animal Processing	Light Butchery	Cutting skin and disarticulating bone, removing meat from bone.	Small bending and step flake scars, slight edge-rounding, intersecting striae and striae parallel to the cutting edge (Kamminga 1982; Kay 1996).
	Hunting	Spearing, stabbing – mammal, reptile, bird.	Damaged tip/possible high energy impact shattered, striations parallel or subparallel to the long axis, major damage to retouched edges/large microflake scars, finely striated polish (David 1993:77-79; Kay 1996).
Bone-Working	Primary Stage	Scraping and cutting to remove flesh, sinew and periosteum.	Edge-rounding and fracturing, striations at 45°–90° to the edge, possible retouch (Kamminga 1982).
	Secondary Stage	Cleaning of periosteum by scraping or cutting, smoothing and shaping/ modifying bone.	Edge-rounding and fracturing, striations perpendicular and/or parallel to the edge (Kamminga 1982).
	Tertiary Stage	Working dry bone, engraving, smoothing, polishing, drilling, possibly sawing, adding fine detail, possibly decorating with ochre.	*Sawing:* continuous distribution of bending and step flake scars, feather fractures, rounding/ smoothing, protein film or 'polish' on ventral and dorsal aspects, striations parallel to the worked edge, but rare. *Engraving:* edge-rounding, 'polish', small step and bending scars. *Drilling:* rounding of apex and associated lateral margins, bending and occasional step fractures on lateral margins, frequent tip snapping but continued use, and polish (Fullagar 1986:172-191; Hayden 1979; Kamminga 1982; Tringham *et al.* 1974:189-191).
Skin–Working	Primary Stage (wet)	Separation of skin, removal of adhering fats and tissue, piercing and trimming.	*Fleshing* (scraping and cutting): bending fractures, usually minute with rounded spurs occasionally producing a 'dentate' profile, intersecting striations, dragging in the residue, residue located at least 0.5mm back from the edge, bright greasy polish (Kamminga 1982; Semenov 1964).
	Secondary Stage (dry)	Possible scraping or scoring to soften skin, piercing or awling, cutting to shape, incising.	*Scraping:* striations perpendicular to the edge, bending flake scars, pronounced rounding, abrasive smoothing. *Cutting/scoring:* bending and occasional feather flake scars with rounded spurs producing a serrated edge. *Piercing or awling:* bending, feather and hinge fractures, bifacial edge-damage, fine striations on the tip and parallel to the axis of the awl, frequent snapped tip producing a triangular platform, but continued use. *Engraving:* bending fractures with pronounced rounding on spurs, occasional polish, parallel striations (Fullagar 1986:172-191; Hayden 1979; Hurcombe 1992:148; Kamminga 1982; Tringham *et al.* 1974:189-191).

Table 2. Use-wear criteria for hypothesised task associations and functions (continued).

Task Association		Description of Functions	Use-Wear
Wood-Working	Wood-Working	Scraping, chopping, cutting, incising, adzing.	*Scraping:* edges, both acute and obtuse, exhibit moderate rounding with an almost continuous distribution of bending, and occasional feather and step flake scars, striations are generally broad and shallow if present; polish. *Incising/engraving:* some edge-rounding on the tip and lateral margins at the tip, with small step fractures, striations parallel to the working edge (Fullagar 1986:172-191; Hardy and Garufi 1998; Hurcombe 1992:148; Kamminga 1982).
Plant Processing	General Plant-Working	Cutting, shredding, removing bark (scraping).	Edge-scarring rare and small, usually only bending flake scars, slight to moderate rounding and few or no striations (Fullagar 1986:172-191; Hurcombe 1992:148).
	Starchy Plants and Seeds	Scraping, chopping, cutting.	Edge-scarring rare and small, usually only bending flake scars, slight to moderate rounding and few or no striations (Fullagar 1986:172-191).
Ceremonial and Decoration	Ritual Scarification	'Crimping' or cutting to form cicatrices on the body.	None.
	Other	Decorating churinga or other object or body	Unknown, possibly none.

for during analysis. Sieving and cleaning of artefacts is known to cause significant modifications to an artefact surface, particularly abrasion and striations, and also of course the removal of residues, although this latter issue will be revisited below (Hurcombe 1992:77; Kooyman 2000:154).

A table linking use-wear with various proposed tasks based on a review of the literature was employed in the interpretation of task association/function for each of the artefacts in the study (Table 2). It is important to note that use-wear attributes were observed in less than ideal conditions. Totally accurate use-wear analysis requires artefacts to be thoroughly cleaned, often with harsh chemicals, prior to microscopic examination. However, this research was an integrated study involving both use-wear and residue analysis and cleaning of the artefacts was not a viable option.

Hafting also has a significant influence on the mode of action of a tool and the presence of a haft may occasionally be inferred from wear traces. However, according to Rots (2003:812) the 'use of resin often hinders trace production' which is an interesting finding in relation to interpretations of Australian artefact use where the presence of resin traces is the most distinctive hafting evidence recorded in most previous research. Rots (2003:812) determined that 'absence of scarring and polish in a well-delimited area' usually signifies the use of resin, not necessarily the absence of hafting.

Equipment

Both low and high magnification microscopes were employed in the analysis because they provided a different image of the artefact surface. This difference relies not only on their differing range of magnifications and degree of resolution, but, more significantly, on the angle of lighting (Fullagar 1986:27).

Low Magnification Microscopy

Initial examination of an artefact at low magnification allowed assessment and identification of traces of wear, including use-wear and wear due to taphonomic factors, location of potential use-related residues, hafting evidence, and contaminants. For this analysis, it involved the use of a Wild stereo-binocular microscope with variable magnifications from 6x to 30x diameters mounted with an Olympus DP10 digital camera set at highest resolution (3.2 million pixels). The light source employed was a Microlight

150 fibre-optic light with adjustable arms. These allow observation of artefact surfaces with oblique lighting, which is essential for the identification of a number of use-wear attributes.

High Magnification Microscopy

An Olympus BX60 metallographic microscope fitted with 10x eyepiece lenses and 5x, 10x, 20x, 50x and 100x objective lenses was used for high-power microscopy, providing nominal magnifications of 50x, 100x, 200x, 500x and 1000x diameters. The microscope employs vertical incident brightfield and darkfield illumination for observation of residues and artefact surfaces, but also has the capacity for use as a transmitted light microscope for observation of residue samples removed to slide. The objectives, with the exception of the 20x, are long working distance lenses enabling examination of the characteristically uneven topography of stone artefact surfaces. The Olympus microscope was also fitted with an Olympus DP10 digital camera.

The Site

Turtle Rock is one of four sites in the Central Queensland Highlands excavated by Morwood (1979) as part of his doctoral research, in which he employed a multiattribute approach to the region's archaeology by documenting both the rock art and the artefact assemblages at a number of different sites. Other sites excavated in the region were Native Well I, Native Well II and Ken's Cave (Morwood 1979, 1981).

The Central Highlands are composed of Mesozoic sandstone occasionally capped with tertiary basalt, and consist of numerous hills, gorges and tablelands, which rise steeply from the encircling plains (Morwood 1981:1). The Highlands have a complex geology resulting from a number of events including volcanic, sedimentation and erosional activity. Weathering has produced a large number of rockshelters and the area contains ochre and pipe-clay sources as well as outcrops of material such as quartzite suitable for stone tool production.

Turtle Rock is a low rockshelter occurring as an undercut in a large silcrete boulder on the southern end of the Buckland Tableland near the head of the Warrego River. It is small, measuring only 2.5m x 2.0m in area with a height of 0.6m at the dripline. Stone artefacts were visible on the floor of the shelter and in the surrounding area prior to excavation. The site contains rock paintings and stencils, with white the predominant colour, although some bird tracks have been painted 'with an unusual, opaque, red substance' and yellow is also visible (Morwood 1979:143). There is a quarry with evidence of Aboriginal use in a nearby silcrete outcrop, with other stone resources available in a local creek bed.

Excavation of the site commenced in 1977 in T1, a 1m square against the shelter wall. Excavation Units were initially 10cm but the presence of a large boulder at a shallow depth across much of the floor area limited the deposit to a 70cm wide 'sump' between the boulder and wall, and the texture of the deposit was extremely hard resulting in 'chiselling' rather than trowelling being the only possible excavation method. This meant that most artefacts were only recovered after wet-sieving compacted sections of deposit in a nearby waterhole, thus precluding any three-dimensional recording of their location. Morwood (1979:147) determined that the compacted sediments prevented vertical displacement of artefacts after their initial incorporation when the surface material was wet. He distinguished seven Stratigraphic Layers in the excavation, with Layer 7 comprising sterile weathered bedrock. The depth of the deposit was approximately 0.9m.

Over 5000 pieces of stone were recovered, with 119 identified as tools on the basis of retouch and/or use-wear. Although Morwood (1979:148) noted that organic preservation at the site was poor, small bone fragments, mostly from different species of marsupial, were recovered from Excavation Units 1–4, a freshwater bivalve and fish remains from Excavation Units 1 and 2 respectively, and emu egg-shell also from Excavation Unit 2. No macroscopic plant remains were recorded for the site. Two radiocarbon dates on charcoal samples were obtained for the site: 2410±80 BP (ANU-2120) from a hearth in Stratigraphic Layer 3 and 2800±300 BP (ANU-2202) from the base of Stratigraphic Layer 6 (Morwood 1979:148).

Backed Artefacts

Forty-three artefacts designated as backed were recovered from the basal layers up to and including Stratigraphic Layer 3 (Morwood's 'spit 3') (Morwood 1979:151). Morwood (1979:151) therefore argued for discontinuation of backed artefact manufacture some time after 2400 BP. Hiscock (School of Archaeology and Anthropology, Australian National University, pers. comm., 2001), whose definition of backed artefacts was used to categorise the artefacts selected for this analysis, confirmed that 21 artefacts from the Turtle Rock assemblage are backed. Although there were eight different types of stone material recovered from the site, the backed artefacts analysed were manufactured solely on relatively fine-grained quartzite (Morwood 1979:156). Most were small, with one artefact <1cm and 15 artefacts between 1–2cm, two exactly 2cm, and three between 2–3cm in length.

Results

Certain residue and use-wear patterns resulted in inferences about use of the artefacts, but before discussing the various tasks associated with the use of these artefacts, a table of observed residues and associated use-wear is provided to illustrate how inferences were made (Table 3). This table should be used in conjunction with the table of criteria for residues and use-wear for proposed task associations and functions (Tables 1 and 2). Table 3 also indicates those artefacts with freshwater diatoms and sponge spicules.

Artefacts with similar inferred task associations and functions are discussed as a group under the subheadings of plant processing and bone-working. Hafting assessment was considered in terms of the number of artefacts hafted and also in relation to the inferred task association for each hafted artefact to determine if a pattern emerged relating to task, function or morphology. Other artefacts in this assemblage may have been hafted but residual evidence was insufficient to infer hafting. The presence of other identified residues is noted and discussed. Figure 3 provides a broad overview of the results.

Plant Processing

The inferred task association for eight artefacts was processing either starchy, possibly tuberous, plants or fleshy and/or fibrous plants. The evidence for plant processing was quite complex and requires a relatively detailed explanation. Five artefacts (TR#6, TR#7, TR#8, TR#9, TR#13) retained

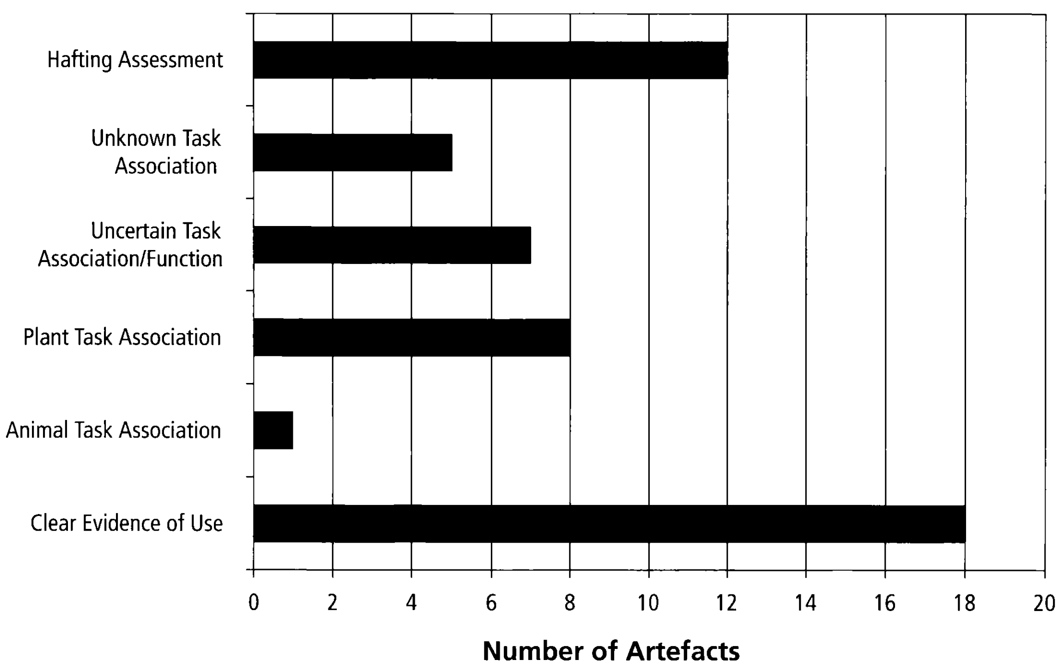

Figure 3. Inferred task association and hafting assessment for Turtle Rock artefacts.

Table 3. Residues and use-wear observed on Turtle Rock artefacts.

TR#	Task Association	Plant Residues	Animal Residues	Mineral Residues	Freshwater Residues	Use-Wear
1	General plant processing/fleshy	c, ex, r, st, st(c)		o		e2, bfs
2	Secondary bone-working/possible bird bone	c, ch, t, r, st	bc, fc, f, l	v, o		e1, bfs, s
3	Unknown	cf, r, st		o	d	e1
4	Unknown	c, cf, ex, st	l	v	d and/or ss	e2, bfs
5	Starchy plant processing	c, cf, ex, t, r, st			d	e3 (chord), e2 (OAR), bfs, lin (90°)
6	Starchy plant processing	c, cf, r, st, st(c)			d	e3 (chord), e1 (BE), bfs
7	Starchy plant processing	c, cf, ch, r, st, st(c)			d	e2, cr (BE)
8	Starchy plant processing	cf, ch, r, st, st(c), dr			d, at	e2 (chord), bfs
9	Starchy plant processing	c, cf, ch, r, st(c), dr			d, at	e2, cr (BE), bfs
10	Uncertain/possible plant processing	c, cf, ch, r, st, st(c), dr			d and/or ss, at	e2 (chord & tip), cr (OAR), bfs(cd)
11	Uncertain/possible plant processing	c, ch, st, st(c)			d, ss	e2 (chord & tip), cr (BE), bfs, HE
12	Unknown	r, dr, st(c)		o	d and/or ss, at	e1
13	Starchy plant processing	c, ch, ex, st, st(c), dr			d and/or ss	e2 (chord & tips), bfs
14	Uncertain/possible plant processing	c, ch, r, st, dr	l	v, o	d and/or ss	e2 (chord), e3 (tips), cr (OAR), bfs
15	Uncertain/possible plant processing	c, r, st, dr			d and/or ss, at	e2, lin (90°)
16	General plant processing/fibrous and sappy	c, cf, ex, t, r, st, dr		o	d and/or ss, at	e2 (chord), e3 (tip), bfs, lin (45°), LE
17	Uncertain/possible plant processing	c, ch, r, st, dr		o	d and/or ss	e2 (chord), e3 (tip), bfs, lin (60°), LE
18	Uncertain/possible plant processing	c, cf, ch, r, st, dr		o	d and/or ss	e2 (chord), e3 (tip), bfs, sfs
19	Unknown	c, ch, r				e1, sfs,
20	Unknown	c, cf, r		o	d and/or ss	e2 (chord), e3 (tip), bfs, lin (60°)
21	Uncertain/possible plant processing/ fibrous	c, cf, r, st	l	o, v	d and/or ss, at	e2 (chord & OAR), e3 (tip), bfs

Key

Plant: c = amorphous cellulose, cf = cellulose fibres, t = plant tissue (vessel elements, parenchyma, tracheids), st = starch, st(c) = cooked starch, d = diatom, ch = charcoal, dr = druse including individual druse crystals, r = resin, ex = plant exudate or sap, ss = sponge spicule, at = algal tissue.

Animal: bc = bone collagen, fc = collagen fibrils, f = feather barbules, l = lipids.

Mineral: v = vivianite, o = ochre.

Use-Wear: bfs = bending flake scar, sfs = step flake scar, s = striations, lin = lineation, e = edge-rounding (1 = slight, 2 = moderate, 3 = pronounced), HE = high energy snap fracture, LE = low energy snap fracture, cd = continuous distribution (of bending or step flake scars), p = polish, cr = crushing, OAR = obtuse angle ridge, BE = backed edge.

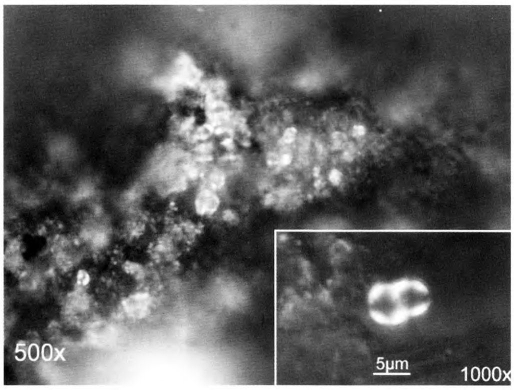

Figure 4. Starch grains (2-4µm) with resinous residue on one tip of TR#7 (BFxp). Inset: Cooked starch grains approximately 5µm diameter (BFxp) (Photograph: Gail Robertson).

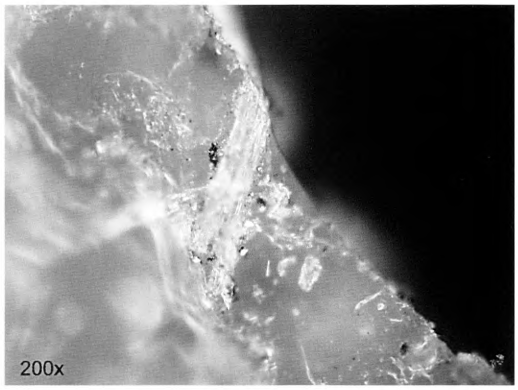

Figure 5. Fibrous plant tissue smeared in plant sap on the backed edge near the tip of TR#16 at a 45° angle (DF) (Photograph: Gail Robertson).

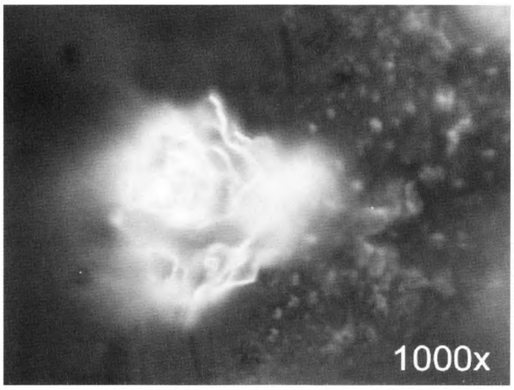

Figure 6. A druse (c.15µm) associated with amorphous cellulose and crystal fragments on one tip of TR#15 (BFxp) (Photograph: Gail Robertson).

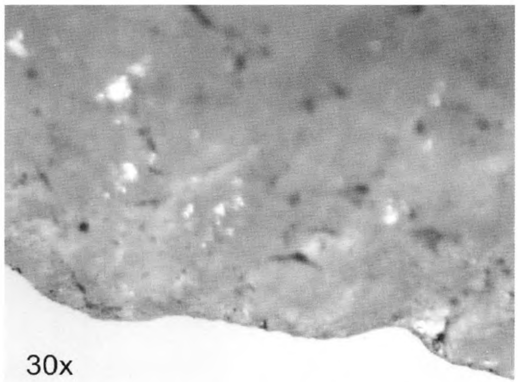

Figure 7. Edge-rounding and bending flake scars along the chord and tip of TR#15 (Wild) (Photograph: Gail Robertson).

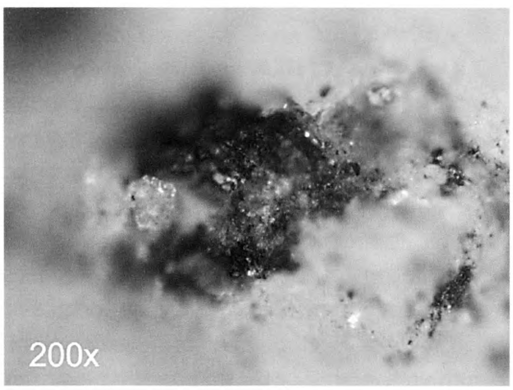

Figure 8. Red-brown charred resin on the obtuse angle ridge on TR#10 (Bfxp) (Photograph: Gail Robertson).

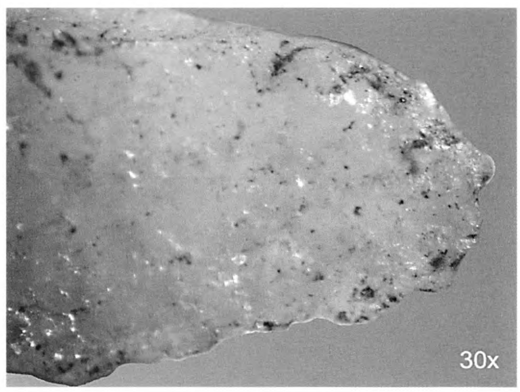

Figure 9. Pronounced rounding on the edge, tip and obtuse angle ridge of TR#5 (Wild) (Photograph: Gail Robertson).

residual heated or cooked starch grains, indicating their possible use for processing edible plants. On these five artefacts starch grain size was less than 10µm with an average of 5µm, with four (TR#7, TR#8, TR#9, TR#13) carrying charcoal particles (evidence of heating) and three (TR#8, TR#9, TR#13) also having fragments of druse crystals. Co-occurring with plant sap and vessel elements with bordered pits, a sixth artefact (TR#5) also had starch grains, mostly 6-10µm, although these did not appear to have been heated. Four artefacts with the inferred task association of processing cooked/heated possibly edible plants appear to have been hafted, although the manner of hafting remains undetermined. The other two artefacts in this group may also have been used to process starchy plant material but there was insufficient evidence to infer hafting. Based on the presence of plant sap, cellulose and/or plant tissue fragments, and small (2µm) starch grains, the remaining two plant processing artefacts, TR#1 (hafted) and TR#16 (insufficient evidence for hafting), were probably used for cutting and scraping fibrous and sappy or fleshy plants. In fact, use-wear features indicated that all eight artefacts functioned as cutting and/or scraping implements, with five having evidence for hafting. Figures 4-9 illustrate some of the residues and use-wear features on artefacts associated with plant processing at Turtle Rock.

A further seven artefacts exhibited use-wear evidence, but only a few plant residues were visible and there was no clear association between residues and used edges. All seven revealed an association with a freshwater environment in the form of the presence of freshwater diatoms, sponge spicules and occasional algal tissue. A task association of plant processing could not be inferred with sufficient confidence to allow their inclusion in this category.

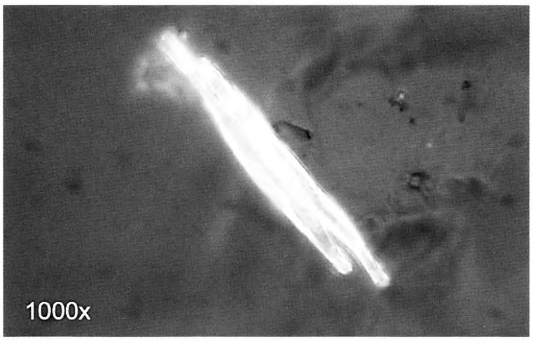

Figure 10. Two 40x2µm diatoms on the ventral surface of TR#6 (BFxp).

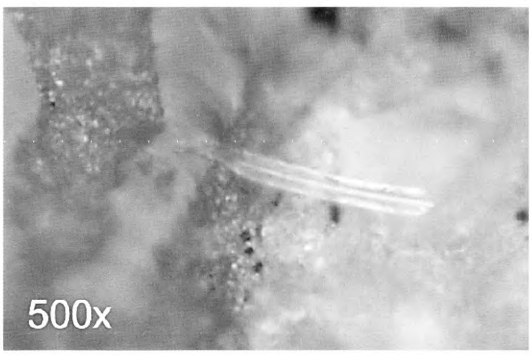

Figure 11. A pennate diatom measuring 40x4µm and exhibiting a central raphe, a characteristic of diatom morphology (BFpp).

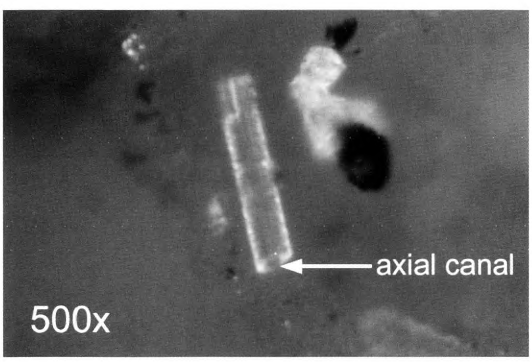

Figure 12. Sponge spicule (38x8µm) exhibiting low birefringence (siliceous) and an axial canal, located on the backed edge near the tip of TR#11 (BFxp).

Bone-Working

Only one artefact (TR#2) exhibited evidence for an animal task association, specifically bone-working, an inference based on the presence of bone collagen, collagen fibrils and vivianite but also feather residues. Co-occurring ochre suggested tertiary bone-working, and the combination of bone and feather residues allowed speculation of use for scraping bird bone. There is ethnographic evidence in the study area for the use of bird bone for producing ornamental accoutrements, as well as for use as implements and ritual objects (Morwood 1979). No freshwater residues were detected on this artefact.

Other Residues

Diatoms and Sponge Spicules

Of particular interest was the presence of diatoms and/or sponge spicules and occasional algal tissue on 18 of the 21 artefacts. These were initially identified as such by Alison Crowther (School of Social Science, University of

Queensland, pers. comm., 2005). All but three artefacts therefore exhibited evidence of exposure to a freshwater source. Of the three artefacts without freshwater residues, one exhibited evidence for bone-working (TR#2), one displayed slight evidence of use in the form of use-wear but with no use-related residues (TR#19), and the third gave clear evidence of use for processing fleshy or fibrous plants (TR#1). In addition, two artefacts (TR#3, TR#12) with limited evidence of use also possessed freshwater residues. Figures 10-12 illustrate some of the freshwater residues associated with Turtle Rock artefacts.

Ochre

Ten artefacts exhibited red ochre residues, usually in small quantities and possibly the result of soil or hand transfer by either the original user or the excavator. The presence of ochre on artefacts was not unexpected given that Turtle Rock is also a rock art site and ochre was found throughout the excavation. However, on two artefacts (TR#12, TR#20), ochre appeared in sufficient quantity to indicate association with use, either addition for aesthetic reasons or possibly already present on the material being worked. Yet, for neither of these was a task association inferred either because of the lack of other identifiable use-related residues (TR#20), or because evidence for use was in any case slight (TR#12).

Resin and Hafting Assessment

Hafting was inferred on the basis of appearance, relative quantity and pattern of distribution of resin on 12 of the 21 tools examined. The single artefact used for bone-working was probably hafted, and five artefacts with clear evidence for plant processing had hafting evidence. Four other artefacts with an uncertain task association, but which was probably plant related, were also hafted at some stage. One hafted artefact (TR#3) was used for an unknown task and another (TR#19) exhibited only slight evidence of use and its task association also remained undetermined.

Discussion

Twenty-one backed artefacts from Turtle Rock were examined for residues and use-wear. Eight of these were almost certainly used for processing either starchy or fibrous or fleshy plants, some of which were edible (requiring cooking). A further seven exhibited some evidence for a similar pattern of use in their use-wear features, but residues were considered of ambiguous provenance and task association was unable to be confidently inferred. Of particular interest was the presence of diatoms and sponge spicules on 18 of the 21 artefacts. Thus, all but three artefacts exhibited evidence of exposure to a freshwater source, despite the fact that the artefacts were excavated from a rockshelter and the nearest waterhole was at least one kilometre away.

Although flaked stone comprises a large proportion of all archaeological material excavated, there are no clear descriptions of the use of flaked stone for plant processing in the ethnographic and ethnohistoric records for the region. In the Central Queensland Highlands, twisted plant fibres from grasses, reeds (*Typha* spp. or *Phragmites* spp.) or kurrajong trees (*Hibiscus* spp.) were used in the manufacture of baskets and bags (Morwood 1979:58). Necklaces of 'strong grass or reed stems cut into lengths and strung on threads' were also a common feature of Aboriginal adornment in the Central Highlands (Morwood 1979:62). Reed stems could refer to either the common reed (*Phragmites* spp.) or bulrush (*Typha* spp.). The rhizomes and young shoots of both species were also cooked and eaten (Gott 2000). A sharp implement such as a stone flake or knife would be required to harvest grasses and reeds, and to prepare the necklaces, but, as Morwood (1979:63) notes, '[e]thnographic accounts are more notable for the range of tools not mentioned'.

In light of the ethnographic information, the presence of residues from a freshwater environment on almost all of the backed artefacts from this site suggested either that most had been used to harvest aquatic plants, or the possibility that processing of aquatic plants occurred on site and residues escaped into the surrounding sediment and contaminated the artefacts. However, further research revealed that the artefacts had been wet-sieved in a nearby waterhole, and the possibility of post-excavation contamination resulting in similar residues could not be ignored, and is the most likely explanation. The lack of freshwater residues on three artefacts may be considered fortuitous.

Conclusion

The evidence from Turtle Rock is limited to some extent by an ambiguity in provenancing plant residues on the artefacts. Although eight artefacts exhibited relatively clear evidence for plant processing, more artefacts from this site (possibly as many as another seven) may have been used to process plant material, in some cases reeds (*Phragmites* spp. or *Typha* spp.), used for food (starchy plant-working), fibre, and their stems (light spears). The presence of plant residues on these tools, however, is more likely the result of contamination during wet-sieving after excavation. This paper highlights not only the importance of access to site reports and accurate information on excavation, post-excavation and curation procedures for the archaeological residue and use-wear analyst, but also the need for early decisions by field archaeologists regarding the handling of artefacts destined for further analysis.

Acknowledgements

I wish to sincerely thank Associate Professor Jay Hall, who initiated this study and has provided support, advice and focus throughout my academic career at the University of Queensland. Jay was my first lecturer in archaeology in the 1980s and supervised both my Honours and PhD research. I wish to acknowledge the immense contribution of Dr Tom Loy, teacher, mentor and friend, who granted me the benefit of his vast reservoir of knowledge and experience of residue analysis and is sorely missed. Dr Val Attenbrow (Australian Museum) has been an invaluable member of my advisory team. My special thanks go to past and present students and colleagues in the Archaeological Sciences Laboratory, particularly my current colleagues, Alison Crowther, Luke Kirkwood, Sue Nugent and Michael Haslam. Their assistance and that of others in creating the comparative reference database used in my research has been invaluable. Other colleagues I wish to thank for their help and advice include Dr Sean Ulm, Dr Jon Prangnell, Dr John Bradley, Dr Leonn Satterthwait, Dr Annie Ross, Dr Vojtech Hlinka, Dr Carney Matheson, Peta-Jane Jones, Jane Cooper, Dr Bruno David, Kim Akerman, and others who provided timely inspiration and encouragement at various stages of this research. I particularly wish to thank Catherine Westcott for her comments and advice on drafts of this paper.

Permission to study the artefacts from Professor Mike Morwood's excavations was granted by the Queensland Museum, and I thank Dr Richard Robins for his support in accessing the collection. Several aspects of my research required help from specialists. I particularly wish to thank: Associate Professor Peter Hiscock (Australian National University) for allowing me to access his unequalled knowledge and innumerable references on the subject of backed artefacts, and for inspecting and confirming the status of backed artefacts included in my final sample; and Dr Richard Fullagar (Department of Archaeology, University of Sydney) for taking time to teach me how to recognise the more significant features of use-wear, and for his discussions and helpful advice on residue and use-wear identification.

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Historical Archaeology at the University of Queensland

Jonathan Prangnell

Abstract

Question: What do Methodists in Paradise and nearly 400 skeletons under a sports field have in common? Answer: Both are sites of historical archaeological investigation by University of Queensland staff and postgraduates. The University of Queensland has a thriving historical archaeological programme thanks in a major way to the foresight and support of Jay Hall. This paper charts the growth of historical archaeology at the university and examines some of the major areas of investigation currently underway within the programme.

Introduction

Archaeology at the University of Queensland was, from the early 1960s to the early 2000s, an integral component of the broader anthropology curriculum. The research emphasis was always on coastal and hinterland Aboriginal subsistence and settlement strategies, particularly related to changing sea-levels (e.g. Hall 2000; McNiven 1991; Ulm 2002; Walters 1986). At the start of 1990 Jay Hall invited me to do my BA Honours project on an artefact analysis of the material culture recovered from the forthcoming University of Queensland Archaeological Services Unit's contract excavation of the Tower Mill, Brisbane's oldest building (see Hall *et al.* 1995; Hall and Yelf 1993; Prangnell 1991). This event marked both the beginning of historical archaeology at the University of Queensland and the start of my academic career, two trajectories that have been interconnected ever since.

Teaching and Learning

Undergraduate teaching of historical archaeology commenced in 1997 when Annie Ross introduced a second-level course efficiently titled 'Historical Archaeology'. I took over teaching that particular course the following year and it has changed greatly since that time as historical archaeology in Australia has grown. In its current form the course provides students with an opportunity to study important historical archaeological sites from Queensland, Australia and internationally from various thematic perspectives related to modernity, gender, ethnicity, colonialism and capitalism. The practical component of the course is devoted to the social interpretation of artefacts and source analyses of documents. This course not only attracts archaeology students, but also others from disciplines such as history, ancient history, architecture and planning.

Until the turn of the century archaeology at the University of Queensland was subsumed under anthropology within the Department of Anthropology and Sociology. Teaching and research in the anthropology programme has for the last 25 years tended to concentrate on post-modern analyses of the social and cultural transformations brought about by colonialism in Australia and the Pacific. Archaeology, then, was seen as a means of providing an understanding of the background to mechanisms of cultural change that operated prior to this modern European expansion. Following reorganisation of the university's faculties and schools it is now one of four separate but interrelated disciplines within the School of Social Science (Anthropology, Archaeology, Criminology and Sociology). With this change there were also changes in the direction of the archaeological research and teaching and two distinct streams emerged: scientific archaeology and cultural heritage management (CHM). Historical archaeology came to be part of the CHM stream but retained the strong emphasis gained

Table 1. Historical archaeology Honours theses completed at the University of Queensland.

Year	Name	Title
1991	Jonathan Prangnell	Brisbane's Tower Mill: Archaeological Investigation and Explanation of an Historic Urban Site
	Darryl Sparkes	Sticks and Stones: The History and Historical Archaeology of the Female Factory of the Moreton Bay Penal Settlement
1996	Phil Manning	The Archaeological Record: An Extension to include Space Junk and Outer Space
1997	Kate Quirk	Reclaiming the Past: Engendering and the People History Forgot
1998	Rhiannon Walker	'All in the Same Boat': Giving Representation to the Disempowered through Museum Interpretation
	Paddy Waterson	Public Involvement in the Management of Non-Indigenous Cultural Heritage: A WWII Case Study
1999	Gerard Niemoeller	Culture Contact on Bradshaw Station in the Victoria River Region, Northern Territory
	Kev Rains	Rice Bowls and Beer Bottles: Processual and Post-Processual Approaches to Explaining the Material Culture of Late Nineteenth and Early Twentieth Century Overseas Chinese Ethnicity in Far North Queensland
	Darren Turner	Marine Archaeology and the Second World War: An Examination of the Emerging Field of Submerged Sites from the Second World War
2000	Angela Cook	Beyond Resistance and Acculturation in Contact Archaeology: A Critical Review of Interpretations of Life at Wybalenna, Flinders Island
	Cameron Harvey	New Perspectives on Change: Using Alternative Methodologies to Re-Analyse Ceramics from the Master Armourer's Residence, Harpers Ferry
2002	Carly Hughes	The Conservation and Management of the St Helena Island Prison and the Peel Island Lazaret
	Tina King	Garden of Eden or Queensland's Inferno?: An Investigation into the Prisoners' Lives on St Helena Island, Moreton Bay
2003	Karen Murphy	Under the Boards: The Study of Archaeological Site Formation Processes at the Commissariat Store, Brisbane
2004	Joanne Brett	Empire of the Ephemeral: Breaking Down Disposable Society
	Alexandra Wisniowiecka	What Lies Beneath?: A Ground Penetrating Radar Study at the Naval Stores, Brisbane
2005	Megan Clift	Mass Grave Investigation: How Archaeologists Assist in the Investigation of Human Rights Abuses
	Joanne Dudley	Paradise Lost: The Archaeological Landscape of a Late 19th Century Queensland Goldmining Community
	Anna Dwyer	Archaeology, History and Cultural Heritage: Interdisciplinary Approaches to Australian-Irish Studies
	Emma Rae	Uncovering Mill Point: Understanding Concepts of Space at Australian Historic Sawmills

from the anthropology programme on interpreting the modern world and the recursive character of European imperialism. To help to consolidate the CHM stream I introduced a second course in 2004, now called 'Historical Archaeology in Practice', that concentrates on the relationship between historical archaeology and heritage management. In this course undergraduate students work in groups to undertake archival research and produce assessments of the social, aesthetic, historical and scientific significance, management assessments and management strategies for historical archaeological places around Brisbane. The course is designed to replicate actual workplace experiences as much as possible, and even includes a job application to a heritage agency as an assessable item.

Undergraduate field archaeological techniques and skills are taught at an on-campus facility known as the TARDIS (Hall *et al*. 2005). Students have been excavating a range of archaeological features within

Table 2. Current postgraduate candidates in historical archaeology at the University of Queensland.

Name	Topic
John Forrest	Underwater Archaeological Visualisation
Geraldine Mate	An Examination of the Social Landscape of 19th Century Gold Mining Areas, as Demonstrated by the Archaeological Remnants of Gold Mines and Townships throughout the Burnett District of Queensland
Glenys McGowan	Artefact Deterioration in the Cemetery Environment: A Study of Archaeological Materials Excavated from the 19th Century North Brisbane Burial Grounds, Lang Park, Queensland
Adrian Murphy	Consumerism, Colonies and Cemeteries: Influences Affecting the Creation of Brisbane's Victorian Cemeteries in Comparison to the Necropolis of Victorian Britain
Karen Murphy	Mill Point: Community and Identity at a 19th Century Timber-Milling Settlement
Stephen Nichols	Public or Perish: An Ethnographic Account of Archaeology in a Contemporary Australian Community
Kate Quirk	The Victorians in Australia: Gentility on the Frontier

the TARDIS since 1996. With the reconstruction of layers within the TARDIS from 2007, it will contain an early twentieth century Australian garbage dump made by aggregating artefacts from a number of consultancy projects around Brisbane city. This will provide undergraduate students with much needed experience in excavating historical sites and identifying historical artefacts.

This growth in undergraduate offerings has led to a steady increase in the number of Honours projects undertaken in historical archaeology. In total 20 theses have been completed (Table 1) and a twenty-first is underway this year, examining the archaeological potential of female convict sites around the country. The Honours projects tend to mirror the changes that have occurred within the archaeology programme with a fifth of the theses concentrating on cultural heritage management topics and over half dealing with the social and cultural meaning of archaeological phenomena. Recently, Honours topics have tended to become tied into existing research and contract consultancies undertaken by the School.

To date there have been two completed historical archaeological doctoral dissertations within the school: one on social relations within a twentieth century leper hospital (Prangnell 2000); and the other on the social landscape and the economic and social position of the Chinese residents of late nineteenth and early twentieth century Cooktown, in far north Queensland (Rains 2005). My thesis (Prangnell 2000) examined the role of disciplinary power, paternalism and pollution in the social and physical organisation of the Peel Island Lazaret, in Moreton Bay. Rains (2005) examined concepts of power negotiation, network formation, landscape learning and the role of portable material culture to gain insights into the interactions that occurred 'at the level of the individual and faction' (Rains 2005:353) within the Cooktown sojourner community, and between that community and key members of the town's European population. Currently there are seven candidates enrolled in postgraduate research degrees studying such diverse topics as gentility and Victorianism on the mining frontier and the decomposition of bone and other buried materials in a nineteenth century cemetery (Table 2). Six of these seven postgraduate projects are directly linked into my ongoing research and consultancy projects and deal with major themes of gender, landscape, community and consumerism.

Consultancy Projects

The University of Queensland Archaeological Services Unit (UQASU) is a commercial archaeological and cultural heritage consulting company of the University of Queensland. It was founded in 1985 by Jay Hall to promote excellence in the delivery of archaeological consultancies in Queensland and I have been managing the company since 1997 and Director since May 2000. For the past 21 years, UQASU has undertaken hundreds of consultancy projects and provided fieldwork and heritage management experience for increasing numbers of postgraduate students. Before 2000, UQASU conducted only a handful of non-Indigenous projects, but since that time they have become the mainstay of UQASU's practice (Table 3). The consultancy projects supply case studies and artefacts for undergraduate teaching and have been the basis of three Honours theses (i.e. Brett 2004; Dudley 2005; Prangnell 1991).

Table 3. University of Queensland Archaeological Services Unit's historical archaeological projects.

Project Number	Year	Title
TMAP90	1990	Tower Mill
158	1990	A Preliminary Assessment of the Aboriginal and European Cultural Heritage of 'Wallace Estate', Noosaville, Southeast Queensland
242	1994	A Cultural Heritage Assessment of the Former Mooloolah Cemetery Reserve
250	1994	A Pre-Development Cultural Heritage Impact Assessment of the Former MacTaggart's Woolstore, Cnr Commercial Road and Vernon Terrace, New Farm, Brisbane
343	2000	Exhumation of Burial Remains from the Millmerran Power Project Site
344	2001	Cultural Heritage Report of Historical Landscapes and Materials at the Lang Park Redevelopment Site
351	2002	Suncorp Stadium Archaeological Salvage: Volume 1: Excavation Report
	2002	Suncorp Stadium Archaeological Salvage: Volume 2: Photographic Record
353	2001	Cultural Landscapes Study for the Mackay Planning Study
356	2001	Cultural Heritage Report of Historical Landscapes and Materials at the Proposed Kelvin Grove Urban Village Site
358	2003	Suncorp Stadium Archaeological Salvage: Volume 3: Fill Artefacts
	2003	Suncorp Stadium Archaeological Salvage: Volume 4: Skeletal Material and Grave Artefacts
359	2002	Initial Archaeological Salvage of Parts of the Kelvin Grove Urban Village Development Site
364	2002	Report on the Monitoring and Salvage Collection of the Queen Street Central Redevelopment Site, Central Brisbane
370	2002	Archaeological Salvage of Paradise: Stage 1: Survey and Historical Research
	2003	Archaeological Salvage of Paradise: Stage 2: Excavation
	2004	Archaeological Salvage of Paradise: Stage 3: Artefact Inventory
	2004	Archaeological Salvage of Paradise: Stage 4: Interpretation
375	2004	Historical Archaeological Survey for Unmarked Graves along the Corridor of the Proposed Green Bridge at Dutton Park
382	2005	Historical Cultural Heritage Desktop Study of Mount Lindesay Highway between Kantenna Street and Rosia Road, Park Ridge
389	2005	Artefacts from the Green Bridge Development Site, Dutton Park
392	2006	Maritime Archaeological Monitoring of the Demolition of the Queensland Maritime Museum Dry Dock Caisson, South Brisbane
397	2006	Salvage Excavation and Artefact Analysis of Powerlink's Algester Substation Site

One major benefit of the large-scale research consultancies undertaken by UQASU is the financing of ongoing and postgraduate research. Two projects that have supplied invaluable experience for students and provided a wealth of material for postgraduate research are the salvage excavations at Paradise and the North Brisbane Burial Grounds.

Paradise

Paradise was a gold mining town on the Burnett River, approximately 100km from Maryborough. Gold was discovered there in 1888 and by 1891 Paradise was the largest town on the Burnett with over 600 residents (Prangnell *et al*. 2005). Gold mining was short-lived however, and the town only survived for 15 years before its inhabitants had moved on and the land reverted to grazing pasture. The town was located on the eastern terrace of the river and the relatively flat parts of this terrace came to be dominated by retail businesses, industrial processing plants and government buildings. The residential areas tended to cluster on the hilltops and slopes above the town centre. Allen Street (named after the brothers who discovered the gold) formed the central corridor through the town and was lined with various businesses. During the life of Paradise, there were many commercial operators in town including seven hotels, three bakeries, seven butchers, two blacksmiths, five drapers, tobacconists, bootmakers, a sawmill and a lemonade factory. The spiritual needs of the inhabitants were catered for by the Wesleyan Methodist Home Mission, which established its first Queensland home mission at Paradise.

As part of the preliminary work for the construction of the Paradise Dam, Burnett Water Pty Ltd commissioned UQASU to undertake an historical and archaeological study of the township site. The fieldwork commenced in 2002 with a survey of the entire township and some outlying areas of interest such as the racecourse, slaughteryard, cemetery and Chinese market gardens. The surveys identified the remains of 97 buildings, mostly in the form of stump posts, postholes, and rocks and bricks from fireplaces (Prangnell *et al.* 2002). Identified buildings included the police stations, courthouse, hotels, blacksmith shops, bakeries, stores and houses. The remains of 22 houses that were not known from the documentary records were identified. The abundance of sheet metal and the absence of window glass from the archaeological record suggests that in many cases the houses were little more than small shacks. The fact that the town gained a more settled appearance as time passed may be indicated archaeologically in the presence of rows of crepe myrtles and the abundance of fence posts marking individual property boundaries (Prangnell 2003).

Test pitting was conducted in 2003 at 17 of these buildings and 13 sites were selected for intensive surface collection or excavation, including the town dump, the lemonade factory, the Methodist Home Mission, Plastow's cobblers, Ware's sawmill, Walker's store, the residential area of the McGhie Machinery Area, and the homes of the Buzza, Shuttleworth, Martin, Bartlett, McGonnell and Turk families (Prangnell and Quirk in press). After the initial phase of miners moving into Paradise without their families, women and children came to dominate the Paradise landscape. By 1894 they represented 65% of the town's population (Prangnell *et al.* 2005:36). Children left their mark on the archaeological record of Paradise, with excavations yielding child-sized boot heels and a variety of toys from eight different sites. The toys consisted solely of cheap, probably German, mass-produced bottom-end-of-the-market dolls and tea sets (Prangnell *et al.* 2004:14).

Research at Paradise has provided a wealth of information on the social features rather than the technological aspects of gold mining (Prangnell *et al.* 2005). The role of various groups within the township such as the Methodists (Prangnell and Quirk 2004), the children (Prangnell 2005; Prangnell and Quirk in press) and the entrepreneurs (Prangnell and Murphy 2006) have been studied. Currently there are two PhD candidates (Mate and Quirk, see Table 2) undertaking research on areas associated with Paradise and an Honours project was completed last year using a landscape approach to understanding spatial arrangements within the township (Dudley 2005).

North Brisbane Burial Grounds

The Lang Park sporting complex (now known as Suncorp Stadium) overlies the area of the North Brisbane Burial Grounds. Between 1843 and 1875 these were Brisbane's main cemeteries and comprised seven separate denominational areas (Anglican, Presbyterian, Roman Catholic, Baptist, Congregationalist, Jewish and Wesleyan) and an Aboriginal cemetery (Fisher 1994; Haslam *et al.* 2003:1). Original estimates placed the number of people interred in these burial grounds at approximately 10,000 (Fisher 1994:52). After the closure of the cemeteries the area became wasteland until 1914, when it was converted to parkland. Later in the 1920s and 1930s the site became the major landfill for Brisbane City (which caused serious contaminated land issues for the redevelopment), then an athletics oval. Finally in the 1950s it was converted to a rugby league field.

Between August 2001 and May 2002, UQASU identified 591 burials in an excavation of 15.8% of the area of the Burial Grounds, and salvaged 397 burials, a broken headstone, a brick vault and trenches containing monumental masonry and other rubble, and material from the twentieth century fill on the site (Prangnell and Rains 2002; Rains and Prangnell 2002). Based on the density of burial plots the archaeological estimate for the number of burials is between 4000 and 4500.

Only one intact coffin was recovered from the entire site. It was a three-layered coffin with a hardwood exterior, lead lining and a pine interior, 192cm long, 56cm wide at the shoulder and 30cm deep. Eighty-seven nails and screws were found in the coffin wood. The coffin itself was filled with rosewood shavings to both soak up the bodily fluids and to perfume the coffin. It contained the complete skeletal remains of a tall, young, red-headed, Roman Catholic man in his late 20s. He had a badly-healed fracture of the left femur that had shortened his left leg by approximately 5cm. This fracture was of a twisting rather than an impact type and occurred at least five years prior to his death. He also had a healed fracture to the second left rib and the lateral end of the right clavicle showed evidence of disarticulation. His teeth were in excellent condition, with only slight signs of wear and no evidence of caries.

Apart from this one outstanding example, almost all the skeletal material was very poorly preserved. This lack of preservation (when compared to other nineteenth century cemeteries around the country) is the topic of a current PhD project (McGowan, see Table 2) and the analysis has led to a publication on the biochemistry of the site (McGowan and Prangnell 2006), with another in preparation. The Burial Grounds were highly acidic, with an average pH of 5.5 and a low of 4.5, except for a few discrete points in the Anglican cemetery that reached a pH of 8.5. These acidic sediments, in conjunction with the water flow through the site, have probably been responsible for the rapid disintegration of the buried material. Evidence for the repeated transmission of water through the graves exists in the presence of finely-laminated silt layers found within partially-collapsed coffins.

DNA studies of a large number of individuals have been undertaken (Loy *et al.* 2003) but unfortunately only one useful DNA sequence was obtained. A child's grave in the Anglican cemetery yielded several teeth and non-dental bone fragments from two individuals, one approximately three years of age, the other approximately 12 years of age (Haslam *et al.* 2003:1). Other research projects that have arisen from the Lang Park salvage include a study of the role of colonialism in the choices people made in selecting coffin furniture (Prangnell and Murphy 2003) and a material culture study of the twentieth century landfill that overlaid the cemeteries (Brett 2004).

Other Research Projects

In addition to research consultancies there are three other ongoing historical archaeological projects: Caboonbah Homestead, Yengarie Mounds and Mill Point. The Caboonbah Homestead project is a new project that is designed to target the recently discovered (and as yet non-bottle collected) nineteenth and twentieth century domestic dumpsite behind the heritage listed Caboonbah Homestead in the Brisbane Valley at Esk. This project is being conducted in conjunction with the Brisbane Valley Historical Society, which manages the site, and SEQ Water, which owns the site, with the support of the Queensland Heritage Council. The Homestead was erected in 1889 by Henry Plantagenet Somerset, who later became an MLA for the district. Currently historical research is underway and excavations commenced in August 2006. This site will make for an interesting comparison with the working class sites of Paradise, Mill Point and Mount Shamrock.

The Yengarie Mounds Archaeological Project is a joint undertaking of the Environmental Protection Agency, the University of Queensland and the Wide Bay South Sea Islander Community. There are eight circular earthen mounds of various sizes located on an alluvial slope at Yengarie in Woocoo Shire, approximately 600m west of the Mary River. Oral history records that these mounds are mass graves of nineteenth century South Sea Islanders who died working on the local sugar plantations. This story is known in South Sea Islander communities and amongst the descendants of the original sugar mill owners. The local South Sea Islander community was keen to test the veracity of the story. In November 2005 a 5.5m x 1m trench was excavated through the centre of one of the larger mounds to determine its contents. Although the mound itself proved to be of cultural origin, with seven distinct stratigraphic units lying above the surrounding landscape, no evidence for human burials was located (Prangnell *et al.* 2006). As yet the purpose of the mounds remains undiscovered and a second field season is currently being planned.

By far the largest historical archaeological research project to be undertaken by the University of Queensland is the Mill Point Archaeological Project (Ulm 2004, 2005). This project is a collaboration between the University of Queensland, Environmental Protection Agency and Queensland Parks and Wildlife Service and has been ongoing since 2004, with five field seasons to date, the latest in July 2006. Mill Point is located on the shores of Lake Cootharaba in the Cooloola Section of the Great Sandy National Park. It is the site of one of the earliest timber settlements in Queensland, being established in 1869 (Brown 2000:158). Owing to its remoteness the workers and families developed a community around the mill site (Rae 2005:5) and the archaeological project is designed to identify the location and character of this community. Surface surveys were conducted in 2004 and 2005 (Ulm 2004, 2005) to find the domestic structures and excavations have since targetted the likely areas. Finally in July this year, building remnants were identified in association with many domestic artefacts, such as jewellery, buttons, beads, cutlery, doll's limbs, sawn and cut animal bones and an infant feeding bottle (University of Queensland 2006). To date three years of research have gone into this site but finally it is starting to pay dividends with a PhD project into the negotiation of community identity at the township well underway (Murphy, see Table 2) and a recently completed Honours thesis (Rae 2005). The Mill Point Archaeological Project has also supplied valuable survey and excavation experience to over 100 undergraduate and postgraduate students from the University of Queensland, other universities around the country and internationally. It is also a major case study for a doctoral project (Nichols, see Table 2) aimed at understanding attitudes towards archaeology and increasing community involvement in archaeological practice. The Mill Point site is also the major case study for an ARC-funded special initiatives grant to establish an archaeological data grid (see Bordes *et al.* 2006).

Conclusion

As this survey has demonstrated, historical archaeology is thriving at the University of Queensland. Undergraduate student numbers are high, with good retention into Honours and postgraduate degrees. All the research projects have more postgraduate research potential than has yet been realised. The teaching, research and consultancy projects are all well integrated with their common element being their concentration on the social world. None of the projects has been undertaken merely to describe archaeological features or to understand past technologies. Even the consultancy projects have been negotiated to focus on the social relationships of groups in the past. This orientation must inevitably derive from the relationship of archaeology and anthropology within the University of Queensland. All our historical archaeology practice is aimed at understanding human behaviour. Jay Hall was responsible for this development of the archaeology programme within anthropology and for encouraging the growth of historical archaeology. My thanks go to Jay for identifying the need for, and the potential of, historical archaeology at the University.

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MRAP and Beyond: Bribie Island, Southeast Queensland

A.D. (Tam) Smith

Abstract

Archaeology in Moreton Bay has a relatively short but nevertheless rich history. Ponosov (1964) conducted an extensive survey of many of the islands in 1963–1964, and Tugby and Tugby's 1965 excavation at Bell's Creek near Caloundra was 'the first of a kitchen midden' in the area (1965:197). More intensive work in northern Moreton Bay began with Haglund (reported in Crooks 1982) who recorded a number of sites at Sandstone Point and along the western coast of Bribie Island in the early 1970s. Stockton (1974) continued survey work along the shores of Pumicestone Passage. The implementation of Jay Hall's Moreton Region Archaeological Project (MRAP) in 1979, shortly after his arrival at the University of Queensland, helped to focus attention on Bribie Island and the adjacent mainland. Based on previous investigations, the area had the potential to address MRAP objectives in the coastal region. This paper reviews the archaeology of Bribie Island over a period of 20 years and presents a brief discussion on latest interpretations.

Introduction

In the late 1970s Jay Hall of the University of Queensland established the Moreton Region Archaeological Project (MRAP), a long-term multistage regional project to coordinate archaeological investigations in southeast Queensland (Hall 1980:79-83; see also Hall and Hiscock 1988). The Moreton region lies in the extreme southeast corner of Queensland, covering an area of approximately 21,400km^2. It is ringed on three sides by mountains from which rivers drain towards the coast through alluvial valleys and coastal lowlands (Hall and Hiscock 1988:4). For research purposes the study area was divided into two subregions: the subcoastal zone, including the Brisbane River drainage west of the Beechmont and D'Aguilar Ranges to the Great Dividing Range; and the coastal zone incorporating the coastal lowlands, the offshore islands, and Moreton Bay (Hall and Hiscock 1988:4-6). Initially the objectives of MRAP were to systematically locate and record sites in the Moreton Region, characterise the archaeological record, and collect and analyse sufficient data to develop a cultural chronology and reconstruct prehistoric cultural patterns (Hall 1980:81). By 1988 the MRAP objectives had extended to a systematic study of the stone artefact component of the archaeological record, as stone artefacts may provide 'the most powerful and reliable medium with which to link the archaeological record with higher level theories about prehistoric human behaviour' (Hall and Hiscock 1988:16). One area of interest was the potential for reconstruction of stone procurement and settlement systems (Hall and Hiscock 1988:17).

Bribie Island is in the coastal zone of the Moreton Region, and is the northernmost island in Moreton Bay. MRAP began work on Bribie Island in 1981–1982, and in the early 1990s the Bribie Island Forest Archaeological Project (BIFAP) was set up under the MRAP umbrella. BIFAP was originally intended as a vehicle through which more comprehensive studies of the sites on Bribie Island could be undertaken. Subsequently it has also investigated and assessed the impact of logging operations on the archaeological record of the island.

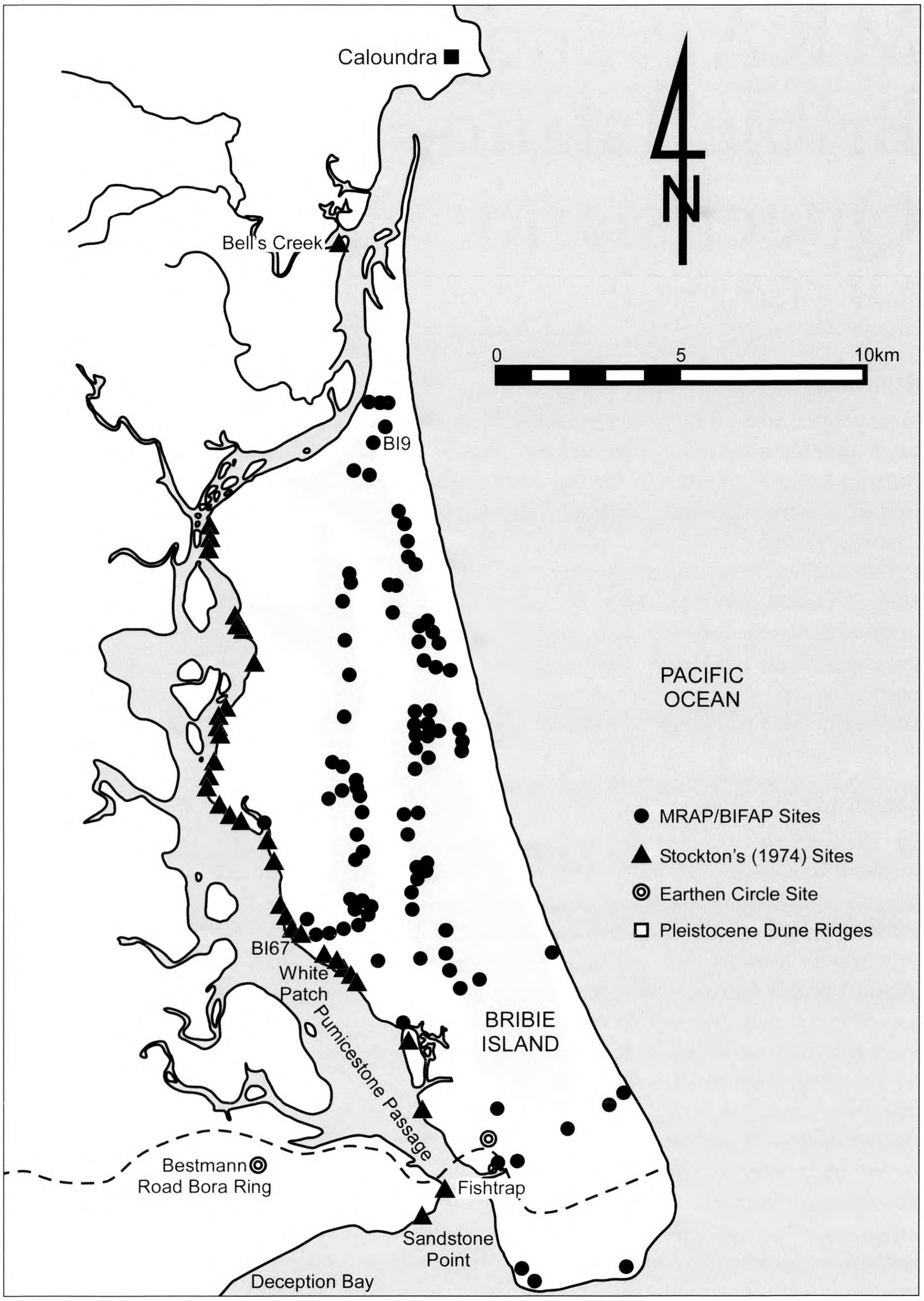

Figure 1. Composite map of Bribie Island archaeological sites and key physiographic features.

Background

Physical Environment

Bribie Island is separated from the mainland on the north and west by Pumicestone Passage, a narrow tidal estuary c.500m–3km wide, and is bounded by Moreton and Deception Bays in the south (Figure 1). The eastern coast directly faces the Pacific Ocean. The island is 32km long and between 5–8km wide, with an area of approximately 143km². Much of the island lies at or below 5m in elevation, but some areas reach elevations of up to 14m. The island is largely formed of remnant Pleistocene aeolian sand dunes, which run roughly north-south. In east-west cross-section the terrain exhibits low peaks and swales. The southernmost area of the island consists of Holocene dunes which run east-west (Willmott and Stevens 1988).

The island has a large central swamp or swale, fed in part by Westaway Creek, which runs in from Pumicestone Passage in the northwest. High groundwater levels (see Harbison and Cox 1998) also maintain this swamp. There are lagoons behind the foredunes on the east and southwest coasts of the island, and five freshwater creeks have been identified. Pools and small swamps of low salinity (Batianoff and Elsol 1989) are present in almost all low-lying areas.

Vegetation

Bribie Island is typical of the coastal lowlands or 'wallum' country characterised by Coaldrake (1961:5) as low undulating areas below the 30m contour, all of which have an assured rainfall, similar soil morphology, low soil fertility and similarly constructed floristic communities. The floristic communities form a dynamic mosaic of dry scelorophyll open forests, heaths, sedgelands, dunes, swamps, lakes, streams and mangrove communities. The Bribie Island mosaic has been significantly altered by residential development on the southern one-third of the island, and the planting of approximately 4000ha of exotic slash pine (*Pinus elliotti*) in the northern half of the island between 1959–1972.

The commercial pine plantation covers much of the area of former heath and sedgeland, as well as former open forest areas, mainly along the relic Pleistocene dune ridges and slopes. The ridges and slopes are also the locations of many archaeological sites, having provided a desirable combination of elevation away from swamps and insects, possible vantage points, and shaded dry, campsites (see Jochim 1976; McNiven 1984; Smith 1992). Clearance of the native vegetation prior to the planting of the exotic pines was achieved by chaining using pairs of D7 Caterpillar Tractors (Bruce Youngblutt, former APM foreman, pers. comm., 1991). Usually the felled vegetation was pushed into windrows, but occasionally larger trees were left where they fell if they did not interfere with the planting operation. One such example, probably a forest redgum (*Eucalyptus tereticornis*), was found at site BI74 on the main western ridge, in an area of former open forest (Figure 2). Harvesting of the pine plantation commenced during fieldwork and native species were observed vigorously recolonising the cleared blocks. The National Park, which fringes all but the southern boundary of the pine plantation, has in many areas heavy undergrowth not only of native species but also of introduced lantana and other noxious species; in places this undergrowth is virtually impenetrable. Owing to funding and personnel constraints, and management strategies, these areas are not burned off or otherwise cleared.

The density of the pine plantation, and the height of the trees, obscured the topography of the island. No landmarks or important cultural landscape features were visible from within it. Once harvesting was well advanced one could see the Glasshouse Mountains, important landscape features in the Dreaming of the region, from the higher elevations (Vicki Turner, pers. comm., 1991).

The distribution of vegetation types is related to soil water availability and nutrient status, salinity and waterlogging tolerance, landform ages (Harbison and Cox 1998:116) and also elevation. These are important considerations in explicating patterns of Aboriginal settlement and use of the island. The environmental, ethnohistorical and archaeological data suggest that the vegetation of Bribie Island during Aboriginal occupation was more open than at present. Although McDonald and Elsol (1978) mapped the pre-plantation vegetation using pre-1958 aerial photographs, these photographs were taken more than 80 years after traditional Aboriginal occupation and use of the island ceased. Direct ethnohistorical evidence is lacking, but it is reasonable to infer that, in common with other groups in the Moreton Region, the Aboriginal occupants of Bribie Island managed their environment by various means including the use of fire. The presence of banksia species that require firing to set seed (with the

Figure 2. Fallen *Eucalyptus tereticornis* at site BI74 (Photograph: Tam Smith).

exception of *Banksia integrifolia*) supports this inference. Traditional management processes would have kept forested areas reasonably open.

Geomorphology

Moreton Bay reached its present configuration c.6000 years ago when sea-levels stabilised after the last marine transgression (Flood 1981, 1984; Hekel *et al*. 1979; Willmott and Stevens 1988). Bribie Island existed at that time, although with a slightly different shoreline from today. The present curvature and shoreline position of the island are in part due to its protection by Moreton Island and a large complex of submarine sand banks and channels several kilometres offshore (Batianoff and Elsol 1989:32).

Bribie Island is essentially a large sandmass formed of remnant Pleistocene beach dune ridges; Quaternary sandplains, estuarine, flood and/or tidal deposits; and Holocene beach ridges. In cross-section the island exhibits a series of low peaks and swales. The Pleistocene dunes form beach ridge plains running mostly parallel to the present coastline (Batianoff and Elsol 1989:27). The Holocene ridges are generally narrower, more sharply crested and closely spaced than the broader, more widely spaced Pleistocene ridges which are usually of higher elevation (Hekel *et al*.1979). The southern Holocene beach ridges are roughly transverse, and represent a progradation of approximately 2km over the last 4500–6000 years (Coaldrake 1961; Flood 1984; Hekel *et al*. 1979; Willmott and Stevens 1988:16-17). The soils are siliceous podzols and humus podzols (or intergrades between the two) with very low fertility and salinity levels (McDonald 1983 in Batianoff and Elsol 1989). In the western section of the island there are clayey sands associated with the lowering of the sea-level (Harbison and Cox 1998:116).

Hydrology

Bribie Island has a complex groundwater model, with the upper of two water tables close to the ground surface allowing groundwater to breach the surface in the swales and low-lying depressions between the major relic dune ridges and within the minor ridges (Armstrong and Cox 2002; Harbison and Cox 1998:123). The nature of the upper water table means that there are plentiful sources of freshwater across the island, easily accessible for humans, other animals and birds. Freshwater is also a determinant of site location.

Most surface water runoff is from the two major dune systems into the central swale, with runoff also into local low-lying depressions. The central swale generally has a slow, northerly flow, discharging into Pumicestone Passage via Westaway Creek. Some southerly flow also discharges via Wright's Creek (Armstrong and Cox 2002).

More than 5.2 million pines were planted in the commercial plantation, an average of 1320 trees per hectare (Matt Grant, CSR Softwoods, pers. comm., 1999). This is a much higher density than would have been the case with the native forest, particularly in the former open forest and heathland-sedgeland, the favoured locations for the commercial plantation. The result is that the massively increased evapotranspiration rate of pine forest affects the water table and discharge rates. Pine plantations in other sandy areas of mainland southeast Queensland have altered the water table by up to 1m (Matt Grant, CSR Softwoods, pers. comm., 1999). As monitoring of the water table on Bribie Island only began in the 1980s it is impossible to be certain of the pre-plantation levels, but certain inferences may be drawn.

The upper, perched water table was closer to the surface during pre-European times than is now the case and breaches were more common, widespread and permanent. In 1877, Petrie observed '[t]here is an abundance of fresh water at the place I selected [for an Aboriginal settlement] and in fact on many other parts of the Island' (QSA LAN 5475/77). More direct evidence of the effect of the pine plantation on the water table has been observed in the field since the commencement of harvesting in 1996 (CSR/Sunchip Crews, pers. comm., 1999; Armstrong and Cox 2002; personal observation). The levels of water both in standing bodies and soaks has risen, new waterlogged areas have appeared and the existing areas extended, including the central swale (Matt Grant and Craig Morris, CSR, pers. comm., 1999; Armstrong and Cox 2002; personal observation). The permanency of the wetland areas has also increased. Hydrographs indicate a considerable rise in the perched unconfined water table although the relationship has not yet been quantified (Armstrong and Cox 2002). It is inferred that the surface water patterns observed on Bribie Island since commencement of harvesting more closely reflect those during the period of Aboriginal occupation than those levels mapped during the plantation era.

The People

The Aboriginal inhabitants of Bribie Island are called the Joondaburri (also known as Jindoobarrie, Joondabarrie, Joondoobarrie, Joondubarri, Joondiburri, Djundabora and Joondooburri – see Ford and Blake 1998; Meston 1895; Thomson 1967; Leisha Krause, pers. comm., 2005). The Joondaburri are a subgroup of the Undanbi people, speaking a dialect of the Gubbi Gubbi (Kabi Kabi) language (Steele 1972:171).

The number of Joondaburri resident on Bribie Island is unclear. Between 600 and 1000 people were observed on the island during the nineteenth century (see Eipper 1841), but this was most likely during some sort of festival. The terrestrial fauna of the island could not permanently sustain such a large population, even with the associated rich marine resource base. In 1823, Uniacke observed 'about thirty men, sixteen or seventeen women, and about twenty children' (in Mackaness 1979). Hall *et al.* (1991:6) believe that a figure of 70–100 to be most likely, based in part on the number of people who lived in the villages described by Flinders (1799 in Mackaness 1979) and Uniacke (1823 in Mackaness 1979). This figure gives a population density slightly higher than the 1:1.25km^2 postulated by Bowdler (1981:107) for coastal areas of Arnhem Land and southwest Victoria. Lourandos (1997:57) considers this may be an underestimate given the effects of diseases such as smallpox.

Subsistence and Settlement

The Aborigines of the Moreton Region had available to them a rich resource base, particularly marine and littoral resources, a veritable 'seafood supermarket' (Hall 1982:87). This resource base afforded the groups a relatively sedentary lifestyle, in that there was no need to relocate to pursue different types of food only seasonally available (see also Nolan 1986; Ulm 1995; Walters 1987). The Reverend John Gregor observed in 1846:

> Their condition is one of plenty … It is a great mistake to suppose that the Aborigines of these districts have not an abundance of food. Throughout the whole year the supply is plentiful, and two hours exertion generally secures them enough to satisfy their wants for twenty-four (Gregor 1846:549).

Daily subsistence activities are most commonly recorded as fishing by men, and fern root collection and processing by women (see Uniacke 1823 in Mackaness 1979). Other subsistence activities included shellfish gathering, hunting of terrestrial mammals and reptiles, birds and plant foods (see Hall 1982:85).

Flinders (1799 in Mackaness 1979) and Uniacke (1823 in Mackaness 1979:29) both recorded groups of sturdy, well constructed huts on Bribie Island:

> The principal station of the tribe … was about two miles higher up the Pumice-stone River … as they depend principally on fish for their support, they have several huts, at a distance of three or four miles from each other, to which they migrate from time to time as fish become scarce … spacious and commodious … capable of containing from ten to twelve people.

Resettlement

In 1877, the first reserve for Aborigines was formed near White Patch on the southwest coast of the island under the management of Thomas Petrie, a member of a prominent early colonial family. Fifty people were gathered together. They were supplied with a boat, fishing net, and harpoons for dugong:

> They had to work in exchange for their rations, catching fish and curing them, and making dugong, shark, and stingaree [sic] oils. These and sometimes a turtle, were all sold in Brisbane in exchange for the rations, which afterwards were doled out to the blacks by an old man, who, with his wife, was engaged to live on the island (Petrie 1992:214).

Petrie visited the reserve about once a month. When the government changed in 1879, the reserve was closed and most of its inhabitants dispersed. By the late 1800s it seemed many of the Joondaburri had died or been scattered around other settlements. Certainly, the traditional way of life on Bribie Island had ended. 'There is now in 1894 but one man and one woman to represent the race of the Joondoobarrie' (Meston 1895:127). It was Meston, in his capacity as Protector of Aborigines under the *Aborigines Protection and Sale of Opium Act 1897*, who oversaw the relocation of Brisbane-based Aborigines to reserves at Deebing Creek near Ipswich and Fraser Island (Cryle 1992). In 1913, Welsby wrote that no Joondaburri existed, whilst on Moreton and Stradbroke 'a few of the earlier tribes still remain' (in Thomson 1967:16).

Meston's and Welsby's observations that the people of Bribie Island and the surrounding areas had died out or disappeared have proved to be unfounded. The descendants of the people of Bribie Island and other Moreton Bay Aborigines represent a dynamic community.

Archaeology

Before MRAP

Ponosov's extensive 1963–1964 survey of Moreton Bay islands excluded Bribie Island (Ponosov 1964). In 1972–1973 Haglund conducted five excavations on the west coast of Bribie Island, in the vicinity of White Patch, as part of a larger exploration of sites in the Pumicestone Passage area. Shellfish remains, predominantly cockle (*Anadara trapezia*) and whelk (*Pyrazus ebeninus*) were recovered, as was some unidentifiable animal bone and a few stone artefacts. White Patch 3, later analysed by Crooks, returned dates of 450±95 BP and 670±95 BP (Crooks 1982:64-65).

Stockton (1974) surveyed the west coast of Bribie Island and the adjacent mainland coastline as part of his BA Honours thesis in 1973. He identified three types of archaeological sites in the area: living sites (e.g. middens/camp sites), ceremonial or sacred sites (e.g. bora rings) and 'other' sites (e.g. scarred trees) (Stockton 1974:27). In all 76 sites were recorded, 69 of them middens. Of these 30 were on Bribie Island, with cockles, oysters (*Saccostrea glomerata*) and whelks the predominant shellfish remains. A total of 84 stone artefacts was collected during the survey and categorised as pebbles, cores, chunky flakes, thin flakes, large, medium sized and microlith (1974:62-97). It is probable that 28 of the artefacts described by Stockton are bevelled pounders, later characterised by Kamminga (1981) and popularly known as 'bungwall bashers', used to process fern root. Stockton observed that major factors affecting site location were proximity to freshwater, shellfish habitats, water navigable by canoe, potential for a breeze, availability of dry sand and proximity to a range of microenvironments (1974:54). He concluded that no single factor appeared to influence site location, but rather that a combination of all six plus other unknown factors impinged on the choice of site (1974:59).

MRAP

The main problem with Stockton's work was that his study was restricted to coastal sites, and was not representative of the entire island. Hall redressed this focus on coastal sites by initiating a large-scale survey of the interior of the island as part of MRAP in 1981–1982. Hall and Field Archaeology students from the University of Queensland recorded 69 sites including midden and artefact scatters, the majority along or abutting the firebreaks in the commercial pine plantation (MRAP files, School of Social Science, University of Queensland). These firebreaks generally follow the higher areas of the north-south trending Pleistocene dune ridges. Analysis of the shellfish remains at the sites across the island indicated that the majority were estuarine species, predominantly cockle, whelk and oyster found in Pumicestone Passage. Species from the high energy surf beach on the eastern coast (e.g. pipi, *Donax deltoides*) were found in relatively greater numbers in the eastern sites, less so in the western sites (MRAP files, School of Social Science, University of Queensland; Smith 1992). Artefacts, including flakes, flaked pieces, cores and bevelled pounders were noted and selectively collected. A wide range of raw materials including quartz, quartzite, silcrete and chert was noted. This in itself was interesting, as Bribie Island has no naturally occurring stone and all raw materials had to be imported.

In 1982, again as part of MRAP, Crooks undertook an analysis of the material excavated by Haglund at Bell's Creek and Sandstone Point on the mainland, and Bribie Island, 10 years earlier. She also analysed stone artefacts casually collected by a local resident, Mr Ted Clayton, from deposits eroding on to the beach at White Patch and identified 439 flakes, 500 cores, 474 flaked pieces, 95 bevel-edged implements, and 334 manuports in the Bribie samples. The mainland sample was much smaller, with 179 artefacts, and comprised 50 flakes (16 with retouch), 73 cores, 30 flaked pieces, 26 bevel-edged implements and six manuports (from Bell's Creek only) were identified (Crooks 1982:90). Crooks found that the differences between the mainland and the island were no more or less marked than differences between sites from any particular complex (Crooks 1982:100).

By the late 1980s our understanding of Aboriginal lifeways in coastal southeast Queensland had been dramatically increased through major studies such as McNiven (1984), Nolan (1986) and Walters (1987). The results of these studies lead to a broadening of questions concerning human behaviour in the Moreton Region, and whether similar behavioural patterns could be demonstrated in areas such as Bribie Island.

Smith conducted BA Honours fieldwork on Bribie Island in 1991–1992. At the same time, Hall and students from the University of Queensland Field Archaeology class undertook investigations at sites BI9 in the far central north of the island, BI30 on the main eastern dune ridge, BI50 on the main western dune ridge, and BI67 in the southwest close to White Patch. The investigations showed that, despite disturbance by heavy vehicles during clearance of the native vegetation through the creation of the commercial pine plantation, in areas subsurface remains were substantially intact (Hall *et al.* 1991; Smith 1992). The combined fieldwork formed the basis of the Bribie Island Forest Archaeological Project

(BIFAP), an extension of MRAP. The 1992 Field Archaeology class excavated a number of test pits at BI9. Two samples of charcoal from test pit T4/P1, taken from levels also containing cultural shellfish remains, returned dates of 200±80 BP (Beta-56565) at a depth of 20cm and 3280±80 BP (Beta-56566) at a depth of 70cm (Smith 1992).

Smith's 1992 study characterised the archaeological record of Bribie Island and developed and successfully tested a predictive model of site location slightly different to that of Stockton (1974). Site location was found to be dependent on five factors: proximity to the estuarine or oceanic coast; proximity to freshwater; proximity to the fern root bungwall (*Blechnum indicum*); elevation; and vegetation type. Multivariate analysis showed only one aberrant site out of 71 in the study. Smith (1992) also proposed an explanation for the archaeological variability in terms of subsistence and settlement. While the stone artefact assemblage was considered in determining settlement patterns on the island, the study was principally based on shellfish remains. As stone does not occur naturally on Bribie Island, stone raw materials for the assemblage must have been imported.

The hypothesised model of Aboriginal settlement on Bribie Island posited movement over the island north-south along the remnant Pleistocene dune system, with limited west-east movement where swamps did not present a barrier. It also posited that groups coalesced and dispersed in response to varying stimuli and that the large sites, BI9 (c.900,000m^2) and BI67 (c.300,000m^2), were semi-permanent residential areas as well as import points for stone. Associated with these base or large-scale semi-permanent residential camps were smaller sites considered to be the result of movement up and down the island's dune system by small family groups, or specific activity groups such as hunting parties. A technological analysis of the stone artefact assemblage could test this hypothesis, and Smith undertook this for her MA. In addition to gathering data on stone artefacts, between 1996–1999 Smith identified and recorded a further 21 midden and artefact sites within the commercial pine plantation by employing the predictive site location model developed and raking possible target areas (Smith 1997, 2003). Locating sites within the pine forest away from the firebreaks had previously been problematic owing to the poor ground visibility resulting from the carpet of pine needles.

The results of the analysis of 2133 artefacts from 43 sites did not support the hypothesis that BI9 and BI67 were import points for stone. It did however reveal spatial variations between artefacts on the western and eastern sides of the island. Average whole flake length was less on the eastern side, as were the length of core scars. The eastern cores also tended to have more flake scars. Manuports on the eastern side were heavier than those on the western side. Overall there was a relatively low number of retouched flakes (n=51, 2.4%) (Table 1).

There are more sites recorded on the eastern dune ridges, but with the exception of BI9 the generally larger sites are on the western side of the island. The western ridges are close to the estuarine resources that played a prominent role in the subsistence economy, and also have easy access to the mainland. They are in what was originally a forested area suitable for camping and lend themselves to residential occupation. Both sides of the island do have sites at which the full range of artefacts associated with subsistence activities were found suggesting that they were residential or base camps, but this does not negate the argument of greater residential occupation on the western side. Open heath and sedgeland largely covered the eastern side of the island which, while useful for resource exploitation, would be less desirable for long-term occupation (see Jochim 1976). There are gaps in the distribution of other artefacts and bevelled artefacts on the eastern side indicating that less processing of resources may have taken place there.

Although exact import points for stone remain undetermined, the west-east spatial variations suggest that most stone came into the western side of the island (despite BI9's proximity to the mainland and the potential of Moreton Island as a source), because of its proximity to the mainland and ease of transport. As discussed above, the central swamp was deeper and wider during the Aboriginal occupation of the island, and presented a barrier to east-west movement for most of its length. This barrier was sufficient to cause the occupants of the eastern side to be more conservative in their use of raw materials than is evident on the western ridges.

The picture that emerges is one of the use of the western dune ridge as a 'residential' area with sites more or less evenly distributed along much if its length. On the eastern side, residential camps are located at the northern and southern ends of the dune ridge. Between these camp sites are scattered specific activity or short-term resource exploitation areas. The presence of smaller whole flakes and

Table 1. Percentages of artefacts by technical category. * includes ground and abraded artefacts.

	Whole Flake	Broken Flake	Retouched Flake	Flaked Piece	Bevelled Artefact	Other*	Core	Manuport
Total	269	422	51	768	30	68	88	437
%	12.6	19.8	2.4	36.0	1.4	3.1	4.1	20.5

more extensively reduced cores at the eastern sites provides further evidence of the differential use of these ridges. The eastern cores may have been cached for use, rather than bringing 'new' cores for each visit, and consequently been reduced further than the western cores. The sites may have been used by travellers who perhaps brought with them and discarded relatively reduced artefacts, or who may have taken advantage of cached materials to use along the way (cf. Binford 1979).

The study confirmed a difference in the usage of the western and eastern sides of the island. This may reflect a combination of the importation of the majority of stone through the west coast, and the barrier formed by the central swamp. The island afforded a relatively sedentary lifestyle to a population with a strong, well-established self-identity as well as a dynamic role in equally well-established socio-cultural networks (see Smith 2003). The characteristics of the artefact assemblage are those of a relatively sedentary lifestyle in a low risk environment with assured economic resources. These include rich estuarine, marine and plant resources, as well as access to stone raw materials. The artefacts demonstrate opportunistic (or expedient) techniques of manufacture and reduction typical of exploitation of low risk resources and a reliable supply of raw materials. The relatively small number of retouched artefacts is fairly typical of Australian assemblages. The 'toolkit' is also fairly simple as befits exploitation of low risk resources and a sedentary lifestyle. These findings support previous interpretations of sedentism in the Moreton Region (see Hall 1982; Hall *et al.* 1991; Nolan 1986; Walters 1987).

Manufacture and maintenance of artefacts occurred across the island, but the evidence also indicates that artefacts were imported as well. The differences noted in flake lengths and core scars on the eastern side of the island suggest differences in the use of the western and eastern dune ridges, although not in the use of the raw materials themselves. This lack of differential usage of raw materials is similar to that described by Morrow and Jefferies (1989). The assemblage does not necessarily resemble the highly reduced assemblages associated with high sedentism by Hiscock (1994), nor the expedient core technology associated with sedentism by Hiscock (1996) and Parry and Kelly (1987). Smith (2003) suggests that this is because the procurement of raw materials is 'embedded' in its broadest sense. While the population of Bribie Island may have been sedentary in terms of resource exploitation, it was socially and culturally mobile.

The Bribie Island study highlights certain further research considerations. While a spatial pattern of stone variability has been demonstrated, the relationship between the surface sites containing stone and those containing only shellfish remains need to be better understood. Understanding of the chronology of Aboriginal occupation is still poor. Further excavation of sites along the dune ridges is required not only to determine temporal control for the island itself but also to tie into sites on the mainland and on Moreton and Stradbroke Islands. Similarly, surveys on the mainland and the offshore islands need to be extended to establish spatial patterning relative to stone sources. These may reveal patterns like those demonstrated by McNiven (1990, 1991, 1992, 1993) for the Cooloola region on the mainland north of the study area.

BIFAP's Expanded Role

BIFAP's role expanded when Hall negotiated with CSR Softwoods (now Weyerhaeuser Australia) to allow ongoing monitoring, assessment and advice on mitigating the impact of harvesting operations on archaeological sites within the 4400ha commercial pine plantation on Bribie Island between 1996–2000. The impact of logging operations was monitored by Smith, and assessments and advice were provided to CSR Softwoods/Weyerhaeuser Australia, and later DPI Forestry, on a regular basis. It became clear during the monitoring that the least destructive machine was the Hydro-axe used to cut down the trees. Most damage was inflicted by the large tyred vehicles such as the sniggers and loaders, which churned up cultural material to a depth of 20–30cm (Smith 1997).

Positive results of the collaboration included the harvesting of the culturally sensitive site BI9 by highly controlled and time-consuming means which left the surface with few signs of the harvesting activity, and the subsurface deposits undisturbed. Specific loading sites were agreed, well away from the visible cultural material, with the Hydro-axe rather than the destructive sniggers and loaders being used to move the harvested timber (Smith 1997). BIFAP, DPI Forestry personnel and the traditional owners also developed plans for establishing buffer zones around established site boundaries, appropriate use of machinery, and clearance and replanting strategies for areas of the plantation designated for replanting (Smith 2000).

Postscript

My first introduction to the archaeology of Bribie Island was an undergraduate field trip with Jay in the late 1980s. I was hooked from the start. I remain deeply grateful to Jay for his support and guidance over the years I subsequently conducted research on the island. The Bribie work also provided the venue for a number of memorable events involving some colourful characters (not the least of whom were Jay and René Viel). Some of the stories about these events even resemble the truth …

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This paper is a palimpsest of 20 years of archaeological research on Bribie Island and the number of contributors is large. In particular thanks go to Jay Hall who started off my work on Bribie and continues to direct research in the area; Ian Smith; Sean Ulm; Ian McNiven; the original 1981/82 MRAP crews; the 1991/92 University of Queensland Field Archaeology class members; Nicola Roche; Brit Asmussen; Vanessa Krueger; Jon Prangnell; Jim Smith; Paddy Waterson; Stephen Skelton; the Sunchip crews; CSR/ Weyerhaeuser Australia; Alex Bond; and not least my late faithful field companions and archaeolydogs Nell and Alice. Thanks to Sean Ulm and Antje Noll for their work on the figures. Many thanks also go to the referees who offered invaluable comments on improving the paper.

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The Antiquity of Marine Fishing in Southeast Queensland: New Evidence for Pre-2000 BP Fishing from Three Sites on the Southern Curtis Coast

Sean Ulm and Deborah Vale

Abstract

The antiquity of marine fishing in southeast Queensland has been debated since the mid-1980s. Walters has argued that systematic marine fishing was only adopted in the last 2000 years as a response to the marginality of terrestrial landscapes fringing the coast, while Hall, McNiven, Ross, and Ulm, among others, have maintained that fishing was always an integral component of coastal settlement, but that a variety of taphonomic processes and recovery problems under-represent fish remains dating to before the late Holocene. Zooarchaeological data from shell midden deposits on the southern Curtis Coast at the northern end of the southeast Queensland bioregion shed new light on this debate, with fish remains recovered from three deposits dating prior to 2000 BP and up to 4000 BP. Implications for understanding the antiquity of marine fishing in the wider region are considered and directions for future research identified.

Introduction

A major feature of archaeological accounts of Aboriginal lifeways in southeast Queensland is an apparent intensification of marine fishing over the last 2000 years (e.g. Hall 2000; Morwood 1987; Walters 1989, 1992a). Walters (1986, 1989, 1992a, 1992b, 1992c, 2001) has forcefully argued that marine fishing was only regularly incorporated into Aboriginal subsistence and settlement regimes in southeast Queensland in the last 2000 years as part of permanent and intensifying coastal settlement. In fact, he argued that there was no firm evidence for fishing in southeast Queensland before 2000 years ago (Walters 1992b). Others, however, have pointed to limitations imposed by taphonomic factors, recovery techniques and the presence of earlier fish remains to the north and south of the region as the basis for alternative interpretations (McNiven 1991; Ross and Coghill 2000; Ulm 1995, 2002a). Clearly, understandings of the antecedents of the systems observed ethnographically and inferred from the late Holocene archaeological record, and the role that fish played within them, are hampered by the limited number of deposits containing faunal material dating to before the late Holocene. Determining the antiquity and nature of marine fishing in the region has therefore been an important focus for various southeast Queensland studies (e.g. Bowen 1989; Frankland 1990; Hall and Bowen 1989; McNiven 1991; Ross and Duffy 2000; Walters *et al.* 1987). This paper reports the recovery of pre-2000 BP fish remains from three sites on the southern Curtis Coast: Seven Mile Creek Mound, Mort Creek Site Complex and Eurimbula Site 1.

Table 1. Southeast Queensland sites with fish bone dating to before 2000 BP. NA= fish remains present, but quantification data are not available.

Site	Earliest Fishing	Number Specimens	Weight (g)	NISP	MNI	References
New Brisbane Airport	4830±110 BP (Beta-33342)	NA	NA	NA	NA	Hall 1990:180, 1999:174; Hall and Lilley 1987; Ulm and Hall 1996
Booral Shell Mound	2950±60 BP (Beta-32046)	695	–	11	9	Bowen 1998; Frankland 1990:Tables 6-7
Wallen Wallen Creek	c.3000 BP	NA	NA	NA	NA	Neal and Stock 1986; Walters 1986:244-246
Toulkerrie	2290±80 BP (Beta-32047)	384	NA	NA	0	Hall and Bowen 1989: Tables 5, 7

Fishing and Archaeology in Southeast Queensland

Jay Hall's (1982) early synthesis of ethnographic and archaeological material from Moreton Bay identified the centrality of marine fishing to Aboriginal lifeways in the region, informed by the patterns revealed at early excavations undertaken at Minner Dint and Toulkerrie on Moreton Island (Hall 1980, 1984). The key role of marine resources in the subsistence economy was further supported by ecological studies demonstrating the marginality of coastal landscapes in terms of low terrestrial mammal diversity and abundance (e.g. Dwyer *et al.* 1979a, 1979b). Hall's work was elaborated by Walters (1986, 1988, 1989, 1992a, 1992b, 1992c, 2001), who argued that many of the changes observed in the archaeological record of southeast Queensland were ultimately related to the late Holocene development and intensification of a marine fishery. Although Walters (e.g. 2001:61) has always allowed that people may have fished occasionally prior to 2000 years ago, a key observation underpinning his model is the fact that there is little evidence for an established marine fishery until the last 1000 years.

Fish remains are a rare component in southeast Queensland faunal assemblages before the late Holocene (Ulm 2002a; McNiven 2006; Walters 1992b). Only four sites in southeast Queensland have been reported to contain marine fish remains dating to before 2000 BP (Table 1, Figure 1). All contain very low numbers of fish remains dating to this time, leading Walters (2001:61) to comment that older sites reported in the region 'have been uncontaminated by evidence for a fishery'. The oldest fish remains have been reported from the New Brisbane Airport site where 'fragmentary fish bone' (Hall 1999:174) dating to the mid-Holocene occur encased in the ironstone conglomerate matrix of the lower excavation units. Walters (1992b:35) noted that only a few fragments of fish bone were recovered from the site and argued that these remains have not been demonstrated to be cultural. Stratigraphic and other details published to date do not provide a clear cultural context for the fish remains (Hall and Lilley 1987). The Booral Shell Mound on the shores of Great Sandy Strait has the largest number of fish bone specimens dated to before 2000 years ago, but even here it amounts to only a NISP of 11 and an MNI of nine (Frankland 1990). At Wallen Wallen Creek, Walters (1986:244-246) reported the distribution of fish remains by excavation unit from the undated square WWC-M28-B. Although Neal (Queensland Environmental Protection Agency, pers. comm., 1995) indicated that fish remains are restricted to the last 3000 years, it is unclear which of the data reported by Walters belong to the pre-2000 BP assemblage. The site of Toulkerrie on Moreton Island has abundant fish remains dating to the last 1000 years, however, less than 1% of the fish bone specimens reported by Hall and Bowen (1989) belong to pre-2000 BP deposits. It should be noted that Ulm (2002a:Table 3) incorrectly reported fish remains dating to before 2000 BP at Sandstone Point. However, re-examination of Nolan's (1986:Table 31) results for square SSP 5-G, the deposit at Sandstone Point dated to before 2000 BP, does not show fish in excavation units before 2000 years ago. The paucity of fish remains in older sites is reinforced by the complete absence of fish remains from other sites in southeast Queensland pre-dating 2000 BP, including Hope Island (Walters *et al.* 1987), Teewah Beach Site 26 (McNiven 1991), King's Bore Sandblow Site 97 (McNiven 1992) and Sandstone Point (Nolan 1986).

From a wider perspective, coastal archaeological sites containing faunal remains dating to before the late Holocene are not common anywhere on the Queensland coast (see Ulm *et al.* 1995; Ulm and Reid

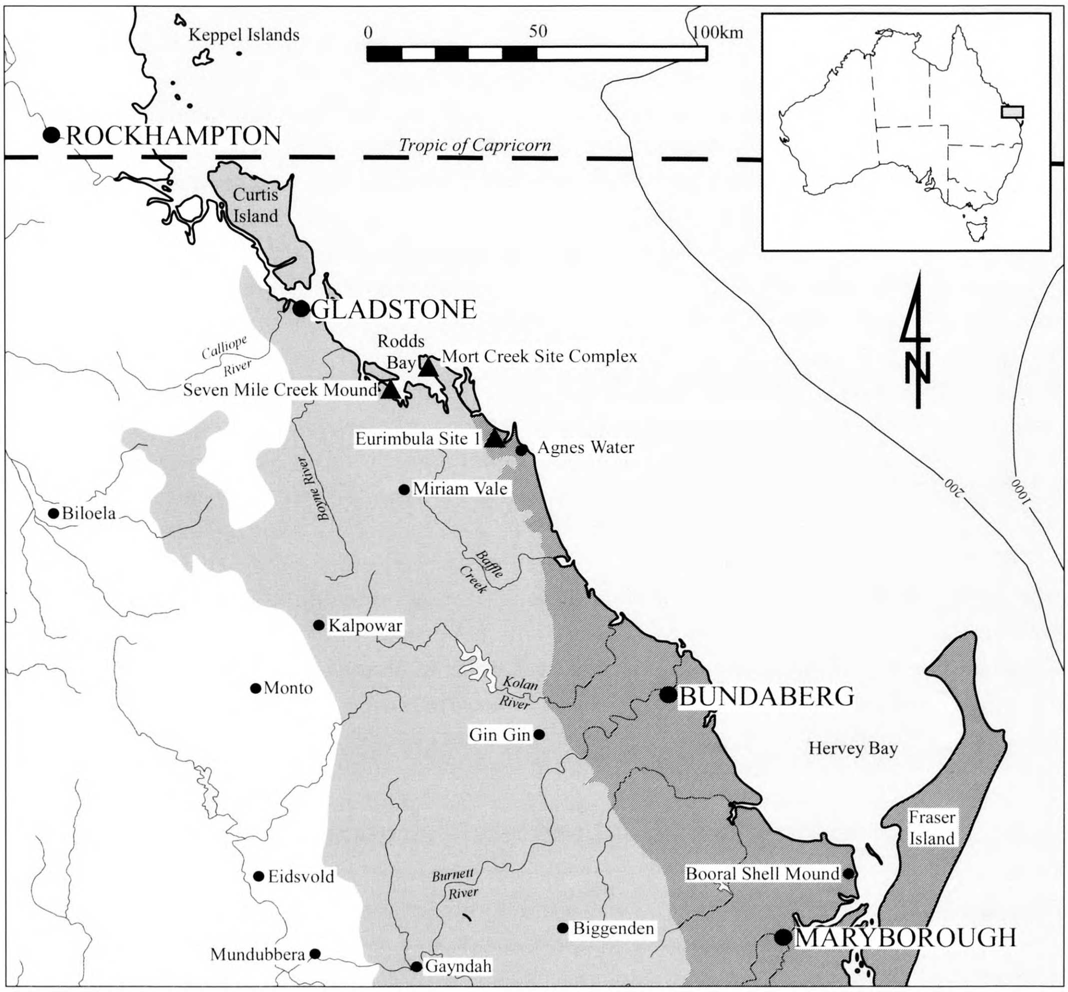

Figure 1. Northern southeast Queensland, showing sites mentioned in the text. The southeast Queensland bioregion is shaded, with the darker shading indicating the extent of the coastal lowlands or 'wallum' (after Young and Dillewaard 1999).

2000 for a review). Although several rockshelters containing evidence for marine resource exploitation in the Whitsunday Islands (Barker 1989, 1991, 2004) and Princess Charlotte Bay areas (Beaton 1985) date to around or before the mid-Holocene, only two open sites on the Queensland coast have evidence for focused marine resource exploitation before 3000 BP. The Hope Island site on the Coomera River, dated on charcoal to 4350±220 BP (Beta-20799), contains abundant shell remains, although fish bone is reportedly absent (Walters *et al*. 1987). Mazie Bay on North Keppel Island is dated on charcoal to 4274±94 BP (NZA-456), but quantities of shell and fish bone are only present in deposits dated to shortly before 3000 BP (Rowland 1999). In all other open coastal sites in Queensland pre-dating 3000 BP (n=7) faunal remains are either entirely absent, represented in minute quantities or restricted to deposits dated to the last 3000 years.

The absence of faunal remains from early deposits is commonly attributed to a combination of recovery strategies, taphonomic considerations and/or differential site preservation (Ulm 2002a). Ulm (1995, 2002a) and Ross (2001; Ross and Coghill 2000; Ross and Duffy 2000) have suggested that the routine use of large sieve mesh sizes (e.g. 3mm) may have biased against the recovery of fish remains. Ross (2001:63) has argued that '[f]ish bone may have been more prevalent in these older sites had more effective recovery techniques been used'; specifically, the use of 1mm mesh. Walters (2001:61) countered that the use of 'tiny mesh sizes is not the solution' as it has 'not produced evidence of an earlier focus on fishing'.

McNiven (1991:21) suggested that Walters underestimated the 'role of fishing in the mid-Holocene due to an analytical bias towards fish remains recovered from late Holocene shell middens'. He suggested that fish remains would only have a high survival potential if incorporated into a shell matrix and concluded that 'as most coastal shell middens in southeast Queensland date to the last 1000 years ... most preserved fish bones will similarly date to this period and few valid inferences can be made concerning fishing conditions prior to 1000 BP' (McNiven 1991:21; see also McNiven *et al*. 2002:15, Ulm 2002a). However, Walters (1992b:36-37) responded that the prominence of late Holocene shell middens in the sample 'is not so much a bias, as it is a reflection of the data available', and he pointed to the lack of evidence from sites known to span this period to demonstrate that a developed fishery was not evident until late Holocene times. In a recent review Ulm (2002a) demonstrated that fish remains are more common in southeast Queensland sites after 2000 BP, and especially in the last 1000 years, although no simple pattern towards increasing marine fish production could be identified. In fact, many sites dating to the last 1000 years contain no fish remains at all. However, variability in data recovery techniques and analytical methods combined with poorly developed site chronologies inhibit meaningful integration of these data (see Ulm 2002a). Recent work in northern southeast Queensland provides new data relevant to this debate.

Southern Curtis Coast Regional Archaeological Project

Since 1993, archaeological surveys and excavations have been conducted along the southern Curtis Coast as a component of the Gooreng Gooreng Cultural Heritage Project (see Lilley and Ulm 1995, 1999; Lilley *et al.* 1996; Ulm 2000, 2002b, 2002c, 2004, in press; Ulm *et al.* 1999, 2005; Ulm and Lilley 1999). The study area extends along the coast from Baffle Creek in the south to Rodd's Bay in the north and inland to Miriam Vale in the west. It falls within the northern end of the well-defined southeast Queensland bioregion and comprises two major landscape provinces – the Burnett-Curtis Coastal Lowlands in the southeast and the Burnett-Curtis Hills and Ranges in the north and west (Figure 1) (Sattler 1999; see also Coaldrake 1961). The former are a part of Coaldrake's (1961) 'wallum' and are characterised by fine-grained sediments; alluvium; coastal and estuarine sediments; a broad coastal plain; high rainfall (1100mm); low elevation (<50m); and eucalypt and melaleuca forests and woodlands (Young and Dillewaard 1999). The latter are characterised by acid volcanics; metamorphics; localised basic volcanics; small areas of elevated sediments; hills and ranges; alluvial valleys; high rainfall (900mm); medium elevation (<250m); and eucalypt woodlands and araucarian microphyll rainforest (Young and Dillewaard 1999). Like elsewhere in southeast Queensland, the coastal components of the bioregion are characterised by the low diversity and abundance of terrestrial mammals (e.g. Dwyer *et al.* 1979).

The southern Curtis Coast exhibits a rich and diverse suit of marine fauna, including a number of whale species (including the humpback *Megaptera novaeangliae*), four species of dolphins (including the common bottle-nose *Tursiops truncatus*), dugong (*Dugong dugon*) and turtles (including loggerhead *Carreta caretta* and green *Chelonia mydas*). A total of 148 species of fishes from 69 families is recorded for the Curtis Coast (QDEH 1994:68). Useful data are provided by Lupton and Heidenreich's (1996) detailed study of Baffle Creek just to the south of the study area. The lower estuarine component of this fisheries resource assessment covered habitats similar to the coastal estuaries in the study area. Despite significantly depressed regional rainfall levels (25% under the annual average) before and during the survey period, 55 fish and nine crustaceans were recorded. The larger fish species were (in order of abundance) flat-tail mullet (*Liza dussumieri*), sand mullet (*Myxus elongatus*), whiting (*Sillago ciliata, S. maculata* and *S. sihama*), yellowfin bream (*Acanthopagrus australis*), blue-tail mullet (*Valamugil seheli*), sea mullet (*Mugil cephalus*) and garfish (including *Arrhamphus sclerolepis* and *Hyporhamphus ardelio*) (Grant 1993; Lupton and Heindenreich 1996). Commercial finfish catches for the region reflect this pattern, with mullet, whiting and bream accounting for 64.1% of commercial catches (Olsen 1980:11). Early European historic accounts suggest that fish may have been more abundant in the past, with both Banks and Parkinson impressed by the quantities of fish in the bay and estuary (Banks in Beaglehole 1963; Parkinson 1773). Mud crabs (*Scylla serrata*) and sand crabs (*Portunus pelagicus*) are also common.

The environmental context and archaeological signature of Aboriginal occupation, dominated by shallow shell middens located on landforms dating from the mid-Holocene, is shared with the wider southeast Queensland region, providing the ideal context for new research to contribute to continuing debates, including the antiquity of marine fishing, using targetted recovery and analysis techniques. Excavations and analyses of eight open coastal sites located on six separate estuaries were undertaken, with three sites yielding evidence for pre-2000 BP fishing, discussed below.

Methods

An important sampling consideration was to recover data to evaluate the role and antiquity of marine fishing in the region. Experiments have demonstrated that sieve mesh sizes create significant biases in faunal recovery (e.g. Ross and Duffy 2000; Shaffer 1992; Shaffer and Sanchez 1994). Walters (1979) found that as much as 80% of fish remains passed through 3mm mesh (based on analysis of a single 661.6g bulk sample). Walters' study also demonstrated that the use of larger mesh sizes biased recovery against some fish taxa with small diagnostic skeletal elements, such as Mugilidae (mullet) and Sillaginidae (whiting) (see also Hall 1980:105-106). Experiments which have included fish bones indicate that mesh sizes between 0.5mm and 2mm are required for maximum representative recovery (Casteel 1970, 1972, 1976; Colley 1990; Gordon 1993). Indeed, Casteel (1976) has argued that column- or core-sampling is the only reliable method for representative recovery of fish remains. Recent studies by Butler (1994) and Vale and Gargett (2002), however, have found that the relative abundance of fish taxa across different mesh sizes is similar, with smaller screen sizes (e.g. 1mm) increasing the abundance only of undiagnostic bone elements. In southeast Queensland, 3mm mesh is almost universally the smallest screen size used (Ulm 2002a:Table 1). The use of different sieve sizes makes it difficult to compare the representation of fish remains between sites. To ensure comparability with fish bone assemblages recovered from elsewhere in southeast Queensland, 3mm mesh was used in this study. This recovery strategy yielded large numbers of fish bones from several sites, including identifiable elements of mullet and whiting, the main regional taxa thought to be under-represented by large mesh sizes (Walters 1979).

All fish bone recovered from analysed squares was separated from the faunal assemblage and subject to basic characterisation studies, including body part representation, vertebral sizing, identification rate, number of fragments, number of identified specimens (NISP) and minimum number of individuals (MNI). MNI was calculated for each excavation unit, which may overestimate the MNI for the site as a whole. Fish taxa were identified using a comparative reference collection assembled for northern New South Wales and southern Queensland and adapted for the study area (for example, the tiger flathead, *Platycephalus indicus*, uncommon in New South Wales, was included). Owing to the limitations of the reference collection, however, taxonomic identifications were only made to the family level, with the exception of the bream, *Acanthopagrus australis*, which was identified on the basis of distinctive diagnostic cranial elements.

A variety of abundance measures has been employed in the analysis of fish remains from archaeological sites in southeast Queensland. For example, Walters (1986) used NISP, McNiven (1990) used both weight and MNI and Frankland (1990) used MNI and NISP. These abundance measures are not necessarily comparable (see Grayson 1979, 1984). NISP is particularly prone to problems of intersite comparability, given the potential effects of fragmentation and differences in the way that different investigators calculate the measure (Lyman 1994:38). This is a particular problem in southeast Queensland, where all investigators who have used NISP as a measure of fish abundance have adopted the Class (i.e. fish) as the basic unit of identification, exacerbating the potential for spurious results derived from site-specific fragmentation patterns. This measure is more accurately characterised as a specimen count. In this study, fish NISP is calculated on the basis of the number of specimens identified to family or species only (Vale and Gargett 2002). The number of specimens is also reported to allow comparison to NISP data reported for other sites in the region.

Results

Seven Mile Creek Mound

The Seven Mile Creek Mound is a discrete shell mound located on a low, sandy ridge isolated on tidal flats fringing Seven Mile Creek, approximately 35km southeast of Gladstone (Figure 1). The site measures 20m east-west x 10m north-south x 0.8m high. A single 1m² pit divided into four 50cm x 50cm quadrants (Squares A–D) was excavated into the highest part of the mound to a maximum depth of 117cm. Excavation revealed an 85cm thick deposit of dense shell resting on well-rounded beach sands containing occasional pieces of shell and degraded pumice. Eight radiocarbon determinations were obtained for the deposit, demonstrating extremely rapid accumulation over a period of about 350 years with initial occupation around 3950 cal BP and abandonment shortly after 3600 cal BP. Fish bone data are available for Square A. For further site details see Ulm (2000, 2002c, 2004, in press).

Fish bone is present throughout the cultural deposit, totalling 34.4g and consisting of 1346 pieces of bone, a NISP of 54 and an MNI of 37 (Table 2). The weight of bone identified to taxon was 1.6g,

Table 2. Fish bone abundance, Seven Mile Creek Mound, Square A.

XU	Number Specimens	Weight (g)	NISP	MNI
1	0	0	0	0
2	14	0.5106	0	0
3	47	1.2786	3	2
4	74	1.1613	1	1
5	53	0.9165	2	1
6	98	1.3380	5	3
7	60	1.4591	5	4
8	16	0.2120	0	0
9	27	0.6474	2	2
10	18	0.2565	0	0
11	169	4.8736	6	3
12	115	2.2661	3	2
13	61	3.5652	8	6
14	176	4.7367	10	5
15	132	3.9176	6	5
16	52	2.0026	0	0
17	47	0.7844	0	0
18	8	0.1657	0	0
19	22	0.2808	0	0
20	12	0.4353	0	0
21	69	0.8567	0	0
22	16	0.3883	2	2
23	17	0.3532	0	0
24	14	0.1496	1	1
25	7	0.1879	0	0
26	18	1.5749	0	0
27	2	0.0260	0	0
28	1	0.0113	0	0
29	1	0.0299	0	0
30	0	0	0	0
31	0	0	0	0
Total	1346	34.3858	54	37

giving an identification rate of 4.75%. Identified taxa in descending order of abundance include flathead (Platycephalidae), whiting (Sillaginidae), Sparidae (including bream, *Acanthopagrus australis*) and mullet (Mugilidae). Size-classing of vertebrae showed that 69% have a centrum diameter of 3mm or less. These represent very small fin fish. Some larger fish are represented by vertebrae from XU9–15.

Mort Creek Site Complex

The Mort Creek Site Complex is located on the west bank of Mort Creek, on the west coast of Rodds Peninsula (Figure 1). Natural and cultural shell deposits extend discontinuously over an area of about 6ha, characterised by a complex of beach ridges, cheniers, shell middens and tidal inlets. Test excavations undertaken in 1995 (reported in Carter *et al.* 1999) revealed cultural deposits dating to before 2000 BP. In 1998, a further 1m² pit divided into four 50cm x 50cm squares (Squares A–D) was excavated in the area identified in the earlier investigations as having the oldest cultural deposits. Excavation revealed approximately 65cm of sediments overlying microgranite bedrock. Large quantities of shellfish remains, dominated by mud ark (*Anadara trapezia*), were recovered from a shell layer across the upper 20cm of the deposit. Remains of dugong (*Dugong dugon*) and turtle, probably loggerhead (*Caretta caretta*), were recovered towards the middle of the deposit immediately below the shell layer. Fish bone was recovered from every excavation unit. Twelve radiocarbon determinations are available suggesting first occupation shortly before c.3300 cal BP and abandonment around 2000 years ago. Fish bone data are available for Square C. For further site details see Carter (1997), Carter *et al.* (1999), Lilley *et al.* (1996, 1999), Rosendahl (2005) and Ulm (2004, in press).

Fish bone is present throughout the cultural deposit, consisting of 1635 pieces of bone totalling 38.4g and a NISP of 34 and an MNI of 21 (Table 3). The weight of bone identified to taxon was 4g, giving an identification rate of 10.5%. Identified taxa in descending order of abundance include Sparidae, flathead (Platycephalidae), whiting (Sillaginidae) and catfish (Ariidae). Size-classing showed that 71% of all vertebrae have a centrum diameter of 3mm or less, representing very small fin fish. Some larger fish are represented by single vertebrae recovered from XU5 and XU9. Three Sparidae otoliths from XU7 range in size from 12.4–21.5mm which represent very large fish. Comparative Sparidae otoliths from bream (*Acathopagrus australis*) with total lengths of 305mm and 365mm had otoliths measuring 9.8mm and 11.1mm in length respectively. In addition, a Platycephalidae dentary fragment from XU7 measured 6.9mm at the symphysis, much larger than a comparative Platycephalidae dentary with a symphysis length of 4.3mm for a 418mm fish. There is discordance between the presence of at least several large individual fish represented by cranial elements (dentary and otoliths) and the very few vertebrae recovered above 3mm in centrum diameter. This pattern may relate to differential representation of skeletal elements caused by butchering practices on large fish, with post-cranial elements discarded elsewhere. Although fish bone occurs in every unit, it is most abundant in units where shell is also abundant.

Sixty-eight pieces of bone weighing 26.2g could not be assigned to a fish skeletal element. The small size of these specimens and the lack of diagnostic attributes generally prevented identification to taxon. However, positive identification of bone elements at a similar depth towards the base of SUII in adjacent squares as dugong (*D. dugon*) and turtle, probably loggerhead (*C. caretta*), suggest that many of the unidentified small bone fragments in Square C derive from these taxa. Dugong remains were recovered from Squares A–C in association with the lower half of the shell layer between 13.6–21.3cm below ground surface. Although the turtle carapace fragments recovered from between 24.5–35.2cm in Squares B and D are associated with occasional *A. trapezia* valves, they are clearly located below the major shell layer.

Table 3. Fish bone abundance, Mort Creek Site Complex, Square C.

XU	Number Specimens	Weight (g)	NISP	MNI
1	0	0	0	0
2	36	1.0086	0	0
3	64	0.9123	0	0
4	97	2.1781	2	1
5	90	2.3407	5	4
6	272	7.0749	7	2
7	313	10.7277	7	5
8	332	6.7944	8	5
9	82	1.9631	1	1
10	74	1.1594	0	0
11	73	0.9109	2	1
12	69	0.8443	0	0
13	28	0.4571	1	1
14	8	0.0957	0	0
15	13	0.1390	0	0
16	5	0.0587	0	0
17	18	0.2461	0	0
18	49	1.1300	1	1
19	12	0.3115	0	0
Total	1635	38.3525	34	21

Eurimbula Site 1

Eurimbula Site 1 is a large, stratified midden complex intermittently exposed in a steep erosion section on the west bank of Round Hill Creek (Figure 1). The site is approximately 2km long (north-south) and up to 100m wide (east-west), although surface exposures of shell and stone artefacts are mainly confined to a 50m wide band parallel to the creek bank. It was formed on and in a series of low Holocene beach ridges and swales which run roughly parallel to the modern coastline forming Bustard Bay. Test excavations undertaken in 1995 (reported in Ulm *et al.* 1999) revealed cultural deposits dating to before 3000 BP and recovered small numbers of fish bones (n=76) in deposits dating to shortly before 2000 years ago (see Ulm 2004:Table 12.1, 12.4). In 1999 a further 1m² pit divided into four 50cm x 50cm squares (Squares A–D) was excavated in the area identified in the earlier investigations as having the oldest cultural deposits. Excavation revealed approximately 55cm of sediments containing cultural material overlying culturally-sterile sands. Fish bone was recovered from every excavation unit in the top 35cm, with occasional specimens present to the base of the cultural deposit. Twelve radiocarbon determinations are available, demonstrating occupation from around 3000 cal BP into the historical period. Fish bone data are available for Squares A–D. For further site details see Ulm *et al.* (1999; see also Ulm 2004, in press).

Fish bone is present throughout the cultural deposit, totalling 26.93g and consisting of 1345 pieces of bone with a NISP of 18 and an MNI of 15 (Tables 4–5). Identified taxa in descending order of abundance include Sparidae (bream, tarwhine, snapper) (NISP=8; MNI=8), Sillaginidae (whiting) (NISP=10; MNI=7) and Mugilidae (mullet) (NISP=1; MNI=1). Although fish bone occurs in every unit, it is most abundant in units where shell is also abundant. In Square A, three Sparidae identifications were made, two from XU6 identified from a vertebra and an otolith and one from XU7 from a dentary. The otolith was identified as bream (*Acanthopagrus australis*). In Square B, XU4, a single vertebra each was identified as Sillaginidae and Mugilidae and a Sparidae otolith was identified as snapper (*Chrysophrys auratus*). XU5 contained two vertebrae identified as Sparidae and Sillaginidae, and two otoliths identified as Sillaginidae. The centrum diameter of the Sillaginidae vertebrae from the adjacent XUs is similar suggesting that they derive from the same individual. A single vertebra and three otoliths in Square C, XU6, were identified

Table 4. Fish bone abundance, Eurimbula Site 1, Squares A–B. * indicates deposits dated to pre-2000 BP.

	Square A				Square B			
XU	Number Specimens	Weight (g)	NISP	MNI	Number Specimens	Weight (g)	NISP	MNI
1	0	0	0	0	0	0	0	0
2	0	0	0	0	2	0.02	0	0
3	9	0.06	0	0	32	0.69	0	0
4	20	0.25	0	0	187	4.04	3	3
5	49	1.54	0	0	28	0.75	4	2
6	72	2.05	2	2	50	0.57	0	0
7	52	0.82	1	1	36	0.44	0	0
8	25	0.36	0	0	3	0.01	0	0
9	16	0.24	0	0	4	0.09	0	0
10	20	0.44	0	0	25	0.37	0	0
11	12	0.13	0	0	8	0.07	0	0
12*	5	0.08	0	0	5	0.01	0	0
13*	5	0.08	0	0	4	0.04	0	0
14*	7	0.11	0	0	4	0.02	0	0
15*	6	0.04	0	0	0	0	0	0
16*	2	0.01	0	0	4	0.02	0	0
17*	0	0	0	0	6	0.06	0	0
18*	0	0	0	0	0	0	0	0
19*	0	0	0	0	5	0.01	0	0
20*	0	0	0	0	2	0.02	0	0
21*	1	0.01	0	0	2	0.01	0	0
22*	1	0.01	0	0	0	0	0	0
23*	0	0	0	0	0	0	0	0
24*	1	0.03	0	0	0	0	0	0
25*	0	0	0	0	NA	NA	NA	NA
Total	303	6.26	3	3	407	7.24	7	5

as Sparidae, two of which are snapper, and two further otoliths were identified as Sillaginidae. XU9 contained an otolith identified as snapper. Square D, XU4, contained a Sparidae otolith. Around 6% of the fish bone assemblage recovered from Squares A–D is estimated to date to before 2000 BP.

Discussion

Evidence from the three sites presented above demonstrates a pre-2000 BP antiquity for systematic marine fishing within the southeast Queensland bioregion. Significantly, the data show continuities in the general antiquity of marine fishing at sites spanning the boundary of the coastal lowlands ('wallum') landscape province (Eurimbula Site 1) with the Burnett-Curtis Hills and Ranges to the north (Seven Mile Creek Mound and Mort Creek Site Complex). The data from the southern Curtis Coast indicate a well-developed marine fishery, including predation of dugong, turtle, crustaceans and shellfish, in operation before 2000 years ago. Table 6 shows that the pre-2000 BP southern Curtis Coast fish assemblage almost trebles the number of specimens reported for the entire southeast Queensland bioregion. In fact, the quantity of fish remains is more akin to that reported for sites dating to the last 1000 years (see Ulm 2002a:Table 3). Fish are likely to have provided most of the protein for people on the southern Curtis Coast despite the relatively low representation of this material compared with shellfish (but see Erlandson 1988, 1991) (compare Figures 2 and 3). Identified fish remains indicate targetting of a range of shallow water estuarine species, including whiting (Sillaginidae), flathead (Platycephalidae), bream,

Table 5. Fish bone abundance, Eurimbula Site 1, Squares C–D. * indicates deposits dated to pre-2000 BP.

	Square C				Square D			
XU	Number Specimens	Weight (g)	NISP	MNI	Number Specimens	Weight (g)	NISP	MNI
1	0	0	0	0	0	0	0	0
2	5	0.50	0	0	5	0.01	0	0
3	7	0.09	0	0	2	0.01	0	0
4	20	0.33	0	0	15	0.31	1	1
5	95	1.98	0	0	128	1.86	0	0
6	97	3.99	6	5	44	0.87	0	0
7	75	0.97	0	0	40	1.41	0	0
8	26	0.46	0	0	2	0.01	0	0
9	8	0.28	1	1	13	0.19	0	0
10	13	0.08	0	0	4	0.04	0	0
11	9	0.10	0	0	1	0.19	0	0
12*	6	0.02	0	0	6	0.06	0	0
13*	2	0.01	0	0	1	0.03	0	0
14*	3	0.01	0	0	0	0	0	0
15*	0	0	0	0	1	0.01	0	0
16*	2	0.01	0	0	0	0	0	0
17*	0	0	0	0	0	0	0	0
18*	0	0	0	0	0	0	0	0
19*	0	0	0	0	0	0	0	0
20*	2	0.01	0	0	0	0	0	0
21*	1	0.03	0	0	0	0	0	0
22*	0	0	0	0	0	0	0	0
23*	2	0.01	0	0	0	0	0	0
24*	0	0	0	0	NA	NA	NA	NA
25*	0	0	0	0	NA	NA	NA	NA
26*	0	0	0	0	NA	NA	NA	NA
Total	373	8.43	7	6	262	5.00	1	1

tarwhine and snapper (Sparidae), mullet (Mugilidae) and catfish (Ariidae). These findings are in keeping with findings from adjacent regions to the north of southeast Queensland indicating continuous use of marine resources throughout the marine transgression (e.g. Barker 2004). These data suggest that fish were always a key resource along the southern Curtis Coast and were not recently incorporated as a regular feature of subsistence production systems.

The pattern of fish bone distribution on the southern Curtis Coast closely follows that of shellfish, with a decrease between 1000–1500 years ago and major increases in the last 1000 years (Figures 2–3). The shell and fish bone datasets should not be considered entirely independent, however, as it is likely that fish bone survival in the archaeological record is closely linked to shell abundance (McNiven 1991). For the Waddy Point Rockshelter 1 on Fraser Island, McNiven *et al.* (2002:15) demonstrated that fish bone is only consistently represented in the faunal assemblage after shell densities exceed 9–10g/kg of deposit. McNiven (1991:21; McNiven *et al.* 2002:15) suggested that the survival of fish bone in southeast Queensland deposits may be correlated with the occurrence of shell, as these shellfish remains provide a protective matrix, altering the chemical properties of the sedimentary matrix towards conditions conducive to fish bone preservation. At the Mort Creek Site Complex, however, fish bone is represented throughout the deposit, including excavation units where shell densities are well below 1g/kg of deposit. Nonetheless, there is generally a positive relationship between the abundance of fish bone

Table 6. Southeast Queensland sites with fish bone dating to before 2000 BP, including data from the southern Curtis Coast. NA= fish remains present, but quantification data are not available.

Site	Earliest Fishing	Number Specimens	Weight (g)	NISP	MNI	References
New Brisbane Airport	4830±110 BP (Beta-33342)	NA	NA	NA	NA	Hall 1990:180, 1999:174; Hall and Lilley 1987; Ulm and Hall 1996
Seven Mile Creek Mound	3660±60 BP (NZA-12118)	1346	34.4	54	37	Ulm 2004, in press
Mort Creek Site Complex	3380±90 BP (Wk-6988)	1635	38.4	34	21	Ulm 2004, in press
Booral Shell Mound	2950±60 BP (Beta-32046)	695	–	11	9	Bowen 1998; Frankland 1990:Tables 6-7
Wallen Wallen Creek	c.3000 BP	NA	NA	NA	NA	Neal and Stock 1986; Walters 1986:244-246
Eurimbula Site 1	2390±70 BP (Wk-7688)	86	0.76	0	0	Ulm 2004, in press
Toulkerrie	2290±80 BP (Beta-32047)	384	NA	NA	0	Hall and Bowen 1989: Tables 5, 7

and shellfish remains, particularly in the upper deposit. As McNiven *et al.* (2002:15) warned, whether this indicates patterns of subsistence or patterns of bone survivorship remains to be determined, although the presence of fish bone in the lower deposits of the Mort Creek Site Complex indicates that fish bone may survive under certain conditions without an accompanying shell matrix.

The Mort Creek Site Complex is the only site in the study which has evidence for the procurement of large marine animals, such as dugong and turtle, as a component of the marine fishery. Despite several detailed eighteenth and nineteenth century ethnohistoric accounts of dugong and turtle hunting in southeast Queensland (e.g. Backhouse 1843; Colliver and Woolston 1978; Fairholme 1856; Petrie 1904:24-25, 65-69, 82-83; Watkins 1891), archaeological remains are relatively rare and very recent. The oldest evidence appears to be from Wallen Wallen Creek on North Stradbroke Island, where dugong remains were identified in the late Holocene deposits, but the chronology of the remains is unclear from the reported data (Neal and Stock 1986). At the site of St Helena Island in Moreton Bay, dugong bone was recovered from the top 15cm of the deposit, which Alfredson (1984:73) dates to the mid-to-late nineteenth century. On Moreton Island, several bone fragments have been tentatively identified as dugong at the Little Sandhills site, where the radiocarbon date indicates a probable post-contact chronology (Robins 1983, 1984). Walters (1979:47, 1980) identified nine specimens of dugong bone from Trench B at Toulkerrie on Moreton Island, although no provenance is available and the entire analysed assemblage appears to date from the last 400 years (see Ulm 2002a:86-87). The secure dating of dugong remains to before 2000 BP at the Mort Creek Site Complex therefore provides some of the earliest evidence for dugong hunting in southeast Queensland.

Taken together this evidence points to the existence of a well-developed and broad-ranging marine fishery dating from the start of the regional chronology some 4000 years ago, coincident with local sea-level stabilisation (Larcombe *et al.* 1995). Later patterns of fish bone discard across sites excavated on the southern Curtis Coast dating to the last 1000 years support Walters' contention that an expanded focus on marine fish production occurred across the region in the recent past (Figure 2). Analyses of the vertebrate and invertebrate faunal assemblages from the unanalysed squares excavated at the early sites of Seven Mile Creek Mound and the Mort Creek Site Complex have the potential to shed further light on fishing, subsistence and occupation activities from this poorly understood period of southeast Queensland archaeology. Detailed analysis of fish remains including study of differential body part representation may also help elucidate butchering patterns such as those thought to be represented at the Mort Creek Site Complex.

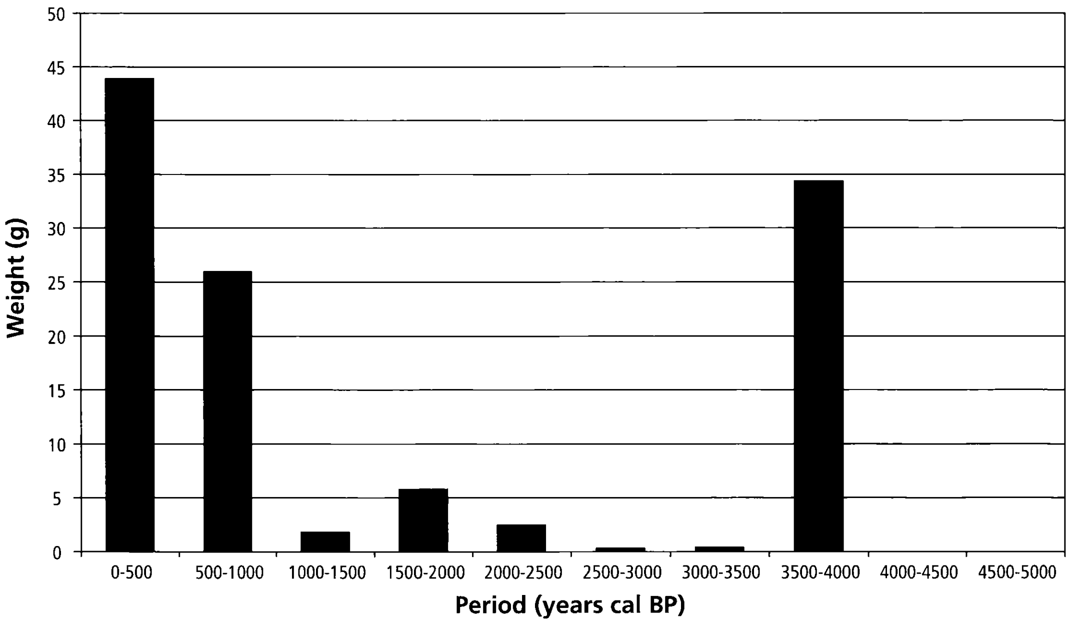

Figure 2. Total weight of fish bone recovered from all southern Curtis Coast sites per 500 year interval (Ulm 2004, in press).

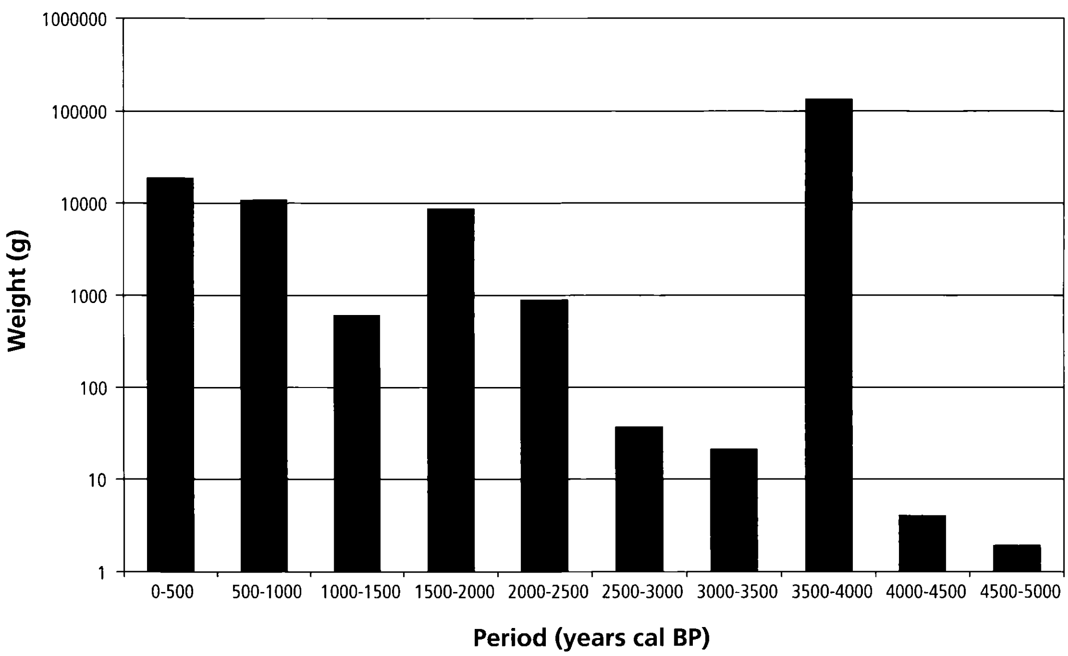

Figure 3. Total weight of shell recovered from all southern Curtis Coast sites per 500 year interval (Ulm 2004, in press). Note logarithmic scale on y axis.

Conclusions

Data from the Seven Mile Creek Mound, Mort Creek Site Complex and Eurimbula Site 1 demonstrate that a marine fishery was in place well before 2000 years ago in the northern section of the southeast Queensland bioregion. The findings from the southern Curtis Coast conform with patterns of continuous use of marine resource use demonstrated elsewhere and do not suggest that southeast Queensland was an anomaly (cf. Walters 1992b:35). There is strong evidence that fish resources have been an important component of food production strategies in coastal and riverine contexts since initial occupation of the continent (e.g. Allen *et al.* 1989; Balme 1995) with a range of studies confirming Pleistocene use of marine resources throughout Australia at sites which have always been in close proximity to the sea (e.g. Morse 1988; O'Connor 1999; Smith and Sharp 1993; Veth 1993). Early marine resource use, however, is poorly documented in most regions owing to a dearth of coastal sites dating from the early Holocene, many of which were presumably drowned by marine transgression.

The southern Curtis Coast fish bone data contribute to our understanding of the role of marine resource use in early post-transgressive marine-based economies in southeast Queensland. From around 5000 BP, and broadly coincident with the final stages of the last marine transgression, increasing numbers of open coastal sites are known, with dates of 4830±110 BP (Beta-33342) at New Brisbane Airport and 4350±220 BP (Beta-20799) at Hope Island in the Moreton Bay Region, 4780±80 BP (Beta-25512) at Teewah Beach 26 in the Great Sandy Region and 4274±94 BP (NZA-456) at Mazie Bay in the Keppel Islands (Ulm and Reid 2000). The first evidence for occupation on the southern Curtis Coast at the Seven Mile Creek Mound at 3780±60 BP (Wk-8327) conforms well with these findings, suggesting continuity rather than disjunction in patterns of coastal occupation.

As always, caution needs to be exercised in interpreting data from early periods of occupation owing to reduced 'archaeological visibility' of settlement-subsistence strategies 'with low-level seasonal visitation or occupation of regions with unstable and rapidly eroding land surfaces' (Mulvaney and Kamminga 1999:179). Dortch *et al.* (1984) have also pointed out that low intensity shellfish gathering (and fishing) is unlikely to be represented in the archaeological record owing to the low probability of small shell scatters being preserved (see also Smith 1999). First evidence for occupation of the region should not, therefore, necessarily be taken as indicating the antiquity of coastal settlement or use of the coast. Following the positions advanced by McNiven (1991), Hall and Hiscock (1988) and others, we argue that marine and estuarine resources would have always been an integral feature of broad-based Aboriginal coastal economies. Although access to coastal resources may have been difficult at periods of maximum sea-level fall, expanded river valleys across the continental shelf would have offered a range of resource zones, some perhaps with no modern correlates. After rising sea-levels breeched the continental rise and began to invade the continental shelf in the terminal Pleistocene/early Holocene there is no reason to suspect that coastal environments did not always provide a range of resources, which were exploited by people even if these resources were not identical to those available today.

Postscript

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Interpreting Surface Assemblage Variation in Wardaman Country, Northern Territory: An Ecological Approach

Chris Clarkson

Abstract

Stone artefacts discarded on the ground surface can be interpreted as the material remains of human decisions about where and when to obtain raw materials, what items to make, how to use them, when to discard them, where to spend time and how to gear-up for trips around the landscape. These decisions are in turn governed by the availability of resources and immediacy of need, and are thus amenable to ecological modelling that specifies actors, currencies and goals in relation to variable foraging conditions. This paper employs ecological models to explore the determinants of open site lithic assemblage variation in Wardaman Country, approximately 120km southwest of Katherine in the Northern Territory. The results suggest that foraging models are a useful means of exploring assemblage variation that are perhaps underutilised in the Australian context.

Introduction

Archaeologists have long sought the meaning of patterning in the chipped stone artefact scatters strewn across the Australian landscape. Modelling the advantages of certain technological strategies and foraging behaviours can help understand patterning in open sites and assemblages, yet this approach has played a minimal role in exploring assemblage variation in Australia. The purpose of this study is to determine the factors conditioning the location, duration and complexity of past human activities in the landscape from variation in the size and composition of open stone artefact assemblages. By examining patterning in surface assemblages from Wardaman Country, it may be possible to infer foraging practices and the various technological provisioning strategies employed to balance the constant need for stone tools with the differential structuring of resources in the landscape.

Understanding the effects of foraging practices and land-use strategies on lithic assemblage composition involves combining several bodies of theory. This includes theory derived from processual and behavioural archaeology that examines optimality in the strategic organisation, design and assembly of stone tools, and models drawn from evolutionary ecology that explore trade-offs in prey harvesting and processing strategies. Working from this theoretical background, a number of predictions can be made about past foraging practices and technological strategies that might have been employed in different land systems given varying resource distribution and value. These predictions are tested against data from 305 open surface assemblages, and the utility of this approach to modelling past land-use assessed.

Technological Provisioning Strategies

A large body of theory has been developed to explore optimality in the manufacture and assembly of lithic technologies (Bamforth 1986; Bamforth and Bleed 1997; Beck *et al.* 2002; Binford 1979; Bleed 1986; Kuhn 1995; Nelson 1991; Parry and Kelly 1987; Shott 1986; Torrence 1983, 1989; Ugan *et al.* 2003). This theory specifies the ways in which technologies can offer people specific advantages in different foraging contexts. Technology is expected to respond to a number of variables, such as variation in the frequency, predictability and range of residential moves (Shott 1986), the functional requirements for exploiting different kinds of resources (Binford 1979), time-stress and risk (Bamforth and Bleed 1997; Fitzhugh 2001; Torrence 1983, 1989), opportunities for maintenance (Bleed 1986), the richness and diversity of foraging opportunities (Ugan *et al*. 2003), and the availability of replacement raw materials (Goodyear 1989; Nelson 1986; Parry and Kelly 1987). Different circumstances may give rise to different responses in terms of the way raw materials are provisioned and the way the toolkits themselves are manufactured and assembled. Two popular models are described here that could represent solutions to the problem of maintaining a constant supply of tools under conditions where mobility and the abundance and predictability of resources vary. These strategies are called the *provisioning of individuals* and the *provisioning of places* (Kuhn 1995:22), and subsume the more common and problematic concepts of 'curated' and 'expedient' technologies (Binford 1979; Nelson 1991).

Kuhn's provisioning of individuals represents one possible response to situations where mobility is high, foraging is unpredictable and future contingencies must be planned long in advance, with little certainty over where or when manufacturing and maintenance tasks will take place. This strategy could be linked to situations of high logistical mobility in patchy environments, to high residential mobility where foraging opportunities may not coincide well with opportunities to reprovision with raw materials, and where opportunities to make and repair tools cannot be scheduled with any certainty. Individual provisioning might also arise as a result of resource depression – or diminishing encounter rates with high-ranked prey owing to over predation (Broughton 2003; Broughton and Grayson 1993) – leading to longer travel times to more distant patches, as well as increased stochastic variation in resource availability and foraging returns.

This strategy should have direct consequences for the production and form of lithic assemblages, as determined from ethnographic studies and optimality models. For instance, the significant transport costs entailed in high mobility (whether frequent residential or long-distance logistical moves; see Binford 1979) may tend to select for light-weight tools (Shott 1989). Increased frequency and/or range of moves may also constrict the diversity of assemblages to some degree, placing greater focus on versatile, multifunctional implements, as opposed to the transport of numerous tools designed for specific tasks (Shott 1989). Because access to replacement material may be difficult to predict during times of uncertainty, tool use-life might also tend to be extended and high quality raw materials suited to constant resharpening might be employed (Goodyear 1989; Hiscock 2006; Macgregor 2005). Alternatively, tools might tend to be manufactured with the capacity for recycling so that unscheduled tasks can be more easily accommodated (Dibble 1995; Kuhn 1995). As high mobility toolkits are likely to be smaller, they may also tend to be employed as components in composite, hafted tools to increase efficiency and power (Keeley 1982; Odell 1989). Opportunities to reprovision with new tools might be few and unpredictable in highly mobile and/or variable foraging contexts, and so stone tools might also tend to incorporate aspects of maintainability and/or reliability (Bleed 1986). To meet these requirements, stone artefacts might be designed as interchangeable tool bits to fit pre-fabricated hafts, thus requiring a degree of standardisation in their morphology. To increase reliability by offsetting the risk of breakage at times of critical need, tools may also form one of a number of multiple redundant components, such that if one component fails the entire system need not fail (Bleed 1986; Myers 1989).

Toolkits designed for individual provisioning might therefore tend to be portable, versatile, flexible, maintainable and reliable, and might also tend be made well in advance of use so as to be on-hand when and where they are needed (Bleed 1986; Nelson 1991). It should be noted here that while statements such as these are framed as speculative assertions, they are derived from countless observations of hunter-gatherer technologies in purpose-driven observational settings and have been tested to varying degrees against archaeological cases (Binford 1977; Ebert 1979; Kelly 1995; Shott 1986; Smith 1983; Torrence 1989). Thus, individual provisioning could provide one effective solution for dealing with high mobility, high subsistence risk and problems of time-stress (Torrence 1983, 1989). In the Australian context, retouched implements such as points, tulas, backed artefacts and burrens (along with other heavily retouched standardised forms) have been suggested as good examples of the kinds of implements that might be employed in individual provisioning (Clarkson in press; Hiscock 1994, 2006; Law 2005).

The provisioning of places, on the other hand, may be a suitable strategy when the location and timing of activities to be performed in the future is much more predictable and mobility is low. According to Kuhn (1995), this strategy would tend to be employed at locations where the diversity or richness of subsistence opportunities is much greater, such as when high-ranked resources are abundant and close by, variance in foraging returns is low, and resources are clumped and patchy and suited to exploitation from a central place of low residential mobility. The provisioning of places should promote the stockpiling of raw material (i.e. tool making potential) and other site furniture (Binford 1979) at places of relatively longer-term residence, where the type of equipment needed can be predicted and where the range and quantity of extractive and processing tasks is greater. Caching such items would likely provide greater flexibility in tool production and use, and would also guarantee access to costly but efficient processing technologies like grindstones that may be desirable to have at such locations. Since this provisioning strategy would be best adopted under conditions of low mobility and relatively short-range logistical foraging, material might be expected to be transported to the central place over relatively short distances, and not to have been pre-processed to any significant degree. Raw material stockpiling might therefore be a common feature of place provisioning, and might include such strategies as the provisioning of large cores that offer maximum flexibility in terms of the creation of fresh sharp edges of a range of shapes and sizes with minimal processing required.

The following section introduces the study region and identifies variation in the structuring of resources in the landscape. This enables different land systems to be ranked in terms of resource value and specific predictions about foraging practices and technological provisioning to be developed which can be tested against the archaeological record.

The Structuring of Resources in the Study Region

The study region represents an area of c.2300km² in the heart of Wardaman Country in the Northern Territory (Figure 1). The region was chosen for investigation as it has been a focus of archaeological research since Davidson's (1935) work in the 1930s, playing a central role in the construction of northern Australian prehistory (Mulvaney 1969), and resulting in the excavation of many deeply stratified sites and in detailed rock art recording and analysis (David 1991; David *et al*. 1990, 1992, 1994, 1995). This combination of factors has made the region an ideal one for exploring long-term technological change and for positioning the numerous excavated rockshelters within the context of varying land-use patterns, as revealed from open sites. The study region itself was delimited in such a way as to encapsulate previously excavated rockshelters and to capture variation in the region's physiography and natural resources.

The region has a hot, dry, monsoonal climate with vegetation and soils typical of semi-arid to arid lands, especially in the south (Slayter 1970). Rainfall is generally restricted to a short, heavy, wet season when low-lying country is often totally inundated, but waterholes and creeks dry up during the long dry season. This region experiences great variability in inter-annual rainfall (Dewar 2003), and this is likely to have been the case for many thousands of years (Clarkson and Wallis 2003; Schulmeister and Lees 1995).

The region can be partitioned into a number of land systems developed by the CSIRO to capture variation in vegetation, geology, hydrology, geomorphology and soils (Stewart 1970). These units provide a useful means of exploring potential influences of resource variability on past land-use practices. Six land systems exist in the study region: Pinkerton, Dinnabung, Napier, Frayne, Mullaman and Willeroo (Figure 1). Pinkerton consists of rugged stone country in the form of tablelands and well-watered gorges; Dinnabung of gently undulating limestone country with many creaks and waterholes; Napier and Frayne consist of hilly basalt country with mesas and volcanic benches; Mullaman of dissected elevated lateritic plains, mesas and scarplines; and Willeroo of predominantly black soil plains.

Both the Dinnabung and Pinkerton systems are rich and diverse in wild foods and permanent water, contain higher than average densities of fringing vegetation communities and vine thickets, and contain all of the largest permanent waterholes in the region (see Clarkson 2004 for details). The Napier, Mullaman, Willeroo, and Frayne systems are less productive in terms of wild foods, have poor water availability and possess little more than the generic range of woodland, grassland and savannah dwelling species. The small pockets of richer habitat found in these systems tend to be isolated and patchy. Natural shelter is reasonably abundant in these poorer systems, however, and the Napier, Willeroo and Frayne systems possess large sandstone outliers with numerous overhangs and declivities. Shelter is

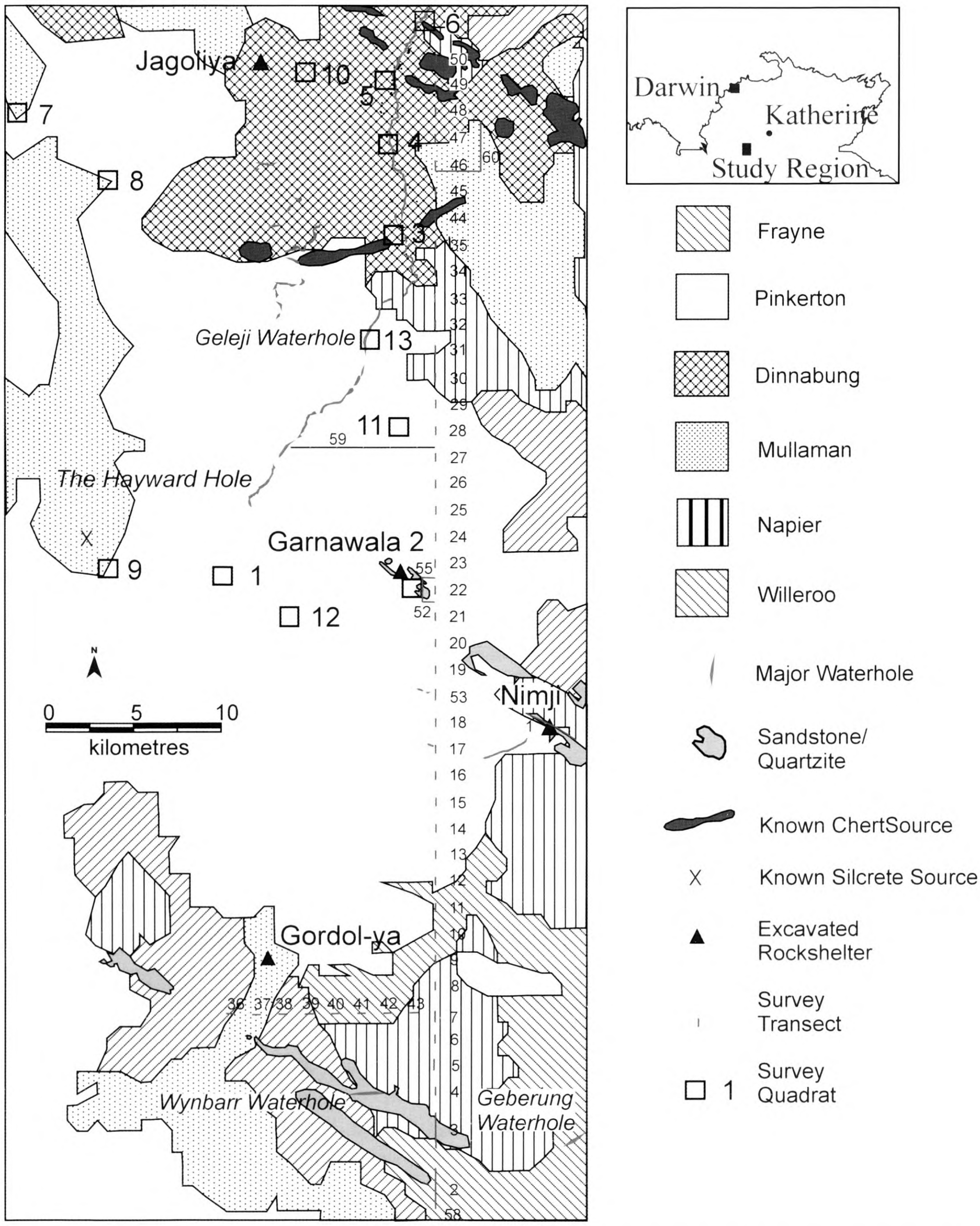

Figure 1. The study area showing the location of land systems, survey quadrats and transects (numbered boxes and lines), raw material sources, excavated rockshelters and major waterholes.

relatively scarce in the richer Dinnabung system as rock outcrops are typically limited to chert ridges and limestone pavements. The Pinkerton system offers natural shelter in gorges and rocky outcrops, although traversing this terrain is more difficult owing to its dissected and rugged nature.

Raw materials are also differentially distributed across land systems. The Frayne, Napier and Willeroo land systems contain many suitable raw materials in abundance, such as chalcedony, hydrothermal jasper and abundant quartzite with excellent flaking properties found in enormous outcrops. Raw materials are more limited in the Pinkerton system, with rare and highly localised sources of distinctive white quartzite representing the only known sources. Silcrete is found atop laterite-capped tablelands and mesas in the Mullaman system, but is also not particularly abundant. Chert is abundant within the Dinnabung land system, both in terms of number of sources and size of outcrops, with outcrops sometimes up to several kilometres in length. Specific sources can be identified archaeologically from distinctive colours and cortex in some cases, and almost all artefacts can be assigned to their likely geological formation, providing clues as to their provenience and minimum transport distances.

Overall, this combination of resources and disjunctions in resource location should create a tendency towards more intensive habitation of some areas than others and at different times of the year. This should have important implications for the amount of time people spent in each location, the range of activities conducted there, the predictability and cost of locating and exploiting adequate supplies of food, water and shelter, and the various strategies employed to maintain a supply of stone tools. Further precision in modelling differential land-use can be obtained by ranking each land system in terms of economic value, access to raw materials and seasonal constraints and opportunities.

Calculation of the rankings for 25 categories of prey found in the study area according to kcal/hr returns as gleaned from the literature, as well as their differential occurrence in each land system, allows land systems to be ranked in terms of the abundance of high-, medium- and low-ranked resources (see Clarkson 2004 for details). The most high ranking resources are found in the Dinnabung (50 high, 27 medium, 7 low) and Pinkerton (45 high, 22 medium, 7 low), followed by Mullaman (32 high, 11, medium, 7 low), then Napier and Willeroo (6 high, 1 medium, 4 low) and finally Frayne which had the lowest ranking and contained only the generic range of woodland species found throughout the study region.

Modelling Foraging and Technological Responses to Resource Structuring

Foraging models are mathematical models that help understand the sorts of actions people *should* take in given situations, even if no-one ever acts like this all of the time or even conceptualises problems in exactly this way. Although foraging models are typically written out as formal mathematical models, such descriptions are not required to understand the basic principles outlined here. Foraging models not only predict what actions foragers should take in searching for and capturing food in certain circumstances but also help understand how and why people's behaviour might change to increase foraging returns over time. Popular models include the diet breadth model, patch choice and time allocation model, central place foraging model and the geometric model of optimal dispersion.

The diet breadth, patch choice and time allocation models predict that foragers should apportion time to pursuing resources and searching patches (in this case, land systems), according to their intrinsic value once encounter and processing times have been factored in (Kaplan and Hill 1992; MacArthur and Pianka 1966). The diet breadth model also states that lower-ranked resources should be pursued in order of diminishing returns only when higher-ranked resources are unavailable. A drop in the density of higher-ranked prey, for instance, should result in foragers broadening the diet to include lower-ranked resources. Based on the resource rankings presented for each land system above, we should expect foragers to have spent more time exploiting the Dinnabung and Pinkerton land systems, followed by Mullaman and then Willeroo, Napier and Frayne.

We might also expect that the combination of high-ranked subsistence resources and permanent water sources would have attracted prolonged human habitation of certain systems over the long, hot, dry seasons in preference to other land systems. Such a situation might have lead to resource depression (i.e. a decline in resource encounter rate) around those waterholes. The central place foraging model (Orians and Pearson 1979) predicts that in such a situation people should broaden the diet and/or begin to exploit surrounding areas where returns may be higher, requiring longer foraging trips (Broughton 2003; Broughton and O'Connell 1999; Charnov *et al*. 1976; Nagooka 2002). The geometric model of optimal dispersion (Horn 1968) suggests that people tethered to such well-watered areas should exploit more distant resources via long-distance, logistical forays because high ranking resources in the surrounding systems in the study region tend to be patchy and clumped. Alternatively, people may include lower-ranked resources in the diet such as starchy seeds and other foods that require lengthy processing times. Use of such resources might be indicated by the use of grindstones and anvils in these land systems. Heavy rains would likely have made exploitation of the Dinnabung and the low-lying black soil plains of the Napier, Frayne and Willeroo land systems difficult in the wet season, and elevated terrain offered by the Pinkerton and Mullaman systems may have been preferable areas for foraging and habitation at such times.

A derivation of the central place foraging model is the field processing model. This predicts that people procuring stone in landscapes rich in lithic materials, but for use in land systems where subsistence opportunities are greater and more downtime is available for implement manufacture, should field-process raw material and transport only the highest utility components back to the central place (Beck *et al.* 2002; Bettinger *et al.* 1997; Metcalfe and Barlow 1992). The greatest diversity and abundance of raw materials is found within the low-ranked Napier, Frayne and Willeroo land systems, and usually occurs at least several kilometres from the major waterholes of the Pinkerton and Dinnabung land systems. We might expect to find evidence of field-processing at sites and stone sources located within the Napier, Frayne and Willeroo land systems.

Some predictions can now be formulated about likely foraging practices and technological provisioning strategies employed in the study area, as well as some of their likely archaeological correlates:

- Higher patch value and permanent water sources should translate into lower mobility in the Dinnabung and Pinkerton land systems, more intensive occupation, and more frequent and predictable revisitation. This should be detectable archaeologically in terms of more and larger sites with greater artefact densities in these two land systems.
- The high economic value, greater water availability, low residential mobility and frequent revisitation of the Dinnabung and Pinkerton should result in more frequent provisioning of places in these land systems. The use of a place provisioning strategy in these land systems should be detectable as the stockpiling of raw materials in places of predictable use, the establishment of site furniture and greater assemblage diversity than for other land systems.
- If, as predicted, both of these land systems were also used as staging points for logistical forays into other lower-ranked patches, we might also expect an element of individual provisioning, since foraging parties would likely gear-up for high mobility, time-limited trips during periods of downtime while situated in residential camps. Evidence for the manufacture and repair of toolkits characteristic of individual provisioning should therefore also be found in these land systems. The ability to identify the various stone sources accessed from each land system also allows the diversity of other land systems visited to be tracked to some degree. We might also expect to see the use of equipment for processing hard, starchy resources at low mobility camps as people broaden their diets to include such lower-ranked items as seasonal or other kinds of resource depression set in.
- Medium resource ranking means Mullaman should show intermediate intensity of use as measured by assemblage size, site density etc. If Mullaman was also more intensively occupied in the wet season owing to inundation of surrounding low-lying areas, we might expect an element of place provisioning in the assemblages found in this land system. Technologies should, however, tend more toward individual provisioning since mobility is likely to be moderately high and predictability of reoccupation somewhat less than for Dinnabung and Pinkerton.
- Low resource ranking and water availability mean the Frayne, Willeroo and Napier systems should all show the least intensive use, as measured by site numbers, assemblage size and density, and assemblage richness. Individual provisioning should be represented exclusively in this land system as people pass through quickly in search of dispersed mobile game, to procure raw materials or to access patchy and clumped resources during time-limited logistical forays. Raw material procurement within these land systems may show signs of field processing in preparation for transport to residential camps in other land systems. Fewer technological activities should be represented at sites in these land systems.

Survey Method

To examine variability in site location and assemblage structure, open site surveys were undertaken in two forms. The first was site survey and artefact recording within short transects along sections of a 65km transect running north-south from the Victoria Highway to Hayward Creek and following a recently graded survey track (Figure 1). Several east-west transects were run off this north-south axis to important sites and locations. The north-south axis enabled sampling of many land systems along the main axis of the study region. The second approach involved total survey of 13 x 1km² quadrats strategically placed in relation to land systems, natural resources, and vehicular access. Obviously much of the study region could not be sampled, but all major land systems were targetted so that the effects on the archaeological record of regional variability in resource structure could be examined.

A total of 305 sites was located and more than 9000 stone artefacts were recorded in detail. Survey transects and quadrats sampled all land systems found in the study area and located sites on a wide range of landforms (see Clarkson 2004 for details). Many of the sites located during surveys are likely to be palimpsests and cannot be placed within a precise chronological framework. However, no traces of occupation have yet been found in this region beyond c.15,000 years ago, and the frequent occurrence of retouched implements dating to the last 5000 years in stratified contexts indicates a mid-to-late Holocene occupation for many open sites (Clarkson 2004). The difficulty of examining temporal changes in site use from undated open sites means that all sites will be analysed as though they represent occupations dating to the last 5000 years, even though older assemblages may be mixed with more recent ones. The possible biases and effects of this approach are discussed below.

Site and Assemblage Structure in the Study Region

To test the predictions made above about the likely consequences of resource variability on past land-use practices, a set of tests are employed to explore variation in site type, abundance and assemblage characteristics between land systems. These focus on differences in site type, site size, assemblage diversity, reduction intensity and raw material transport to elicit differences in occupational intensity, the nature and complexity of site use, the range of manufacturing stages and activities, patch visitation history and field processing.

Site Type

We should expect to find differences in the kinds of sites located in each land system that reflect the kinds of resources present, opportunities for specific activities, and the potential for varying occupational durations and intensities. Figure 2 plots the percentages of open scatters, quarries and rockshelters found in each land system and confirms the differential distribution of resources and foraging opportunities identified above. Quarries are most abundant in land systems where an ample supply of stone exists (i.e. Napier, Frayne and Willeroo), whereas open site scatters are dominant in land systems where the range of resources is greatest (Dinnabung, Pinkerton and Mullaman). This likely reflects the broader range of activities performed and the greater propensity for habitation in these systems (see below).

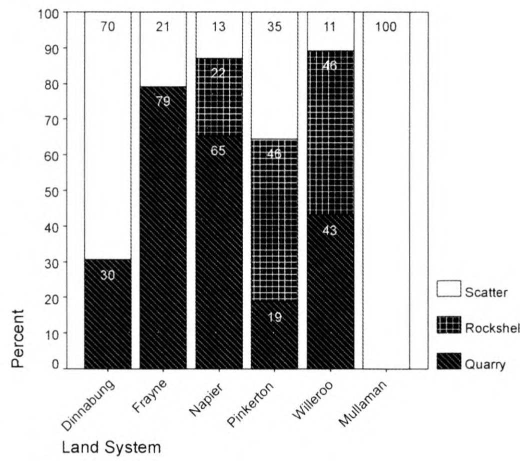

Figure 2. Site type by land system.

Site Size

Site area and artefact density together provide a useful measure of occupational intensity, although such measures offer no indication of whether differences represent the duration of occupation, frequency of visitation, group size or combinations of these. Figure 3 plots the mean area of sites in metres squared for each land system. Dinnabung has by far the largest sites of any land system, followed by Mullaman and Pinkerton. As predicted, the largest sites occur in Dinnabung and are at least five times the size of those in any other land system. The larger size of the Mullaman sites compared to Pinkerton, however, does not meet the predictions made above. One possible explanation is that large Mullaman sites (Quadrats 7 and 8) were found along the edges of elevated tablelands overlooking the rich river valleys and lower-lying areas of the Dinnabung and Pinkerton systems below. It is possible that these large sites are the result of people relocating from low-lying seasonally inundated areas to dry, elevated terrain with good breezes during the hot monsoon season (see below), but nevertheless continuing to focus on the exploitation of resources in the nearby Pinkerton and Dinnabung land systems.

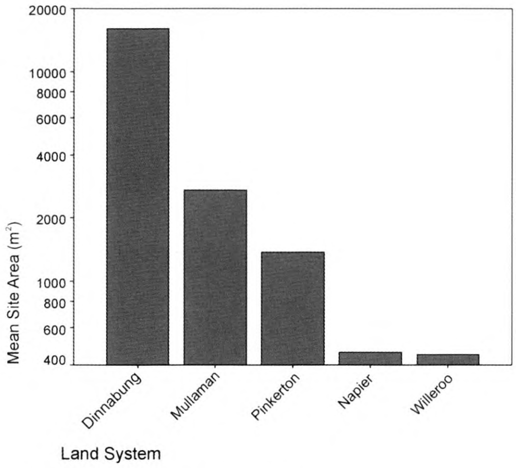

Figure 3. Site area by land system.

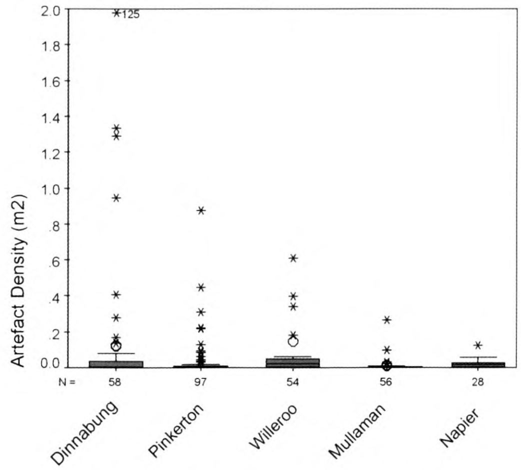

Figure 4. Artefact density for scatters by land system.

Dinnabung and Pinkerton also have the highest artefact densities for scatters in the study region (Figure 4). This time the trend is reversed, and Mullaman has the second lowest artefact densities. This is most likely because sites in Mullaman, though large, are stretched out along broad, flat, plateau edges, rather than confined within more limited habitable areas on undulating terrain.

Assemblage Diversity

Table 1 provides data on the range of assemblage components found in each land system. A wider range of technological activities is evident in the higher ranking systems of Dinnabung and Pinkerton. Mullaman and Willeroo show moderate diversity while Napier and Frayne show the least. Assemblage diversity is comparable for the Mullaman and Willeroo systems, and the stone implements found in both of these systems are suggestive of the use of a few portable, long use-life artefacts, typical of individual provisioning. These include unifacial points, bifacial points and tulas. The diversity of implements found in Dinnabung and Pinkerton, on the other hand, is not only greater, but also qualitatively different. Sites in these land systems contain many more recycled implements, such as burinated flakes, scrapers and points, recycled broken flakes and bipolar cores, suggestive of low mobility situations where old and damaged equipment is replaced and recycled during periods of downtime.

Grindstones probably fall within Binford's (1979) concept of 'site furniture' in the sense that they are bulky and costly items only found in places where people intend to return frequently in order to recoup the considerable costs in time and energy required to manufacture and transport them. Grindstones and anvil stones were found in open sites in the Dinnabung, Pinkerton, Mullaman and Willeroo land systems, but not in the Frayne or Napier systems. This is consistent with frequent and predictable reoccupation of sites in these landscapes, and also suggests that people included lower-ranked resources in their diet in these places, possibly in response to resource depression brought on by over predation of favourable habitation areas in dry seasons where opportunities for residential moves were limited.

Table 2 shows the frequency of different retouched implements found in each land system. The high proportion of points and tulas and the low proportion of lancets (Cundy 1990; Roth 1904) stands out for the Mullaman system. This points to heavy reliance on the most portable and extendable items in the toolkit at these sites, as well as infrequent manufacture of new implements from transported blanks. The high proportion of quartzite lancets found in the Willeroo, Pinkerton and Dinnabung systems points to frequent pre-processing of cores in the Willeroo system to obtain high utility blanks for point manufacture, and their transport to and stockpiling in the two high-ranked systems – an indication of field processing in anticipation of long-distance transport to residential areas where down time for tool manufacture was available. Once again it can be seen that recycling of implements and the discard of exhausted tools such as tula slugs is largely confined to Dinnabung and Pinkerton.

Table 1. Diversity of implements found in each land system (presence/absence).

Frayne	Napier	Willeroo	Mullaman	Pinkerton	Dinnabung	Land System	
	•	•	•	•	•	Rotated Core	Unretouched
•	•	•	•	•	•	Redirecting Flake	
•	•	•	•	•	•	Single Platform Core	
		•	•	•	•	Anvil/Grindstones	
•	•	•	•	•	•	Flakes	
•	•	•	•	•	•	Lancet	
		•			•	Bipolar Core	
				•	•	Burin Spall	Retouched
			•	•	•	Retouched Flakes (Scrapers)	
		•	•	•	•	Bifacial Point	
		•	•	•	•	Unifacial Point	
				•		Ground-Edge Axe	
		•	•	•	•	Tula	
				•	•	Tula Slug	Worn, Transformed and Recycled
					•	Burinated Unifacial Point	
					•	Retouched Broken Unifacial Point	
					•	Retouched Broken Bifacial Point	
				•	•	Burinated Lancet	
				•	•	Retouched Broken Flakes	
					•	Burin	
4	5	9	9	14	18	Diversity	Summary Statistics
0	0	3	4	8	11	Retouched Implement Diversity	
0	0	0	0	2	6	No. Recycled Classes	
0	0	10	104	219	187	No. Retouched Implements	

Table 2. Percentage of retouched implements and lancets found in each land system.

Willeroo	Pinker	Mulluman	Dinnabung	Land System
55.9	27.6	11.1	25.5	**Lancet**
17.6	31.6	66.7	28.6	**Unifacial Point**
23.5	14.8	11.1	18.0	**Bifacial Point**
0	0	0	0.6	**Bipolar Lancet Butt**
0	0.5	0	5.0	**Burins**
0	0.5	0	1.2	**Burin Spall**
0	1.5	0	2.5	**Burren**
0	0.5	0	0	**Ground-Edge Axe**
0	20.9	0	14.9	**Recycled Artefacts**
2.9	1.5	11.1	3.1	**Tula**
0	0.5	0	0.6	**Tula Slug**
34	196	9	161	**Total Retouched Implements**

Reduction Intensity

The index of invasiveness (Clarkson 2002) is used to measure the amount of retouch found on flakes and hence the stages of manufacture and repair represented in each land system (intensity of reduction ranges from 0 to 1 on this index). An interesting pattern emerges when retouch intensity is examined for each land system. The Mullaman assemblages show the highest average retouched artefacts of all land systems (median = 0.7, index range = 0.5–1), yet Dinnabung and Pinkerton show the greatest range (median = 0.5, index range = 0.1–1.0), with both early and late stage reduction represented. This suggests that more downtime was available within the Dinnabung and Pinkerton systems in which to repair and recycle implements at late stages of reduction, and to manufacture early stage items in preparation for time-limited forays. In contrast, only high levels of retouch are found in the Mullaman system, which suggests higher mobility and less available downtime for implement manufacture. The fact that the Mullaman sites are also located at moderate distances (>7km) to replacement stone suggests that the use-lives of transported toolkits were extended through more intensive resharpening, leading to higher levels of reduction.

The same pattern is seen for core reduction. The cores transported to sites within the Mullaman system show signs of more extensive reduction (mean = 1.75 rotations, range = 1–4 rotations), suggesting a greater need to conserve raw materials while mobility is high and access to replacement raw materials more difficult to predict. The range of early and late reduction stage cores in Dinnabung (mean = 1.5 rotations, range = 0–4) and Pinkerton (mean = 1 rotation, range = 1–3 rotations) implies frequent stockpiling of raw material at locations of regular and predictable use where a wide range of activities was anticipated. The high average number of core rotations in these systems also likely reflects the effects of prolonged use of sites such that available materials were often exhausted before they were restocked. Cores from Napier and Willeroo are little rotated in comparison (mean = 0.5 and 0.3 respectively), with a maximum of two rotations in Napier and one rotation in Frayne, reflecting abundant access to raw material and low intensity site use.

Raw Material Transport

Consistent with the pattern of artefact reduction, Mullaman shows the highest rate of long-distance raw material imports, suggesting occupation frequently took place within the context of long-distance high mobility forays (Figure 5). Dinnabung and Pinkerton show both long- and short-distance raw material transport, indicative of both local and long-distance foraging and procurement, while the remaining land systems show almost exclusive use of local raw materials. Artefact procurement in these systems is almost exclusively centred on local quartzite, consistent with stone procurement as the dominant activity carried out at open sites in these land systems. The few sites in Willeroo that contain evidence of longer-distance raw material transport are also associated with toolkits typical of individual provisioning (i.e. bifacial points and tulas), and hence likely represent infrequent logistical forays into this land system.

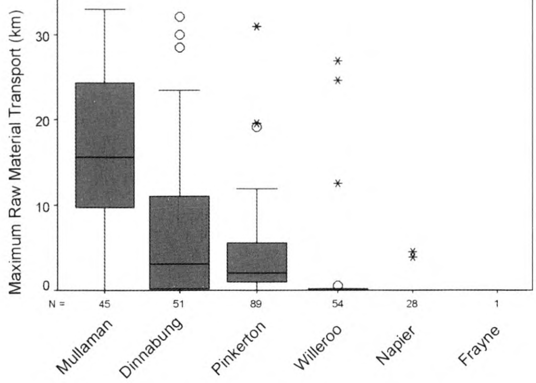

Figure 5. Maximum raw material transport distance for each land system.

Dinnabung, Pinkerton and Mullaman all show extensive travel to and from a large variety of sources at differing distances to sites. If raw material use reflects patch use history, as it should if procurement is embedded within foraging trips (Binford 1979), then raw materials indicate the potential visitation of at least nine raw material sources outside Dinnabung, at least eight outside Pinkerton, and at least six sources outside Mullaman. Only a single additional locality was exploited from Willeroo, and no evidence for the use of additional external sources was found at sites in Frayne and Napier.

Discussion

From the patterning in site and assemblage characteristics documented above it is possible to infer something of the nature of time allocation, patch choice, mobility and technological provisioning in the study region. The measures of site size, area, complexity and density indicate that a great deal more time was allocated to foraging and occupation in the Dinnabung and Pinkerton systems than to other land systems. This accords well with predictions made above about resource structuring and optimal patch use. The lower occupational intensity seen for the Mullaman system (though still much higher than for the Frayne, Willeroo and Napier systems) is also in step with a medium patch ranking.

The greater technological diversity seen in the Dinnabung and Pinkerton systems supports the notion that people conducted a greater range of activities there, and that residential mobility was probably lower than in neighbouring systems. The evidence in top ranking systems for long-distance transport of raw materials, high artefact diversity and greater use of surrounding patches also meets predictions, and appears to indicate exploitation of the surrounding landscape through the use of logistical forays mounted from low mobility residential bases. Raw materials imported over long distances probably reflect embedded procurement of stone encountered while engaged in such long-distance forays. The signature for Dinnabung and Pinkerton therefore appears congruent with place provisioning of a number of low mobility residential bases, as well as high mobility logistical use of surrounding regions employing toolkits characteristic of individual provisioning. The high diversity of items and abundant signs of retooling and recycling in these systems most likely reflects the manufacture and maintenance of items during periods of downtime spent in residential bases. The relatively high frequency of lancets in the Dinnabung and Pinkerton systems confirms the transport and stockpiling of blanks at residential sites for use in the manufacture of new implements, or as cached items to be used as situation demands.

Use of the Mullaman system appears to have been a mix of both high residential mobility, in which only the most portable and extendable retouched toolkits were employed, and lower mobility, as signified by the presence of site furniture and large sites on plateau edges. One possible interpretation is that Mullaman saw lower mobility place provisioning of the elevated plateaus during the wet season when large parts of the Dinnabung land system were inundated by heavy rains. Individual provisioning and higher residential mobility were likely a feature of occupations during the dry season.

In contrast to these three systems, the low-ranked Willeroo, Napier and Frayne systems show low occupational intensity, with a strong focus on stone procurement and early stage core reduction and flake production. It is also likely that blank production took place at quarries situated within these systems ready for transport to more distant residential camps. Though few large sites exist in these land systems from which to assess the nature of technological provisioning, the one site found in the Willeroo system with a sizeable sample of retouched implements possessed an assemblage characteristic of individual provisioning (i.e. points and tulas).

Climatic and ecological changes have likely been significant in the study region over the last 15,000 years, involving drier more variable conditions in the mid-Holocene, wetter and more stable conditions in the early Holocene, and drier and more variable conditions in the terminal Pleistocene (Kershaw 1995; McGlone *et al.* 1992; Schulmeister and Lees 1995). Fluctuations in the quantity and predictability of rainfall would most likely have resulted in contractions and expansions of various resources with different rankings. The fact that strong patterning exists in the data despite such fluctuations perhaps indicates that while land systems, prey species and important habitats may have waxed and waned, they did not do so to the degree (at least in the last 15,000 years) that general patterns are completely obscured or obliterated. Testing the effects of climate change may be possible by dividing the assemblages into those with and those without temporal markers such as points and tulas, but such an analysis is beyond the scope of this paper.

Conclusion

The relationship documented between high resource ranking, intensive occupation and low residential mobility in some patches, of medium ranking, poorer resource availability and a mixed mode of occupation in others, and low ranking, high mobility and infrequent visitation for anything besides stone procurement in the remaining patches, confirms the enormous potential of foraging and technological modelling in interpreting surface assemblage variability. The approach adopted here has facilitated our understanding of the scheduling and structuring of subsistence and land-use and the strategic organisation and manufacture of lithic technologies.

The tight fit between modelled expectations and observed patterns also means an important point can be made in relation to the existence of past systems of indigenous land classification. While it is not possible to directly observe prehistoric systems of resource ranking and land-use, the fact that predictions modelled from ecological theory find a satisfactory match with the archaeological record indicates that people must have in some way embedded notions of patch value and time budgeting into their knowledge frameworks, land classification and foraging actions. This is what we should expect of intelligent foragers successfully exploiting variable landscapes, and it highlights the human capacity to track and maintain foraging efficiency at temporal scales that must at times have been greater than human life spans. We therefore need not see ecological approaches to the explanation of human behaviour as dehumanising, for they may in fact make apparent the underlying decision-making that must have taken place to generate such a close fit between predicted behaviour and the archaeological record. Aberrations from our models of course stand to illuminate historical contingencies and local factors that brought about the deviations or alternative strategies that constitute human diversity. Unfortunately, the precise detail of historical events and the ways that ecological information and decision-making was encoded, enacted, modified and reified is largely lost to us.

That optimality models appear to explain even some behaviour attests to their utility in anthropology and their ongoing importance in explaining human evolution and cultural variability. Analyses that combine ecological modelling with a focus on the strategic role of lithic technology in efficient land-use have the potential to tap the vast amount of information that resides in surface assemblages, and derive meaning from this ubiquitous but largely underutilised archaeological resource. When used to solve problems encountered in the interpretation of other kinds of sites, such as inter-assemblage variation in rockshelter deposits, such studies could prove very powerful indeed.

Postscript

This paper presents the results of lithic analyses first begun while a student of Jay Hall's at the University of Queensland. Jay is largely responsible for beginning my possibly foolhardy fascination with stone artefacts. He introduced me in my third year to the debate between François Bordes and Lewis Binford concerning the interpretation of Mousterian assemblage variability. He also piqued my interest in human ecology both through his class teaching and a series of departmental seminars he organised to encourage student awareness of this body of theory. Of course, Jay's own modelling of hunter-gatherer settlement and subsistence has proved very influential in Australian archaeology as it has to me and to the many others involved in the highly successful long-term MRAP programme he initiated in southeast Queensland. I offer this paper in thanks to Jay for beginning my career in archaeology and for his advice and mentorship over the years.

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Starch Grains, Stone Tools and Modern Hominin Behaviour

Richard Fullagar

Abstract

Starch has been found in a wide variety of archaeological contexts over time periods spanning much of human history. Starch grains, particularly in conjunction with use-wear traces on stone tools, have high potential for tracking the exploitation of plant resources and particularly the nature of plant food processing in many parts of the world. This paper reviews the evidence of starch grains as indicators of food in the archaeological record, and suggests that plant processing techniques such as grinding seeds, cooking and leaching might be found much earlier in the history of modern humans than previously thought possible. To explore origins of modern human behaviour, it is argued that we need comparative datasets on starchy plant food processing among different hominin species.

Introduction

Stone tools provide indirect but compelling ways to identify food in the archaeological record, a methodological topic dear to Jay Hall's heart (e.g. Hall *et al.* 1989). The latter publication was one of the first in the Australasian region to attempt identification of plant species (in this example a fern, *Blechnum indicum*) on the basis of starch granule properties. In this paper, I review recent advances in documenting the history of starchy plant food processing, particularly in the Australasian region, and suggest frameworks with relevance for questioning the nature, if not tracking origins, of modern human behaviour.

There is a vast literature on the social context of prehistoric diet and food (e.g. Gosden and Hather 1999), which itself has the habit of transforming people in a more visceral way than more abundant items of material culture like pot sherds or stone chips. Past human diets can be reconstructed in many ways, including study of gut contents, bones, teeth, storage facilities and faecal remains (again, dear to Jay's heart). And, mostly in the context of modern humans, archaeologists have devoted much discussion to environmental constraints, social organisation and the cultural significance of cereal crops, hunting, herding, fishing, feasting and alcoholic beverages in different societies past and present. However, direct macroscopic evidence for plant food and plant processing rarely survives long periods of time, and arguments concerning origins of modern human behaviour have neglected plants, in part because of their apparent or perceived invisibility, compared with faunal remains, in archaeological sequences (Henshilwood and Marean 2003).

A great strength of lithic analysis is its potential to compare vast time depths, even spanning hominid evolution over about 2.6 million years, with an enormous spatial diversity of stone sources and technology. Stone artefacts interact with humans in many ways, and lithic quarries are among the most visible and dramatic of all human structures. Where the material has been available, stone tools have been made and used by nearly all societies. Stone, however, does not always survive; both wind and water can erode the toughest rocks, and stone artefacts can provide a useful taphonomic record. Nevertheless, connected with its relative durability, stone artefacts also often preserve traces of use in the form of scratches, scarring, rounding, polish and abrasion. Less frequently, stone artefact surfaces form tiny time capsules or cultural and natural history data banks, where organic residues survive and can be identified taxonomically (Fullagar 2006a). Stone tools may be in themselves 'only the fingernails of cultural and economic adaptations' (Mellars 2006:ix), but they are also traps for other kinds of data, and the potential contribution of microwear, hafting and residue studies has hardly scratched the surface.

Reliable interpretation of stone tool function takes into consideration raw material, technology and morphological design as well as microscopic traces. Use-wear and residues are particularly important indicators of how tools were used and also what resources were exploited in the past. Consequently, functional analysis of stone artefacts has the potential to test and stimulate new hypotheses about prehistoric subsistence, settlement history and human evolution (Fullagar 2006b). Microscopic residues surviving on stone tools include starch grains, phytoliths and other plant tissues (e.g. parenchyma and resin), which, in certain contexts, can indicate details of plant food processing. In this paper, I focus on recent use-wear and residue studies that indicate human use of starchy plant foods.

Plants and Models of Human Behaviour

Unsurprisingly, archaeological research into plants has focused mostly on agriculture, and transitions to agriculture. Harris (1996) and others have pointed out that since the 1960s, archaeologists have focused attention on the *processes* of plant domestication, as opposed to *states of being* (e.g. wild vs domestic). Harris suggests that a paradigmatic shift occurred 'that emphasised the behavioural and evolutionary continuities that linked, rather than the contrasts that separated, hunter-gatherer 'food-procurement' from agricultural 'food production" (Harris 1996:442). Harris' model of domestication, in conjunction with similar models of animal-human interactions, provides a predicted temporal sequence for the configuration of social and technological variables of which intentional genetic modification is only one among many. Hunter-gatherers, particularly in Africa and Australia, have contributed significantly to our understanding of agricultural origins, transitions to agriculture and alternative trajectories some of which maintained sophisticated knowledge of plants but seemed to avoid full-on agriculture (Spriggs 1997; Yen 1995).

A major impetus for archaeological research into plants and prehistory has been the study of gender by archaeologists, who have re-examined theoretical, anthropological and methodological evidence to indicate roles for women and men from stone technology to hunting, gathering and processing of plant resources (see Gero and Conkey 1991; Soffer *et al.* 2000). Unsurprisingly these enquiries have been initiated by women (Kehoe and Levine 1996), and women have also dominated use-wear studies of plant working (e.g. Anderson 1999; Beyries 1988; Juel Jensen 1994) and fundamental research in Australia on plant microfossils including pollen, starch granules, phytoliths and other tool residues (e.g. Bowdery 1989; Furby 1995; Robertson 2006). Functional studies have decoupled form and function (e.g. all points are not projectile tips), and have changed the way we view artefact assemblage variation (e.g. Beyries 1987). Plant remains are now visible on tool surfaces, and we doubt the idea of a lithic record as the sole consequence of being dropped, discarded or lost by stressed male hunters. While researchers recognise problematic dichotomies of hunter-gatherer/farmer and nature/culture among horticultural (e.g. Dwyer 1996), hunter-gatherer (e.g. Head 2000) and academic (e.g. Head *et al.* 2005) populations, perceptions of the use of plants have changed markedly through time, and Aboriginal Australian intensive use of grass seeds in the late Holocene was seen by many to hover on the threshold of agriculture (Lourandos 1997). Just as 'domestication' and 'agricultural origins' have been recognised as problematic concepts, so too a continent-wide assumption of late Holocene 'intensification' in Australia has been recognised as unsatisfactory (e.g. Cosgrove 1995; Law 2005). An important outcome of research on agricultural origins and hunter-gatherer subsistence is the fact that plant foods have been the mainstay of human subsistence in most societies for most of hominid history. Plants, by their nature, are immobile and can mostly be harvested without danger or, unlike many animal food sources, without retaliation. Whether or not we interpret human evolution as progressive, a time-span way beyond the Holocene is required for investigating the inter-relationships linking people and particular plant species since the emergence of anatomically modern humans, now well beyond 100,000 years ago (cf. Harris 1966). Henshilwood and Marean (2003) outline weaknesses in competing models that promise to explain the origins and evolution of modern human behaviour, usually presented in terms of trait lists. They argue that test implications for these models are often inadequate for at least three reasons. First, they are based primarily on European data (rather than African or other contexts relevant to early human evolution). Second, some explanations are ambiguous, because other processes (e.g. population pressure and forced intensification) might explain the archaeological record better than unproven assumptions of increased brain power or the capacity to create symbols. Third, we need to ask whether particular traits are indeed reliable, appropriate indicators of modern behaviour, which begs the question of what we mean by 'modern human behaviour' – is it what anatomically modern humans do? Is it part of a complex definition of what makes us human? Chase (2003) suggests we drop the term altogether, and adopt specific concepts such as 'symbolically organised behavior' or 'the behavior of anatomically modern humans'. Examples of traits used to indicate modern human behaviour have been listed by Henshilwood and Marean (2003:628) and relate specifically to burial, art, ochre, bone and antler working, lithic blade technology, standardisation, artefact diversity, hearth construction, use of domestic space, exchange networks, large mammal exploitation, seasonality, use of harsh environments and fishing and fowling. McBrearty and Brooks (2000) had previously provided some specific traits with timelines for African prehistory that indicate clusters of activities emerging at different times. Blades, grindstones, pigment processing and points were all being manufactured by at least 200,000 years ago – about the time of the earliest anatomically modern *Homo sapiens*, which comes from Omo (McDougall *et al*. 2004). There is scant mention of plants. Arguments that once linked some of the earliest (1.8-1.0 million years ago) bone tools with plants have been revised by Backwell and d'Errico (2001), who argue they were used to dig up termites for food, which might better account for isotope ratios in bone. The detailed evidence for plant foods appears to have been taken out of the equation in human evolution (but see Soffer *et al*. 2000), and is not commonly reported until closer to agriculture and the Holocene. I discuss the evidence from both ends of time. What evidence is there linking plant food and human behaviour in the early archaeological record? And, how far back in time can we trace particular plant foods from the ethnographic present?

Early *Homo* and Plants

Recent research suggests that the role of plants in human evolution may have been highly significant at times close to the emergence of *Homo erectus*, about 1.8 million years ago.

Although bipedalism and meat eating must have been important factors in hominid evolution, nutritional advantages conferred on humans by hunting large game are at best contentious (Hawkes *et al*. 1991). Wrangham *et al*. (1999) has also maintained that early meat eating could not explain tooth reduction and big brains (despite criticism – see Pennisi 1999), and that cooked tubers, which could have provided regular reliable energy needs may have been the critical ingredient. Moreover, cooking improves taste, digestibility and calorific value. However, plants need to be gathered or accumulated and therefore, they can be stolen; hence the need for bonding between males and females to prevent theft. This social arrangement (i.e. beginnings of pair bonding) might explain sexual receptivity and reduced sexual dimorphism. The evidence for early human fireplaces has been controversial, although Rowlett (1999, 2000) provides strong evidence from diverse phytolith assemblages in fireplaces at Koobi Fora about 1.6 million years old.

O'Connell *et al*. (2002) provide compelling evidence that supports the hypothesis that early East African Rift Valley sites between 1.2 and 2.6 million years ago accumulated from scavenging, not hunting. Scavenging and hunting males with infrequent meat deliveries do not provide reliable food sources for hunter-gatherers. Hawkes *et al*. (1998) and O'Connell *et al*. (1999) suggest that plant food gathering by females nourished family groups on early African savannahs. Female foraging patterns, particularly by grandmothers, would have freed daughters to have more children, and favoured the evolution of post-menopausal longevity (where women live beyond their reproductive years). Tubers are specifically important in this model because young children could not easily dig them up, and kids were more dependent on females for foraging (rather than for milk), after shifts to more seasonal climatic conditions reduced availability of some foods, particularly fruit (O'Connell 2006).

Plants are not only used for food. Recent studies indicate that a range of simple to complex techniques of plant utilisation can be documented archaeologically. For example, microwear studies indicate hafting of core axes at least 200,000 years ago (Rots and van Peer 2006). An indirect connection between plants and an early capacity for language was proposed by Agger *et al*. (2004) who noted the early occurrence of microwear indicating a grass tooth pick, which was reported by Hlusko (2003) on a 1.8 million year old fossil *Homo* premolar from Omo, in Africa. Agger *et al*. (2004) suggest that the ability to sense and the consequent need to remove food particles from between the teeth developed as a result of selective pressures driving the evolution of complex speech which requires development of both the trigeminal nerve and the auditory nerve (the trigeminal nerve in the mouth makes small holes feel like craters and tiny fragments of meat feel like the whole T-bone steak). Of course, there are problems with identifying a capacity (of speech, say) and the unambiguous demonstration of the actual activity or behaviour (Noble and Davidson 1996).

Starch grains have been reported from many environmental and archaeological contexts (see Torrence 2006:19, Table 1.1). Microwear and residue studies are thus well placed to evaluate these hypotheses about processing starchy plant foods (see Torrence and Barton 2006). Research was initiated by Tom Loy to investigate the use of bone implements by *Homo erectus* to dig up starchy roots of *Hypoxis*. Loy announced to the Ancient Starch Research Group at the Australian Museum in 1998 that he had identified starch granules (probably *Hypoxis*) on bone implements from 1.8 million year old levels from Drimolen, in Southern Africa (see Fullagar 2001). Unfortunately the details have not been published, but the survival of starch grains from ancient archaeological and palaeontological time scales demands further study, and may be related to plant fossilisation processes (Barton and Torrence 2006:219).

Later *Homo* and Plants

Van Peer *et al.* (2003) report an assemblage of artefacts from Sai Island, Egypt, dated between about 182,000 and 223,000 years old. Artefacts included core axes with distinct hafting traces (Rots and van Peer 2006), flake tools, cores, large hammerstones and grinding stones made from sandstone and chert, some with ochre (red and yellow) attached. Large cobbles, interpreted as upper grinding and pounding stones, were also found and these bear traces of polish (from grinding), starch granules and phytoliths. Although the starch and phytoliths have not yet been identified to species, their association on tool surfaces suggests processing starchy and siliceous plants, possibly seeds. The absence of hand axes and the evidence for processing pigment and plants provides evidence more typical of later modern human behaviour, absent in preceding Acheulean assemblages. More recent starch grains (c.50–60,000 years old) from Sibidu Cave, South Africa, have also been found on stone points with use-wear and residues indicating hafted projectile tips (Lombard 2005).

However, we should not assume that processing seeds or the use of pigment is necessarily associated with modern human behaviour. Wadley (2001) argues that the first undisputed evidence of cultural modernity lies in storage of symbolic information outside the brain, and discusses four types of symbolic storage that need not be in a package: art, personal ornamentation, style in lithics and the formal use of space. Thousands of pieces of red ochre (two with carved designs), small bone points and 49 shell (*Nassarius kraussianus*) beads (with microwear typical of a necklace) from Blombos Cave appear to be more than 75,000 years old (Henshilwood *et al.* 2004), purportedly providing the oldest evidence of cultural modernity. The problem with Blombos is that it seems so exceptional, although why should we expect such cultural developments to be unidirectional, rapid and widespread?

Hardy *et al.* (2001) report plant traces on tools of Neanderthals from levels at Starosele about 40,000–80,000 BP, and on tools from later, early Upper Palaeolithic levels from Buran Kaya III (32,000–37,000 BP) in the Crimea region. Although the starch is unidentified, they (Hardy *et al.* 2001:10975) explicitly draw attention to currently inadequate microscopic studies of plant remains:

> The perception that plant materials were unavailable to Middle Paleolithic hominids also stems from the differential preservation of macroscopic plant and animal remains … As more investigators look for plant microremains, however, more are being found … and the results presented here suggest that residue analysis may be one way to detect plant remains that might otherwise be unrecovered.

Modern *Homo sapiens* and Plants

The search for archaeological traces of starchy plant food has only just begun, with study of both agricultural and hunter-gatherer trajectories. Importantly, the use of at least 25 genera (with some species more securely identified than others) of plants can now be shown to have a history extending beyond ethnographic contexts (Table 1). Some species identifications are based on starch granules from contexts earlier than 40,000 years ago, roughly the time with the first clear and widespread evidence of symbolic human behaviour (in the form of rock art and beads – see Kuhn *et al.* 2001) in other parts of the world; not that we should expect cultural modernity as a package everywhere at the same time.

The use of tubers, identified from starch granules in dated sediments, is near the limits of reliable age estimates in Niah Cave, Malaysia (Table 1). Barton (2005) discovered a variety of plant species on the basis of starch grain identification indicating sophisticated knowledge of rainforest resources 40,000 years ago. The processing of unpalatable oxalates in taro can be inferred through the evidence of tuber remains on flaked stone tools, presumably used to scrape the outside skins. Later traces of taro are found on grinding stones and flaked stone artefacts in the early and later phases of drainage channel construction at Kuk Swamp, Papua New Guinea (Denham *et al.* 2003; Fullagar *et al.* 2006).

Judith Field and I have identified starch granules on sandstone grinding fragments from a 30,000 year old level from Cuddie Springs, in semi-arid southeastern Australia (Fullagar and Field 1997; Fullagar *et al.* in press). Likely species include a kind of lily (*Crinum flaccidum*), a Poaceae grass and probably nardoo (*Marsilea drummondii*). Nardoo, a fern with a small sporocarp in a hard testa or shell, is reported ethnographically as an important food in arid country, and accounts include reference to the noisy pounding of the hard seeds at Aboriginal settlements (Wills 1863). Four European explorers (Wills 1863) ate nardoo when they ran out of food but, unlike local Aborigines, they did not include leaching in their processing. King survived, but Burke, Wills and Gray probably died of beri-beri, caused by an enzyme that destroys thiamine (Earl and McCleary 1994).

Processing bitter tubers and the use of grass seeds and potentially toxic nardoo about 30,000 years ago may seem precocious for Australasian hunter-gatherer groups. However, in the context of an apparently rapid emergence of symbolic behaviour of modern humans soon after 50,000 years ago, it is perhaps what we might expect (Klein and Edgar 2002). On the other hand, if there were a much earlier, gradual or sporadic emergence of modern human behaviour in Africa, then we might also expect that further research in Africa (and Asia – see Dennell and Roebroeks 2005) will reveal similar early traces of sophisticated processing of plant foods. It will also be interesting to assess the plant food processing skills of *Homo neanderthalenis* and *Homo floresiensis*.

In agricultural and pre-agricultural contexts, starch grains have been useful in documenting exploitation of cereals. Piperno *et al.* (2004) found starch granules of wild barley (*Hordeum* sp.) and possibly wheat (*Triticum* sp.) on a 23,000 year old flat basalt slab (with charred seeds) from the Israeli site of Ohalo II, perhaps the best preserved hunter-gatherer 'village' known in the Upper Palaeolithic world. This is at least 12,000 years before wheat and barley were cultivated and genetically modified into domesticated crops. Following research of Ugent and Vedun (1983) on *Solanum* potato, Perry (2002) has argued that starch granule size may be a useful indicator of manioc (*Manihot esculenta*) cultivation practices and domestication.

Discussion

When and how seed grinding evolved in Australia has been problematic, although it does appear that a range of morphologically distinct implements like large, wet seed milling sandstone grinding dishes (Smith 1989) and tuber processing pounders ('Planks' – Lourandos 1997 and 'Bungwall pounders' – Hall *et al.* 1989) became more common in the Holocene. But a crucial part of the problem is that we lack sufficiently large samples to be able to identify relatively rare items like grinding stones, except at a few sites. Of significance is that when large lithic assemblages are available, as at Cuddie Springs (or well-preserved sediments as at Niah Cave), otherwise rare or absent tool types (or plant microfossils at Niah) are more likely to appear. How are these technological changes to be assessed in the light of taphonomic problems? I suggest that current indications are that we should expect to find in some environmental contexts at certain times, an early capacity in modern humans to harvest a wide range of plants (including seeds), and a diversity of processing techniques (like grinding, cooking and leaching to remove unpalatable substances and toxins).

A key problem is in identifying the importance of ecological variables and biological variables, like increased intellectual capacity. For example, Henshilwood and Marean (2003) draw attention to the problem of ambiguity in explanations of modern human behaviour; how do we know that colonisation of a particular harsh environment (like a barren desert or the Arctic Circle) or exploitation of a lower-ranked food source (like seeds) is not the result of 'natural' population pressure, or climatically-forced intensification? The boundaries between nature and culture are blurred from both theoretical and

Table 1. Selected list of taxonomically identified starch granules identified archaeologically and found on artefacts, macroscopic plant remains and/or in sediment.

Taxa	Common Name	Location	Notes on Processing	Approx. Dates BP	References
Alocasia sp.	Taro	Niah Cave, Sarawak, Malaysia	Scraping, cooking	40,000	Barton 2005
Alocasia sp.	Taro	Kilu Cave, Solomon Islands	Scraping, cooking	28,000	Loy 1994; Loy *et al.* 1992
Aroid, probably: *Cyrtosperma merkusii*, *Alocasia macrorrhiza*, and *Xonthosoma sagitifolia*	Aroid	Balof 2, New Ireland	Scraping, cooking	14,000	Barton and White 1993
Aroid, probably: *Cyrtosperma merkusii*, *Alocasia macrorrhiza*, and/or *Amorphophallus paeoniifolius*	Aroid	Uripiv Island, Vanuatu		2700	Horrocks and Bedford 2005
Attalea?	Corozo palm	Monagrillo, Panama		5000-3500	Piperno and Holst 1998
Blechnum indicum	Bungwal fern	SE Queensland, Australia	Pounding	2000	Hall *et al.* 1989
Calathea sp.	Leren	La Mula, Panama		2300	Piperno and Holst 1998
Calostemma?	Lily	Cuddie Springs, Australia		30,000	Fullagar *et al.* in press
Canna edulis	Achira	Peru		2500	Ugent *et al.* 1984
Caryota mitis?	Fishtail palm sago	Niah Cave, Sarawak, Malaysia		40,000	Barton 2005
Colocasia esculenta	Taro	Kilu Cave, Solomon Islands	Scraping, cooking	28,000	Loy 1994; Loy *et al.* 1992
Colocasia esculenta	Taro	Kuk, PNG Highlands	Scraping, cooking	10,000	Denham *et al.* 2003; Fullagar *et al.* 2006
Colocasia esculenta	Taro	Motutangi, New Zealand	Cultivation	250	Horrocks and Barber 2005
Colocasia esculenta?	Taro	Kamgot, New Ireland, PNG	Cooking (Lapita pot)	3300	Crowther 2005
Crinum flaccidum?	Lily	Cuddie Springs, Australia	Grinding	30,000	Fullagar *et al.* in press
Cyrtosperma sp.	Taro	Niah Cave, Sarawak, Malaysia		10,000	Barton 2005
Dioscorea sp.	Yam	Niah Cave, Sarawak, Malaysia		40,000	Barton 2005
Dioscorea sp.	Yam	Kuk, PNG Highlands	Scraping, pounding	10,000	Denham *et al.* 2003; Fullagar *et al.* 2006
Dioscorea sp.	Yam	Aguadulce, Panama		7000-5000	Piperno *et al.* 2000; Piperno and Holst 1998
Dioscorea sp.	Yam	La Mula, Panama		2300	Piperno and Holst 1998
Dioscorea sp.	Yam	Matutangi, New Zealand	Cultivation	250	Horrocks and Barber 2005
Elaeis?	Oil palm	Monagrillo, Panama		5000-3500	Piperno and Holst 1998

Table 1. Selected list of taxonomically identified starch granules identified archaeologically and found on artefacts, macroscopic plant remains and/or in sediment (continued).

Taxa	Common Name	Location	Notes on Processing	Approx. Dates BP	References
Eugeissona utilis?	Hill sago	Niah Cave, Sarawak, Malaysia		40,000	Barton 2005
Hordeum sp.	Barley	Ohalo II, Israel	Grinding	23,000	Piperno *et al.* 2004
Ipomoea batatas	Sweet potato	Casma Valley, Peru		3800	Ugent *et al.* 1981
Ipomoea batatas	Sweet potato	Great Barrier Island, New Zealand	Coprolite	250	Horrocks *et al.* 2004
Ipomoea sp.	Sweet potato	Motutangi, New Zealand	Cultivation	250	Horrocks and Barber 2005
Manihot esculenta	Manioc	QLP1, Peru		9200-7600	Rossen *et al.* 1996
Manihot esculenta	Manioc	Peru		3800	Ugent *et al.* 1986
Manihot esculenta	Manioc	Aguadulce, Panama		7000-5000	Piperno *et al.* 2000; Piperno and Holst 1998
Manihot esculenta	Manioc	Manchan, Casma Valley, Peru		500	Torrence and Barton 2006:Plate 22 (Donald Ugent)
Maranta arundinacea	Arrowroot	Aguadulce, Panama		7000-5000	Piperno *et al.* 2000; Piperno and Holst 1998
Maranta sp.	Arrowroot	Waynuna, Peru	Grinding	4000-3600	Perry *et al.* 2006
Marsilea drummondii	Nardoo	Cuddie Springs, Australia	Leaching, cooking, grinding	30,000	Fullagar *et al.* in press
Nelumbo sp.	Lotus	Poverty Point, Louisiana	Cooking	3730	Scott-Cummings 2006
Panicum miliaceum	Broom corn millet	Lajia, China	Noodles	4000	Lu *et al.* 2005
Poaecae	Grass	Cuddie Springs, Australia	Grinding	30,000	Fullagar and Field 1997; Fullagar *et al.* in press
Pteridium sp.	Bracken fern	Great Barrier Island, New Zealand	Coprolites	250	Horrocks *et al.* 2004
Setaria italica	Foxtail millet	Lajia, China	Noodles	4000	Lu *et al.* 2005
Solanum maglia	Wild potato	Monte Verde, Chile		12,500	Ugent and Scott-Cummings n.d.; Ugent *et al.* 1987
Solanum sp.	Potato	Waynuna, Peru	Grinding	4000-3600	Perry *et al.* 2006
Solanum tuberosum	Potato	Casma Valley, Peru		3800	Ugent *et al.* 1982
Triticum sp.	Wheat	Ohalo II, Israel	Grinding	23,000	Piperno *et al.* 2004
Zea mays	Maize	Aguadulce, Panama		7000-5000	Piperno *et al.* 2000; Piperno and Holst 1998
Zea mays	Maize	Monagrillo, Panama		5000-3500	Piperno and Holst 1998
Zea mays	Maize	Real Alto, Peru		4800	Pearsall *et al.* 2004
Zea mays	Maize	Waynuna, Peru	Grinding	4000-3600	Perry *et al.* 2006
Zea mays	Maize	La Mula, Panama		2300	Piperno and Holst 1998
Zea mays	Maize	Copan, Honduras	Grinding, taphonomic	2000	Haslam 2006
Zea mays	Maize	Cerro Juan Diaz, Panama		1300	Piperno and Holst 1998

methodological perspectives. Moreover, what seem to us in the present as harsh environments, may have had peculiar advantages to past hominid populations.

There were probably few, if any, technological barriers (in terms of intellectual knowledge or actual toolkits) which inhibited exploitation of any potential plant food resources in any environmental zone from at least 30,000 years ago; certainly cooking, leaching, scraping (to remove oxalates), grinding and pounding were available. Exploitation of particular plant food species was probably determined by other economic and social constraints. We need to sample earlier assemblages for starchy residues in Africa, Europe and Asia to investigate when and how technological barriers (which inhibited exploitation of potential food plants that required increasingly complex processing) collapsed, and if these data correlate with particular hominin species.

Conclusions

Stone tools with their evidence of starchy food plants provide a new kind of archaeological dataset that may help evaluate competing explanations of early hominid evolution. As well as documenting particular plant species as might be indicated by starch granules and other tool residues, artefacts and their context also potentially provide a record of use-wear and other traces that indicate digging, harvesting and processing activities such grinding, pounding, grating, scraping, cooking, brewing and other tasks.

Recent studies of starchy plant food processing have shown that many wild plant foods were probably processed in similar ways to their ethnographically-cultivated descendents, including the scraping and cooking of yams, grinding and dough preparation of cereals, and grinding and leaching of some toxic plants. Some specific predictions can be proposed. First, it seems likely that the first colonists of the Australian region, about 40,000–50,000 years ago had a sophisticated and essentially modern knowledge of plant foods that probably included harvesting and grinding grass seeds, digging tubers and processing toxic plants. These activities are likely to become visible when sufficient artefact numbers are available and dietary constraints favour exploitation of particular resources.

Second, if initial human colonisation of the Australian continent is arguably contemporaneous with, or visible soon after, the first evidence of 'the fully modern capacity for culture … in Africa' (Klein and Edgar 2002:245ff; cf. Brumm and Moore 2005), development of sophisticated plant food processing techniques (like seed grinding) are likely to be found in Africa and Asia prior to 50,000 years ago. A detailed knowledge of plants is a part of being human, and processing techniques (particularly of unpalatable or toxic plant foods) are likely to be important indicators of modern human behaviour, however we choose to define it. However, comparative studies of plant food residues and plant processing among different hominin groups (*Homo erectus*, *Homo sapiens*, *Homo neanderthalensis* and *Homo floresiensis*) are likely to be equally, if not more productive, than theoretical attempts to define 'modern human behaviour'.

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The Ceramic Chronology of Copan: A Plotted History and Some Revisionist Reflections

René Viel

Abstract

Chronologies in Mesoamerican archaeology rely heavily on ceramic sequences. These sequences are constantly subject to revision in the light of new data, chronometric dates and also changing theoretical approaches. While we must exercise caution, it can be expected that major shifts in ceramic assemblages, especially when they are fairly sudden rather than gradual, may also reflect restructuring of sociopolitical organisation and external relationships. The ceramic sequence of Copan, Honduras, provides a continuous unbroken thread spanning c.2500 years, making it an ineluctable reference when exploring changes in the cultural process. This chapter presents an overview of the development of the ceramic chronology for Copan and reflects on current understandings of Copan archaeology arising from this sequence.

Introduction

In 1991, the University of Queensland commenced a wide-ranging archaeological research programme at Copan, one of the major sites of Maya civilisation, which continues to the present day. This project focused on the Formative period (1500 BC–AD 400) and, in particular, developing an understanding of the transformation of the landscape during that era. A significant contribution of the programme is a better understanding of the ceramic complexes of Copan, especially those dating to the Formative period. A ceramic sequence remains the most common device for dating Mesoamerican archaeological deposits and an essential component for understanding cultural processes. This paper is a revised and updated version of a paper presented at the Society for American Archaeology Meeting held in Seattle in 1998 (Viel and Hall 1998).

Background

The first chronology of Copan, based on ceramic sequencing and dates carved on monuments, was established by Longyear (1952) and included four periods: Archaic (AD 300–450), Early Classic (AD 450–600), Full Classic (AD 600–800), and a Postclassic resurgence (AD 950–1200). The Proyecto Arqueológico Copán (PAC) (1978–1985) presented a new chronology based on ceramic complexes (Viel 1983, 1993a, 1993b): Rayo (1200–900 BC), Gordon (900–800 BC), Uir (800–300 BC), Chabij (300 BC–AD 100), Bijac (AD 100–400), Acbi (AD 400–600/650), Coner (AD 600/650–800) and Ejar (AD 800–1100). At the same time, the Harvard Project (1976–1977) constructed its own ceramic sequence (Willey *et al.* 1994) that differed from the PAC sequence by the inclusion of a Cueva phase (AD 600–700) between Acbi and Coner, and an extension of the Coner phase until AD 900. Several projects in the 1990s brought new data that led to refinements of some parts of the chronology and reconsideration of some other parts (Bill 1997; Freter 1992; Manahan 2003; Viel 1999; Webster and Freter 1990). Revision of the chronology has been a central facet of the re-evaluation of cultural process at Copan.

Revision of the Chronology

The backbone of the revised chronology is still a sequence of ceramic phases tied to other regional sequences and tentatively anchored to a limited number of chronometric dates provided by radiocarbon, archaeomagnetism and obsidian hydration. Common attributes found on pottery (form, surface treatment, decoration) over a large area during a period of time provide the basis for defining broad ceramic horizons. Inscriptions also provide very specific dates, but they apply only to the Classic period. The Classic period, including the collapse and its implications for the Terminal Classic and Postclassic periods, has been reassessed in light of a refinement of the dates for the Classic period through reinterpretation of inscriptions and additional data (Manahan 2003; Webster and Freter 1990). However, despite these advances, the chronology of the preceding Formative period remained limited and constrained understandings of the site's cultural trajectory. This problem was addressed by a joint research programme of the University of Queensland and the Centre Français d'Etudes sur le Mexique et la Centre-Amérique (CEMCA), employing new data and a revised definition of ceramic horizons for the Pacific coast (Blake *et al.* 1995).

It is now common to consider three main periods in the Copan chronology, based on the recognition of the founding of the Maya Dynasty in AD 427, and its demise in AD 822:

- the Pre-Dynastic period, equated with the Formative period;
- the Dynastic period, equated with the Classic period; and
- the Post-Dynastic period, equated with the Terminal Classic and the Postclassic periods (Figure 1).

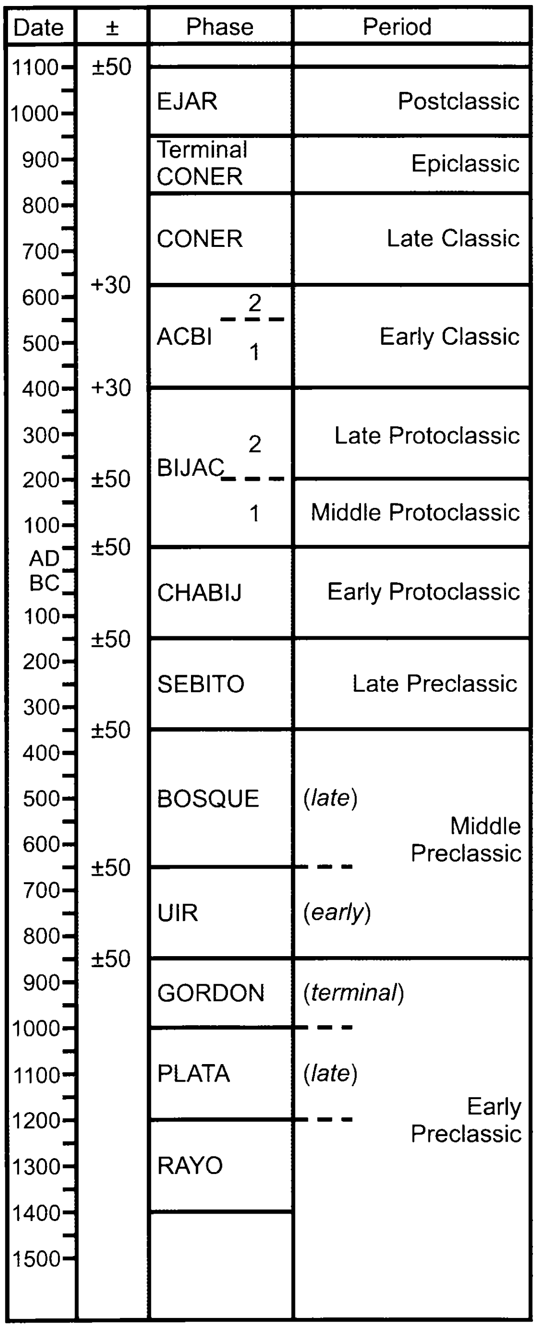

Figure 1. The ceramic chronology of Copan.

The Formative (or Pre-Dynastic) Period (1400 BC–AD 400/430)

The Formative period includes the Preclassic (1400–150 BC) and the Protoclassic (150 BC–AD 400) periods. The earliest secure evidence of occupation in the Copan Valley is a floor found in the area of Sepulturas, under the patio of compound 9N-8. The pottery from that surface (characterised by red rim globular bowls and surface alterations like brushing, shell-edge and rocker-stamping) has proved the basis for defining the Rayo ceramic phase (1400–1200 BC) (Viel 1993a). According to the revised ceramic sequences from the Pacific coast (Blake *et al.* 1995), such a phase can be equated with a Locona horizon (1400–1250 BC), and this is supported by an associated radiocarbon date of 1390 BC. Some other deposits probably related to that horizon have been found in an area northwest of the Principal Group. Together with recent evidence from Puerto Escondido (Joyce and Henderson 2001), these findings indicate a broader distribution of the Locona horizon than previously acknowledged (Pye *et al.* 1999:82). It

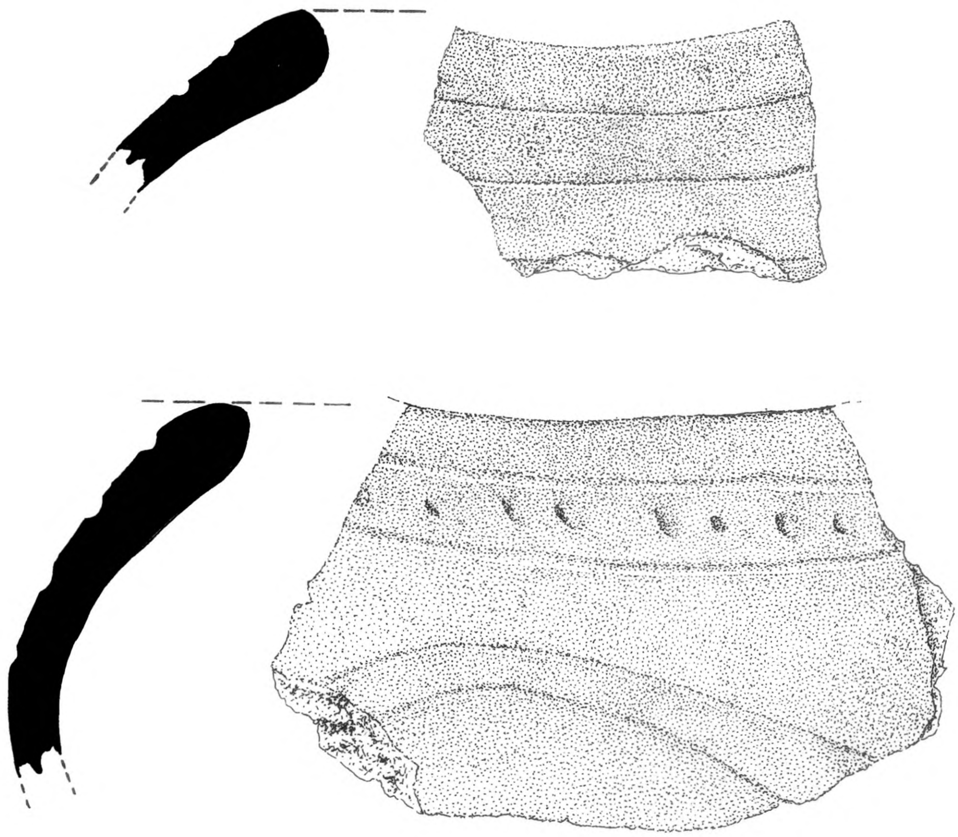

Figure 2. Plata ceramic complex, Early Preclassic (Drawing: José Espinoza).

should be mentioned that a few isolated Barra-looking sherds have been found below Rayo deposits, in some cases separated by sterile levels, leaving the door open to a possible earlier phase of occupation contemporary with Barra ceramics from the Pacific coast c.1500 BC (Blake *et al.* 1995:167).

A new ceramic phase, called Plata (1200–1000 BC), represented by a collection of sherds found at the bottom of the western side of the Northwest Platform of the Principal Group, characterised by linear incisions and distinctive differential black-and-white decoration, is equated with the Ocos-Cherla phases (1200–1000 BC) (Figure 2) (Blake *et al.* 1995:173). Gordon (1000–850 BC) is the last Early Preclassic phase, contemporary with the Cuadros phase (1000–900 BC) on the Pacific coast (Figure 3). Essentially represented by funerary pottery (Viel 1993a), with 'Olmec' designs, Gordon has been found, however, in at least one other stratigraphic context, which appears Cuadros, suggesting that Gordon might be more than just a funerary subcomplex.

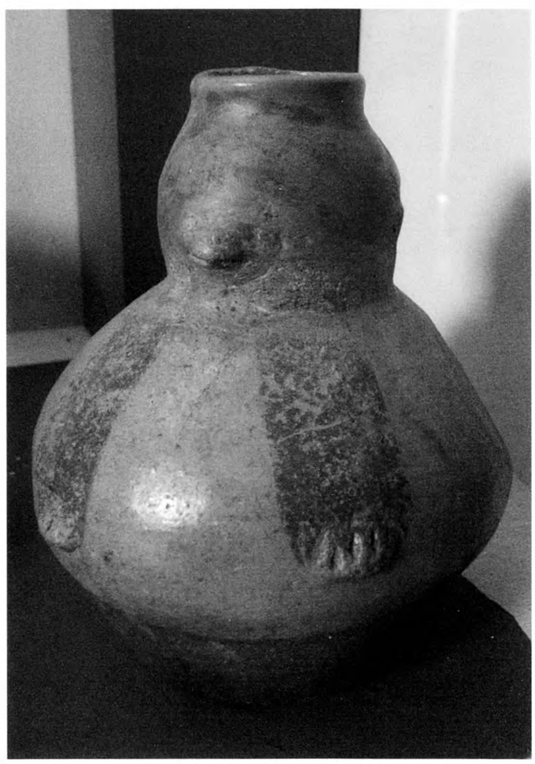

Figure 3. Gordon ceramic complex, Early Preclassic (Photograph: Daniel Cummins).

Similarities between ceramics from Copan and the Pacific coast and more distant locales have been tentatively explained by an expansion of a Proto-Mixe-Zoque population from Mexico, but some other mechanisms may have been at play through a lattice of exchanges. In any case, the influence of the

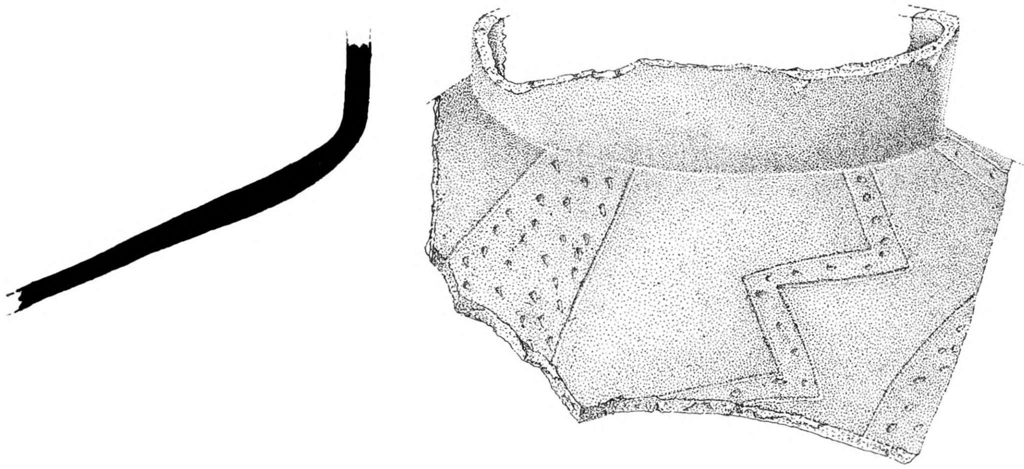

Figure 4. Uir ceramic complex, Middle Preclassic (Drawing: José Espinoza).

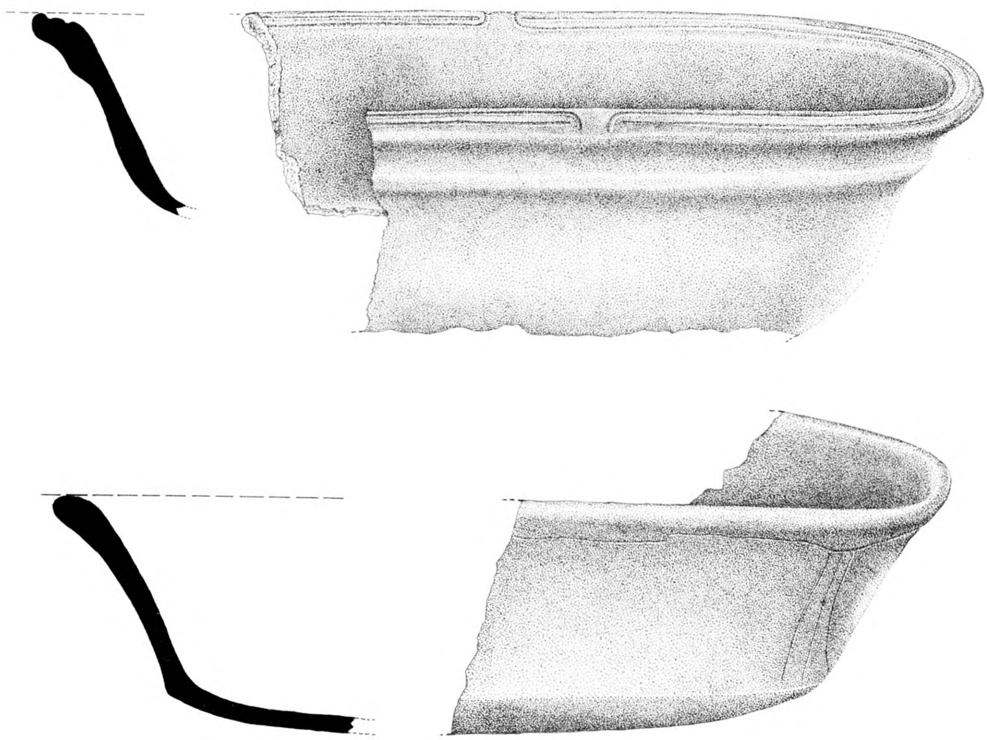

Figure 5. Sebito ceramic complex, illustrating large Lubia red serving vessels, Late Preclassic (Drawing: José Espinoza).

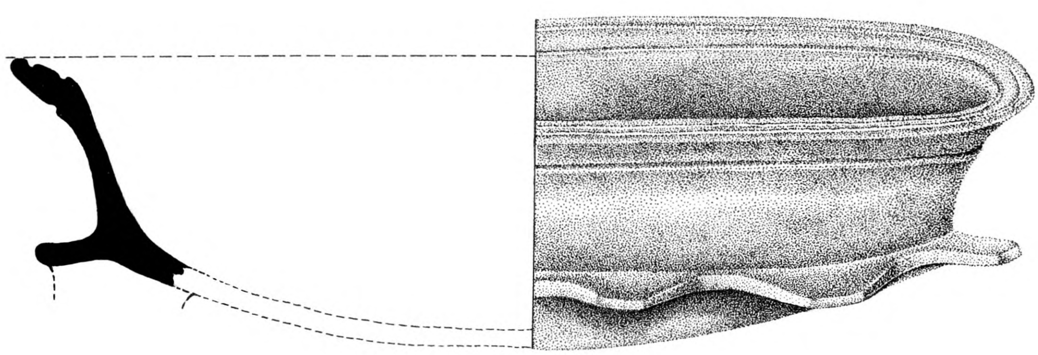

Figure 6. Bijac ceramic complex, Protoclassic (Drawing: José Espinoza).

Pacific coast was felt during the Early Formative of Copan, as well as in the Lower Ulua Valley (Joyce and Henderson 2001).

The Middle Preclassic, starting around 850 BC, is first represented by the Uir ceramic phase (Figure 4) (Viel 1993a), with distinctive incised geometric patterns and punctation, marking some rupture with the former Pacific connections and new affinities with central Honduras (Viel 1993b). Recent excavations and analyses date the termination of the Uir phase to about 650 BC when it is replaced by the Bosqué ceramic phase (650–350 BC), radiocarbon dated to between 800 and 400 BC. The marker of Bosqué is a large flat-bottomed red-slipped bowl. The Late Preclassic Sebito phase (350–150 BC) is not yet firmly established, and further excavations are necessary to clarify its status, as it might be just a late facet of the Bosqué phase. Sebito mostly comprises small-to-medium-sized bowls with flat bases and a variety of sculpted rim, composite silhouette and wall protrusions (Figure 5). Sebito manifests some similarity with the Chul phase in western El Salvador (Sharer 1978).

The Chabij ceramic phase (150 BC–AD 50±50) confirms the links with both the Ulua Valley to the east through the Zoned Dichrome and the Miraflores sphere to the west through the Usulutan decoration (Viel 1993a). It is obviously equivalent in time with the Early Caynac phase of western El Salvador (Sharer 1978). Chabij is the beginning of the Protoclassic period at Copan, defined on the basis of pottery as the time when ceramic traditions are established which will develop into the Classic complexes (see Brady *et al.* 1998). A Chabij surface has provided a radiocarbon date between 100 BC and AD 40, and an archaeomagnetic date between AD 40 and 100. The Bijac ceramic phase (AD 50–400) is marked by the imports of several Highland types (like Aguacate orange), the appearance of mammiform supports and of the Linear Dichrome (Figure 6). Late Bijac demonstrates definite ties with the Cholan area of Guatemala. A feature expected to be at the transition Early/Late Bijac has provided a radiocarbon date between AD 130 and 300.

The Classic (or Dynastic) Period (AD 400/430–830)

The Dynastic period is accurately dated between AD 427, when Yax Kuk Mo founds the dynasty, and AD 822, the last date known on a monument (Altar L). The Classic period, therefore, should start some time around AD 430 and finish around AD 830. There are two phases defined for the Classic period: an Early Classic Acbi and a Late Classic Coner. Acbi indicates ties with central Honduras, the general Cholan area of Guatemala, the Petén, and the Mexican Highlands. Some similarities with the Esperanza phase of Kaminaljuyu (Kidder *et al.* 1946) may reflect common connections through intermediaries rather than a direct connection between the two sites. The distinction between Early and Late Acbi (facets 1 and 2, respectively) is based essentially on a reduction in representation of imported polychromes (especially basal-flanged polychromes), as well as the development of the 'red-on-usulutan' types and their inclusion in ritual assemblages. The Early/Late Acbi transition should probably be set around AD 550 (Viel 1993a, 1993b). The Cueva phase of the Harvard sequence looks like Late Acbi, and should be regarded as a funerary subcomplex of Late Acbi.

In the 1980s, the view of the Harvard Project was that Copador polychrome, a marker of the Coner phase, had not been introduced until AD 730, an assumption based on the offerings found in the caches under stelae (Leventhal 1986). I personally favoured a much earlier date between AD 600 and 650, more in line with other regional sequences. It must be stressed that the date of AD 700 for the beginning of the Coner phase presented in Viel (1983) was a compromise between those divergent views. A date of AD 600/650 (with AD 625 as a convenient average) is now strongly supported by chronometric dates for the Coner phase.

Bill (1997:Table 1.2) considers three facets for Coner: Early (AD 650–700), Middle (AD 700–800) and Late (AD 800–900) based on relative frequencies of ceramic types. However, the Middle facet is not mentioned elsewhere in her text and it is thus difficult to determine the basis on which this facet is defined. A distinction between an Early and a Late Coner on the basis of frequencies is possible in theory, but complicated in practice as the material from upper levels is often badly eroded and difficult to identify. Nevertheless, Bill made some valuable findings about Late Coner: a substantial decline of Copador, an increase of Surlo, as well as an increase of Ulua-Yojoa polychromes and its inclusion in ritual assemblages. These findings, and that from the ceramic assemblage of compound 9N-8 excavated in the 1980s, suggests the Early/Late Coner transition may have to be set earlier than AD 800, closer to AD 750.

The Post-Dynastic Period: Terminal Classic and Early Postclassic

While there is general agreement that the Post-Dynastic period starts after AD 822, there is continuing debate about how and when it finished. The preliminary PAC ceramic sequence, in step with Longyear (1952), suggested that the collapse was sudden with some kind of short 'resurgence' of activity around the Principal Group between c.AD 900 and 1200, based on the presence of a few Postclassic markers, like Tohil Plumbate (Viel 1983). These understanding were re-evaluated in Viel (1993a,1993b) where it was suggested that Coner might have persisted until about AD 950 on the basis of comparisons with the Las Vegas polychrome dated after AD 900.

In Viel (1993a, 1993b) the Ejar phase was divided between a 'Pre-Tohil' level and a 'Tohil level'. The Pre-Tohil level was regarded as an 'Epiclassic' intrusion associated with a post-AD 800 Terminal Coner lasting until AD 900/950, and the Tohil level was regarded as 'Postclassic' and dated some time between AD 950 and 1100. Rosemary Joyce (1986) had reached similar conclusions and distinguished a Terminal Classic Ejar and a Postclassic Ejar. The picture then was of a post-AD 800/850 Coner-like assemblage which included an intrusive Ejar 1 composed of Terminal Classic/Epiclassic markers such as the San Juan Plumbate and the Pabellon group (which belongs to the Fine Orange ware), followed by another intrusive Ejar 2 assemblage composed of Early Postclassic markers such as Tohil Plumbate and not associated with any Coner-like assemblage. Now, I would simplify the sequence by reserving the name Ejar for the Early Postclassic phase exclusively, and labelling the earlier Epiclassic material as Terminal Coner (Figure 1). These conclusions are supported by excavations around Ballcourt B (the Bosqué area) which recovered an Ejar assemblage, radiometrically dated to between AD 950 and not later than AD 1100, indicating a relatively short Early Postclassic occupation (Fash and Lane 1983; Manahan 2002, 2003).

The Post-Dynastic Debate

Based on obsidian hydration dates, Webster and Freter (1990) revised the preliminary version of the Coner phase to extend it from AD 700 until AD 1250/1300. They admitted, however, that there might be a 'late bias' in the hydration dates. Indeed, there are a few shortcomings in such an extension. As an example, Webster and Freter (1990:81) state that 'Ulua imports are present throughout most of the extended Coner phase'. However, the archaeological record indicates that Ulua polychrome ceased to be manufactured around AD 900. Furthermore, Sheehy (1978, 1982) demonstrated that the end of the Ulua polychrome tradition preceded the appearance of the Fine Orange wares in the Sula Valley, a finding confirmed by Joyce (1991) at Cerro Palenque. Therefore the presence of Ulua imports into Copan until AD 1250 is not consistent with the conventional polychrome chronology.

The obsidian hydration measurements obviously exhibit a late bias (see also Braswell 1992). An adjustment of 50 to 100 years might be in order. Such an adjustment would make most of the obsidian hydration chronology fall into line with the traditional chronology based on ceramic sequences. If we apply these corrections to the demographic modelling presented by Webster and Freter (1990; see also Webster *et al*. 1992, 2000), it would appear that the Copan population was at a maximum between AD 675 and 825 (with a peak between AD 730 and 750), had a steady decline after AD 825, followed by a sharp decline after AD 900. By AD 1000, the decreasing population would have been back to its size of AD 400, between 1500 and 2000 people. Such a model would be more in line with the rest of the archaeological record.

In sum, despite the need for adjustment, the obsidian hydration dates confirm that there was no discontinuity of occupation between the fall of the dynasty in AD 822 and the end of the Terminal Coner, whatever the date of its ending. Then, the question is: Did this Terminal Coner assemblage persist along with the Early Postclassic Ejar? At present there are no data available to address this question directly. Webster and Freter (1990) did not find any Postclassic markers associated with their Coner-like assemblage, although such markers have been found in and around the Principal Group. As a working hypothesis, the two assemblages may be modelled as briefly coexisting in the valley with little geographical overlap: one around the Principal Group, the other in rural settlements away from the urban core. While it is quite possible that Terminal Coner has to be extended until AD 950 (see above), it is unlikely it continued much beyond AD 1000. The findings by Manahan (2002:35) that the Ejar occupation may have ended suddenly and violently, suggest a second and final collapse of the elite, possibly at the hands of populations living in the rural area, no later than AD 1100.

Discussion

Early Formative Copan ceramic complexes point to ties with the Pacific coast and the possibility of Proto-Mixe-Zoquean migration into the Copan Valley. At the time, the eastern part of the valley was like a swamp (Hall and Viel 2004), a kind of environment favoured for settlement elsewhere during the Early Formative (Clarke 1991:16). The Gordon phase suggests that the Copan elite may have been involved in the Olmec trade network as a culmination of this earlier interaction with the Pacific coast.

The Middle and Late Formative ceramics continue to show connections with western El Salvador and the Pacific coast, but also new linkages with central Honduras and the Ulua Valley. The pot-bellied sculptures at Copan are similar to those of Santa Leticia in western El Salvador (Demarest 1986:Figures 4-14) and, by comparison, are probably contemporary with the Late Formative Sebito ceramics. The mysterious date of 355 BC recorded on Altar I dedicated by Smoke Imix in the Late Classic (Fash 1991:87, 104), would also fall in the Sebito phase.

During the first part of the Protoclassic (Chabij), Copan is peripheral to the Miraflores cultural sphere, but the connections with the Highlands intensify during the Middle Protoclassic, culminating with the definite intrusion of Highland types in the Late Protoclassic, suggesting some migration from the Highlands into the Copan Valley. Such migration is possibly part of a more general redistribution of Cholan populations between the Highlands and the Lowlands, which coincides with the first manifestations of Classic Maya culture. Some Late Classic inscriptions mentioning AD 160 as the founding date of Copan as a political entity may refer to the arrival of a Cholan party (see Schele and Freidel 1992:309; Stuart 2004:219). Therefore, Late Protoclassic Bijac may correspond to a 'Cholanisation' of the Copan Valley, paving the way for Copan to move from a 'peripheral' to a 'central' position in regional interaction (Viel and Hall 2000), and creating the conditions for the full realisation of Classic Maya culture in the Copan Valley.

Inscriptions carved on the monuments provide some accurate dates for the Dynastic period, with the Classic period marked by the 'arrival' of Yax Kuk Mo at Copan in AD 427. Ceramic offerings in the tombs of such identified individuals can also help refine chronologies of ceramic complexes. The ceramic content of the Hunal and Margarita Tombs (Reents-Budet *et al*. 2004), for example, are consistent with an Early Acbi assemblage. On the other hand, the five 'local' vessels of the Sub-Jaguar tomb (Reents-Budet *et al*. 2004:Figure 9.13), that are obviously Chilanga Red-on-Usulutan, are more in line with a Late Acbi assemblage. The occupant of the Sub-Jaguar tomb is possibly Ruler 8 who died in AD 551 (Bell *et al*. 2004:152). Sharer (2004:307) draws attention to the critical period AD 554–564 as marking either a single destructive event or a longer period of monument destruction after the short reign and possibly violent death of Ruler 9. The question is whether these events and the ceramic shift demonstrated at the Early/Late Acbi transition are related.

Other critical periods mentioned by Sharer (2004:Table 14.1) happen to fall within or very close to the suggested dates of other ceramic transitions. The Acbi/Coner transition may correspond to the hiatus of almost 30 years between AD 623 and 652, and the Early/Late Coner shift, suggested above to be closer to AD 750 than 800, may coincide with another hiatus of 18 years (AD 738–756) that follows the death of Ruler 13 at the hands of Quirigua.

After another critical period surrounding the death of Ruler 16 (around AD 820) and the collapse of the dynasty (AD 822), the population continued to employ a Coner-like assemblage while the elite maintained some long-distance contacts (e.g. central Honduras; Ulua Valley). The Early Postclassic Ejar, similar to the Rio Blanco phase of Los Naranjos (Lake Yojoa) may actually reflect a continuity of the connection with central Honduras.

Conclusions

The Copan ceramic chronology covers some 2500 years from 1500 BC to AD 1100. The Formative period still needs some rectifications but the sequence of ceramic complexes is now fairly well outlined. The limits of the Classic period are well grounded between AD 400/430 and around AD 830 and the Acbi/Coner transition is established between AD 600 and 650. The Post-Dynastic period is still under scrutiny, but there is a growing consensus that Terminal Coner ended before AD 1000, and the Early Postclassic Ejar lasted less than 150 years between AD 950 and 1100.

It appears that the ceramic changes may reflect in some way the fortunes of conflictive politics. However, there are three ceramic connections that were maintained over long periods and constitute the mainframe of the elite ceramic subcomplexes: (1) the Pacific coast/western El Salvadoran connection that started at least by Rayo times and was maintained until Early Coner; (2) the Cholan connection that started with the Protoclassic Bijac and was maintained until Late Coner; and (3) the central Honduran connection that started around the Early/Middle Formative transition and lasted until the very end of the sequence with the Ejar phases. An understanding of these long-term continuities and discontinuities in the ceramic sequence of Copan provide an increasingly robust framework for ongoing research into both the local and regional sociopolitical landscape.

Postscript

The contribution of Jay to the work that forms the basis of this paper cannot be overstated. Although I first met Jay in 1982 it was not until 1991 that we commenced work at Copan together through a programme of research initiated at the University of Queensland. Jay's fresh insights forced me to re-evaluate my own work and his numerous suggestions helped me to give form to my reinterpretation of the Copan chronology.

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Filling the Gaps: Extending the TARDIS Concept to Teaching Cultural Heritage Management Skills

Anne Ross

Abstract

Jay Hall pioneered a technique for teaching undergraduate archaeology students at the University of Queensland the skills needed to become competent archaeological practitioners, especially in the 'meckanic trades' (McBryde 1980) relating to excavation, data recording and basic site analysis, through the use of a TARDIS. Although such skills remain essential to archaeological competency training, with the rise in prominence of cultural heritage management, more diverse 'trades' are expected of archaeology graduates (Ulm *et al.* 2005), including working with traditional owners, documenting heritage from a variety of perspectives, determining significance assessment as a framework for conservation and management planning, and running a business. Hypothetical field exercises and problem-based learning (PBL) packages developed for courses in cultural heritage management at the University of Queensland, along with specialist laboratory courses, have filled some of the gaps in skills training that the TARDIS has not been able to address.

Introduction

In 1995 Jay Hall instigated a unique and innovative concept for teaching archaeology students the technical skills of excavation. The TARDIS (Teaching Archaeological Research Discipline In Simulation) at the University of Queensland (UQ) provides undergraduate archaeology students with a unique opportunity to learn excavation techniques and the associated skills of site documentation, data organisation and field note management in a safe, culturally neutral (i.e. not specifically linked to any one cultural group), convenient and relatively cheap environment (Hall *et al.* 2002, 2005). In this paper I examine other similar learning practices for UQ archaeology undergraduates, particularly those involved in studying cultural heritage management. I demonstrate the ways in which these learning opportunities address concerns by some in the archaeology profession who have highlighted what they perceive to be poor standards of graduate skills and knowledge in cultural heritage management (Gibbs *et al.* 2005). I review the place of the TARDIS in the wider context of the UQ major and double major programmes in archaeology that have a number of applied, skills-based courses in excavation, artefact and soil analysis, site survey, site recording, working with Indigenous peoples, undertaking significance assessment, developing conservation and management plans, and writing professional reports. In particular, I discuss the development of solutions to a problem identified in recent literature on training for students for cultural heritage management (Ulm *et al.* 2005): How can educators provide students with a heritage management field-based experience that is realistic, yet logistically, ethically and practically achievable within the constraints of current university budgets? University educators are rarely able to allow large numbers of relatively unskilled students to participate in actual cultural heritage projects. In this paper I demonstrate how field-based exercises (both 'real' and simulated) can offer real-life opportunities and experiences for undergraduates.

The debate about the role of universities in providing vocational training for archaeology students has been part of the Australian archaeological landscape at least since the rise of the cultural heritage industry. At the 1979 Australian Archaeological Association (AAA) conference on 'Education and Training in Prehistory and Archaeology in Australia' (Frankel 1980), McBryde (1980) asked a question that was asked again at the 2003 AAA National Archaeology Teaching and Learning Workshop (Colley 2004):

> should the acquiring of vocational expertise be regarded as part of the educational role of prehistory or historical archaeology, or indeed of any other university subject? (McBryde 1980:76).

In 1979 the answer was a clear 'yes' and it remains the same answer today. The controversy is not about whether or not undergraduate archaeology students should be taught technical proficiency in archaeology (Lydon 2002) and cultural heritage management (Colley 2003; Pate 2005), but *how* to achieve this important aim. One of the main problems has been to know how to impart technical skills in realistic management contexts to archaeological trainees in an environment of increasing funding cuts and various political challenges (Colley 2004; Hall *et al.* 2005; Lydon 2002).

Many have devised programmes and projects to give archaeology undergraduates opportunities to learn archaeological skills in class or as volunteers (e.g. Colley 2003; Coutts and Wesson 1980; Fredericksen 2005; Hall *et al.* 2005; Lydon 2002), with varying degrees of success. Coutts and Wesson (1980), for example, outlined the Victoria Archaeological Survey's summer schools that were commenced in the mid-1970s after the promulgation of the *Archaeological and Aboriginal Relics Preservation Act 1972 [Vic]*. These summer schools had an emphasis on survey and excavation for research, but provided few opportunities for students to learn the application of baseline skills in a management context. It is the provision of training in *management* decision-making (with all its attendant skills – Pearson and Sullivan 1995) that has been the problem up until now (Gibbs *et al.* 2005; Ulm *et al.* 2005). Recently, Colley (2003) negotiated with cultural heritage practitioners to develop work attachment learning opportunities for students, whereby a variety of student placements with professional archaeologists were organised between the University of Sydney and different professional archaeological organisations, both locally and nationally. The activity proved popular with both students and the industry, but the cost in staff time to organise the off-site activities was too great and the programme was unable to continue (Colley 2003:91).

The rise in the urgency to provide opportunities for students to gain experience in site survey and excavation may have been a result of the growth of 'relics' protection legislation in the 1970s (Bowdler 1983; McBryde 1980; Ross 2005) and the subsequent growth of the cultural heritage profession. Yet it is clear that despite many attempts for over 30 years to fashion adequate training opportunities for students, there is still a perceived gap in professional and other skills-training of undergraduates intending to work in the cultural heritage management (CHM) industry (Colley 2004; Colley and Ulm 2005:7; Ulm *et al.* 2005), which is the largest employer of archaeology graduates in Australia (Colley 2003; Lydon 2002; Ulm *et al.* 2005:15, Figure 5). In particular, there is a need to facilitate the involvement of many stakeholders in archaeology, especially traditional owners (Colley and Ulm 2005:8; Zimmerman 2006), given that more than half of the 301 archaeologists surveyed by Ulm *et al.* (2005:14, Figure 4) indicated that they were primarily involved in Indigenous archaeological pursuits.

The TARDIS - Filling the Excavation Gap

In response to the recognised need for courses teaching applied archaeological field methods, in the 1980s Jay Hall introduced a field-based archaeology course into the UQ archaeology programme (currently coded and labelled ARCS3010 Field Archaeology, where 'ARCS' stands for 'Archaeological Science'; other codes used for UQ archaeology and CHM courses are ARCA [Archaeology] and ANTH [Anthropology]). Hall's course was the first such university-based teaching programme in Australia (Hall *et al.* 2002:1-2). The course was taught for over 10 years, from the early 1980s to 1994, and it proved both popular and successful. However, as time went by, Hall became increasingly concerned at the growing 'pedagogical, ethical, pragmatic, logistical and equity issues' (Hall *et al.* 2002:1) of taking unskilled undergraduates to excavate Aboriginal heritage sites. The TARDIS was Hall's response to these issues.

The TARDIS is a controlled, simulated archaeological 'site', constructed on the University of Queensland's St Lucia campus, on the banks of the Brisbane River. The site comprises five layers: Lower Palaeolithic Africa, Middle Palaeolithic Western Europe, Upper Palaeolithic Ukraine, Formative Period Maya and Bronze Age Europe (Hall *et al.* 2002:4, 2005:49).

The TARDIS reduces the problems of having untrained and unskilled undergraduates let loose on a 'real' site (Colley and Ulm 2005:8; Hall *et al.* 2002, 2005:48, 53), and avoids some of the problems of the logistics of taking a large number of students into the field (Colley 2003; Fredericksen 2005). Because the TARDIS also includes cultural layers from different time periods and different continents, it offers a 'diversity of archaeological field experiences' not available at a single 'real' site (Hall *et al.* 2005:49).

But no one exercise can possibly meet all the needs of a student training programme. Despite the very important learning advantages offered by the TARDIS, it omits training in negotiation with traditional owners and in recognising the different approaches to land and resources management that exist in the real world. The TARDIS is geared towards excavation experiences and the development of technical skills rather than the broader needs of CHM: survey, site recording, assessment of significance, development of management plans, and preparation of professional reports. These latter skills are the aspects of training that were recognised as essential for the production of skilled archaeological practitioners at the AAA Archaeology Teaching and Learning Subcommittee's National Archaeology Teaching and Learning Workshop held at Redfern in Sydney in September 2003 (Colley 2004) and subsequently by Ulm *et al.*'s (2005) survey of 301 archaeology practitioners.

At both the Redfern workshop and in the survey, archaeologists from academia, the heritage profession (both private and government) and museums all indicated that they were largely dissatisfied by the standard of archaeology graduates produced by the universities, especially in areas deemed essential for cultural heritage management (Colley 2004; Colley and Ulm 2005; Gibbs *et al.* 2005; Ulm *et al.* 2005; see also Lydon 2002). Although an ability to excavate was recognised as important, broader cultural heritage management skills were widely acknowledged as more urgently needed. Furthermore, the importance of training *Australian* archaeology graduates about *Australian* archaeology and heritage is vitally important in a country where misconceptions about the geographical location of archaeological research are rife (Nichols 2004; see also Colley and Ulm 2005; Ulm *et al.* 2005). The TARDIS does not have one layer that simulates an Australian site (Hall *et al.* 2005). Although this 'ethically neutral' approach may have logistical advantages (Hall *et al.* 2005:48, 53), it does reduce a student's ability to understand the political context within which Australian archaeology is undertaken.

Therefore, although the TARDIS remains an essential tool in providing UQ students with excavation experience, on its own it cannot fill the identified gaps in skills learning in Australian archaeology graduates.

Filling the Wider Gap

Partly as a result of the success of Jay Hall's field archaeology course, when I was appointed to establish courses in heritage management at the University of Queensland in 1993, I investigated the possibility of having students undertake a simulated cultural heritage survey and assessment. At first these hypothetical exercises were undertaken in the classroom, augmented by field visits to heritage places in Moreton Bay, accompanied by traditional owners. At this stage the field visits involved understanding Aboriginal approaches to knowledge about heritage places, particularly setting significance in a cultural landscapes context (Bradley 2001; Ellis 1994; Greer 1996, 1999; Rose 1996; Ross 1996; Ross and Quandamooka 1996; Smith and Burke 2004). No actual site survey or site recording exercises were undertaken.

Over time and with input from various traditional owners from southeast Queensland, the field visits gradually evolved from passive observations to active site and landscape assessment. By 1999 the fieldtrip for the course currently labelled ANTH2098 Aboriginal Heritage: Anthropological and Archaeological Perspectives had become the major hypothetical cultural heritage assessment project. Students were divided into four groups, each group having responsibility for a hypothetical development proposal at one of four different locales on North Stradbroke Island (an example of one of the hypothetical proposals appears as Figure 1). Students were required to undertake many of the components of a heritage assessment for the 'development':

- writing to the Land Council for approval to undertake the survey and requesting assistance from traditional owners;
- applying for a permit from the (then) Queensland Department of Environment (under the new Aboriginal heritage legislation in Queensland [the *Aboriginal Cultural Heritage Act 2003*], permits are no longer required);
- planning for the survey;
- undertaking the survey (including map reading) with a member of the Land Council present;
- recording sites and cultural landscape features (using topographic maps and GPS where appropriate);
- assessing significance – including scientific, public and Aboriginal;
- making management recommendations within the context of current legislation and government policy; and
- writing the report.

Sand Loader, Myora Creek

Coloured Sands Limited (CSL), a major new sand mining venturer on North Stradbroke Island, is planning a new sand loader for Myora Creek, 5km north of Dunwich. The sand loader is needed here as the facility at Dunwich, used by the existing mining companies on the Island, is already working at full capacity. Without a new sand loading facility, CSL cannot operate its lease. This will mean job losses for people on the Island (many of whom are Aboriginal).

The location of the proposed new sand loader at Myora Creek is ideal. There is room on both sides of the creek for construction of a truck parking-bay on the southern bank of the creek, with the sand storage facility on the north bank. The existing bridge over the creek will be widened to allow truck access to the storage silos.

The creek mouth will be widened and the estuary dredged to allow access to the storage silos by ships. Some mangroves will need to be removed to facilitate ship access, but the numbers needing to be removed from this location are far fewer than would need to be removed if the sand loader were to be moved either north or south of Myora Creek.

CSL is keen to retain its image as a clean, green operator with sensitivity towards cultural heritage needs.

The cultural heritage brief for this project requires the consultant to:

- determine whether there are any archaeological sites in the development area, and make recommendations regarding their management;
- assess whether or not there are any broader cultural heritage concerns for the development area; and
- make recommendations for any Aboriginal heritage places, in the light of relevant legislation and government policy.

Figure 1. One of four hypothetical development proposals for North Stradbroke Island used as a training exercise for students studying ANTH2098.

In 2002, for a variety of reasons, the ANTH2098 visits to North Stradbroke Island were no longer possible and a new field exercise was developed in consultation with the Kombumerri Aboriginal

Corporation for Culture on the Gold Coast. In this exercise, students are supplied with a hypothetical report (ostensibly by a fictitious heritage archaeologist, but in reality written by me) on a cultural heritage assessment of a hypothetical development at Burleigh Heads. Students are required to reassess the development proposal in light of dissatisfaction with the original (fictitious) report by the traditional owners. Changes to Aboriginal heritage legislation in Queensland in 2004 also make the hypothetical/ fictitious report legally problematic. Students are not told of the problems with the report. They must redo the heritage survey and assessment for themselves, finding out about not only the archaeological sites but also Aboriginal perspectives on other places of heritage significance in the cultural landscape, and then write a new report that incorporates a critique of the original, fictitious report. In this exercise students are required to:

- plan for the survey;
- undertake the survey (including map reading) with members of the Kombumerri Aboriginal Corporation for Culture present;
- record sites and cultural landscape features (using topographic maps and GPS where appropriate);
- visit the Kombumerri Aboriginal Corporation for Culture office and ask questions of other traditional owners there;
- assess significance – including scientific, public and especially Aboriginal significance – in a cultural landscape framework;
- make management recommendations within the context of current legislation and government policy;
- critically evaluate the original report and critique its contents; and
- write a new report.

Both the North Stradbroke Island and the Burleigh Heads fieldtrips have been funded annually by the School of Social Science at the University of Queensland as part of the teaching allocation for the course. The total costs of the exercises (bus hire and payments to Aboriginal participants) have never exceeded $2000. Student numbers have ranged from a minimum of 18 to a maximum of 56. Current numbers average 40 each year.

Although these two field exercises have addressed some of the learning gaps in undergraduate archaeology student skills relating to CHM (see below), there were some areas of training that I felt were not sufficiently met by this process. These were skills relating specifically to site survey and site documentation. Because the field areas are relatively small in size, and because students are accompanied by traditional owners who take the students to heritage places of value to them, there is little opportunity for students to actually 'find' sites, particularly any sites adversely affected by ground surface visibility. There is also no component on managing time and finances – students effectively have 'unlimited' time to walk through the heritage landscape (it is a small area, with survey area and schedule determined by the traditional owners and me based on the availability of the bus), and there is no need to plan for the financial consequences of over-running a budget. A new course that addressed these more mechanistic elements of CHM was needed.

In 2005, I developed a new introductory course in heritage management (ARCA2118 Introduction to Cultural Heritage Management), focusing more on archaeological sites than heritage landscapes (hence an ARCA, rather than ANTH code). In this new course I include both classroom exercises and a 'field trip', this time on a strip of land along the Brisbane River immediately upstream from the TARDIS. The ARCA2118 classroom exercises focus on basic cultural heritage skills: map reading, site recording (using site cards developed by regulatory authorities in Queensland, New South Wales, Victoria and Western Australia), stone tool analysis, budgeting for a job, assessing significance and making management recommendations. The 'field trip' combines all these skills into one problem-based learning (PBL) exercise over a four-week period.

This ARCA2118 PBL exercise requires students to design a survey for a hypothetical widening of the road that follows the Brisbane River through the St Lucia campus of UQ. They must budget the time and finances needed for the work and then conduct the survey to find 'sites' – scatters of artefacts made by Chris Clarkson and placed strategically (in bags so that they can be easily collected after the exercise and not inflict damage if caught in the slasher) amongst the leaf litter and vegetation along the riverbank. In the first stage of the 'survey', students are advised by the hypothetical Aboriginal Land

Council that they are only required to make an assessment of the archaeological significance of the sites, as the Land Council will produce the overall heritage assessment and requires only the technical advice of an archaeological heritage assessor. Students, at this stage of the PBL exercise, therefore only provide an archaeological assessment of the development based on an assessment of the scientific significance of the artefacts and 'sites' located. This approach is permitted under the current Queensland heritage legislation.

However, to assess only archaeological heritage value, without the broader context of the Aboriginal significance of the area, is meaningless. Consequently, after first assessing only the archaeological significance of the sites and artefacts located, students are given the opportunity to place the sites in a broader anthropological context. To facilitate this, the hypothetical Land Council tells the students that the Land Council no longer wishes to receive advice only on the technical parameters of the cultural heritage. Students are asked to complete a full assessment of the area with the involvement of hypothetical traditional owners. Students are given information about hypothetical Aboriginal concerns for the sites and their associated cultural landscapes. The results of this second assessment affect both the significance assessment undertaken after the initial survey and the consequent management recommendations.

Once the final assessment and recommendations using both archaeological and Aboriginal knowledge have been made, students are contacted by the hypothetical developers and given new information about changed political and bureaucratic frameworks for the road-widening. Preservation of all sites (which is the recommendation most commonly proposed from the archaeological and Aboriginal significance assessment, and permitted by the original development plans) is no longer possible. Students must reassess, once again, their recommendations and learn to make a balanced management plan for the sites and the river bank landscape.

At the end of this assignment students are required to reflect on all the processes involved in informing the PBL exercises, and review what they have learned from all the class activities in the course.

Discussion

In all three CHM training exercises outlined above, the aim is to provide students with safe, yet realistic scenarios within which to undertake heritage assessment and management. There is no excavation component in either of these courses, but excavation is well covered by the course based on the TARDIS. Laboratory experience is encompassed by other courses in the archaeology programme at the University of Queensland (such as ARCS2030 Practising Archaeology: Introduction to Contemporary Archaeological Methods; ARCS2000 Science in Archaeology; and ARCS2003 Forensics). In my courses I emphasise site survey and planning, understanding heritage in a cultural landscape framework, making management decisions based on significance assessment, and presenting recommendations in a coherent, critical, well-argued and well-written report.

Colley and Ulm (2005) argue that there is disagreement about the extent of training universities should provide to undergraduates when so many who take archaeology do not go on to become archaeologists. In my field trips and class exercises, the training is broader than just archaeological skills. Working with traditional owners, designing management plans, learning that there is more than one way to view the cultural landscape, and communicating ideas in both oral and written format, all provide life skills to students who will end up in a variety of workplaces, not just in CHM or archaeology. Coupled with the field archaeology course and laboratory courses, skills learned by students in the archaeology programme at UQ meet a range of 'graduate attributes' selected by UQ to meet national generic learning skills (Figures 2 and 3). This is the value of a real-life experience that goes beyond just documenting heritage.

The benefits of generic skills (graduate attributes) in learning have been demonstrated by Bennet *et al.* (1999), who identified four learner management areas: *self*, *others*, *information* and *task*. These four key learner areas provide benchmarks for assessing effective student learner outcomes (Bennet *et al.* 1999; O'Connor and Ross 2004). Hall *et al.* (2002, 2005) have already demonstrated that exercises relating to the TARDIS meet some of Bennet *et al.*'s learning outcomes, particularly those relating to observation and description, analysis and interpretation, and team skills (Hall *et al.* 2005:52). As I demonstrate in Table 1 and in the discussion below, many of Bennet *et al.*'s key learning areas are also met in the Burleigh Heads fieldtrip and other cultural heritage management class exercises.

In-Depth Knowledge of the Field of Study

- A comprehensive and well-founded knowledge of the field of study.
- An understanding of how other disciplines relate to the field of study.
- An international perspective on the field of study.

Effective Communication

- The ability to collect, analyse and organise information and ideas and to convey those ideas clearly and fluently, in both written and spoken forms.
- The ability to interact effectively with others in order to work towards a common outcome.
- The ability to select and use the appropriate level, style and means of communication.
- The ability to engage effectively and appropriately with information and communication technologies.

Independence and Creativity

- The ability to work and learn independently.
- The ability to generate ideas and adapt innovatively to changing environments.
- The ability to identify problems, create solutions, innovate and improve current practices.

Critical Judgement

- The ability to define and analyse problems.
- The ability to apply critical reasoning to issues through independent thought and informed judgement.
- The ability to evaluate opinions, make decisions and to reflect critically on the justifications for decisions.

Ethical and Social Understanding

- An understanding of social and civic responsibility.
- An appreciation of the philosophical and social contexts of a discipline.
- A knowledge and respect of ethics and ethical standards in relation to a major area of study.
- A knowledge of other cultures and times and an appreciation of cultural diversity.

Figure 2. UQ graduate attributes (from University of Queensland 2006).

Learning Outcomes

In terms of *management of self*, students are required to use a range of academic skills to undertake tasks in a timely manner through the setting of achievable goals in individual and group environments. Students apply a variety of learning skills to new situations, with new data requiring students to reflect on their decisions critically and vary outcomes to meet changing situations. The relevant elements of Bennet *et al.*'s 'management of self' category that are met by the CHM exercises are highlighted in Table 1.

All the CHM activities require students to work in teams as well as individually, and so *management of others* was an important component of the deep-learning that results from all the exercises. In particular,

In-Depth Knowledge of the Field of Study

- An introduction to cultural heritage discourses within the context of anthropological and archaeological literature.
- An understanding of the philosophy of cultural heritage management in Australia.
- An introduction to the principles and practices of cultural heritage management in a practical framework.
- An introduction to Aboriginal heritage discourses within the context of anthropological and archaeological literature.
- The placement of Aboriginal heritage in a natural resources management context.
- An understanding of how natural resources management relates to cultural heritage management.
- An understanding of how legislation relates to Aboriginal heritage mismanagement in the real world.
- An introduction to the principles and practices of Aboriginal heritage management in a practical framework.

Effective Communication

- The ability to collect, analyse and organise information and ideas and to convey those ideas clearly and fluently, in written and oral form, through the writing of essays and workbooks, the presentation of a field trip report, and participation in oral presentations in tutorials.

Independence and Creativity

- The ability to work and learn independently, through individual assessment and research tasks.
- The ability to work and learn in a group through participation in class and fieldwork exercises and work in groups during tutorial exercises.
- The ability to identify problems and create solutions through participation in problem-based learning exercises.
- The ability to identify problems and create solutions through the presentation of assessment and tutorial projects that require problem analysis.

Critical Judgement

- The ability to define and analyse problems through participation in field exercises and projects which require problem analysis.

Ethical and Social Understanding

- An understanding of Indigenous and other 'owner' perspectives on cultural heritage management.
- An understanding of Indigenous perspectives on natural and cultural resources management.
- An appreciation of the philosophical and social contexts of the cultural heritage discipline, which include recognition of Indigenous knowledge and local approaches to heritage management.
- A knowledge and respect of ethics and ethical standards in relation to the involvement of Indigenous peoples and other 'owners' in heritage management.
- A knowledge of other cultures and times and an appreciation of cultural diversity.

Figure 3. Combined graduate attributes acquired by students studying ANTH2098 and ARCA2118 at UQ.

Table 1. Elements (highlighted) of Bennet *et al.*'s (1999) learner management areas addressed by ANTH2098 and ARCA2118 class and field exercises.

Management of Self	Management of Information
Effective time/stress management	Use appropriate sources/information
Set appropriate objectives/priorities/ standards	Use/integrate large amounts of information
Use a range of academic skills	Use appropriate technologies
Take responsibility for own learning	Use appropriate media
Listen actively/purposefully	Use appropriate language/form
Develop/adapt learning strategies	Use information critically/creatively & innovatively
Demonstrate intellectual flexibility	Present information competently
Use learning in new/different situations	Respond to different purposes & contexts and audiences
Plan/work towards long-term goals	
Reflect purposefully on own learning	
Clarify and constructively criticise	
Management of Others	**Management of Task**
Perform agreed tasks	Identify key task features
Respect others' views/values	Conceptualise ideas
Work productively in a cooperative context	Set/maintain priorities
Adapt to group needs	Identify strategic options
Defend/justify views/actions	Plan/implement a course of action
Take initiative/lead others	Organise subtasks
Delegate/stand back	Use/develop appropriate strategies
Negotiate	Assess outcomes
Criticise constructively	
Adopt role of chairperson	
Learn in a collaborative context	
Assist/support the learning of others	

students are required to perform agreed tasks in a cooperative environment where the views of others in the team need to be respected, and where other constructions of the 'truth' (particularly those held by traditional owners) are also to be recognised. Decisions need to be justified both within the team and to the rest of the class, and this requires an ability to negotiate and criticise. The relevant elements of Bennet *et al.*'s 'management of others' category that are met by the CHM exercises are highlighted in Table 1.

Information management is critical in all forms of university learning, and this is no exception in the exercises devised for the cultural heritage courses. A variety of sources of information are used, including academic texts, field observation and Indigenous knowledge. Survey techniques and site recording materials are used to find and document the resource, and reports are written to integrate all forms of data used and generated. Reports must be written in an appropriate format and in clear English, presenting a critical review of the data and management options, with oral presentations designed to ensure students learn to convey information competently to a variety of audiences. The relevant elements of Bennet *et al.*'s 'management of information' category that are met by the CHM exercises are highlighted in Table 1.

Finally, *management of task* is achieved through a variety of processes; some controlled by the teacher and others controlled via mechanisms of student-centred learning and problem-solving. Some key tasks are set by the teacher in small in-classroom exercises, but others must be identified by the students themselves in the more student-oriented tasks of the field trips and PBL exercises. Students set and maintain priorities to ensure the tasks are completed in a timely manner, and this requires the identification of subtasks and alternative options for management and decision-making. The ideas and theories that underpin the decisions made must be conceptualised by the students and critically evaluated as part of a process to reflect on and assess outcomes. The relevant elements of Bennet *et al.*'s 'management of task' category that are met by the CHM exercises are highlighted in Table 1.

Overall, the vast majority of Bennet *et al.*'s (1999) key learner outcomes are met by the activities and exercises devised in the CHM courses taught at UQ. In this way, then, the CHM practical exercises not only meet the requirements of the graduate attributes devised for these courses, but also address many of the more generic 'gaps' identified in archaeology graduate skills by members of the archaeology profession.

Addressing Skills Gaps

But generic skills are not sufficient to provide undergraduate archaeology students with the expertise they need for employment once they graduate. In a survey of 301 Australian archaeologists, Ulm *et al.* (2005) found that lack of survey skills was the most significant gap in graduate training, with other skills relating to CHM (such as significance assessment and management planning) also rating a significant mention amongst those skills lacking in graduates. The programmes I have implemented in my courses at UQ are aimed (in part) at filling these gaps by providing students with real-life opportunities to analyse data in a management context – producing assessments of site significance (including within a landscape context), making recommendations, recognising the political (both Aboriginal and non-Aboriginal) frameworks of decision-making, and writing reports.

In the 1980s, cultural heritage management was regarded as rather peripheral to 'mainstream' archaeology. The sidelining of cultural heritage sessions at Australian Archaeological Association annual conferences at this time is testimony to this attitude. Today, however, cultural heritage provides a critical link between 'archaeological knowledge and its uses by our society' (Lydon 2002:132). As a consequence it is no longer acceptable for students to be taught about 'sites' and 'artefacts' as if these entities were finite and defined elements in their own right. The concept of understanding archaeological sites in a wider cultural landscape context is now a widely accepted paradigm (see, for example, Byrne 2002; Byrne and Nugent 2004; Cole *et al.* 2002; Ellis 1994; Greer 1996, 1999; Lewis and Rose 1985; Lydon 2002; McIntyre-Tamwoy 2002; Neate 1999; Ross 1996; Ross and Quandamooka 1996) and, as a consequence, learning about CHM needs to go beyond putting 'dots on maps' and emphasising an archaeological preoccupation with bounded sites (Ellis 1994; Lydon 2002; Neate 1999).

By undertaking Hall's TARDIS course, along with laboratory-based courses and CHM courses, students graduating from UQ will have been trained in most of the essential archaeology skills and will have plugged most of the identified gaps relating to the practice of both archaeology and cultural heritage management (Tables 2-4).

Nevertheless, even within a programme that has applied anthropology and archaeology as its focus, some training gaps remain (Table 2). The main gaps in the UQ programme relate to rock art recording and analysis, and drawing/illustration, amongst specific archaeological skills, and business and human resources management in the wider skills of CHM business planning. Perhaps this reinforces the point that it is not possible to teach everything in an undergraduate programme, especially in light of funding cuts and problems in replacing retiring staff (Colley 2004; Lydon 2002). Some on-the-job training is essential, with this on-the-job training needing to be provided by the industry (Ulm *et al.* 2005:20), rather in the manner of Gibbs *et al.*'s (2005) concept of 'apprenticeship', which I now discuss.

Apprentice Archaeologists

At UQ, the fieldwork components of coursework go part of the way towards meeting the notion of 'apprenticeship' promoted by Gibbs *et al.*:

> Graduate[s] should understand that they are expected to continue learning, using their own initiative as necessary, just as new graduates do in other professional entry positions (Gibbs *et al.* 2005:28).

In other words, at university we can teach the basic principles of background research, legislative understanding, basic field techniques of site survey, artefact recognition and recording, artefact analysis and excavation, and communication (Balme and Paterson 2006), but we can only provide a minimum of experiential learning. Failure by a graduate to transfer classroom skills to the real world may not, in fact, be a failure in their university training, just lack of experience (Gibbs *et al.* 2005:29). The application

Table 2. UQ ANTH and ARCA courses that address essential archaeology skills areas as identified in Ulm *et al.* (2005:Table 2; see also Colley 2004).

Skill Area	ARCS3010 (TARDIS)	ANTH2098	ARCA2118	Other UQ ANTH/ARCA Courses
Field survey techniques		•	•	
Excavation techniques	•			
Stone artefact identification & analysis	•		•	•
Faunal analysis	•			•
Residue & use-wear analysis				•
Archaeological theory				•
Rock art recording & analysis				
Ceramic analysis				•
Human skeletal identification & analysis				•
Knowledge of legislation		•	•	•
Significance assessment		•	•	•
Heritage management planning		•	•	•
Conservation of artefacts				•
Policy development		•		
Understanding of research ethics		•		
Drawing/illustration				

Table 3. UQ ANTH and ARCA courses that address the top-10 most valuable skills in archaeological workplaces as identified by Ulm *et al.* (2005:Table 3).

Skill Area	ARCS3010 (TARDIS)	ANTH2098	ARCA2118	Other UQ ANTH/ARCA Courses
Report writing	•	•		•
Interpersonal communication	•	•	•	•
Field survey techniques		•	•	
Computer literacy				•
Library/archival research		•		•
Time management	•	•	•	•
Project management	•	•		•
Critical thinking	•	•	•	•
Knowledge of legislation		•	•	•
Significance assessment		•	•	•

of university learning can only result in professional activity when coupled with genuine experiences gained outside the university environment. The TARDIS and my field exercises, together with laboratory courses at UQ, give students the background they need and the basic skills required for work in the archaeology profession, but not the genuine experience that comes with working on 'real' sites and with 'real' problems. Whether graduates apply their university-gained knowledge and skills in the professional world is really up to them.

Conclusion

By combining the CHM courses with the TARDIS course and other applied courses in the UQ archaeology programme, almost all of Bennet *et al.*'s key learner management areas are addressed and the majority of the skills gaps identified by archaeological practitioners are plugged. The exercises also

Table 4. UQ ANTH and ARCA courses that address the top-10 skills gaps in archaeology training as identified by Ulm *et al.* (2005:Table 3). Note that two skills were ranked equal tenth.

Skill Area	ARCS3010 (TARDIS)	ANTH2098	ARCA2118	Other UQ ANTH/ARCA Courses
Geographical Information Systems (GIS)				
Human skeletal identification & analysis				•
Advocacy/public relations				
Faunal analysis	•			•
Residue & use-wear analysis				•
Statistical analysis				•
Rock art recording & analysis				
Human resource management				
Occupational health/safety				
Conservation of artefacts				•
Policy development		•		

meet the criteria for E.R.O.T.I.C. learning, as defined by Ross *et al.* (2003), where learning is required to be Entertaining, Relevant, Organised, Thematic, Informative and Creative. In this way, the archaeology programme at UQ is meeting the needs of the archaeology profession, broadly defined to include cultural heritage management, and of the students by providing rigorous yet entertaining skills training in archaeology and cultural heritage management.

Acknowledgements

The TARDIS has made a considerable difference to the skills-based knowledge of UQ graduates. This 'site' is testimony to Jay Hall's commitment to teaching at the University of Queensland. Jay has provided me many opportunities for discussion and debate about teaching archaeology and cultural heritage management over the years, and the development of my own teaching programmes has arisen, in part, from such exchanges. The ideas for the specific CHM exercises outlined here have evolved over many years of collaborative work with Shane and Brian Coghill, Dale and Donna Ruska, and others from North Stradbroke Island; Pat and Rory O'Connor, Ysola Best and Dee Gorring from the Kombumerri Aboriginal Corporation for Culture; and Sue O'Connor and Tam Smith (UQ). I thank all these people for their input in developing practical and workable teaching exercises. Funding for the field projects has come annually from the School of Social Science. I thank Dee Gorring and Sue O'Connor for a review of an earlier draft of this paper, and Sean Ulm and Wendy Beck for their review of the final draft. The final product, of course, is my own responsibility.

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Archaeology under the Bitumen: Excavations at the Bribie Island Road Site, Southeast Queensland

Jill Reid

Abstract

Excavations at the Bribie Island Road site in southeast Queensland revealed a rich archaeological record under the current road. It is argued that the 800 year old site, dominated by shellfish remains with small amounts of fish and mammal bone and stone artefacts, was used on an ephemeral basis as a component of a broader contemporary cultural landscape centred on Sandstone Point. Results conform to findings for the broader region, suggesting more intensive use of the area in the last 1000 years and point to a range of structured settlement-subsistence strategies in place by this time.

Introduction

This paper details archaeological investigations carried out at the Caboolture-Bribie Island Road and Bestmann Road East intersection by the Queensland Department of Main Roads in July 2005. Upgrade of the intersection was identified by the Department of Main Roads Road Implementation Program for action in 2005. Although no archaeological material was visible on the surface, shell midden material was identified during the course of road construction. After consultation with Aboriginal stakeholders, a salvage archaeological excavation and other exploratory activities were conducted in the project area focusing on the site labelled Bribie Island Road (BIR). The vast majority of archaeological research conducted in this region, like the excavations reported here, has been conducted in response to development pressure, although much of these data remain unpublished. This paper reports the basic site data and places it into the broader regional context.

Background

BIR is located approximately 70km north of Brisbane at Sandstone Point near the southern opening of Pumicestone Passage and opposite Bribie Island (Figure 1). BIR is located within the archaeologically-rich 'Sandstone Point subregion' of Moreton Bay, defined here as the area east from the site of Brown's Road and north from Sandstone Point to White Patch. The vast archaeological database for this region dates almost exclusively to the very late Holocene, a characteristic that makes it ideal to test models of change in the recent past that have been proposed for the Moreton Bay region.

Archaeological investigations in the Bribie Island area include the earliest systematic coastal archaeological excavations in Queensland. In response to land development in the area, Tugby and Tugby (1965) conducted a 6ft x 6ft excavation of a shell midden (which they labelled 'Caloundra I') on the north bank of Bell's Creek, near Caloundra (Figure 1). Excavations revealed a deposit dominated by estuarine shellfish (especially cockle and oyster) with a range of stone artefacts, mainly manufactured on quartzite. In 1972, again in response to development, Haglund (reported in Crooks 1982) excavated four 50cm x 50cm test pits on the southern side of Bell's Creek near where it enters Pumicestone Passage,

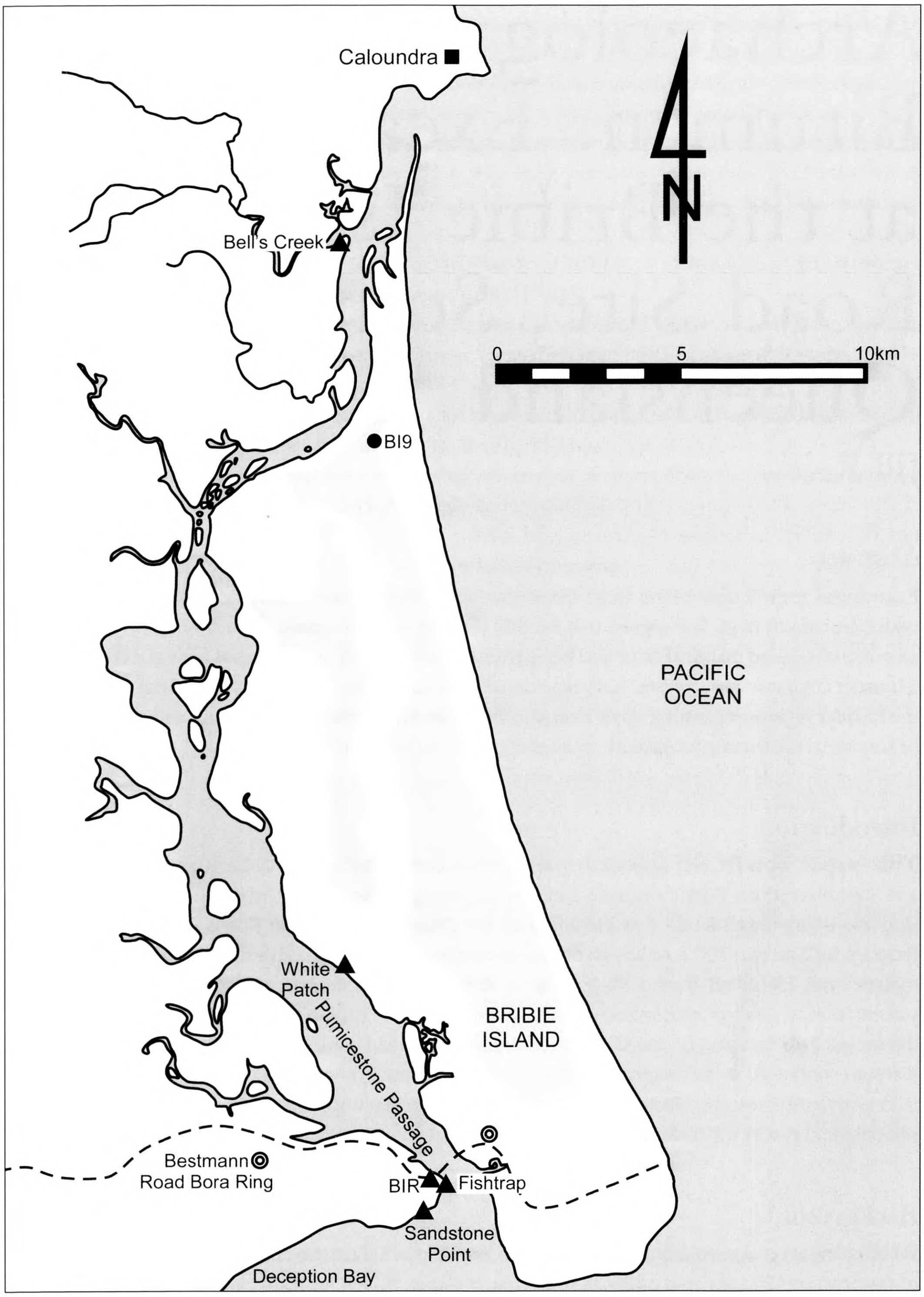

Figure 1. Location of the study area.

labelling the site 'Bell's Creek Midden' (QE9761). Haglund reported a similar range of shellfish and stone artefacts as Tugby and Tugby's (1965) excavations.

Stockton (1974) subsequently recorded numerous shell middens in the Bell's Creek area as part of systematic surveys of both sides of Pumicestone Passage in the early 1970s. On the basis of characteristics of 69 sites, he concluded that in general middens were located up to 100m from freshwater sources and that they represented temporary stopping points were food was consumed along the journey to the main camping site.

Sandstone Point, located on the east coast of Deception Bay about 1km southeast of BIR, has been the major focus of research in the area since the early 1970s. The site was first recorded by Haglund during surveys of the area between 1970 and 1972 conducted ahead of development activities (reported in Stockton 1974 and Crooks 1982). The extensive shell midden (c.20,500m²) lies along and behind a 100m stretch of beach c.600m west of a rocky headland which gives it its name. Freshwater swamps are located behind the site and a permanent water hole is located 100m from the western end of the midden (Crooks 1982:20). The site was first subject to test excavations in 1972 when Haglund dug three pits, recovering cockle, whelk and hairy mussel as well as fish, dugong and bandicoot bone radiocarbon dated to 780±95 BP (SUA-479) (Crooks 1982:37; Nolan 1986:33). Walters (1986:202-209) excavated two more 50cm x 50cm squares recovering a dense fish bone assemblage dating to 740±50 BP (SUA-2357). In 1985, Hall coordinated a more intensive excavation programme at the site. Thirty-eight excavation pits were strategically located across the site in an attempt to examine inter-site variation (previous research had focused specifically on the frontal dunes). A further nine radiocarbon determinations were obtained from the site, establishing earliest occupation by 2290±100 BP (Beta-15810/B) (Nolan 1986:53).

In 1976, the Moreton Region Archaeological Project (MRAP) was launched from the University of Queensland by Jay Hall. The project divided the Moreton Bay region into zones, including subcoastal, coastal and island zones (Hall 1980) and aimed to identify and record sites, analyse data and develop a cultural chronology for the region. Moreton Bay has been the subject of intensive research and consultancy-based archaeological investigation since that time. MRAP provided the structure for additional studies of data collected during earlier phases of research (e.g. Crooks 1982) as well as for new excavations of previously-investigated sites, such as Walters' (1986) and Nolan's (1986) studies at Sandstone Point referred to above.

The site of Brown's Road was first identified in 1980 after the completion of land clearing activities in preparation for the planting of exotic pines (Strong 1980) and is located c.1.5km west of BIR. During 1980 over 400 surface artefacts were collected from the site by Strong and Gillieson. In 1981, a series of three excavations were carried out by Hall, Gillieson and Strong (Gillieson and Hall 1982; Ulm 2002a). Shell, bone and over 1000 artefacts were recovered during excavations. Charcoal from basal units was dated to 2030±70 BP (Beta-3077). During analysis of the stone artefact assemblage from the site Hall and Gillieson (1982) identified 28 possible bevel-edge tools. Richter (1996) undertook a use-wear analysis of the this assemblage and concluded that substantial processing of the fern root *Blechnum indicum* took place at the site. A similar faunal and stone assemblage to that of Sandstone Point was also noted (Crooks 1982:136).

In 1982, Crooks undertook an analysis of the stone assemblages from three sites bordering Pumicestone Passage, including Sandstone Point, Bell's Creek Midden and White Patch. Each of these sites was excavated by Haglund between 1972 and 1973. White Patch was found to date to 670±95BP (SUA-481) (Crooks 1982:64-65). Crooks (1982) noted the similarity of the faunal and stone assemblages recovered from all three sites. The homogeneity of collections from throughout the general region was surprising, with technology and raw materials the same for mainland and island. The importance of shellfish as a dietary component was also noted, as was the evidence of fern root processing in the form of bevel-edged artefacts.

Other more limited studies have also been undertaken as part of cultural heritage assessments, particularly around the Beachmere area. Hall (1990) surveyed a proposed canal estate located at Beachmere, approximately 11km southwest of BIR (Hall 1990), although no archaeological material was identified. Wallin (1994) assessed a potential sand extraction site located at Beachmere. A large midden and numerous shell scatters accompanied by background levels of stone artefacts were identified. Subsurface testing indicated that the midden material had been substantially impacted upon by pine plantation planting and clearing practices. Davies (1995) surveyed another extractive site at Beachmere, noting four low density shell scatters, despite extensive ground disturbance. Ann Wallin and Associates (1998) identified a large midden at Beachmere during a cultural heritage assessment of a sand extraction site, although the extent and nature were difficult to define owing to extensive ground cover.

In 1992, Smith (1992) developed and tested a predictive model of site location for Bribie Island. The model hypothesised that site location could be predicted with reference to five main elements – the coastline, freshwater, fern root resources, elevated areas and vegetation type. Of the 71 sites tested against these criteria, only one did not fit the predicted pattern.

Smith (2003) subsequently developed a model of movement around Bribie Island, proposing that people predominantly travelled north-south along relic Pleistocene dune ridges between two semi-permanent base camps, with limited west-east movement. These base camps were hypothesised to have acted as import sites for stone artefact raw materials on the island. Smith's (2003) analysis of stone assemblages from 43 sites on Bribie Island, however, failed to support this model. Results revealed no consistent spatial pattern for the import of raw materials and/or stone artefacts. The lack of distinct import points was explained by the island's close proximity to the mainland and ease of transport of raw materials and artefacts to the island. Smith (2003) concluded that the stone assemblage indicated a low risk sedentary lifestyle.

The Bestmann Road Bora Ring is located approximately 1.2km southeast of BIR and consists of two raised earthen circles joined by a meandering pathway. Nique and Hartenstein (1841) recorded this site in use during an initiation ceremony and the gathering of around 2000 Aboriginal people nearby. This site represents one of the few complete earthen circle sites remaining in southeast Queensland (Satterthwait and Heather 1987). Another earthern circle is located 2km east of BIR on Bribie Island. A stone-walled tidal fishtrap is also located nearby (Morwood 1987; Walters 1986), approximately 500m east of BIR.

The impressive archaeological database described above has underwritten the key models for late Holocene culture change in Moreton Bay, including those proposed by Morwood (1987) and Walters (1989). Both models argue for intensification as a late Holocene phenomenon linked to the intensive use of marine resources. The intensification models focus on the increasing number of sites from this time, with associated increases in the numbers of stone artefacts, new technologies, marine resources (fish and shellfish) and ceremonial activities. Both Morwood (1987) and Walters (1989) use data from Sandstone Point to support their models. In particular, both researchers point to dramatic increases in the deposition of fish and shellfish remains over the last 1000 years and link this with more sedentary occupation. The presence of earthen circles and the stone-walled tidal fishtrap nearby is linked to intensive use of the region, linked to inter-group gatherings implicated in activities associated with the earthen circles.

Identification of BIR

During construction of a merge lane facility along Caboolture-Bribie Island Road (Figure 2), RoadTek Asset Services (South) identified what they believed to be a shell midden below the level of the existing road. Shell material was visible as a lens in a trench dug by an excavator for the purposes of grading and filling to construct a level merge lane that joined back into the existing road. The trench was located on the northern side of Caboolture-Bribie Island Road with shell material identified in the final excavator scrape. The shell material in the excavated trench was positively identified as having a cultural origin on the basis of the restricted range of shellfish species present and the presence of stone artefacts and appeared to be *in situ* under the existing road. The material was primarily located in a lens (Figure 3) exposed for 4.5m along the section of the trench at a depth of 70cm below the current road level. The lens was situated within a dark brown organic matrix underlying a layer of orange gravel, then road base and finally bitumen – all associated with previous road construction activities during the early 1960s. The shell material in the lens was dominated by cockle (*Anadara trapezia*), with some oyster (*Saccostrea glomerata*) and whelk (*Pyrazus ebeninus*) evident.

Shell material was also evident on the southern side of Caboolture-Bribie Island Road, however, this material appeared to no longer be *in situ*. The bank on which the shell material was located was significantly elevated above the surrounding ground level and appeared to be associated with the construction of the road in the 1960s. The shell material on this bank was interspersed with modern rubbish, including concrete, ceramics, cut bones, gravel and pumice.

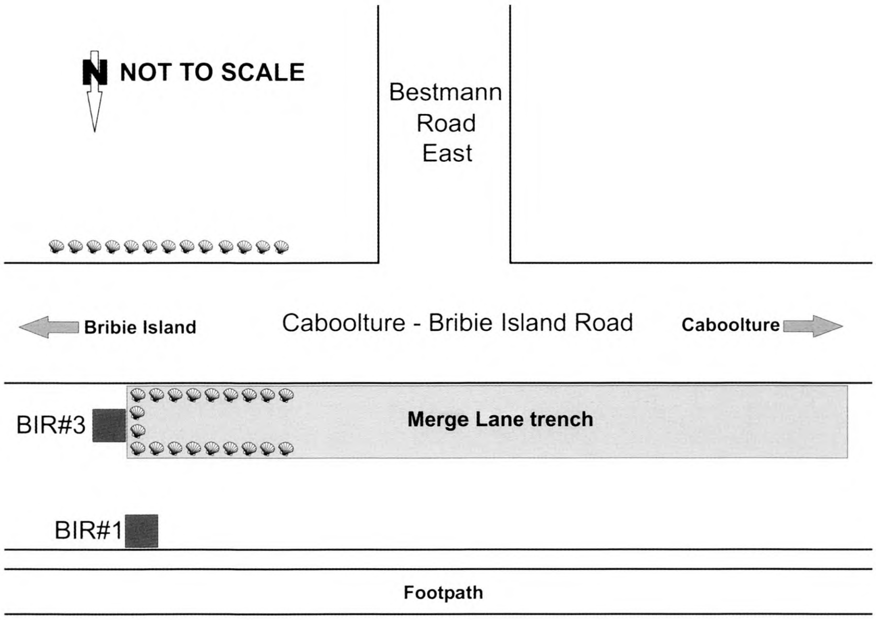

Figure 2. BIR site layout.

A number of isolated whelk and cockle shells were also found on the surface of a trench that had been excavated for the installation of services along the footpath to the north of the shell midden identified under the road (Figure 2). It appeared likely that the shell material identified in the excavated merge lane trench extended further north and that trenching activities associated with service installation had disturbed midden material.

Methods

Archaeological investigations were identified as necessary at the site by the traditional owners. It was agreed that a number of exploratory activities would be undertaken to determine site character, context, depth, antiquity and extent:

- A backhoe/grader scrape on the south side of the road.
- A shovel test pit (BIR#1) on the north side of the road.
- A controlled test pit (BIR#3) on the north side of the road.

Grader Scrape

On the southern side of Caboolture-Bribie Island Road (Figure 2), a backhoe dug a small trench parallel to the road to create a clean profile. The trench measured 2.4m long (parallel to road), 1.3m wide (at right angles to road) with a maximum depth of 80cm. Three stratigraphic layers were clearly identifiable. Stratigraphic Unit I (SUI), consisted of bright yellow sands topped with a thin covering of what appeared to be intermixed Aboriginal cultural material (stone artefacts etc) and modern rubbish (plastic etc). SUII consisted of dark grey sand with no cultural material present. SUIII consisted of light to dark grey mottled sand with no cultural material present.

A grader was then used to scrape a section the length of the southern bank starting several metres west of the backhoe trench. This scrape coincided with the area where the shell lens was thickest on the northern side of the road in an attempt to identify if the shell midden extended south under the road. The scrape was located 2m from the edge of the bitumen. The length of the scrape was 13m to a depth of 50cm. The sediments were similar to those recorded in the backhoe trench with yellow and dark grey sands including a lens of orange clay at the western extent of the scrape. A single piece of oyster shell was identified in SUI of the scrape, establishing that midden material did not extend south under the road.

Figure 3. Shell material evident as a lens beneath the current road level (Photograph: Ross Jones).

Figure 4. Completed excavation showing the shell lens in a rich dark brown organic soil matrix (Photograph: Kathleen Hillcoat).

Shovel Test Pit

A shovel test pit labelled Bribie Island Road 1 (BIR#1) was located next to the footpath on the northern side of the road, 7m north of the merge lane (Figure 2). As BIR#1 was an exploratory test pit to determine if the cultural material present in the merge lane trench extended north, and if so in what densities, this pit was dug using a shovel. A 50cm x 50cm test pit was strung using builders string and excavation proceeded in two excavation units (XUs) defined by stratigraphic change in the sediments. Excavated materials were sieved, but not weighed. Sediment samples were taken from three different locations throughout the excavation including the base of the grassy layer, the base of SUI and the base of SUII. These sediment samples were used to perform pH tests and Munsell® colour chart readings that showed the grading of sediment colour through the deposit.

The top 25cm of sediment (SUI) was extremely compact and difficult to excavate. Cultural material, including oyster and cockle shells, was recovered from the top SU, however it was intermixed with modern material, including road base, bitumen and concrete. SUI included the top grassy layer and graded from a dark orange to deep brown coloured sediments. This SU had a pH reading of 5.5. The compactness of the deposits and the mixture of cultural and modern materials indicated that the area had been previously disturbed, likely during 1960s road construction activities. A single stone artefact was recovered from SUI, manufactured on yellow-brown chert and measuring 37.1mm in length, 25.5mm in width and 10mm in thickness. The artefact has cortex on the entire dorsal face. SUII extended from 25–44cm, where excavation ceased. This unit was characterised by less consolidated soils grading from dark brown to light yellow sands. The SU had a pH reading of 6.0 and was culturally sterile.

Controlled Test Pit

A controlled test pit labelled Bribie Island Road 3 (BIR#3) was located on the eastern edge of the excavation merge lane trench (Figures 2-3) and 73cm north of the existing Caboolture-Bribie Island Road. The pit consisted of a single 50cm x 50cm test pit which was positioned at the easternmost edge of the merge lane trench to allow excavation to proceed from the 'known to the unknown'.

Excavation proceeded using trowels, brushes and pans. XUs were each approximately 2cm in depth with a volume of around 10l. Excavation recording forms were used to detail the progress of the excavation. Photographs were taken at the end of each excavation unit. All excavated material was placed into buckets with the residue weighed, sieved through a 3mm sieve mesh and placed into labelled bags using a unique field specimen identification number. Sediment samples, pH readings and basic soil analyses were undertaken for each XU. Sections were drawn and photographed at the end of the excavation (Figure 4).

A total of 21 XUs was removed from BIR#3 to a depth of 47cm below ground surface. While the deposit was dominated by shell material, organic material, charcoal, stone artefacts, bone and non-artefactual stone were also present. At the end of the excavation, the pit was backfilled with the sediments that had passed through the 3mm sieve.

Results

Stratigraphy

Excavation reflected the structure of the site observed in the merge lane trench. Four Stratigraphic Units (SUs) were defined on the basis of sediment colour and texture (Table 1). SUI was similar in composition to nearby BIR#1 with extremely compacted sediments. Cultural material was present, though sparse and fragmented, and included modern material. SUII was slightly less compacted than SUI. Larger fragments of shell were encountered along with charcoal. SUIIA was a subunit of SUII encountered across the whole pit and consisted of a low density shell lens. The distinct shell lens identified in the merge lane trench was concentrated in SUIII between 25–35cm below ground surface. Shell densities dropped off below this level, with only occasional shell encountered below SUIII. SUIV had occasional shell material, with larger non-artefactual stones and blocky charcoal encountered. Overall, sediments graded from light grey to dark grey sands, with slightly acidic to neutral pH values (6.0–7.0). A large number of small non-artefactual stones were encountered throughout the deposit, concentrated in the top SUs. Known to the traditional owners as 'Goat's pebbles', the stones are round and orange in colour. Discussions with Jay Hall and Tam Smith (School of Social Science, University of Queensland, pers. comm., 2006) indicated that these stones are not present in other archaeological sites in the surrounding area. Large quantities of blocky charcoal were recovered towards the base of the excavation. This material is thought to be largely of natural origin.

Some post-depositional movement of material within the deposit is evident in the presence of modern material. The first mixing event occurs within the topmost units of SUI with glass, plastic, cigarette butts, bitumen, road base and concrete present. The second mixing event occurs at the base of SUII with modern material consisting of two heavy metal objects including a key to open a can and a bottle top. Root penetration appears to be the major source of post-depositional disturbance in SUI, while the weight of the metal objects and ant activity in SUII likely accounts for the movement of this material with the interlocked shell lens in SUIII posing a barrier for the continued movement of material down the deposit.

Table 1. Stratigraphic Unit descriptions, BIR#3.

SU	XU	Description
I	1-3	Extends across the entire square with a maximum depth of 15cm in the southeast corner. Deposit very compacted, comprising light grey, poorly sorted sands. The unit is dominated by humic material with roots and fine rootlets common. Fragmented oyster and cockle shells are present, as are numerous non-artefactual stones. Some modern material including plastic and glass is also present. pH values are slightly acidic (6.5).
II	4-7	Extends across the entire square with a maximum thickness of 18cm. The deposit remains compacted, but less so than the unit above, comprising dark grey, poorly sorted sands. Large and small shell fragments of oyster, cockle and whelk are present throughout. Small pieces of charcoal are also present, as are non-artefactual stones. pH values are neutral (7.0).
IIA	4-6	This unit is only exposed in the southern profile and overlies SUII, with a maximum thickness of 8cm. The deposit remains compacted, but less so than SUI, comprising dark grey, poorly sorted sands. The unit is distinguished from SUII as a concentration of shell dominated by cockle is present including small pieces of charcoal and non-artefactual stones. pH values are neutral (7.0).
III	8-16	This unit extends across the entire square with a maximum thickness of 14cm. The deposit grades from compacted to coarser, less compacted, dark grey sands. A distinct lens of shell is evident across the entire square, comprising whole shells and large fragments of oyster, cockle and whelk, with the densest concentration of shell in the southeast corner of the southern half of the square. Large pieces of blocky charcoal are also present, as are non-artefactual stones. pH values are neutral (7.0).
IV	17-21	This unit extends across the entire square with a maximum thickness of 17cm. The deposit comprises fairly compacted, mottled dark and light grey, well-sorted sands. Shell, although present throughout the SU, falls away dramatically with only small, fragmented pieces recovered from basal XUs. Small pieces of charcoal and small non-artefactual stones are present throughout. pH values are neutral (7.0).

Table 2. Summary of radiocarbon results, BIR#3.

Lab No.	XU	Depth (cm)	Sample	Weight (g)	$\delta^{13}C$ Age	^{14}C Age	Calibrated Age/s
Wk-18341	18	32-35	*A. trapezia*	37.64	-0.1±0.2	1152±34	632-766

Table 3. Summary of shellfish taxa at BIR#3.

Taxa	Family	Scientific Name	Common Name	Weight (g)	%
Bivalvia	Arcidae	*Andara trapezia*	Cockle	5057.47	68.7
	Chamidae	*Chama fibula*	–	0.61	<0.01
	Mytilidae	*Trichmomya hirsuta*	Hairy Mussel	4.75	0.06
	Ostreidae	*Saccostrea glomerata*	Oyster	1466.36	20
Gastropoda	Batillaiidae	*Pyrazus ebininus*	Whelk	816.27	11
		Velacumantus australis	Mud creeper	8.19	0.11
	Littorinidae	*Bembicium nanum*	–	2.65	0.04
	–	*Polinices sordidus*	–	3.00	0.04
	–	Unidentified gastropod	–	0.29	<0.01

Radiocarbon Dating and Chronology

A single sample of cockle shell (*Anadara trapezia*) was submitted for radiocarbon analysis to the University of Waikato Radiocarbon Dating Laboratory. The disturbance noted above meant any date obtained from SUI–II could be problematic and was therefore avoided. This sample was selected from XU18 (SUIV) as this unit exhibited cultural material and was free of modern intrusions. The XU is located below the thick shell lens within SUIV and associated with oyster, cockle, hairy mussel, whelk, charcoal and fish bone. Four left valves were selected for dating.

A conventional radiocarbon age of 1152±34 BP (Wk-18341) was achieved (Table 2). This age was calibrated into calendar years using the CALIB radiocarbon calibration programme (Stuiver and Reimer 1993), using the calibration dataset of Hughen *et al.* (2004) and a ΔR value of 11±15 (Ulm 2002b) applied to correct the age for local marine reservoir conditions. This resulted in a calibrated one-sigma age-range of 632–766 years BP.

Cultural and Non-Cultural Materials

All excavated material was wet-sieved using freshwater and air-dried before laboratory analysis was undertaken. Each XU was sorted using tweezers into various components including artefactual stone, non-artefactual stone, charcoal, bone, organic material, shell and modern material. Each category of material was then bagged in individually labelled press-seal bags and weighed.

Invertebrate Remains

Cultural material at BIR#3 was dominated by shellfish remains comprising 30% of the 3mm residue. Nine taxa of shellfish weighing a total of 7359.62g was recovered, consisting of four marine bivalves and five marine gastropods (Table 3). The shell deposit is dominated by cockle (*A. trapezia*) (69%), followed by oyster (*S. glomerata*) (20%), whelk (*P. ebininus*) (11%) and the mud creeper (*Velacumantus australis*) (0.11%).

The remaining five taxa are relatively rare, each contributing less than 0.5% of the shell assemblage by weight. Many of the smaller taxa represented, particularly the gastropods, are likely to have entered the deposit attached to the larger shellfish taxa. Oyster was recovered still attached to rock platforms, indicating that at least some oyster was gathered from rocks located in the nearby subtidal zone. The small range of shellfish recovered indicate that gathering activities focused on a broad intertidal zone similar to that which occurs adjacent to the site today.

Figure 5 shows the distribution of shellfish throughout the deposit. A weak bimodal trend is evident with two peaks in the graph. The first occurs in XU16 which is the major shell lens of SUIV and is that visible in the merge lane trench. Commencing in XU19, this peak dates to around 800 years ago with the second peak centring on XU7, being smaller than the first. Basic analysis was completed for the

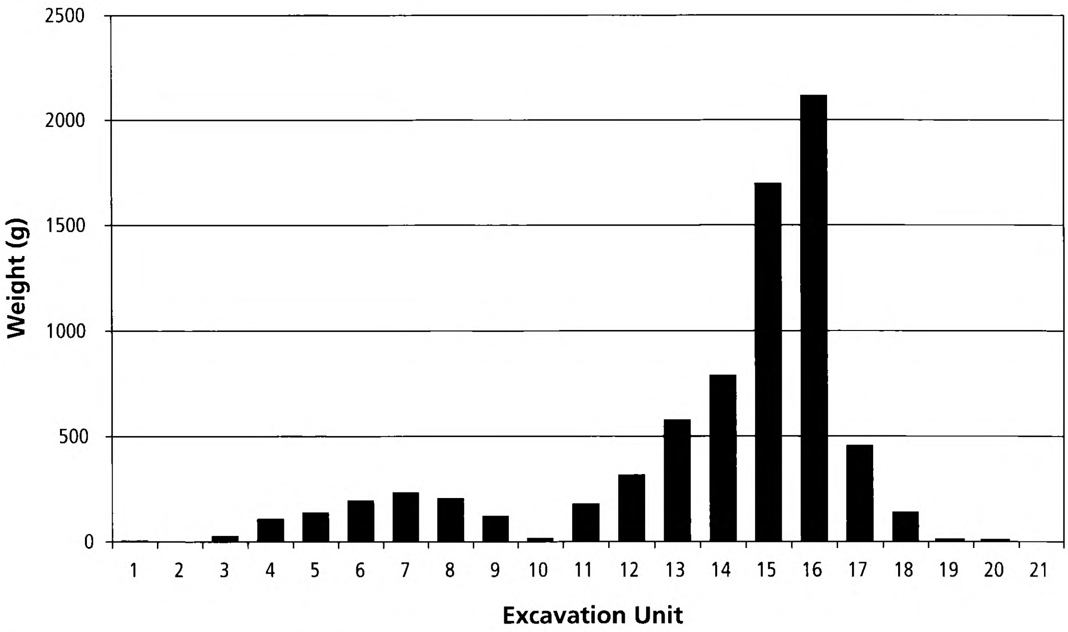

Figure 5. Shellfish distribution at BIR#3 showing the peak of the shell lens in XU16.

Table 4. MNI and NISP data for dominant shellfish taxa, BIR#3.

XU	*A. trapezia*		*S. glomerata*		*P. ebeninus*	
	MNI	NISP	MNI	NISP	MNI	NISP
1	0	6	0	23	0	0
2	0	2	0	1	0	0
3	1	25	0	0	1	1
4	3	103	0	51	3	3
5	2	104	0	66	2	4
6	6	107	0	42	2	2
7	0	105	0	37	2	2
8	9	157	1	16	0	4
9	5	117	0	27	0	1
10	1	4	0	31	0	1
11	5	39	3	254	3	8
12	4	45	5	340	1	3
13	6	78	5	437	4	9
14	16	129	5	679	1	5
15	47	252	9	649	8	18
16	69	279	8	702	14	28
17	15	129	5	337	4	31
18	4	42	2	150	2	7
19	0	10	0	16	1	3
20	0	8	0	0	0	0
21	0	0	0	2	0	0
Total	193	1741	43	3860	48	130

Table 5. Fish bone from BIR#3.

XU	Weight (g)	Number Specimens	MNI
9	0.08	3	0
11	0.01	1	1
12	0.01	2	0
13	0.12	4	0
14	0.32	12	1
15	0.10	10	5
16	0.29	11	2
17	0.13	8	1
18	0.16	6	1
19	0.11	3	1
20	0.12	4	1
Total	1.45	64	13

material including the number of identified specimens (NISP), and the minimum number of individuals (MNI) calculated as the highest number of the left and right or lid and base elements counted for each XU, with the highest number taken as the MNI (Table 4).

Vertebrate Remains

Sixty-four pieces of fish bone with 13 identifiable elements were recovered from BIR#3 weighing a total of 1.45g (Table 5). This material was extremely well preserved. Generally the fish bone recovered was fragmented pieces of fish spine, consistent with fish bone material reported from other sites in Moreton Bay (see Ross and Duffy 2000; Ulm 2002a). Basic analysis was completed for the fish bone material including a specimen count and MNI calculations. The MNI was calculated by totalling the unique number of identifiable elements (e.g. otoliths, vertebra etc) per excavation unit.

Interestingly, fish bone was restricted to deposits below XU9 (c.30cm) and appears to be associated with the first shellfish peak (Figure 5). On the basis of analysis of Teewah Beach Site 26 and Double Island Point Site 1, McNiven (1991:20) argued that fishing is poorly represented in the archaeological record when compared to the numerous ethnographic reports available. McNiven suggested fish remains were unlikely to be recovered archaeologically unless they were discarded with shellfish remains owing to both site visibility and preservation considerations. Of the 64 pieces of fish bone recovered, only three pieces were located in XU9 associated with the beginning of the second shellfish peak. While it is acknowledged that the total sample size is small, the lack of fish in the upper units (XU1–8) may indicate differences in site activities during the two peak episodes of activity at the site in support of McNiven's (1991) argument, or could alternatively be the result of post-depositional disturbance that has occurred in the upper XUs.

Eighteen pieces of mammal bone were also recovered from the site, weighing a total of 1.2g. No identifiable elements were recovered from the deposit; however, the bone was clearly distinguishable from the fish bone, being more robust, larger in size and heavier. The distribution of the mammal bone is similar to that of the fish bone, being restricted to the basal units (XUs 14, 15 and 20).

Stone Artefacts

Six stone artefacts weighing 1.41g were recovered from BIR#3 (Table 6). The artefacts were located in the three basal XUs dating to older than 800 years. All stone artefacts were small and are likely debitage. Two raw materials, silcrete and chert were identified. All artefacts were classified as flaked pieces as they have no formal attributes.

Table 6. Stone artefacts from BIR#3.

XU	Weight (g)	#	Raw Material	Type
19	0.13	1	Silcrete	Flaked piece
20	0.88	3	Chert	Flaked piece
			Chert	Flaked piece
			Silcrete	Flaked piece
21	0.4	2	Silcrete	Flaked piece
			Chert	Flaked piece
Total	1.41	6	–	–

Other Remains

Non-artefactual stone was the dominant component of the 3mm residue by weight comprising some 17,222g. This material consisted almost exclusively of small-to-medium-sized orange pebbles known to the traditional owners as 'Goats pebbles'. This raw material is available locally with modern quarries used by Main Roads for road construction in the Caboolture area (Dave Warren, RoadTek Asset Services (South), pers. comm., 2005). Scattered fragments of blocky charcoal were present throughout the deposit, with larger pieces of blocky charcoal associated with SUIV towards the basal units of the deposit, totalling some 154g. Organic material consisting of roots and rootlets weighed a total of 48g. Modern material recovered from the deposit included concrete, glass, bitumen and metal and weighed a total of 25g.

Discussion

Through a variety of salvage and test excavation techniques, the character, context, depth, antiquity and extent of the BIR site were able to be determined. Via a process of systematic elimination, the site was determined not to extend under the road south, nor any great distance north, of the exisiting road. Covering an area of 16m², excavations at BIR revealed evidence for a discrete *in situ* shell midden with a rich archaeological deposit that provides new evidence for the marine fishery of Moreton Bay which conforms to that of nearby Sandstone Point and White Patch.

Fishing is one of the most well-recorded activities for the Sandstone Point area in the ethnographic literature (e.g. Gregor 1846:549; Simpson in Langevad 1980; Uniacke in Mackaness 1956:30). Most often nets were used for this activity in association with fishtraps. Uniacke (Mackaness 1956:30) observed local fishing parties with seine nets requiring a group effort, and with scoop nets. Petrie (1904:72) witnessed mullet fishing techniques, as well as those used to catch tailor and flathead. Fish are available year round in Moreton Bay (Walters 1986), however the numbers and variety available vary from season to season.

The pre-European Moreton Bay fishery has been the focus of intensive research since the 1980s. Walters' (1986) model describes a late Holocene fishery intensification in Moreton Bay, and southeast Queensland more generally, broadly arguing for a pattern of increased fish discard through time associated with an increase in the number of sites containing fish bone remains. Ulm (2002a) critiqued this model demonstrating that there was no simple increase in the discard of fish remains through time. Ulm's (2002a:88) review revealed that of the 23 sites reported to contain fish remains only two of these sites (including Sandstone Point and Toulkerrie) actually strongly supported Walters' model for increased fish discard through time.

The small fish bone assemblage from BIR#3 provides new data to this debate. The site provides evidence of fishing confined to a few elements, potentially representing a single episode, with fish bone comprising only a small component of the overall faunal assemblage. Fish bone enters the record at XU20 (c.800 years ago) and is continuously represented until XU9, corresponding with the commencement of the second episode of site use. In fact, from the BIR#3 evidence, rather than an increase of fish bone discard through time as predicted by Walters' model, fish bone is not a component of the deposit after this time. While this trend may in some way be accounted for by post-depositional disturbance, the presence of a second shellfish peak and the heavy nature of the metal items located in SUII indicate that, for the most part, the deposit below SUI remains *in situ*. These data may also reflect timing and use of the nearby fishtrap. Species of fish recorded at Sandstone Point (Crooks 1982:130) were considered to reside near the mouth of a stream and be caught in a net or in a fishtrap, which is the enthnographically recorded method of collection for this area.

Documentary evidence suggests that the Sandstone Point subregion has always been an area of significance to local Aboriginal people, certainly since historic times. BIR#3 is situated within 3km of two focal sites within the subregion, Sandstone Point and the Bestmann Road Bora Ring. Reliant on the exploitation of local resources, the area was known historically to host major intergroup gatherings associated with use of the Bestmann Road Bora Ring (Eipper 1841; Petrie 1904; Steele 1984). It has been argued (Nolan 1986; Walters 1986) that major marine fishery production was taking place at Sandstone Point that enabled such gatherings to take place. Sandstone Point was not considered by Ulm (2002a) to be typical of Moreton Bay coastal sites owing to the accumulation of deposits on the foredune, low rates of damage to fish bone and high preservation rates. Of relevance here is Ulm's (2002a:90) third reason for Sandstone Point's uniqueness, the favourable preservation conditions of the site, meaning (if present) every opportunity existed for fish bone to be preserved. If we can therefore assume people are using Sandstone Point more intensively during the late Holocene as reflected by the fish bone assemblage, why is BIR#3 deposit so similar to that of Sandstone Point? The answer may lie beyond consideration of the marine fishing in isolation.

Petrie (1904:317) and Steele (1984:163) noted the importance of shellfish historically as a food source, especially the oyster. This was the name given to the local people, Ningi-Ningi, meaning oyster. Eipper (1841:10) recounts a story that describes a group of Aboriginal women gathering oysters in Pumicestone Passage. A canoe was used to row to a nearby island where the women would gather oysters from the mud and place them in the boat. The most abundant component of the cultural deposit at BIR#3, as with most sites in the subregion including Sandstone Point, is shellfish remains, within which two major peaks are evident. The peaks are considered to represent two focal points of occupation of the site, indicating that BIR#3 was initiated as a short-term camping area c.800 years ago. At that time, people ate shellfish and fish at the site and used stone tools. BIR#3 might be indicative of what Meehan (1982:26) termed a 'dinnertime camp'. These sites are described as small camps located away from the main camping area and used ephemerally while completing daytime activities. Such sites were usually located in closer proximity to the resource being exploited than the main camp (in the case of BIR#3 shellfish and fish), near freshwater and provided a degree of shade (Meehan 1982:26). Some dinnertime camps were used only once and are discrete in their size, while others were used repeatedly (Meehan 1982:114). The critical observation here is the dinnertime camp site is a smaller, but similar, version of the main camp – the latter being larger and generally more complicated in its composition.

The content and age of BIR#3 is similar to that of nearby Sandstone Point. Twelve of the 15 radiocarbon dates available for Sandstone Point fall between 0 and 1500 years BP, suggesting relatively intense occupation at least in that time interval (Ulm and Reid 2000:31). Not only are the shellfish and fish bone remains similar, but the range of stone artefact raw materials conforms to the assemblage recovered from Sandstone Point (Nolan 1986:84). The absence of formal tool types in the BIR#3 assemblage is likely a result of BIR#3 being an ephemeral camp site and the small sample size investigated. BIR#3 is located in close proximity to the resource rich southern opening of Pumicestone Passage where abundant shellfish and fish were available, as well as the nearby stone-walled fishtrap. BIR#3 is also located on a high barrier dune near the mangrove fringe and mudflat interface, in proximity to freshwater, making it a prime location for hunting and gathering activities.

A final note is made regarding the apparent homogeneity of the archaeological record of the subregion as a whole. As demonstrated above, the majority of sites located in the Sandstone Point subregion reflect to varying degrees a similar faunal and stone assemblage to that of Sandstone Point. The subregion is known historically to be owned by the Joondaburri people and the standardisation of the archaeological record provides strong evidence for social continuity, which would have been reinforced through ceremonial activities at the nearby earthen circles and participation in wider events such as Bunya Nut festivals. Therefore, it is argued here that BIR#3 should be considered in terms of the broader contemporary archaeological landscape centring on Sandstone Point. Sandstone Point can be considered a central residential base camp from which foraging activities were carried out, while BIR#3 was a waypoint located conveniently within the landscape where meals of shellfish, mammal and fish were captured and consumed during two main periods in the last 800 years. While no formal tool types were identified at BIR#3, debitage is present suggesting limited stone tool manufacture and/or maintenance. Analysis of BIR#3 provides a unique opportunity to investigate a site where a limited range of activities were completed over a relatively short period of time, culminating in two major events. The information gained from the fish bone assemblage has provided further evidence of the complexity of the prehistoric marine fishery industry of Moreton Bay.

Conclusion

Investigations at Caboolture-Bribie Island Road during July 2005 were not only successful in facilitating road construction in an appropriate manner, but also in providing new scientific information about the way in which the Sandstone Point subregion was used by Aboriginal people over the last 800 years. Each of the research aims was answered, with the area investigated to the satisfaction of the Aboriginal stakeholders allowing road construction to recommence, and the road to be built.

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To Trash and to Cache: Analysis of a Late Formative Living Surface at Copan, Honduras

Daniel Cummins and Michael Haslam

Abstract

Several studies on the archaeology of Copan in western Honduras have focused on the excavation of 'households' dating to the Classic period (Hendon 2003; Webster *et al.* 2000; Willey *et al.* 1994). In this paper we expand on this approach to incorporate the analysis of Late Formative residential deposits. Excavation during the 1997 Copan Formative Project field season revealed an expansive terminal Pleistocene alluvial terrace that was the foundation for several deposits of both Middle and Late Formative age (Hall and Viel 2004). In this paper we evaluate a series of pits and other localised deposits excavated into this alluvial surface in the Bosqué region of the Copan pocket. The evaluation of these pits illustrates several distinct problems with the typological definition of refuse deposits at Copan, and indicates a more complex engagement (agency) with the objects within these deposits. This engagement blurs the line between caching and trashing and points to a flexible approach to disposal, incorporating foreseeable reuse and storage of both domestic and ritual items.

Introduction

The Late Formative period (300 BC–AD 100) has been considered an anomaly in the apparently otherwise predictable evolution of social complexity in the Copan Valley. The virtual absence of indicators of increasing social inequality, such as settlement expansion and large-scale architecture, made Copan distinct from other lowland Maya polities during the period (Fash 1986; Willey 1988:396). This apparent lack of sociopolitical development has generally been attributed to a decline in population (Sharer 1989). However, recent excavation in the Bosqué region of the Copan pocket has revealed several extensive deposits of Late and Middle Formative material culture (Hall and Viel 2004). These deposits point to continuity between Early and Middle Formative occupants of the Copan Valley and the site's Classic period inhabitants, as Hall and Viel (1994) originally hypothesised. Consequently, we should not necessarily expect the Late Formative material culture or its manifestation in the archaeological record at Copan to reflect those processes underway in the Maya lowlands. It is increasingly apparent that Copan, during the Late Formative period particularly, needs to be evaluated within the context of, firstly, its proximity to emerging centres in western Honduras and El Salvador, and, secondly, the internal dynamics that structured the performance of daily action that contributed to the formation of domestic deposits. The latter of these two theoretical agenda is pursued in this paper.

The Pit 9 Surface

Hall and Viel (2004:21) have described the details of Pit 9. Some salient points of their discussion are summarised here:

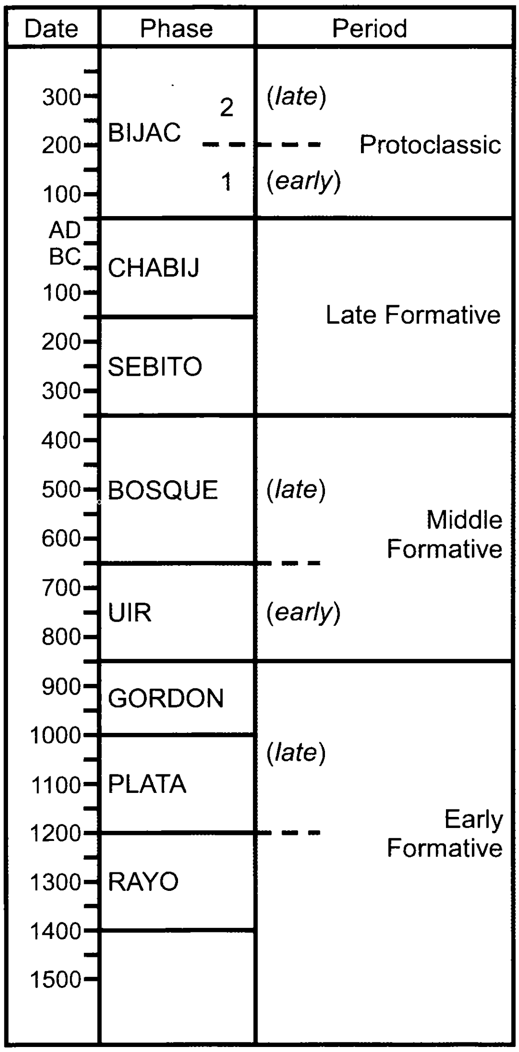

Figure 1. Copan Formative ceramic chronology (adapted from Viel 1993, 2006; Viel and Hall 2000).

- In the northern half of the pit, some 40–50cm below Late Classic (Coner) construction fill (SUI) lies a disconforming, culturally sterile gravelly sand (SUIV).
- The upper (northern) surface is pitted with several cultural features that have been interpreted as ovens, kilns and trash pits.
- Dating of these surface features on the upper surface from *in situ* ceramics and a single radiocarbon determination from one excavation unit (100 BC–AD 30) places the SUIII surface toward the end of the Late Formative Sebito phase (see Figure 1; Viel 2006).
- The surface of the deposit is relatively level until it slopes sharply downward in the south of the pit, becoming associated with a feature interpreted as a collapsed house lying at the top of the current water table and radiocarbon dated to 800–500 BC (Hall and Viel 2004).

These observations serve as a good starting point for our discussion of Pit 9. Three cultural episodes are evident in the deposit. The earliest of these is associated with the sunken house complex dated to the Middle Formative, the second to the Late Formative Sebito phase and a third, in which the landscape was remodelled, the late Classic Coner phase. Analyses by one of the authors (DC) suggest the two Formative period deposits represented in the Pit 9 excavations are separate occupations, probably with a hiatus in habitation of the locale between approximately 500 and 150 BC. This conclusion is based on both the radiocarbon dates and the lack of transitional ceramics identified between the upper and lower terraces and the presence of at least one intermediary form elsewhere in the valley. In this paper we evaluate the cultural features along the upper, Late Formative, terrace and the material culture contained within them.

Very high volumes of cultural material were encountered across the upper (northern) alluvial surface. The entire ceramic inventory from 50cm above the surface at its deepest point was analysed from Pits 9.15, 9.16, 9.18 and 9.20. Analysis revealed these ceramic materials were concentrated in a series of four deposits associated with other features in a roughly north-south orientation along the Pit 9 surface. The surface itself appears to have been utilised as a living floor – being marked by a number of surface modifications, including the excavation of several pit features (Figure 2). Large areas of the surface were also scattered with red pigment, most likely cinnabar. Several examples of late Sebito/early Chabij phase ceramics were concentrated in these features, including a very high concentration of Usulutan resist decorated wares (32%), and Usulutan-imitation (Cepillo) sherds (12%). The very low number of figurines from this part of the pit correlates with Longyear's (1952:104) appraisal of the 'Archaic' period at Copan as 'figurine poor'. Several other new forms of ceramic and stone representation are also encountered in these features.

Four Late Formative 'Trash Pits'

At Copan, a number of Formative period deposits containing large amounts of ceramics have been called *basureros* (e.g. Fash 1983a:323). This term implies that the principle purpose of these deposits

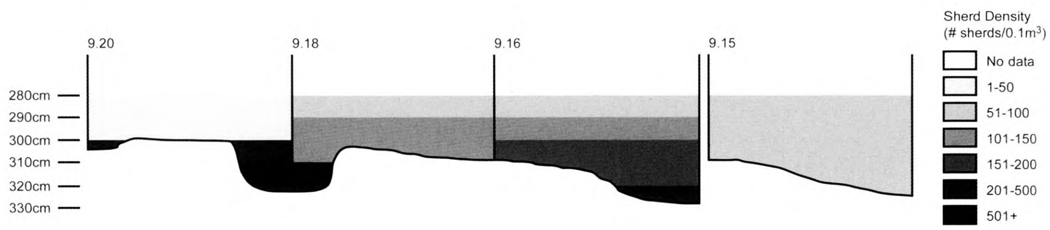

Figure 2. Sherd concentrations along the upper terrace of Pit 9, showing pit features (Sebito phase levels, vertical scale exaggerated).

was the intentional 'trashing' of ceramic material, resulting in large, dense aggregations of ceramics. However, even from the earliest employment of the term, its interpretative limitations were recognised (Fash 1983b:306-308). The dominance of large and almost complete vessels and the absence of animal bone led to the development of two entirely inconsistent interpretations – one which suggested the sorting of the material by taphonomic processes (favoured by Baudez [in Fash 1983b]), and a second that predicted the involvement of ritual agency in the formation of the *basurero*. In the case of the Pit 9 surface, four separate ceramic '*basureros*' can be identified, and for the first time it is possible to further evaluate the variability within this Formative period deposit type, and to suggest a diverse, rather than uniform range of behavioural correlates, more akin to caching than trashing, may have been responsible for their formation. It is thus hoped to reconcile the divergent perspectives that have been formulated to account for such problematical deposits.

The entire upper alluvial surface of Pit 9 was littered with cultural material that displays characteristic stylistic attributes such as resist decoration and exaggerated rim profiles that date to the Late Formative period. Kunen *et al*. (2002:200) have called this type of material 'ceremonial trash', and Late Formative/Protoclassic pits similar in content and structure to the Bosqué deposits have been described as 'trash pits' when found in other locations surrounding the Copan Principal Group (e.g. Andrews and Bill 2005:244-246). Here we evaluate the ceremonial character and content of the deposits along the upper terrace of Pit 9, expanding upon the behavioural objective of Kunen *et al*. (2002) and Walker and Lucero (2000), to focus on the agency, or activity that created ceremonial trash:

> By emphasising the multiple, potentially cross-cutting activities that resulted in archaeological residues we study, we move away from the identification of caches as reified objects and toward an understanding of how behaviours including storing, burying, caching, dumping and reusing all contribute at different times and in varying circumstances to the creation of ritual spaces and objects (Kunen *et al*. 2002:201).

Feature 47

The southernmost of these features lies at the crest of the undulating surface. First encountered as a dense aggregation of ceramics in Pit 9.8, Level 5, it was later recognised in Pit 9.16 as a circular depression in the clay surface 1.2m in diameter. The pit was focused on a central, large boulder. The presence of this boulder initially led to the suggestion that this was an oven pit. However, the dense concentration of ceramics, animal bone and the presence of other objects such as ceramic stamps and a greenstone ornament, suggest the deposit is a more generalised trash pit. Although charcoal was found throughout the pit, the ceramics do not have the appearance of having been repeatedly burnt. Moreover, a number of other artefacts point to complex action in the formation of Feature 47.

Feature 47 yielded two figurines. The first of these, Figurine 35 (Figure 3), is a flat-chested male in the orange paste characteristic of many Late Formative figurines. The second figurine, Figurine 53 (Figure 4), is an unslipped, disjunct crude head. This fragment of solid rounded figurine head with appliqué 'coffee-bean' eyes and crude nose is fractured diagonally from top right to lower left part of head. This figurine type is widely reported from Late Formative deposits at Copan, incorporating what Longyear (1952) called the 'crude' type. Feature 47 also included a circular greenstone ornament that was broken laterally (Figure 5). The greenstone artefact displays a number of undulating ridges along the exterior. A flat

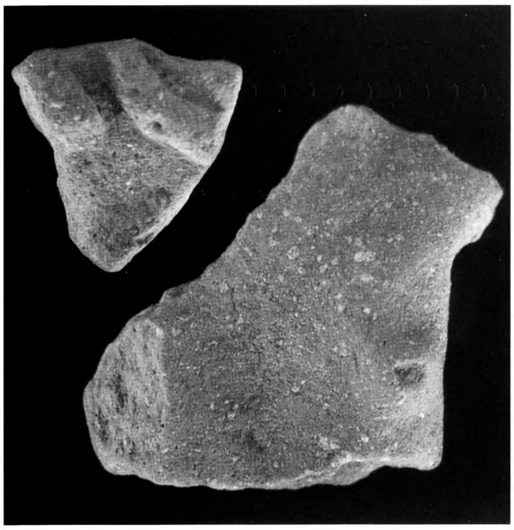

Figure 3. Figurines 35 and 36 from Feature 47 (Photograph: Daniel Cummins).

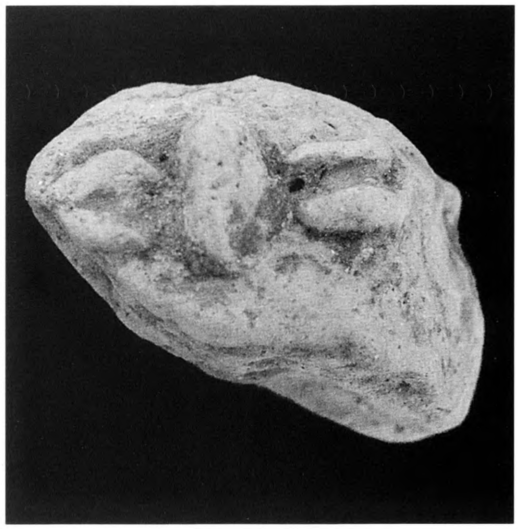

Figure 4. Figurine 53 from Feature 47 (Photograph: Daniel Cummins).

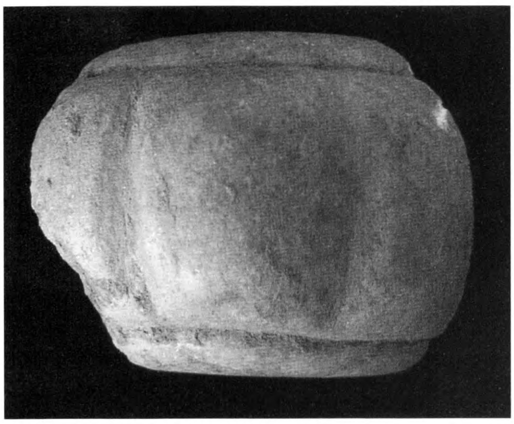

Figure 5. Greenstone ornament from Feature 47 (Photograph: Daniel Cummins).

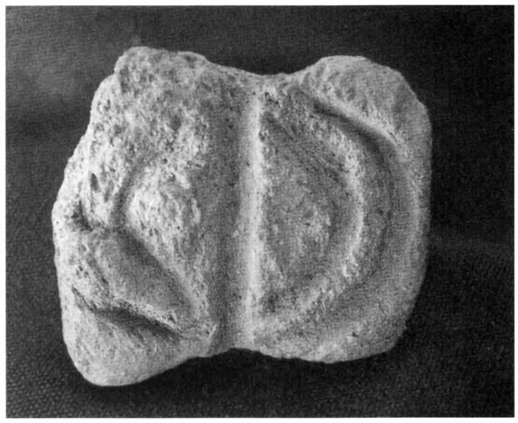

Figure 6. Ceramic stamp from Feature 47 (Photograph: Daniel Cummins).

ceramic stamp from Feature 47 is of very course clay in the Okla tradition. It features a circular design with concentric encircling rings (Figure 6).

Feature 44

To the north and east of Feature 47, lying approximately 10cm above the surface (approximately 30cm above Feature 47), lies a second feature, a concentration of ceramics centred on a number of larger river cobbles. Being the only feature not in contact with the alluvial surface, Feature 44 is more dispersed through the surrounding matrix. Feature 44 included a complete vessel, ceramic tubes and a concave sherd with an unusual incised design. Other artefacts recovered included a pigment stone and two pieces of flaking ilmenite. A pecked stone sculpture was also located in Feature 44. It was placed facedown. This unique sculpture (c.25cm) is made of a soft volcanic tuff and has shallow-crude incising distinguishing the predominant facial features (Figure 7). The figure is executed to produce considerable symmetry, both vertically and, to a lesser extent, horizontally. A second ceramic stamp from Feature 44 has a geometric spiral design akin to that identified by Longyear (1952:103; Figure 83e) (Figure 8). This design also mimics a resist-decorated sherd from the surface, to the west in Pit 9.15. Again, rather than presupposing an exclusively discard purpose for the feature, Feature 44 appears to have had a varied function, incorporating the placement of symbolic and utilitarian artefacts into a shared context, perhaps focused around the carved-stone face.

Figure 7. Stone head from Feature 44 (Photograph: Daniel Cummins).

Figure 8. Ceramic stamp from Feature 44 (Photograph: Daniel Cummins).

Feature 52

Feature 52 is another feature that intrudes into the clay surface. Stratigraphically it lies in the same unit as Feature 47 and is most likely contemporary. A shallow circular depression in the surface over 1.1m in diameter, Feature 52 contains a large number of stone artefacts including grindstones, obsidian and chert. In the northwest of the pit a large, broken metate was found deposited with a mano atop it. Compared to the surrounding very compact soil, Feature 52 exhibited an unconsolidated ash stained and discontinuous charcoal fill. A very high concentration of ceramics of Usulutan decoration and the cinnabar-stained matrix suggest a highly ritualised set of behaviours resulted in the Feature 52 deposit. Unlike Features 44 and 47, there are no figurines in Feature 52. However, it is unique amongst the pits in the inclusion of worked sherds and a small 'crucible' vessel.

Feature 52 was initially hypothesised by Hall (1999) to be primarily a dump for lithic waste flakes derived from knapping, based on the observation of high numbers of small unretouched stone pieces in the pit assemblage. This hypothesis followed the observations of Clark (1991) and others among contemporary Maya communities regarding lithic waste disposal. Residue and use-wear analysis of a sample of the lithic material from Feature 52 showed, however, that significant numbers of the flakes had been used for processing plant material including maize (Haslam 1999, 2003). Interestingly, the stone flake assemblages discarded before and after the metate and mano themselves showed significant differences in use and size, with typically larger, used flakes deposited before, and smaller unused flakes deposited after the placement of the grindstones. Within this one pit we may therefore be seeing the transition in the role of the location from a utilitarian dump for potentially hazardous material to a ritual deposit of broken and unused stone among other items.

Maize starch grains observed in the Feature 52 sediments suggest maize grinding occurred in the vicinity at about the time the pit was created and filled, with one possibility being the starch was incorporated into soils swept into the pit with other debris as part of a ritual cleansing of the site. That the grinding would have been contemporaneous with the formation of the pit deposit is suggested by taphonomic studies of starch survival (e.g. Haslam 2004), which indicate rapid breakdown of starches not protected from decay (with protection in this case provided by the abundant stone and other material culture found within Feature 52). In this circumstance, both the artefactual and sedimentary evidence may be combined to speculate on the specific practices and agency within the Late Formative domestic space.

Pit North Depression

A third pit appears to have been excavated into the alluvial surface, in a continuation of the northern direction of the previous three features. Only a small section of this pit was excavated and its contents are limited to a few ceramic vessels. But this depression does concur with the general interpretation

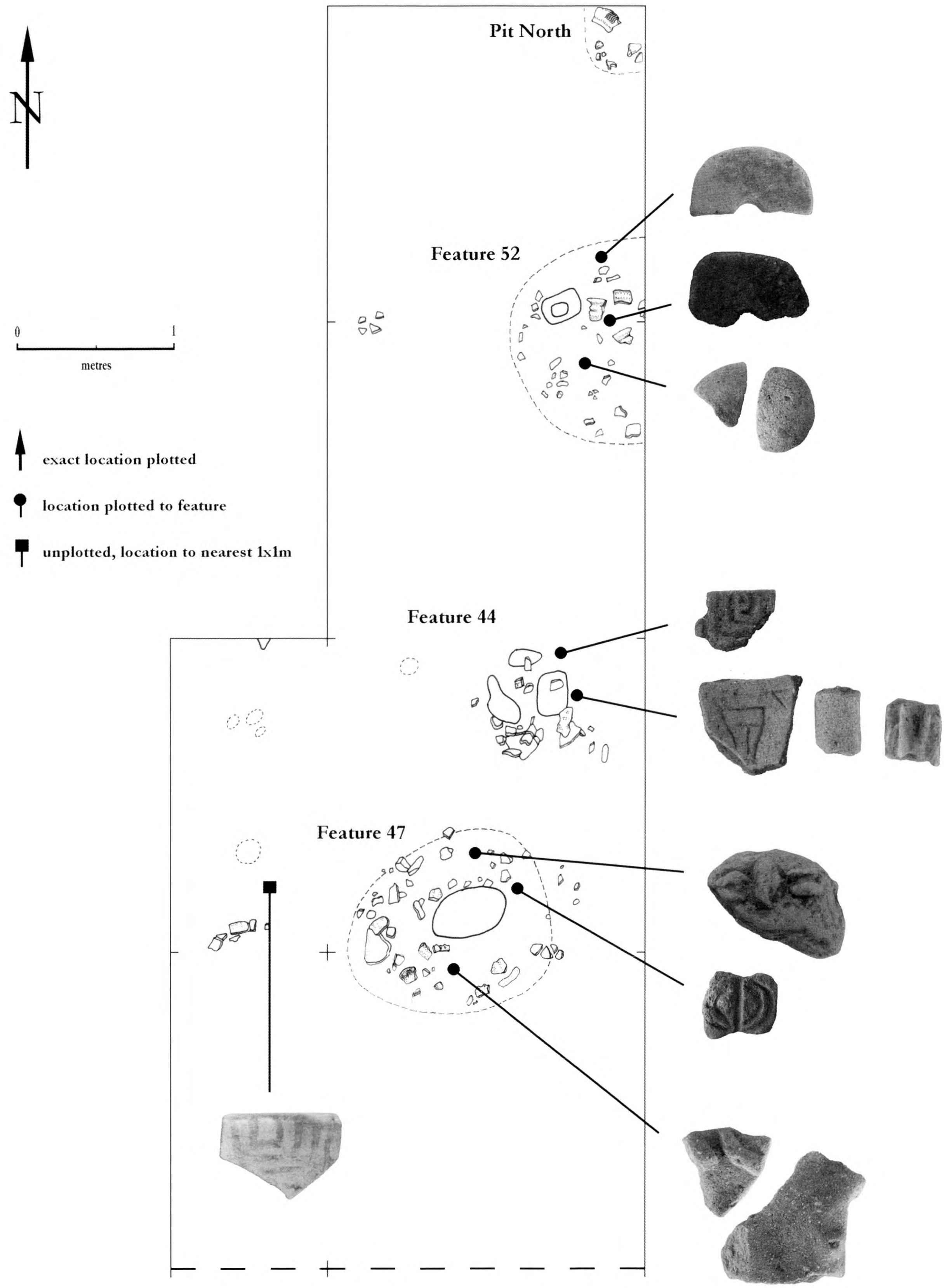

Figure 9. Figurines and ceramic objects from upper terrace of Pit 9 (excavation continues to south).

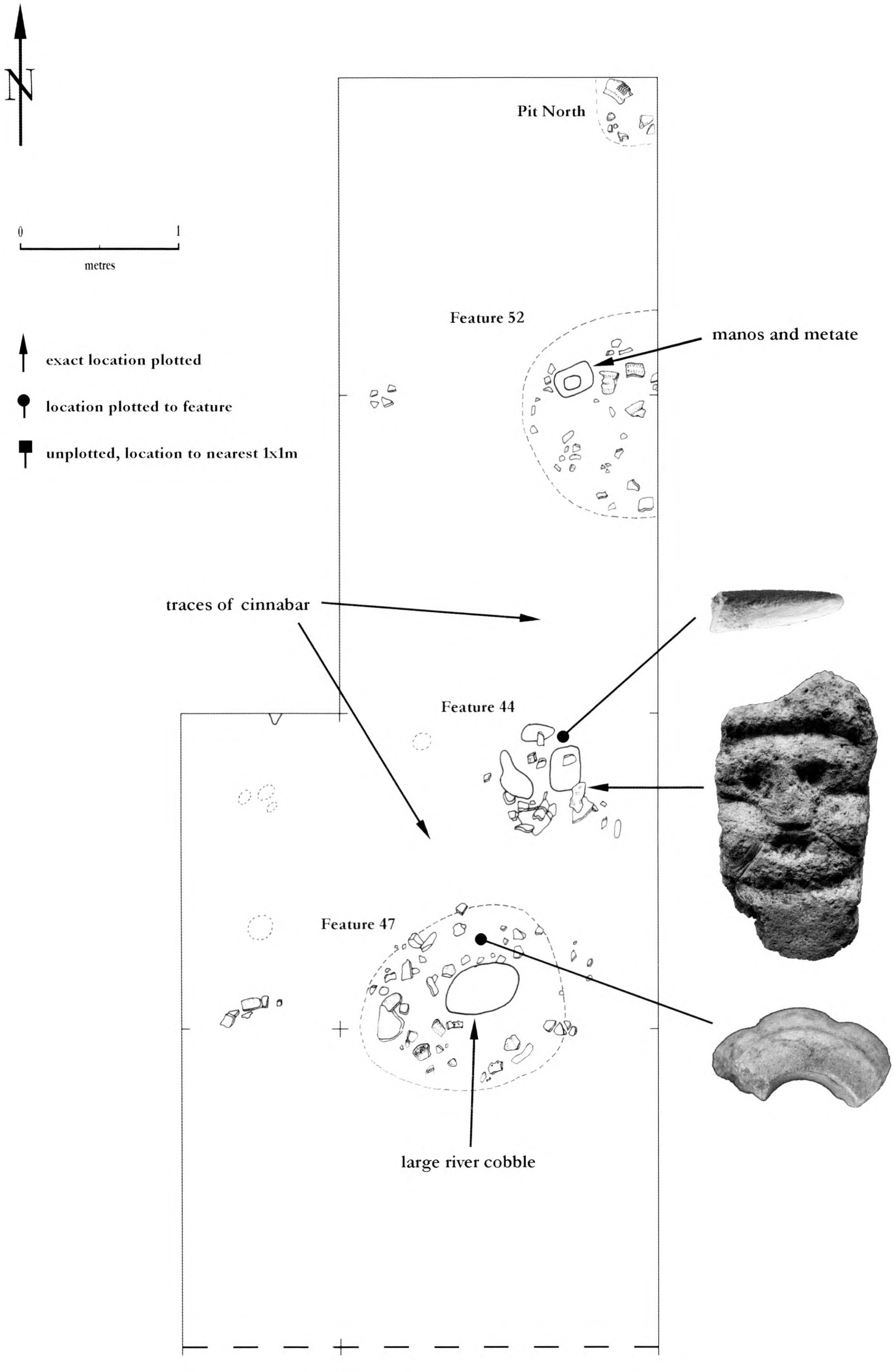

Figure 10. Plan of stone artefacts from upper terrace of Pit 9 (excavation continues to south).

favouring modification of the original alluvial surface, and the deposition of high volumes of ceramic material in these pits.

Discussion

Although each pit appears to have fulfilled a different purpose, all share many similarities. Most, if not all of the pits are contemporaneous, a series of marked locales attained through the placement of specific objects. We suggest the formation of the pits involved both trashing and caching, that they were both ritually orchestrated and utilitarian refuse locales. The majority of ritual paraphernalia appears to be concentrated in Features 44 and 47 (Figures 9 and 10). The pits along the surface of Pit 9 align to a general north-south axis in an arc around the structure to the west. As Kunen *et al.* (2002:200) have suggested, this linear axis of deposits was in itself significant – such orientations are commonly attested to point to a 'sacred topography' that facilitated communication with the underworld. In concert with other unique aspects of the Pit 9 features, such as the inclusion of rare ceremonial objects, and marking of the surface with red pigment, this alignment indicates these pits were likely sites for the performance of ritual involved in this negotiation with the spirit world.

Whilst it is possible that the structure to the west of Pit 9 was initiated at this time and the surrounding surface was a space for the performance of the ritual inauguration of this building culminating in a single large deposition event, we contend the features are the result of several ongoing trashing/caching events, perhaps ritual feasts that resulted in particular in large ceramic concentrations. Wonderley (1991:164) discusses a similar, contemporaneous deposit at Rio Pelo, where the density of Usulutan and Usulutan-imitation sherds led him to suggest a ritual origin for the Rio Pelo deposits. The upper surface of Pit 9 was also flecked with red cinnabar, with the highest concentration of this material between Features 44 and 47, indicating these pits were ceremonially linked and marked accordingly. This demarcation of the landscape is consistent with an increasingly permanent investment in domestic space, evidence lacking during earlier phases of Copan's history.

The ceramics stamps from the Feature 44 and 47 deposits also point to a shift in the structure of social relations at Copan during the Late Formative. Ceramics stamps are not known in earlier phases at Copan. Ceramic stamps are known from Playa de los Muertos burials and rare stamp-seals are also known from the late Middle Formative period at Chalchuapa. According to Joyce (1992:240) designs are specific to each area, and the 'diversity of forms suggests local manufacture of these objects and requires an understanding of local factors in their use and interpretation'. The introduction of ceramic stamps into the Copan Valley during the Late Formative is likely a consequence of the association between such items and institutionalised power structures. Artefacts such as greenstone, statuettes and figurines provide the symbolic potential for the display of authority (without requiring the actual presence of the author themselves). Many of these symbolic accessories had not previously been displayed at Copan, but appear to have been subsequently innovated to account for a growing need for highly regimented and regulated social interaction, perhaps as the Late Formative community became increasingly nucleated in the Bosqué and Principal Group areas.

A final aspect of the caching or deposition of materials into the ground which we would like to touch on is the potential for reuse. Recently Hendon (2000) has discussed aspects of archaeological storage and burial in which she identifies the polythetic nature of deposits which may continue to play an active role through revisiting, reuse and remembrance. Notions of reuse must point inevitably, however, towards questions of intention, which in turn draws on issues of capacity and agency. If, for example, an artefact or deposit displays evidence for activities often seen as socially distinct (such as mundane use of often ritually-associated obsidian blades), then the obvious question is whether those distinctions are meaningful only for the archaeologist. In other words, what is the perspective or intention of the user of those artefacts in the past? Building on these foundations, we can suggest that assessing the social role of the user is an integral part of assessing the (re)use of the artefact/deposit. Individuals with different knowledge, expectations and capacities and engaged in different social spheres cannot have had the same intentions in their use of particular items, both consciously and as a component of their own praxis within a given societal structure. In the Copan Late Formative, we can see therefore the combination of essential spiritual and physical activities expressed in the layered components of these pits, and recognise at least in part the specific knowledges of the actors involved.

Conclusion

At Copan the term 'ceramic *basurero*' or 'trash-pit' has been employed to define the majority of non-funerary primary deposits. We argue this term inferred a limited range of activities resulting from the deposition of discarded domestic items. In contrast, the ceramic *basurero* is neither uniform, nor homogeneous. It is a diverse range of materials, in both functionally-capable locales for the deposition of dangerous items (both literally and symbolically) and an important component of a ritually-marked landscape. The term has thus limited the interpretative potential of these deposits. As Walker and Lucero (2000:133) point out, utilitarian/ceremonial functional classification has lead to simplistic inferences about the forms of prehistoric activity. Rather than viewing ceramics and stone tools as largely 'singular' use artefacts, produced for an explicit usage and subsequently discarded, we propose the deposition of such artefacts, along with more elaborate objects gave them an ongoing function – one coupled to the ritual practices that necessitate the transformation of domestic living space into sacred households (Hendon 1999, 2003; Joyce 1992, 2000). Investigation of the large feature deposits dating to the Late Formative period at Copan points to a flexible approach to disposal, perhaps incorporating foreseeable reuse and a versatile approach to 'storage' involving both caching and trashing.

Emerging evidence suggests that during the Late Formative, Copan, rather than experiencing a hiatus, witnessed a contraction of settlement to the Bosqué and area immediately west of the Principal Group, as well as nucleation of settlement in a number of defensible hill-top sites, such as Los Achiotes (Canuto 2002, 2004; Cheek 1983; Fash 1983b). This transformation of settlement patterns would appear to be mirrored in the structure of such settlement and the corresponding forms of domestic behaviour. An increasingly socially differentiated community had an increasingly large range of ritual artefacts to demonstrate status and authority. The ritual deposition or caching of these 'trash' artefacts transformed their homes into ceremonially sanctified abodes.

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Data Grid for the Management, Reconstruction, Analysis and Visualisation of Archaeological Data

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Abstract

This paper addresses two parallel and interlinked problems: the development of coordinated digital archaeological resources and libraries that focus on the publication of data, and the creation of a framework for the analysis and visualisation of these data. We present our methodology and a prototype for an Australian archaeological digital collection based on data grid technologies and infrastructure. We also report on preliminary results using innovative visualisation techniques for spatio-temporal data based on the Google Maps/Google Earth technology and progress on the development of a 3D reconstruction tool that visualises excavated archaeological deposits and associated stratigraphy. Data from three major archaeological projects in Queensland are employed, spanning Indigenous, contact and historical archaeology: Mill Point Archaeological Project, Cania Gorge Regional Archaeological Project and Index of Dates from Archaeological Sites in Queensland. These case studies were selected to represent the different challenges in deploying digital technologies to Australian archaeological applications.

Introduction

Cutting-edge archaeological field research requires the implementation of digitally-based recording methods to facilitate rapid and cost-effective data acquisition. More importantly, these data must be stored in robust, organised, searchable databases to facilitate analyses, publication and advanced research. Archaeological data are complex. They are varied in format (texts, photographs, videos, audio clips, satellite imagery etc) and in content (artefact attributes, spatial coordinates, isotopic dates etc). Not all are digital. Data are saved in different formats: text and numbers are generally stored either as hard copy raw data or in databases (e.g. Microsoft Access), sometimes in spreadsheets (e.g. Microsoft Excel) or in Geographic Information Systems (GIS) (e.g. ArcGIS, MapInfo). They are stored in different locations on different media: local hard drives, institutional servers, CDs, DVDs or tape archives. As such, these data cannot be accessed or integrated easily. It is therefore difficult for researchers to explore, compare and analyse their own data with other data that are available in other research groups. This absence of coordinated digital resources and tools for the access, curation and analysis of data is an ongoing impediment to the Australian archaeological and cultural heritage industries. Professionals and researchers are either unaware of the existence of datasets, or aware of them, but unable to access them for a particular project. Their ability to work collaboratively is hampered by a lack of tools to access and share data stored in different formats and/or stored across different sites.

To date, there is no formal management process to make these data available in a 'grid environment' for wider access (Foster 2003; Foster and Kesselman 1998, 2003). For archaeology to benefit from the advances made in high performance computing (Kaufmann and Smarr 1993), it is critical to facilitate and automate many basic data management processes. 'Data grids' can provide these functions by establishing and developing infrastructure and tools needed to facilitate discovery and analysis. They also address the problem of long-term preservation of data by providing persistent archives. Based on our experience gained in developing data grids for the physical sciences, this project aims to use and adapt high performance computing techniques and infrastructure for the social sciences and humanities communities. Once the main challenges of data accessibility, data transfer and management of new or derived data are addressed, researchers will be able to access these data and advance the knowledge base of archaeology. In parallel to the creation of a data grid, we are developing visualisation, analysis and data transfer tools specific to the archaeological field. We are also interacting with scientists from other cognate disciplines who are developing data grids such as PARADISEC (see below) and the Australian Partnership for Sustainable Repositories (Australian National University 2006), which targets scholarly information held in university libraries.

Goals

There are two separate aspects to this project. One concerns data management and preservation; the other focuses on the analysis and visualisation of these data. Our goals are to develop and implement a digital archaeological collection and to create a framework for the analysis and visualisation of archaeological data. High performance computing and grid techniques and infrastructure are well embedded in research practice for the physical sciences and the time is ripe for their wider adoption by the humanities and social sciences.

The main aspect of the digital collection project concerns data management, metadata creation and the handling of files and resources. A web-based portal to these collections will provide data entry and retrieval. Researchers and people with an interest in archaeology will be able to access information about artefacts from specific projects. This digital collection will facilitate the dissemination and interchange of archaeological data both across disciplines and institutions and across the public and private sectors; enhance the ability of archaeological research to reach its full potential; and contribute to discourses about Australian cultural heritage and identity. This project will be a model for digital collections and future archaeological portals. There is no national digital collection of data related to Australian archaeology in Australia. Most archaeological data collections are located offshore: it is important for Australia to 'own' and manage information about its past.

A web-based portal to the digital collection will provide data analysis and visualisation capabilities. A researcher should be able to download a set of data for use in a specific application such as a GIS. We will investigate the use of eXtensible Markup Language (XML) schemas to parse data from one application to another. We are also developing a tool based on the Google Maps Application Programming Interface (API) to visualise and access information based on the geographical coordinates of sites. This tool will serve as a visual interface to the data collections. Finally, we report preliminary results on development of a web-based application for the 3D reconstruction of archaeological excavations. The goal is to develop an analytical tool for archaeology that would both display cultural features, artefacts and their stratigraphic associations in 3D and allow further measurement and analysis to be undertaken. Such a tool will essentially 'recreate' the site as it appeared during excavation, thus providing a permanent digital visual reference for subsequent fieldwork and analysis and a more reliable record of a destroyed resource.

The archaeological case study data derive from three projects in Queensland. The Mill Point Archaeological Project in southeast Queensland provides the primary content for the archaeological digital collection prototype. The project has delivered a wide range of digital data (digital audio and video, archival documents, digital topographic datasets, artefact datasets etc) which represent all the major classes of archaeological information routinely collected by archaeologists. A second dataset collected from deep excavations undertaken as part of the Cania Gorge Regional Archaeological Project is used for the 3D reconstruction of archaeological sites. Finally, a large set of radiocarbon dates obtained from sites across Queensland is used for the visualisation of spatio-temporal data.

Related Work

Digital Collections

Several digital collections and repository projects related to archaeology have been developed, especially in the United States and United Kingdom. The Electronic Cultural Atlas Initiative (ECAI) is an initiative of the University of California, Berkeley, which provides a clearinghouse of shared geo-temporal datasets (Buckland and Lancaster 2004; Lancaster and Bodenhamer 2002; University of California, Berkeley 2006). ECAI uses its own metadata set to describe the data. The set is based on the Dublin Core metadata set (Dublin Core Metadata Initiative 2006) along with additional elements such as temporal and spatial information. Data and associated metadata are stored in a centralised database that users query through a web interface. Query results can be visualised in a map-based interface, TimeMap (see below) (Johnson 2004; University of Sydney 2005). Our present project is not focusing exclusively on geo-temporal data, however, and the datasets will not be centralised but distributed.

The Archaeology Data Service (ADS) in the United Kingdom is one of five disciplines supported by the Arts and Humanities Data Service (Arts and Humanities Research Council 2006). The ADS is mainly a catalogue and data are not necessarily archived locally: archaeologists decide whether they want to deposit their data in the ADS. The ADS metadata are based on the Dublin Core metadata set and help the user to find out about a dataset and who to contact if the dataset has not been deposited. As a national service, the ADS supports the deployment of digital technologies and promotes good practice in the use of digital data in archaeology.

The main focus of the Alexandria Digital Library (ADL) at the University of California, Santa Barbara, is to support the earth and social sciences more generally, rather than just archaeology. The ADL provides a federated, spatially searchable digital library of geographically-referenced materials such as maps, photographs and satellite imagery (Hill and Zheng 1999; University of California, Santa Barbara 2006). The project uses its own metadata schema and addresses both physical and digital resources, for instance a map and its digital representation. The commonality with our project is that archaeologists want to catalogue both the physical artefact and also the information attached to the artefact.

The Online Cultural Heritage Research Environment (OCHRE), formerly known as XSTAR (XML System for Textual and Archaeological Research), is an online centralised repository developed at the University of Chicago to facilitate the dissemination of archaeological and cultural heritage data (University of Chicago Oriental Institute 2006). OCHRE uses a semi-structured data model characterised by hierarchical tree structures that can be easily represented in XML (XML.org 2006). Users can download or upload data through a Java user interface. OCHRE is based on ArchaeoML, an XML markup scheme developed at the University of Chicago's Oriental Institute by an archaeologist to represent archaeological datasets (Schloen 2001).

The Pacific And Regional Archive for Digital Sources in Endangered Cultures (PARADISEC) provides a facility for digital conservation and access for materials from endangered languages, cultures and music from the Pacific Region (PARADISEC 2006). Using open standards and tools the project currently has a 2.5 terabyte repository of digitised materials (especially of field tapes from the 1950s and 1960s) supported by a rich metadata catalogue of project materials. The framework allows users to access, catalogue and digitise audio, text and visual materials while preserving digital copies.

3D Reconstructions of Archaeological Excavations

In order to reconstruct the human past, archaeology must destroy that which it seeks to study. As excavation destroys the original matrix within which cultural material is found, special care is taken to record spatial context. The discipline of stratigraphy is crucial to this work and elaborate schemes have been devised to record vertical and horizontal relationships (Harris *et al.* 1993). Although archaeologists still excavate with hand tools, digital technology, especially in the form of survey equipment, cameras and GIS, provides a range of modern tools to field archaeology that generate enormous amounts of data. However innovative and useful these new tools may be, none permit a visual physical representation of the archaeological site – a 'virtual site' through which archaeologists could study the site almost as it was during excavation, even providing the opportunity to carry out subsequent quantitative measurement and analysis. Photogrammetry was once touted as an answer to this conundrum, but has proven difficult to use and is image-based (Pollefeys 2002; Pollefeys *et al.* 2003). Recent advances in scientific data visualisation provide new methods for achieving more accurate and reliable 3D records of excavations and thus bring archaeologists a step to closer to the 'virtual site' ideal.

The goal of scientific data visualisation is to assist the researcher in developing a deeper understanding of the data under investigation by representing it graphically. Currently, numerous data visualisation software applications are available. GIS such as ArcView and MapInfo have their origin in cartography and have been successfully used in archaeology in projects such as TimeMap on which Pailthorpe and Bordes were early participants by working on proof-of-concept map animations (Bordes *et al.* 2004; Johnson 2004; University of Sydney 2005). However, GIS are geared to geographical data and limited in their 3D capabilities. On the other hand, applications such as OpenDX, AVS and VTK are multipurpose visualisation applications and are designed to represent data in 3D; however, they are not well integrated with GIS software applications. Other applications, such as Matlab and Mathematica, are powerful tools with advanced statistical, computational and visualisation techniques, however, the learning curve is steep for novice users. What is now required is an integrative framework within which multidimensional data representation at different resolutions can be erected that will permit better comprehension of spatio-temporal relationships between artefacts and other cultural materials, and thus ultimately a more reliable reconstruction of the human past.

The 3D Measurement and Virtual Reconstruction of Ancient Lost Worlds (3D MURALE) is a set of tools developed at Brunel University to record, reconstruct and visualise archaeological sites and artefacts (Brunel University 2006; Cosmas *et al.* 2001; Hynst *et al.* 2001). 3D MURALE consists of a relational database, and recording, reconstruction and visualisation components. The 3D MURALE data model follows a scene graph data structure that is typically used in visualisation and computer graphics. A scene graph is a data structure used to organise hierarchically the elements that make up a scene: it consists of a collection of nodes and edges in a tree structure. The data and their relation are stored in the relational database that serves as an input to the visualisation process. The database contains georeferenced objects such as buildings, statues, artefacts, digital terrain models and hypothetical objects that are used to represent missing parts of a building or artefact. The database search tools are XML-based and 3D MURALE accepts XML schemas or documents as input, and output XML or Virtual Reality Modelling Language (VRML) documents. The test study site is the city of Sagalassos in Turkey which has been excavated since 1990 by a team from the Katholieke Universiteit Leuven. The 3D MURALE project was developed specifically for the reconstruction of archaeological structures and artefacts. A stand-alone stratigraphic tool, STRAT, has also been developed, although little information is available on the technical background. Stratigraphy can be visualised from existing video records or by entering the coordinates of the different layers.

A further outcome of the 3D MURALE project is a web-based visualisation tool for archaeology, using Maya, a powerful 3D modelling and animation software application (Grabner *et al.* 2003). The scene graph used by Maya is similar to the one developed in 3D MURALE and a plug-in was created to make the Maya data structure compatible with 3D MURALE's so that data can be moved to and from the 3D MURALE database. The 3D reconstructions are done in Maya and the images generated are JPEG-encoded and saved at different resolutions. The 3D scenes can be visualised on the web using an ActiveX plug-in for Microsoft Internet Explorer.

Photogrammetry is an important tool for the visualisation of buildings or structures of cultural and historical significance. Photogrammetry is a 3D coordinate measuring technique that uses photographs from which size, shape and position of objects can be derived. This difficult technique requires careful measurements and positioning of cameras, however, it has become more flexible with recent advances in image acquisition and mathematical geometry correction algorithms and also the availability of low-cost high-speed computers and digital cameras. Drap and Long (2001) developed a photogrammetric tool called ARPENTEUR for architectural applications (ARPENTEUR 2006). The tool was successfully employed in marine archaeology for the Grand Ribaud Estruscan Wreck Digital Excavation System which used a submersible to complete a photogrammetric survey of an Etruscan wreck off the island of Grand Ribaud (Drap and Long 2001). ARPENTEUR uses up to three sources of information: theoretical, photogrammetric measurements and measurements made in the laboratory to create a 3D reconstruction of an object. For instance, the 3D visualisation of an amphora can be done by using both the photogrammetric data and theoretical models of amphorae and can be calibrated with measurements undertaken on the artefact itself. The data can then be represented by an XML data structure and accessed for further analysis. The choice of the format for the 3D visualisations has not been resolved at this time: the project uses VRML, Scalable Vector Graphics (SVG), X3D, Microstation and sometimes Java3D.

Schloen (2001) from the Oriental Institute at the University of Chicago developed ArchaeoML, an XML markup scheme for archaeological datasets as part of the Integrated Facility for Research in Archaeology (INFRA). INFRA was designed to provide storage and retrieval of archaeological information and forms the basis of OCHRE (see above). A particularly useful feature of INFRA is the ability to query data through a Java user interface and display relationships between items in different ways:

- a hierarchical tree showing the spatial containment relationships of the artefacts (this is the default view),
- a stratigraphic sequence diagram as developed by Edward Harris (see Harris *et al.* 1993), and
- a network diagram that shows items touching others.

These diagrammatic representations show the relationships between the artefacts in a site; however, they are not a visual representation of the archaeological site itself.

None of these services use a data grid environment. One of the major aims of our project is to integrate digital collections and visualisation services in a grid environment. However, we first need to define how these archaeological collections will be organised. We are developing visualisation services in parallel. The integration will be done in the next stage of the project.

Data Format Considerations

An important and common component of these projects is the data model. There is currently no formal way to store archaeological data so that they can be queried, retrieved and analysed, let alone visualised. As noted above, archaeological data are diverse and include images, audio, textual information etc. Given this complexity, XML is a contender to represent archaeological data, facilitating parsing of data between different software applications and allowing researchers to perform work in their favourite applications.

The choice of format for the display of 3D objects is also problematic. The options for an operating-system independent tool are VRML, Java3D, X3D and SVG. Java3D distributes visualisation images to end-user computer systems, so that visualisation models no longer depend on the host computer. This approach allows visualisation on the web and offers a dynamic facility linked to the objects. However Java3D is not easy to install for regular users and the API seems to have been adopted by a small community.

X3D is an open standard used for 3D content delivery (Web3D Consortium 2006a). It is the successor of the widely used but obsolete VRML format (the language ceased to be further developed in 1999), and although compatible with VRML 2, X3D has a rich set of features. It has an XML encoding and can be integrated with other applications in order to manage and exchange information. SVG is also an XML markup language designed to describe two-dimensional vector graphics (Web3D Consortium 2006b). Like X3D it is an open standard created by the World Wide Web Consortium. The advantage of both X3D and SVG is that they can be considered XML graphic formats. We chose to use X3D to represent 3D data because of XML compatibility. This facilitates the integration of a data point of view between the digital collection and the visualisation tools.

Case Studies

Three major archaeological projects in Queensland were selected to provide case study material covering all major categories of data routinely collected by archaeologists in Australia.

Mill Point Archaeological Project

Mill Point is an historical archaeological site of recognised State significance located on the shores of Lake Cootharaba in the Great Sandy National Park, southeast Queensland. The forest of large Koori pines attracted the timber industry and settlement of the area began in the mid-1800s. A sawmill was built in 1869 and operated until 1892 when the timber resources were depleted. Over the 20 years of the sawmill operation, Mill Point grew into a small community of up to several hundred people which included the sawmill, workers houses, school, shops, hotel and cemetery (Brown 2000). The presence of extensive cultural material including stone artefact scatters, tramway, cemetery, dairy area, jetties and wharves has the potential to reveal information about pre-European Aboriginal lifeways, nineteenth and twentieth century life and burial practices at a company timber town in rural Queensland, and about timber extraction and processing (Ulm 2004, 2005). The site exhibits surface and subsurface archaeological deposits representing both Aboriginal and European occupation over an area of more than 10km^2 (University of Queensland 2006; Nichols *et al.* 2005). Over 4000 artefacts have been excavated from the Mill Point site over the last three years and are representative of the type of data that make an Australian archaeological digital collection. A key challenge at this site in the integration of data at different spatial scales from specific artefact attribute data to broad scale cultural landscapes.

Cania Gorge Regional Archaeological Project

Cania Gorge is an extensive system of low, dissected sandstone plateaux, in the upper Burnett River basin, southeast Queensland, exhibiting a rich Aboriginal and European occupation record. Field surveys have documented numerous archaeological deposits in rockshelters at the base of the escarpments forming the gorge, including rock art sites. Archaeological excavations at 10 rockshelter sites within a 15km^2 area at the southern end of the gorge have revealed evidence for Aboriginal occupation extending up to 18,000 years ago to the European contact period. Archaeological deposits extend up to 4.5m deep in some sites, with thousands of stone artefacts and faunal remains recovered to date (Eales *et al.* 1999; Westcott *et al.* 1999a, 1999b). These archaeological assemblages provide a key dataset in testing models of Holocene Aboriginal cultural change in Australia. However, the very large stone artefact assemblages coupled with complex stratigraphic associations at many sites hamper meaningful integration of site datasets. Data visualisation tools have the potential to deploy data handling and analytical tools to aid interpretation of such complex datasets.

Index of Dates from Archaeological Sites in Queensland

A third set of case study data comprises 849 chronometric determinations obtained from 258 archaeological sites distributed throughout Queensland (Ulm and Reid 2000). Representing sites in all major environmental zones in Queensland and dating from c.40,000 years ago to the present, this dataset has the potential to reveal gross patterns in Aboriginal settlement and occupation trajectories.

The Archaeology Data Grid Architecture

Data grids (Chervenak *et al.* 2001; Rajasekar *et al.* 2002) and high performance computing (Kaufmann and Smarr 1993) provide archaeologists with new opportunities for accessing and using disparate archaeological data sources. The digital collection that we are building will be one of many that will form the Australian archaeology data grid. The Australian digital collection is using demonstrated grid software applications and 'standards': the Storage Resource Broker (SRB) (University of California, San Diego 2006), Globus (Foster and Kesselman 1997) and XML. The key functions for the management of distributed data are exchange protocols, information tagging, physical and logical organisations of collections, access mechanisms and the management of information repositories from the storage of metadata (Moore 2001; Rajasekar and Moore 2001). A persistent archival system can be developed across a distributed system with the successful combination of the above roles.

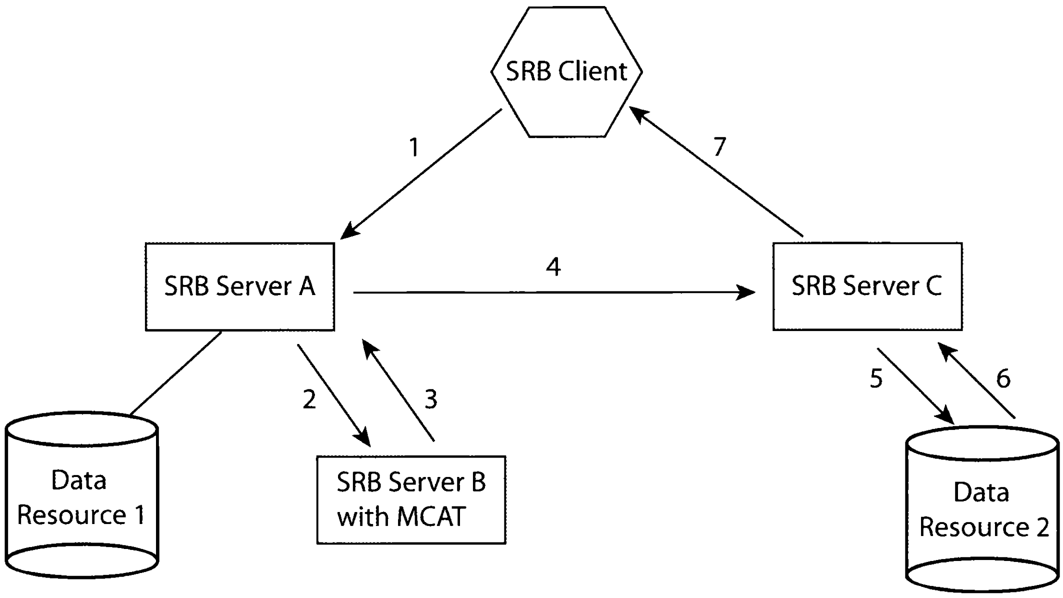

Figure 1. SRB components.

Storage Resource Broker

The Storage Resource Broker (SRB) is a middleware software application developed at the San Diego Supercomputer Center. It provides uniform access to heterogeneous data resources which may be geographically dispersed (Baru *et al.* 1998; Moore *et al.* 1996; Rajasekar *et al.* 2002; University of California, San Diego 2006). The SRB enables the creation of data grids that focus on the sharing of data (Wan *et al.* 2003). Access to a collection by the public and private research community can be set through passwords or through an authentication scheme based on Globus to provide different levels of data security.

SRB handles data through a client-server architecture and allows users to access location-independent data: the user does not need to know where files are located and how they are stored. The SRB organises data logically into a single virtual file system, in a similar way to a filesystem found on a stand-alone computer, rather than physically. The use of stored metadata about each file facilitates the querying of these distributed data. Metadata – data about the data – allow users to quickly find a dataset, what it contains, its format, when or where the data were collected or created etc. Metadata querying and browsing enables user communities to have transparent access to each other's data collections. Users can store or replicate their data collections across several servers to facilitate data preservation, while not losing local access control. Access permissions on individual files can be set so that other users can access the files. Users wishing to access these collections will view a single collection through the SRB middleware and do not need to know the physical location of the data.

The SRB servers that provide access to the archival resources, the Metadata Catalogue (MCAT) and the SRB clients are the main elements of an SRB domain. Files uploaded into the SRB are referenced by logical file handles chosen by the user – a name that is meaningful to the user. The MCAT maps these logical handles to the physical file locations on individual resources, and stores the metadata associated with the files, as well as information about the users and the physical resources managed by the SRB. The MCAT is implemented in a relational database such as Oracle or PostgreSQL and contains all the metadata and information about the files and resources in the SRB domain. The MCAT is usually associated with one SRB server (MCAT-SRB server). A user queries the catalogue about a specific file without knowing in which system the file resides. SRB can be naturally integrated into a data visualisation pipeline (Pailthorpe and Bordes 2000) for repeated analysis of large, diverse, distributed datasets.

Figure 1 illustrates how the SRB works in a typical scenario (the arrows show the typical flow of data). A user needs a file stored in Data Resource 2 which could be a tape archive or a hard disk etc. However the user does not have this information. The only thing that the user has to do is login and request the file by making a query via an SRB client. What follows happens behind the scenes. The client contacts the local SRB Server A and requests the file (1). Server A contacts the MCAT-enabled SRB Server B in order to find the physical location of the file (2). Server B looks up the information in the MCAT and passes this

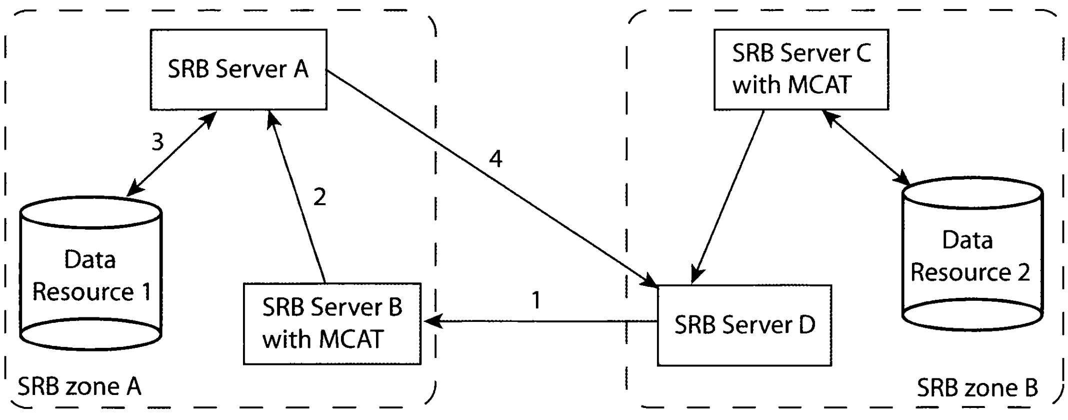

Figure 2. Schematic representation of a federated environment.

information back to Server A (3). As the file is located on a resource maintained by SRB Server C, Server A redirects the request to SRB Server C (4). Server C retrieves the file from Data Resource 2 (5 and 6) and services the client directly (7). The files held on these devices appear to the user as part of a single file system. The full process is transparent to the user who does not need to know in which data resource the requested file is located.

A user can access and download datasets or files through three interfaces: Scommands, inQ and mySRB. Scommands is a command-line interface for UNIX systems that is not intuitive for non-UNIX users. inQ is an intuitive graphical user interface which runs under the Microsoft Windows operating system. mySRB is web-browser-like and runs under any operating system. The SRB manages access and control. When uploading data into the SRB, the user specifies who can have access to the data (read, write, delete). A user only has access to their own data and the data that others have allowed them to share.

The SRB is scalable and can work in a stand-alone configuration or in a federated way with several SRB zones and associated MCATs. In a federation, each SRB zone is part of a larger network and several zones interact with each other. Each SRB zone has its local MCAT-enabled SRB server and its own resources and users. From the user's point of view, a zone is represented as a folder within a logical file system. The user then can move from one folder to the other without being aware that the two 'folders' are different systems and geographically in different places.

Figure 2 shows how two zones can be established in two locations to form a data grid. SRB Zone A comprises Server A that maintains Data Resource 1, and the MCAT-enabled Server B; SRB Zone B comprises Server D and MCAT-enabled SRB Server C which maintains Data Resource 2. An application or a user in Zone B has requested a file located on the Data Resource 1 in Zone A. SRB Server D contacts the MCAT-enabled SRB Server B in Zone A in order to find the physical location of the file (1). Server B redirects the request to Server A (2) which retrieves the file from Data Resource 1 (3) and services Server D directly (4). In this setup all requests are made to local SRB servers, however, the challenge resides in efficiently synchronising all MCATs.

Preliminary Results

Over 4000 entries derived from three seasons of survey, excavation and artefact analysis at Mill Point (2004–2006) were stored in a Microsoft Access database. Fourteen tables make up this database and record information about the artefacts (provenance, raw material, type, dimensions etc). The data were migrated to a PostgreSQL database. Many database management systems are suitable for this project. We are currently using both PostgreSQL (PosgreSQL 2006) and MySQL (MySQL 2006). PostgreSQL is an open source object-relational database with the features of commercial database systems such as Oracle. PostgreSQL is scalable, has superior programmability compared to other open source databases and developers can integrate their own data types. A feature of interest is PostGIS (Refractions Research 2006): this enables PostgreSQL to be used as a spatial database for GIS. MySQL is a relational database. Although developed by a commercial company, the software is free under the GNU General Public License. MySQL is simpler to use than PostgreSQL, has a large users' base and is used in many web applications. The Cania Gorge Regional Archaeological Project uses MySQL, however it is straightforward

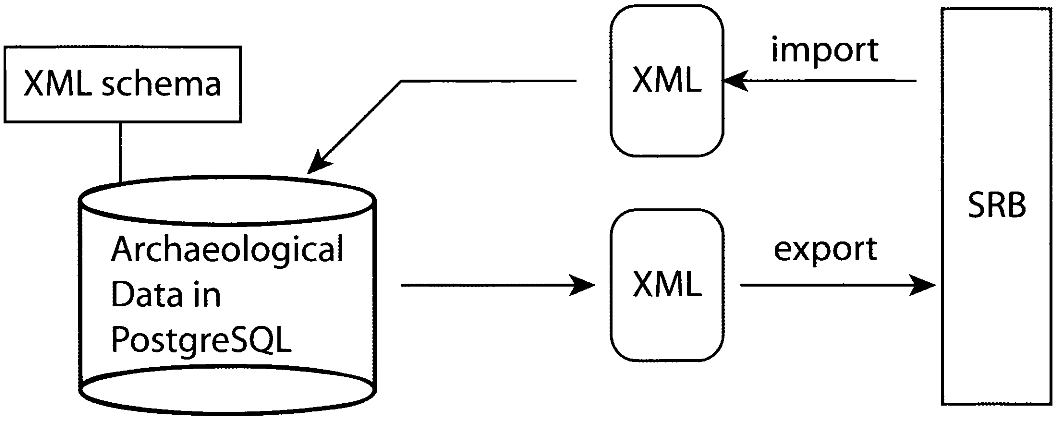

Figure 3. Simple query in the inQ interface.

to migrate the data to PostgreSQL. We used PostgreSQL to store the archaeological data related to Mill Point and also to generate the metadata catalogue for the SRB. Six XML schemas were created to define the data model and relationships. The data were converted into XML files according to the associated XML schemas and imported to PostgreSQL using scripts. In the future, users will enter new data into the database through a customised interface.

The MCAT was implemented in PostgreSQL. It is a database of metadata associated with the files managed by the SRB system containing information about the files such as the logical name and physical location of the data, access control information and also descriptive information on the data itself. The collected data were converted into XML files according to a created XML schema. This allows the data to be shifted through the SRB system without losing file metadata, as these metadata are stored within the file with the data. XML files were uploaded to the SRB server with inQ. Once in the SRB, the user can create a collection: uploaded data are placed inside this logical collection which only exists within the SRB, and physically are stored into a user-specified resource. When the XML files are imported into the SRB, the XML tags display what metadata are available for each file. The metadata attributes, which include information about files and collections within the SRB, physical and logical locations of the data, access control information and descriptive information on the data itself, are ingested into the MCAT along with the virtual and physical location of the data. The user can then query the data or collection according to the defined metadata with an SRB client such as shown in Figure 3.

We created the prototype of a mini-data grid in our laboratory, with one server and several clients. The SRB server and data files are currently located in the same network. We have used SRB's Scommands and inQ clients to query the collection, and upload and download data. We also remotely accessed the SRB server and uploaded and downloaded data successfully via the inQ interface. While the system is currently hard to set up and use, and needs to be hardened, the SRB provides a sound base to establish a digital collection.

Visualisation Tools for Archaeology

We are developing database-backed visualisation tools that work at two different scales. One tool enables an assemblage of archaeological artefacts to be analysed and understood within the original site matrix. The data come from the Cania Gorge Regional Archaeological Project, with the artefacts displayed in 3D within their associated strata. The other tool is based on Google Maps/Google Earth and addresses the problem of moving between geographical scales and is more GIS-like. The data are radiocarbon dates measured at different sites throughout Queensland. The challenge will be to integrate the two tools seamlessly.

3D Reconstructions of an Archaeological Site

The web application is built in the Ruby on Rails software framework (Ruby on Rails 2006). We chose this framework over others because Ruby on Rails is built specifically for database-backed web applications with an emphasis on productivity rather than programming. Asynchronous JavaScript And XML (AJAX)

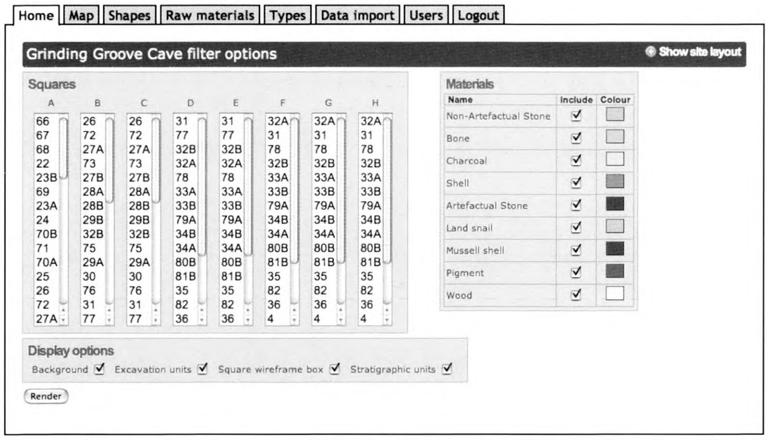

Figure 4. Query form for 3D reconstruction tool web interface.

technologies are implemented in Rails and ensure that data are updated dynamically without the need to refresh a web page. For instance, any data change is sent to the server in the background and a section of the web page affected by the change is updated without refreshing the entire web page. This increases the speed of the web application and improves user interactivity. Finally, the ease of use and deployment of Ruby on Rails makes it a suitable technology for this project.

The data come from Grinding Groove Cave where a c.4.5m deep excavation revealed evidence for Aboriginal occupation extending from 10,000 years ago. The site was excavated in a series of 147 excavation units within stratigraphic units, each unit measuring 30mm in depth. The Grinding Groove Cave data were originally stored in a Microsoft Excel spreadsheet containing several fields: unique identifier, nature of the artefact, attributes, x, y and z coordinates. The application has functionality for parsing (extracting data from) the Microsoft Excel spreadsheet data into the database. Ruby on Rails provides abstraction from the database so switching to another database engine requires simple reconfiguration. At the moment the web application backs to the MySQL artefact database and accept textual queries. Searches can be done by checking boxes or selecting from a menu as shown in Figure 4. A user can select all or a subset of the excavation units, the types of artefacts to be rendered (i.e. shell, bone or rock) or the location of artefacts. In the future the user will be able to search a database by entering text and keywords and searching through the metadata.

Once the user has selected what needs to be displayed, an X3D file is generated. The system was originally designed to have shapes or glyphs on the server and referred to in the generated X3D document. Entity rules defined how to handle the external shapes referenced in the X3D document. However, the X3D browser, FreeWrl, failed to parse the X3D document with its external references. As a temporary solution, each type of artefact is now associated with a shape in the database and is exported to the X3D document. This is not desirable because it forces the user to create a shape field in the database. However this solution caters for X3D browsers that do not handle external references. Further testing will be undertaken on other browsers.

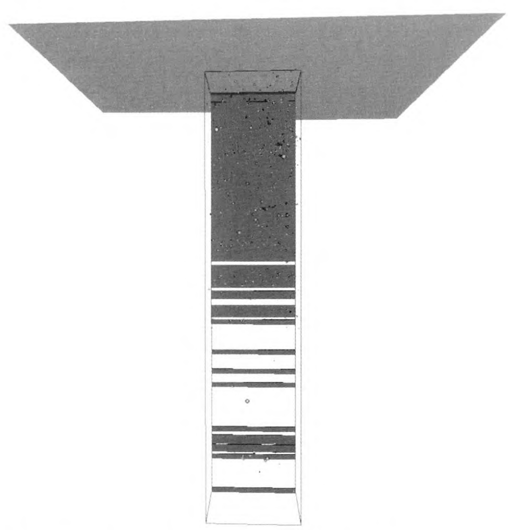

Figure 5. 3D view of all artefacts located in Square A, Grinding Groove Cave, Cania Gorge.

Figure 5 shows the result of a query displayed in a web browser. The artefacts are represented as spheres and the user assigns a colour for each type of artefact (shell, bone etc). All artefacts have a weight and are represented by a sphere to give a sense of size of the artefact. A scaling factor is applied to all artefact dimensions so that they are in correct proportion relative to each other. It is also possible to visualise each excavation unit and the outline of the excavation.

Figure 6. Google Maps user interface, plotting data from Ulm and Reid (2000). The mapping data is provided by and used with permission from MapData Sciences Pty Ltd (www.mapds.com.au).

Google Maps Interface

Google Maps is a free web application that provides dynamic, interactive maps as well as navigation services such as finding specific places or giving directions to get from point A to point B. We developed a user interface based on the Google Maps API (Google 2006) to explore radiocarbon dates from Queensland archaeological sites. The Google Maps API allows developers to embed Google Maps in a web page with JavaScript. It is possible to overlay markers, polylines and pop-up windows that display relevant information. The Google Maps API provides the tools necessary to visualise spatio-temporal data and integrate Google Maps into web or stand-alone applications.

We created a graphical user interface on top of the database with the wxPython library. A user logs into the system with a username and password and selects a database (if several are available). Once connected, searches can be performed with regular Structured Query Language (SQL) queries. When starting, all the data available in the database are displayed as balloons (the icon can be changed as desired) located by latitude and longitude on Google Maps. All the navigation features available in Google Maps are available in the application. It is possible to select a site pin-pointed with a balloon to retrieve the information associated with the site as shown in Figure 6. The latitude and longitude of the site are displayed at the bottom of the interface and any information associated with the site, such as available radiocarbon dates, is displayed in a table to the left of the map. The implementation was straightforward for a programmer and it is possible to display data from two different databases. Incidentally the visualisation helped identify several erroneous data points suggesting that the coordinates for these points were incorrect. This illustrates the important role that visual analysis plays in verifying data quality.

Conclusion and Future Work

We created a mini-data grid in our laboratory, with one server and several clients in the same network. Authorised users can connect remotely to the SRB server with Scommands or inQ to query, upload and download data. The archaeological data are exported as XML files from the local PostgreSQL database to the SRB server and the metadata are created by the user and stored in the MCAT. Once the MCAT is created, the user can search the archive and retrieve the data. The next step is to integrate two small collections at different geographic locations, and create and test a federated data management environment.

We are investigating the use of ArchaeoML for data portability: the use of six customised XML schemas to define the Mill Point data model and relationships was a short-term solution. We are currently working on a web interface for data entry to solve this problem: the data logger will not need to be familiar with databases. Scripts developed by Hungerford for the PARADISEC project will be used to check the integrity of the data. A mistake will prompt the user with a message to check the suspicious data.

The integration of archaeological data and metadata is feasible through the use of the SRB. Data can be queried remotely, downloaded or uploaded. We have not tested the usability of the data grid with the archaeologists: the system is not user-friendly at this stage. The learning curve associated with all the different pieces of middleware and client tools remains a major obstacle. Hence a major effort is required in creating an intuitive and simple interface and writing systematic documentation. Our future work will concentrate on providing user-friendly and intuitive interfaces to users.

The provision of software tools to manage, analyse and visualise datasets is complementary to the creation of a digital collection. The use of the Google Maps technology provides an efficient way to explore geographical data in real-time at different scales in two-dimensions. The reconstruction tool, although at an early stage, provides a way to visualise data in 3D at a smaller scale than is available in Google Maps. The challenge remains to integrate these two visualisation tools with the digital collection and the implementation of a user-friendly interface.

This project has some implications for data capture during a field season. Two options are possible. In one case, archaeologists can enter data in a systematic way according to a defined schema. The data are ingested into the SRB back in the laboratory at the end of the season. The second option is 'SRB in the field': the digital collection or part of it could be installed on a laptop along with the SRB as a stand-alone and taken to the field. Data entry can be done directly into the SRB. The updated collection can be synchronised and updated into the archival system back in the laboratory. We will investigate the functionality of these options and how they are suited to archaeology field practice.

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