Serpent's Glen Rockshelter: Report of the first Pleistocene-aged occupation sequence from the Western Desert

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In this paper we present the initial report for the first Pleistocene occupation sequence to be excavated in the Western Desert of Australia, from the site of Serpent's Glen (Figs 1 and 2). We identify a three phase sequence with an earliest unit dating to before 23,500 BP, an intermediate unit comprising culturally sterile sediments and an upper unit dating to less than 4700 BP. Previous excavations within the Western Desert have only provided Holocene assemblages (Gould 1977; Smith 1988; Veth 1993). Indeed, the majority of these sites have been dated to the mid to late Holocene.

Arguments for demographic restructuring in the arid zone during the Last Glacial Maximum, due to resource stress, have been advanced by a number of authors (Smith 1989; Veth 1989, 1995a; O'Connor et al. 1993). More recent debate has focused on the extent to which groups continued to occupy marginal habitats and the mechanisms by which they (re)incorporated such habitats into a broadly based desert adaptation following climatic amelioration (Smith et al. 1991; Smith 1993; Edwards and O'Connell 1995; Veth 1995b; O'Connor and Veth 1996; Gorecki et al. 1997). With reference to this debate, Veth (1995b:37) has noted that 'The need for further systematic survey and excavation within desert lowlands, having uncoordinated drainage, is clear'.

The identification of a cultural hiatus at Serpent's Glen, falling within a bracket of uncalibrated dates from approximately 23,500 BP to 4700 BP, is consistent with the settlement models which argue for decreased intensity of occupation in desert lowlands during the last glacial maximum.

Equally, a very high rate of discard of cultural items in the upper unit of the site, and specifically within the last 1000 years of occupation, finds parallels with similar efflorescences at sites from the Rudall River area in the Great and Little Sandy Deserts (Veth 1993), from the site of Katampul in the Goldfields (O'Connor and Veth 1996) and from a range of localities in central Australia (Smith 1988).

Environmental setting

Serpent's Glen Rockshelter lies well within the Western Desert Culture Bloc, as defined by Gould (1977). The site is located near the mouth of one of the larger valley systems that dissect the western face of the Carnarvon Ranges, which comprise extensive uplands of quartz sandstones on an otherwise flat plain of sand sheets and low relief dunes. The Ranges fall in the Peak Hill area of the Bangemall Basin, a middle Proterozoic Group occupying an estimated 17,000 square kilometres in the northwest of Western Australia.

The edges of the uplands, and particularly where drainage courses discharge onto the surrounding sand plains, are well vegetated by a number of species of acacia and eucalypt. The surrounding plains and dunes are dominated by Mixed Shrub Steppe comprising *Acacia* spp. and *Triodia* spp. (cf. Beard and Webb 1974). The Ranges lie on the southern edge of the Little Sandy Desert, an area known to provide a multitude of plant resources and particularly seeds. Seeds have been identified as a major staple group for the Martu Aborigines of the Little Sandy Desert (Veth and Walsh 1988; Tonkinson 1991).

The Ranges are clearly visible for tens of kilometres across the surrounding sandplains and dunefields. They contain a number of spring sites which were said by Aboriginal consultants from Wiluna and Jigalong to provide reliable and potable water. A number of these springs were visited by the authors. Large rockholes and soakages were recorded near Serpent's Glen. The Ranges, therefore, provide a highly desirable set of resources, in the same manner as the Calvert and Durba Ranges located further north in the Little Sandy

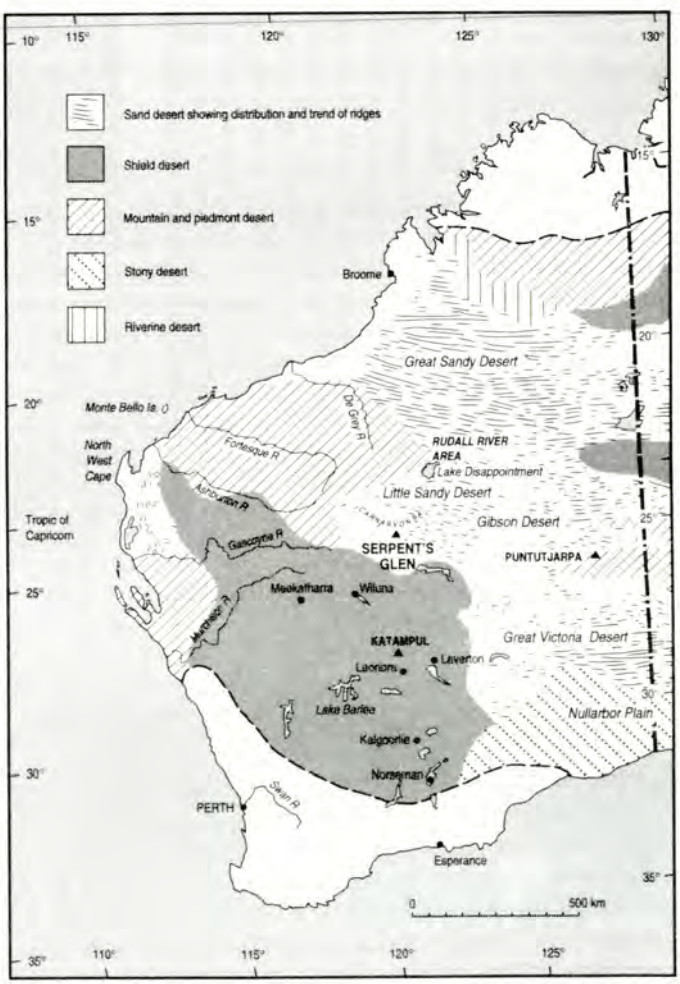

Figure 1 Map of Western Australia showing arid zone boundaries and site locations.

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Figure 2 Serpent's Glen Rockshelter: View facing north showing test excavation.

Desert (see Veth 1993). These major resource refugia are significant mythological referents which also contain the most prolific rock art galleries in the region (see also Veth in press).

Summary of the excavation

The site was excavated over a three week period in July 1995 and represents a component of a larger survey and excavation programme being conducted by the authors within the arid zone of Western Australia. Prior to excavation, consultation was carried out with senior Aboriginal custodians from Wiluna, Jigalong and Punmu Communities, all located in the vicinity of the Canning Stock Route.

Serpent's Glen is a south facing overhang approximately 20 m wide and 8 m deep with a height of 2.5 m above the test-pit (Fig. 3). Extensive panels of art occur on the back and side walls, comprising a range of polychrome paintings of geometrics, anthropomorphs with headdresses, and a range of striking serpentine figures.

A one metre square pit was excavated to bedrock progressing by 2 to 3 cm spits, unless stratigraphic changes indicated that alternate recoveries were warranted. All material was dry sieved through 5 mm and 2 mm nests and accurate records were made of the weights and volumes of all loose sediments and larger grains in the matrix. Bulk samples of sediments were retained for further characterisations.

Eight strata were identified in the sections (Fig. 4). Strata 1-6 represent the upper Holocene unit, Stratum 7 the culturally sterile unit, and Stratum 8 contains the Pleistocene assemblages. Strata 1-4 are organic rich, containing ashy layers, hearths and abundant scattered charcoal. Strata 5 and 6 are poor in organics, while Stratum 7 lacks macroscopic organics. The Pleistocene unit contains minor quantities of charcoal, bone and, of interest, ochre fragments.

Initial particle size analysis of the sediments indicates a trinodal distribution, suggesting polygenetic origins. The peaks were around 0 Phi, 1.5 Phi and 3.0 Phi with most of the sediments falling in the sand fraction. As the frequency curves for particle size distribution are nearly identical for all analysed spits, the mechanisms and sources responsible for sedimentation are thought to have been relatively constant through time (J. Magee 1977, pers. comm.).

Four dates have been obtained so far from the site (Table 1). All dates are based on scattered charcoal which was collected and plotted in situ. Another sample of charcoal from lower down in the Pleistocene unit at Spit 40 has also been submitted for AMS dating. While charcoal was recovered from Spit 42, just above the lowest cultural level, Spit 43, it has not been submitted at this stage, as it is only associated with a small number of stone artefacts. The presence of charcoal in seven out of the ten spits, **beneath** the uncalibrated date of approximately 23,500 BP, affords the opportunity for cross-checking of dates.

Stone artefact assemblages

The stone artefacts recovered from the 5 mm fraction of Square A fall into two distinct stratigraphic units (see Table 2). The lower unit (Spits 34-43) has a minimum date of 23,500 BP and contains a total of 32 flaked artefacts, comprising flakes, flake fragments and a multiplatform core. There are no retouched/utilised pieces in the Pleistocene unit.

The upper unit (Spits 1-26) dates from modern to approximately 4710 BP and contains a dense assemblage of flaked

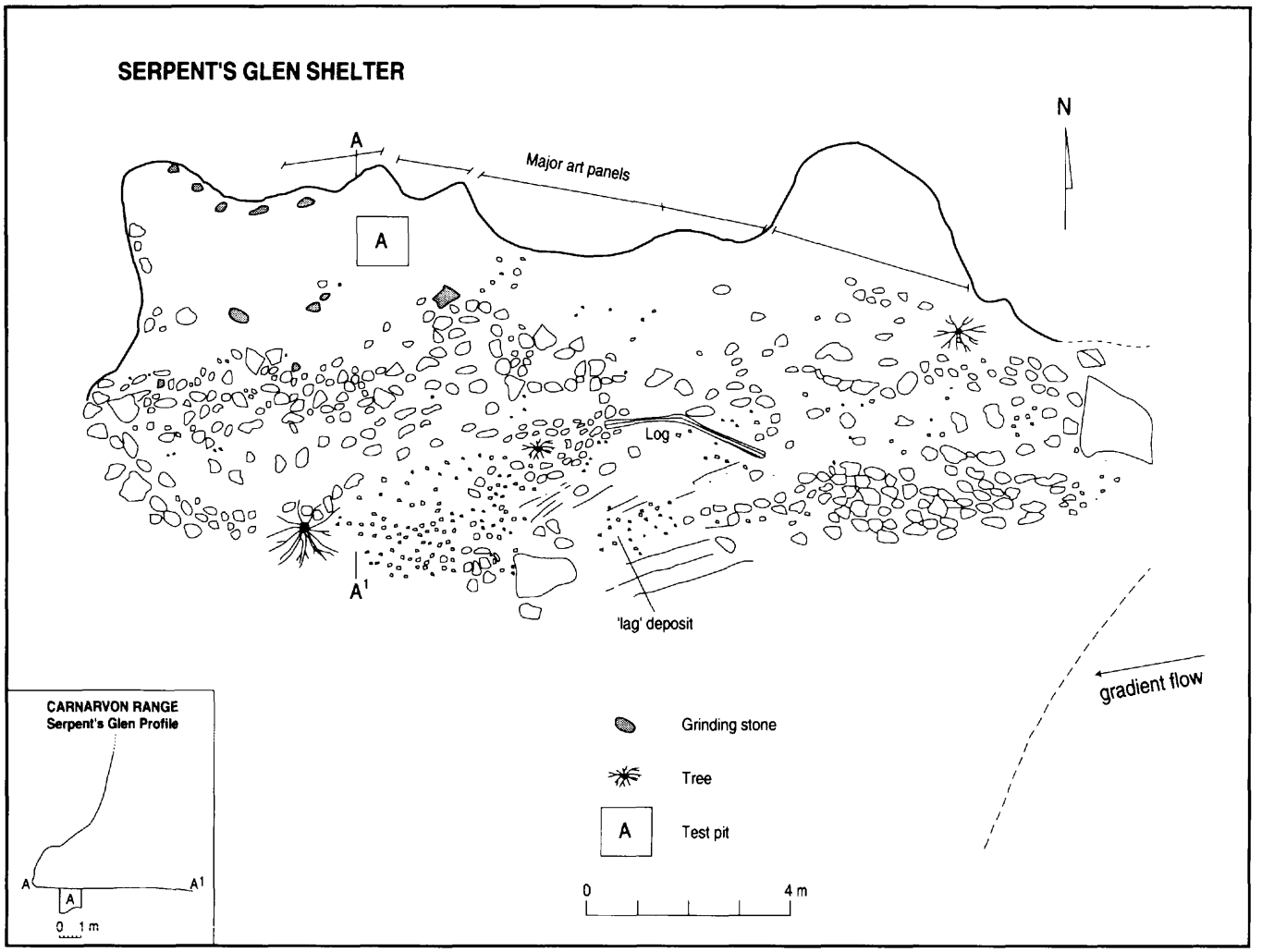

Figure 3 Serpent's Glen Rockshelter: Site plan and section.

stone artefacts, including tula adzes and slugs, backed pieces and blades and a variety of retouched/utilised flakes. A total of 1642 artefacts, or 98% of the excavated assemblage, falls into this upper unit. Approximately half of these artefacts occur in the Spits 1-8 (modern period). Between the dates of 4710 BP and 23,500 BP (Spits 27-33) no artefacts were recovered from the 5 mm fraction. A similar pattern also exists for ochres and faunal remains (Table 3).

Despite the presence of two intact basal grindstones and several fragments on the shelter floor (Fig. 3) and numerous basal grinding stones on the sand plains surrounding the shelter (cf. Veth and O'Connor 1996), only two ground fragments of sandstone were recovered from the entire excavation. These fragments were recovered from Spits 3 and 4 in the upper unit.

The raw materials used for manufacturing the artefacts are available locally and are represented in comparable proportions in both the lower and upper units (Table 2). The only preference appears to be the selective use of chert and silcrete for backed artefacts.

The high densities of artefacts in the upper unit are paralleled in the 2 mm fraction (Table 3). The debitage in the small size class appears to be largely the product of secondary retouch.

Faunal assemblages

The species and genera identified from the Serpent's Glen assemblage appear to be representative of pre-European contact fauna. All taxa identified at Family level or below occur in the Holocene Unit and, as with the stone artefact assemblage, most occur in the Modern portion of this unit. Fragments of bone in the Pleistocene unit were identifiable only as Mammalia.

Taxonomic assignment

The matrix was sorted into two size classes for faunal analysis, in order to determine if the finer fraction (2-5 mm) preserved more information than the larger (greater than 5 mm). This proved to be the case. In the fraction greater than 5 mm there was a total of 331 fragments with 40 (i.e. 12%) taxonomically assigned below class level. There are 1476 fragments in the 2-5 mm fraction with 131 assigned (i.e. 8.8%). In other words, 77% of the taxonomic assignments of vertebrate remains derive from the finer matrix fraction. Tables 4 and 5 document the importance of examining this fraction when finely comminuted bone is present in a deposit.

At Puntutjarpa Archer (1977:158) was able to assign 9.8% of the total faunal assemblage, a proportion not significantly

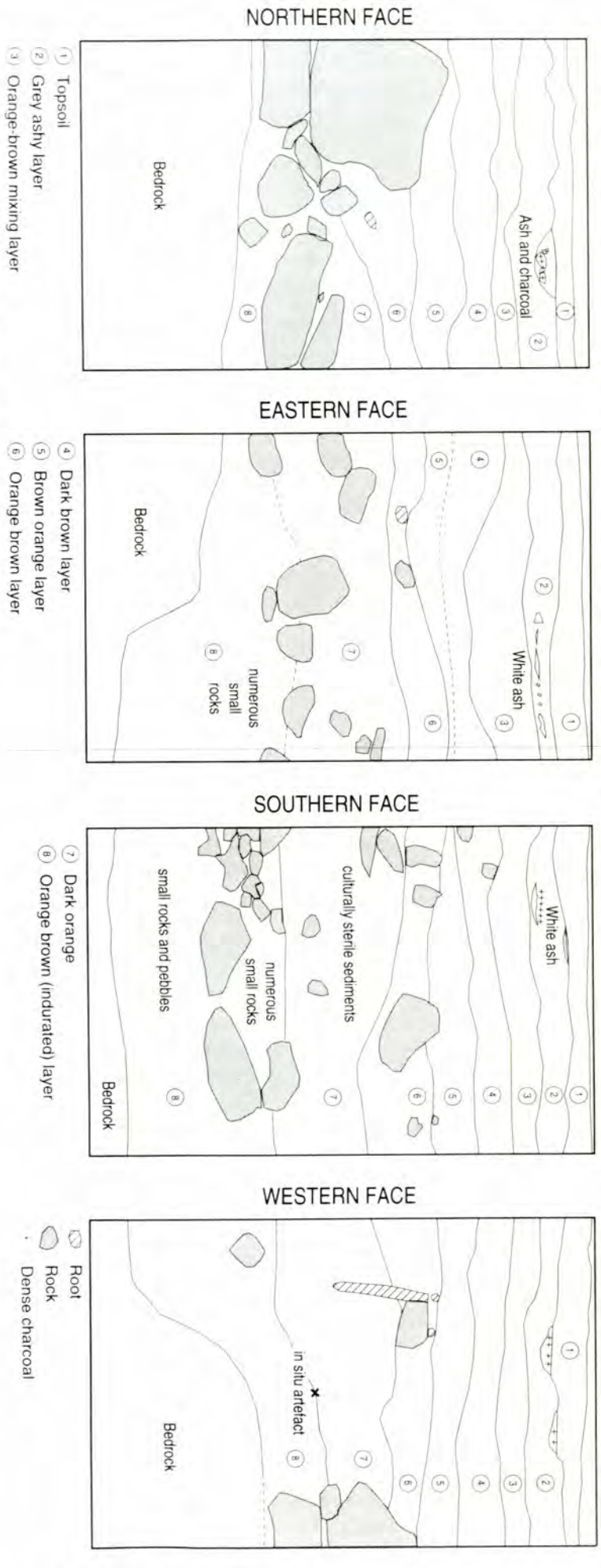

Figure 4 Serpent's Glen Rockshelter: Sections. (Test Pit A.)

different from that achieved in this study and one which precludes the application of conventional analytic approaches to archaeological faunas such as minimum number indices. This analysis recorded each individual fragment that could be assigned to taxon per spit (see Tables 4 and 5).

Marsupial carnivores

Family Dasyuridae

The larger dasyurids are represented by *Dasyurus geoffroii* and possibly *Dasyurus hallucatus*. It should be noted that both could readily deal with the ecology of this locality. *D. geoffroii* can tolerate high temperatures and do without water if fresh meat is available. They can also survive freezing conditions with periods of physiological torpor (Arnold 1983:22).

Sminthopsis sp. is probably represented by a single calcaneum, with known distributions suggesting *S. macroura,* the Stripe-faced Dunnart. This is a widespread inland inhabitant which deals with climatic extremes by widely varying its body temperature and sheltering in cracks and crevices. It stores considerable fat in the tail and does not need to drink free water (Morton 1983:63).

Four edentulous mandible fragments and the coracoid process of a scapula probably represent *Dasycercus cristicauda*, the Mulgara, a small burrowing dasyurid widely distributed in central Australia. It also has the ability to survive without water and store fat in its tail (Woolley 1983:26).

Bandicoots

Family Peramelidae

A species of *Isoodon,* probably *auratus* is represented by an edentulous mandibular fragment, an edentulous maxillary fragment, a worn lower $M_{1\ or\ 2}$, and two caudal vertebrae. Formerly a widespread inhabitant of the northwest inland, and now only abundant in limited areas of the northwest Kimberley and on Barrow Island, it was once found in all varieties of inland arid environments (McKenzie 1983:98).

Three edentulous mandibular fragments belong to *Perameles*, with only the extinct species *eremiana* known to have had a distribution encompassing the Carnarvon Ranges. It was anatomically adapted to extreme heat, with large ears and hairy feet, and was at least locally abundant into the 1930s (Gordon 1983:102).

Family Phalangeridae

The genus *Trichosurus* is represented by a fragmentary $LM^{1\ or\ 2}$, an edentulous maxillary fragment and a scapular fragment. The molar appears not to be *vulpecula,* leaving *arnhemensis,* the Northern Brushtail, as the likely candidate.

Site code	Years BP	Depth below surface	Spit	$\delta^{13}C$	Sample code
SG A 1	modern	2 cm	1	-24.0±2.0%	ANU 10024
SG A 8	modern	19 cm	8	-24.0±2.0%	ANU 10025
SG A 27	4710±180	67 cm	27	-24.0±2.0%	ANU 10026
SG A 34	23,550±140	91 cm	34	-25.00	ANSTO 0ZB582

Table 1 Radiocarbon dates from Serpent's Glen Rockshelter.

Found in woodland or open forest, it would not have been common in the Carnarvon Ranges. However, it could have found sufficient arboreal nesting sites to remain established.

The kangaroos

Family Macropodidae

Several teeth of a very small macropodid, probably *Onychogalea lunata*, are present. Of the larger kangaroos there are three dental fragments which compare closely with *Petrogale cf. lateralis*. There are also tooth fragments of the Common Wallaroo or Euro, *Macropus robustus*, which is the most widely distributed Australian marsupial. A grazer favouring rocky hills or stony rises, it was a staple of inland human populations (Poole 1983:250). Of similar but more arid and semi-arid distribution, the presence of the Red Kangaroo, *Macropus rufus*, is also to be expected as it occurs over most of central Australia in areas of less than 500 mm average rainfall (Sharman 1983:255).

Reptiles

Amongst lizards, the genus *Varanus* (Family Varanidae, the Goannas) and the genus *Egernia* (Family Scincidae, the Skinks) are represented variously by teeth and vertebrae. Specific determinations have not been made, but at least seven species of *Varanus* and four of *Egernia* have concurrent ranges in the Carnarvon Ranges area and are common and readily acquired food animals (Cogger 1994). Snake vertebrae representing the Family Boidae were also identified.

Bone reduction

The bone remains from the site are extensively reduced, with the majority (1476) being in the size range 2-5 mm, with far fewer (331) being 5 mm or over. In Spit 1 at least there is also a significant, although unmeasured, fraction of bone fragments less than 2 mm in size. Identification and taxonomic assignments in this fraction are possible. The largest single bone specimen was 35 x 8 mm. Surviving whole bones, primarily the vertebrae of small reptiles and bandicoots, are in the size range of the common broken pieces. Some bone bears apparent cut marks but these are not common. Burnt bone is present in almost every spit (Table 6, Fig. 5).

All of the 63 macropodid teeth present (52 in the smaller fraction), except for one (probably of the macropodid *Onychogalea*) were broken. It is highly unlikely that there is any nutrient value to be extracted from a broken tooth and it is assumed that they are broken incidentally when mandibles and skulls are reduced.

Index of Fragmentation

Both size classes of sample have been combined for calculation of the Index of Fragmentation (total bone weight/# fragments), see Table 6. The average value for all spits is 0.063 gm/fragment (range 0.020-0.173). The consistency of these values from spit to spit strongly suggests that the same mechanism of breakage was common throughout. Gould's Puntutjarpa Holocene fauna averaged 0.53 gm/fragment, which is considerably larger (Gould 1977). It is likely that at least some of the difference is due to the lower frequency of large macropodid remains at Serpent's Glen. However, the fact that the bone assemblage has been so thoroughly comminuted suggests that the same hypothesis of explanation applies, namely that the human population was protein-stressed and found it necessary to extract every vestige of edible meat and marrow from the vertebrates captured.

Taphonomic factors

Of the six taphonomic factors postulated by Gould as potentially applicable to a site such as Serpent's Glen, namely the effects of predators, crushing due to trampling, crushing due to rockfall, crushing due to weathering and soil compaction, chemical factors and burning of bone, none would convincingly explain the thorough and notably even reduction of bone. There is no evidence of any native predators larger than *Dasyurus*, and no incremental increase in reduction toward the younger strata which would be expected if dingoes were to be the cause. Trampling would produce a greater size range of fragments and rarely so many small fragments, especially those less than 2 mm in size. There are no notable rockfalls in the Holocene levels, and the comminution is similar throughout the section.

Weathering and soil compaction were certainly present, and a minor proportion of the bone is soft and/or whitened. However, such fragments are no smaller than others with no apparent decomposition and with surviving sharp edges on the breaks.

Chemical factors may have operated to soften and hasten bone decomposition but again, the majority of fragments are extremely pristine in appearance and hardness. As noted, burning is common (see Fig. 5), but appears to have acted on most of the bone after breakage for in the majority of instances the fractured surfaces as well as the natural surfaces are burnt. The supposition of intentional and systematic human breakage remains as the strongest hypothesis for the reduced state of the vertebrate remains.

Discussion of patterning in cultural residues

The excavation has provided unequivocal evidence for a human presence in the Western Desert prior to 23,500 BP. The Pleistocene unit contains flaked stone artefacts manufactured from chert, chalcedony, silcrete, banded sediment, quartzite and quartz; the full range of raw materials found in the Holocene unit. The lower unit also contains small quantities of charcoal, ochre, bone and bird eggshell (Table 3). There is a considerable volume of deposit in the Pleistocene unit, between Spits 34-43, though all categories of cultural material are sparse (Table 3). While further dating is required to evaluate the period of time represented by this unit, it is difficult to interpret the low density and nature of cultural materials as representing anything more than occasional forays

Spit	Age	Chert	Chalcedony	Silcrete	Banded sediment	Quartzite	Quartz	Total
1	Modern	42	2	20	9	8	1	82
2		53	5	10	6	27	6	107
3		34	1	11	3	12	5	66
4		28	2	3	5	12	3	53
5		10	0	6	0	8	0	24
6		42	1	4	2	5	1	55
7		143	4	31	3	2	3	186
8	Modern	201	24	16	12	32	8	293
9		187	15	50	4	11	9	276
10		78	12	31	2	7	14	144
11		27	3	22	0	6	18	76
12		8	0	3	0	28	16	55
13		14	2	12	0	23	12	63
14		22	0	9	1	11	8	51
15		20	2	1	1	10	10	44
16		24	3	11	0	7	3	48
17		15	3	10	0	0	6	34
18		7	3	10	2	1	3	26
19		2	0	4	0	4	2	12
20		8	0	2	0	1	0	11
21		0	0	0	0	10	0	10
22		3	0	0	0	0	0	3
23		5	0	0	0	0	0	5
24		0	0	0	0	0	0	0
25		0	0	0	0	0	0	0
26		0	2	3	0	2	0	7
27	4710 BP	0	0	0	0	0	0	0
28		0	0	0	0	0	0	0
29		0	0	0	0	0	0	0
30		0	0	0	0	0	0	0
31		0	0	0	0	0	0	0
32		0	0	0	0	0	0	0
33		0	0	0	0	0	0	0
34	23,500 BP	3	0	0	0	2	2	7
35		0	0	0	0	1	0	1
36		0	0	1	0	4	0	5
37		4	1	1	1	1	0	8
38		4	0	0	0	0	1	5
39		0	0	0	0	3	0	3
40		1	0	0	0	0	0	1
41		0	0	0	0	1	0	1
42		0	0	0	0	0	0	0
43		1	0	0	0	0	0	1
Total		986	85	271	51	239	131	1763

Table 2 Serpent's Glen: Numbers of artefacts from >5 mm fraction.

into this arid landscape. While the breadth of lithic raw materials parallels those from Holocene assemblages, and might imply a level of familiarity with the landscape not consistent with ephemeral usage, all are actually available from the uplands catchment. The form of site use appears to more ephemeral than the Holocene levels, lending support to arguments that Pleistocene land-use systems in the Western Desert are likely to have been different in nature (Veth 1995b).

The culturally sterile middle unit is bracketed by the lower date of 23,500 BP and an upper date of 4700 BP. These dates only provide an envelope for the age of the unit, however. It may have formed at a relatively constant rate or, instead, experienced a number of episodes of rapid sedimentation. Initial characterisations of the sediments and larger grains in the matrix suggest that neither the sources nor mechanisms of deposition have changed significantly between adjacent units. Importantly, there is no evidence for a lag event at the boundary of this and the Pleistocene unit, although an increase in large roof fall fragments is apparent. At this stage we interpret the unit to represent a cultural hiatus where sedimentation has occurred without occupation, and not a stratigraphic unconformity and hiatus.

Spit	Stone artefacts		Ochre		Charcoal	Bone		Emu egg		Plant		Bird egg
	5 mm	2 mm	5 mm	2 mm	5 mm	5 mm	2 mm	5 mm	2 mm	5 mm	2 mm	2 mm
1	77.0	9.5	0.9	0.1	63.3	-	0.2	0.2	0.1	6.3	6.2	-
2	94.8	10.3	0.5	0.2	107.5	0.7	1.0	1.0	0.1	21.3	-	-
3	84.0	10.6	-	0.2	102.4	0.2	1.9	-	0.1	-	-	-
4	50.2	11.1	0.1	0.4	51.5	0.8	1.7	0.3	0.5	-	-	0.2
5	30.5	9.0	-	-	11.3	1.0	2.9	0.8	0.2	-	-	0.2
6	31.7	10.5	-	-	8.2	4.8	3.0	0.7	-	-	-	-
7	153.4	34.3	-	0.2	1.2	13.2	20.3	-	-	-	-	-
8	226.8	79.1	-	0.1	0.3	29.1	34.8	-	0.1	-	-	-
9	183.2	60.9	-	0.3	0.2	23.3	23.3	-	-	-	-	-
10	125.5	25.6	0.2	0.3	0.1	9.9	24.2	-	-	-	-	-
11	104.6	10.3	0.2	0.5	2.3	5.6	9.0	-	-	-	-	-
12	97.6	7.3	2.8	0.7	-	1.4	5.6	-	-	-	-	-
13	54.4	9.2	0.6	0.4	0.2	0.5	0.7	-	-	-	-	-
14	50.8	7.6	3.0	0.1	0.3	-	0.6	-	-	-	-	-
15	81.5	2.3	-	0.1	-	-	-	-	-	-	-	-
16	67.4	3.8	-	-	-	-	-	-	-	-	-	-
17	24.4	5.2	-	-	-	-	-	-	-	-	-	0.1
18	24.6	1.7	-	-	-	-	-	-	-	-	-	-
19	10.3	0.8	-	0.2	-	-	-	-	-	-	-	-
20	6.1	0.9	-	-	-	-	-	-	-	-	-	-
21	4.4	1.0	-	-	0.5	-	-	-	-	-	-	-
22	1.7	0.5	-	-	0.6	-	-	-	-	-	-	-
23	8.1	1.6	-	-	0.6	-	-	-	-	-	-	-
24	-	0.2	-	-	1.3	-	0.1	-	-	-	-	-
25	2.4	-	-	-	0.8	-	-	-	-	-	-	-
26	92.8	0.1	-	-	0.8	-	-	-	-	-	-	-
27	-	0.4	-	-	1.0	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-	-
34	*28.0	0.4	-	0.1	7.3	-	0.3	-	-	-	-	-
35	0.9	0.1	-	-	1.1	-	0.1	-	-	-	-	-
36	7.1	0.4	-	-	4.1	-	-	-	-	-	-	-
37	5.4	0.2	-	0.2	6.0	-	-	-	-	-	-	-
38	3.8	0.5	-	0.2	0.3	-	0.1	-	-	-	-	-
39	7.8	-	-	-	1.7	-	-	-	-	-	-	-
40	0.2	0.2	-	-	0.6	-	-	-	-	-	-	-
41	0.3	0.2	-	-	-	-	0.1	-	-	-	-	-
42	0.1	-	-	-	0.7	-	-	-	-	-	-	-
43	0.1	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-

Table 3 Weights of all cultural materials recovered in 5 mm and 2 mm fractions. (Weights are uncorrected for volume). (Note: * Majority of total weight from one large core).

A stratigraphic unconformity describes a surface of non-deposition that appears as a break between two sediment units in a sequence. Unconformities arise from changes in depositional conditions, to conditions of erosion or non-deposition. The unconformity must be stratigraphically identifiable as a surface. This is not the case with the sequence at Serpent's Glen (O'Connor, Veth and Barham in press).

Some Pleistocene-aged sites in the Australian arid zone, and specifically the nearby site of Katumpul in the Goldfields (Fig. 1), have units with late Pleistocene dates directly overlain by units with mid- to late Holocene dates. This represents a chronological hiatus where the break is not represented stratigraphically. Without evidence for stratigraphic unconformities it has been argued that it is unacceptable to invoke geomorphological explanations, and that the hiatuses can be more plausibly explained through changes in settlement dynamics and types of occupation in shelters (O'Connor and Veth in press).

We argue that the culturally sterile unit provides evidence for the passage of time where occupation did not occur.

Taxon	Spit Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	24	34	35	38	41
TELEOSTEI	-	-	-	5	4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
REPTILIA																			
Lacertilia (Sauria)	1	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-
Agamidae	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Varanidae																			
Varanus sp.	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-
Scincidae	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-
Egernia sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Serpentes	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Boidae	-	-	-	-	-	-	1	2	2	-	-	-	-	-	-	-	-	-	-
Aves	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emu (eggshell)	6	-	1	9	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
MAMMALIA	5	24	35	39	56	30	316	167	200	-	228	-	13	7	-	2	2	2	1
Small mammal	-	-	-	-	-	3	2	-	2	-	-	-	-	-	-	-	-	-	-
Medium mammal	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Marsupialia	-	-	-	-	1	-	6	-	-	-	1	-	-	-	-	-	-	-	-
Dasyuridae	-	1	-	-	1	-	2	1	-	-	-	-	-	-	-	-	-	-	-
Dasycercus cristicauda	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Dasyurus geoffro	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Dasyurus halluca tus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Sminthopsis sp.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Peramelidae	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoodon sp.	-	-	-	-	1	-	1	-	1	-	-	-	-	-	1	-	-	-	-
Isoodon auratus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Perameles ssp.?*eremiana*	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-
Phalangeridae	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Trichosurus sp.	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-
Macropodidae	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Macropodid, large	-	-	1	-	-	-	-	-	13	-	4	-	-	-	-	-	-	-	-
Macropodid, small	-	-	1	-	-	-	1	-	4	-	-	-	-	-	-	-	-	-	-
Lagorchestes hirsutus	-	-	-	-	-	-	-	2	2	-	1	-	-	-	-	-	-	-	-
Macropus spp.	-	-	-	-	2	-	12	-	1	-	-	-	-	-	-	-	-	-	-
Macropus agilis	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
Macropus robus tus	-	-	-	-	1	-	1	-	-	-	-	-	-	1	-	-	-	-	-
Macropus rufus	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Onychogalea sp.	-	-	-	-	-	1	-	2	2	-	1	-	-	-	-	-	-	-	-
Petrogale cf. lateralis	-	-	1	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-
EUTHERIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muridae	-	-	-	-	-	2	3	2	4	-	-	-	-	-	-	-	-	-	-
Rattus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 Serpent's Glen vertebrate fauna, Square A, 2-5 mm fraction; number of fragments assigned to each taxon.

While such a break in one site may not reflect regional trends, we would note that it is consistent with models which argue for significant demographic shifts during the Last Glacial Maximum and significantly decreased intensity of site occupation and possibly regional abandonment (Veth 1995b).

The upper unit contains the majority of the cultural assemblages, for example 98% of all flaked stone artefacts. In fact, much of the assemblage can probably be assigned to the late Holocene, with almost 50% of the site's artefacts dating to the modern period. Further charcoal samples are being submitted to provide better chronological resolution between Spits 8-27.

Tula adzes and slugs, as well as backed pieces and blades, are found only in the upper half of the unit, a distribution consistent with its likely mid- to late Holocene age (cf. Hiscock

Taxon	Spit Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	24	34	35	38	41
Aves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emu (eggshell)	2	-	5	2	5	8	2	1	-	-	-	-	-	-	-	-	-	-	-
MAMMALIA	-	-	-	-	1	-	6	28	-	37	30	8	3	-	-	-	-	-	-
Small mammal	-	-	-	-	1	1	2	-	-	2	-	-	-	-	-	-	-	-	-
Medium mammal	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marsupialia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phalangeridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichosurus cf. vulpecula	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macropodidae	-	-	1	3	3	12	31	49	79	1	-	-	-	-	-	-	-	-	-
Macropodid, large	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-
Macropodid, small	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Macropus robust	-	-	-	-	-	1	-	2	4	-	-	-	-	-	-	-	-	-	-
Macropus rufus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Onychogalea sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
EUTHERIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muridae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5 Serpent's Glen vertebrate fauna, Square A, >5 mm fraction, number of fragments assigned to each taxon.

Spit number	Total bone gm	Burnt bone gm	Unburnt bone gm	Total number of fragments	Number of burnt fragments	Index of fragmentation
1	0.23	0.00	0.23	10	0	0.023
2	1.70	0.27	1.43	29	6	0.059
3	2.10	0.48	1.62	37	10	0.057
4	2.53	0.23	2.30	25	8	0.101
5	3.87	0.89	2.98	69	15	0.056
6	7.79	1.24	6.55	65	21	0.120
7	33.50	9.83	23.67	414	87	0.081
8	44.56	16.29	29.52	258	86	0.173
9	46.51	16.63	29.88	517	143	0.090
10	34.15	11.69	22.46	642	206	0.053
11	14.60	11.69	2.91	294	247	0.050
12	6.95	1.59	5.36	175	55	0.040
13	1.20	0.84	0.36	18	8	0.066
14	0.55	0.10	0.45	11	2	0.050
24	0.04	0.00	0.04	1	0	0.040
34	0.29	0.00	0.29	5	0	0.058
35	0.06	0.00	0.06	2	0	0.030
38	0.04	0.00	0.04	2	0	0.020
41	0.03	0.00	0.03	1	0	0.030

Table 6 Data for combined bone fractions, Serpent's Glen, Square A.

and Veth 1991). Variously retouched/utilised flakes are found throughout the Holocene unit.

The obviously significant increase in discard rates of stone artefacts and ochres from Spits 15-20, which most likely date within the last 2000 years, is consistent with efflorescences in these categories as witnessed from other Western Desert and central Australian sites (Smith 1988; Ross et al. 1992; Veth 1993). Here these changes may be linked to the rapid and widespread expansion of the Western Desert language which has been recently assigned by a number of authors to this period (McConnell 1996; Veth in press). Mechanisms for the expansion are likely to have comprised a combination of changes in social organisation and technological strategies (cf. Evans and Jones 1997).

Conclusion

The early assemblages from Serpent's Glen provide the first firm data for Pleistocene use of the Western Desert and specifically the sandy deserts. Given the unique place of the Western Desert as one of the most marginal arid landscapes to have been occupied (Veth 1995a), this early phase of occupation must be viewed as significant. Equally of interest is the fact that the evidence for ephemeral occupation is not repeated during the critical phase of the Last Glacial Maximum. A substantial unit of culturally sterile deposits attests to at least one period of time when occupation did not occur at all. This evidence for a cultural hiatus is consistent with models for demographic restructuring during the heightened aridity of the Last Glacial Maximum (Veth 1993). In contrast,

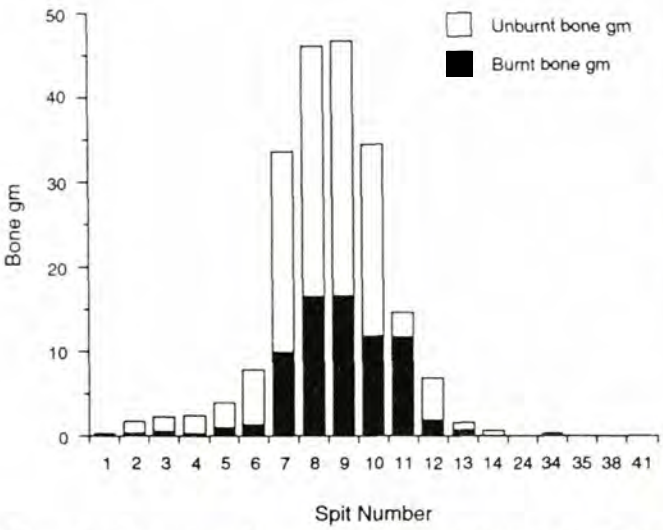

Figure 5 Proportions of burnt to unburnt bone, Serpent's Glen Rockshelter, Square A, combined size fractions.

the central Australian site of Puritjarra, whose catchment shares many ecological features with the sandy deserts, has some evidence for repeated occupations during this period (Smith 1989). The difference in occupation is likely due to the fact that the central Australian ranges are much more extensive than the Carnarvon Ranges and that Puritjarra is proximal to coordinated drainage systems and networks of major and permanent artesian water sources. These could have mitigated the effects of resource stress by providing nodes of access to, and retreat from, the desert lowlands from the central Australian ranges. We would note that the indices of bone fragmentation from Serpent's Glen are considerably higher than those at Puntutjarpa, in the Warburton Ranges, further emphasising the comparatively protein-depauperate nature of the surrounding desert lowlands of the Little Sandy Desert.

In conclusion, we argue that the apparently ephemeral nature of the Pleistocene assemblages at Serpent's Glen and the presence of a clear cultural hiatus highlight the degree to which groups employed highly flexible settlement strategies to cope with resource stress at different scales of time (cf. Gould 1991). We advocate continued characterisations of early settlement behaviours and their comparison to those of the late Holocene, when the Western Desert linguistic and technological unity evolved.

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References

Arnold, J.M. 1983 *Dasyurus geoffroii.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, p.22. Sydney: Angus and Robertson.

Archer, M. 1977 Faunal remains from the excavation at Puntutjarpa Rockshelter. In R.A. Gould's *Puntutjarpa Rockshelter and the Australian Desert Culture*, pp.158-65. New York: American Museum of Natural History. *Anthropological Papers of the American Museum of Natural History* 54.

Beard, J.S. and Webb, J. 1974 *Vegetation Survey of Western Australia: Great Sandy Desert.* Perth: University of Western Australia Press.

Cogger, H.G. 1994 *Reptiles and Amphibians of Australia.* Sydney: Reed Books.

Edwards, D.A. and O'Connell, J.F. 1995 Broad spectrum diets in arid Australia. *Antiquity* 69:769-83.

Evans, N. and Jones, R. 1997 The cradle of the Pama-Nyungans: Archaeological and linguistic speculations. In P. McConvell and N. Evans (eds) *Archaeology and Linguistics: Global Perspectives on Ancient Australia*, pp.385-417. Melbourne: Oxford University Press.

Gordon, G. 1983 *Perameles eremiana.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, p.102. Sydney: Angus and Robertson.

Gorecki, P., Grant, M., O'Connor, S. and Veth, P. 1997 The morphology, function and antiquity of grinding implements in Australia. *Archaeology in Oceania* 32:141-50.

Gould, R.A. 1977 *Puntutjarpa Rockshelter and the Australian Desert Culture.* New York: American Museum of Natural History. *Anthropological Papers of the American Museum of Natural History* 54.

Gould, R.A. 1991 Arid-land foraging as seen from Australia: Adaptive models and behavioural realities. *Oceania* 62:12-33.

Gould, R.A. 1996 Faunal reduction at Puntutjarpa rockshelter, Warburton Ranges, Western Australia. *Archaeology in Oceania* 31:72-86.

Hiscock, P. and Veth, P. 1991 Change in the Australian desert culture: A reanalysis of tulas from Puntutjarpa. *World Archaeology* 22:332-45.

Mabbutt, J.A. 1971 The Australian arid zone as a prehistoric environment. In D.J. Mulvaney and J. Golson (eds) *Aboriginal Man and Environment in Australia*, pp.66-79. Canberra: Australian National University Press.

McConvell, P. 1996 Backtracking to Babel: The chronology of the Pama-Nyungan expansion in Australia. *Archaeology in Oceania* 31(3):125-44.

McKenzie, N.L. 1983 *Isoodon auratus.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, pp.98. Sydney: Angus and Robertson.

Morton, S.R. 1983 *Sminthopsis macroura.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, p.63. Sydney: Angus and Robertson.

O'Connor, S. and Veth, P. 1996 A preliminary archaeological report on recent archaeological research in the semi-arid/arid belt of Western Australia. *Australian Aboriginal Studies* 1996(2):42-50.

O'Connor, S., Veth, P. and Barham, A.J. in press Cultural versus natural explanations for lacunae in occupation deposits in northern Australia. *Quaternary International.*

Poole, W.E. 1983 *Macropus robustus.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, pp.250-1. Sydney: Angus and Robertson.

Ross, A., Donnelly, T. and Wasson, R. 1992 The peopling of the arid zone: Human-environment interactions. In J. Dodson (ed.) *The Naive Lands: Prehistory and Environmental Change in Australia and the Southwest Pacific*, pp.76-114. Melbourne: Longman Cheshire.

Sharman, G.B. 1983 *Macropus rufus.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, pp.255-7. Sydney: Angus and Robertson.

Smith, M.A. 1988 The pattern and timing of prehistoric settlement in Central Australia. Ph.D. thesis, Department of Archaeology and Palaeoanthropology, University of New England, Armidale.

Smith, M.A. 1989 The case for a resident human population in the Central Australian ranges during full glacial aridity. *Archaeology in Oceania* 24:93-105.

Smith, M.A. 1993 Biogeography, human ecology and prehistory in the sandridge deserts. *Archaeology in Oceania* 37:35-50.

Smith, M.A., Williams, E. and Wasson, R.J. 1991 The archaeology of the JSN site: Some implications for the dynamics of human occupation in the Strzelecki desert during the late Pleistocene. *Records of the South Australian Museum* 25:175-92.

Strahan, R. (ed.) 1983 *The Complete Book of Australian Mammals.* Sydney: Angus and Robertson.

Tonkinson, R. 1991 *The Mardu Aborigines: Living the Dream in Australia's Desert.* Fort Worth: Holt, Rinehart and Winston.

Veth, P. 1989 Islands in the interior: A model for the colonisation of Australia's arid zone. *Archaeology in Oceania* 24:81-92.

Veth, P.M. 1993 *Islands in the Interior: The Dynamics of Prehistoric Adaptations within the Arid Zone of Australia.* Ann Arbor, Michigan: International Monographs in Prehistory. *Archaeological Series* 3.

Veth. P. 1995a Marginal returns and fringe benefits: Characterising the prehistory of the lowland deserts of Australia (a reply to Smith). *Australian Archaeology* 40:2-38.

Veth, P. 1995b Aridity and settlement in northwest Australia. *Antiquity* 69:733-46.

Veth, P. in press Language on the move: Archaeologically generated models for the timing and direction of the Western Desert Language. *Origins of the Western Desert Language.*

Veth, P.M. and Walsh, F.J. 1988 The concept of 'staple' plant foods in the Western desert region of Western Australia. *Australian Aboriginal Studies* 1988(2):19-25.

Woolley, P.A. 1983 *Dasycercus cristicauda.* In R. Strahan (ed.) *The Complete Book of Australian Mammals*, p.26. Sydney: Angus and Robertson.