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New evidence from Fraser Cave for glacial age man in south-west Tasmania

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The discovery of a rich archaeological occupation site in the Franklin River valley of south-west Tasmania dated at 15–20 kyr BP is described. The stone tools found support the view that the Tasmanian industries were derived from contemporary mainland Australian ones when the two were still connected. Faunal remains from human hunting and cooking activities indicate a hunting strategy targetted at a few favoured species, especially the large wallaby. No extinct megafaunal species were present. During the height of the last ice age, these glacier edge hunters of southern Tasmania were then the most southerly humans on Earth.

ACCORDING to ethnographic sources of the early nineteenth century, the densely forested inland region of south-west Tasmania was not then occupied by Aborigines¹. G. A. Robinson, who between 1829 and 1834 combed the island to meet most of the surviving Aborigines and persuade them to enter Government settlements, said of the region from a vantage point on the Arthur Range to the south on 13 March 1830 that "there was not the least sign or appearance of natives or of any white man ever being in this part of the country. The natives that accompanied me assured me there was [sic] no natives ever went inland".² It was because of this very inaccessibility that a notorious maximum punishment convict station was established on a small island in Macquarie Harbour in 1825. However, comments from Goodwin, one of the few convicts to escape across the mountains from here, and other explorers suggest that there was at least seasonal Aboriginal use of tongues of grassy country on the Upper Gordon River to the east and around Frenchman's Cap to the north³. A radiocarbon date of 300 ± 150 yr BP (ANU 2787) from an open river bank site on the confluence of the Gordon and Denison rivers (Fig. 1) discovered by an exploratory expedition led by two of us (D. R. and R. J.) in January 1981 shows that some fleeting visits were being made into parts of the region in immediate pre-European times.

Late Pleistocene human occupation east of Tasmania's principal longitudinal watershed has been demonstrated from the Beginners Luck limestone cave site in the Florentine Valley (Fig. 1), an area which was densely forested at the time of European settlement. There, some 20 stone artefacts in a secondary depositional context were initially dated to ~12 kyr BP (ref. 4) but more precisely isolated material has since been radiocarbon dated to $20,650 \pm 1790$ yr BP (ref. 5). Fossils of the extinct megafaunal species *Sthenurus occidentalis* from a nearby site gave an aspartic acid racemization date considerably in excess of this (possibly of the order of 80 kyr), but they indicate radically different environmental conditions in the region some time during the Upper Pleistocene⁶. The discovery of surface stone tools on industrially denuded ridges and moraines on the West Coast Range in 1979⁷, and subsequent unpublished finds by one of us (K.K.) and J. Stockton, further demonstrated the possibility of prehistoric remains existing elsewhere in south-west Tasmania, including the region of the Gordon and Franklin Rivers.

This region offers probably the least archaeological visibility of any in Australia, due to the dense vegetation, rapid peat growth and lack of exposure, but the two rivers run through extensive outcrops of Ordovician limestone where karst landforms are well developed (Fig. 1). Since 1974 a series of pioneering speleological expeditions has documented numerous caves⁸ including in 1977 a large one called Fraser Cave, (F 34), on

the east bank of the Franklin River where original reports noted the existence of an extensive bone deposit⁹. During a later visit in February 1981, Kiernan recognized stone tools and charred bones which indicated this deposit to be of human origin. Accordingly in March 1981 we went up the river to visit the site and conduct a pilot investigation.

Fraser Cave (F 34)

Fraser Cave is a relict outflow stream cave which lies at the head of a resurgence valley 35 m distant from and 10 m above the present level of the Franklin River. It comprises about 200 m of large passages with at least eight surface openings. The largest entrance, which faces north is 12 m wide and up to 3 m high gives easy level access to a spacious chamber (Fig. 2). This chamber is 5 m high, and extends inward for 18 m with a width of between 5 and 12 m. The passages are developed along the strike of the limestone beds which dip to the east at a moderate angle. After having been initiated in phreatic conditions, the cave was further elaborated by the running waters of two small streams which are now intermittent. While some inner sections of Fraser Cave are richly decorated by calcium carbonate speleothems, notably rimstone pools, the downstream areas are dominated by clastic deposits comprising 20–40 cm of moderately rounded fine gravels. These are at present immobile and are subject to manganese encrustation. The gravels are externally derived and consist primarily of Siluro-Devonian metasediments washed from the hillslopes to the east. They are overlain by poorly exposed fine sands which contain at least some stone tools. The sand is in turn overlain by flowstone calcite. This sequence is interpreted as reflecting successive loss of competence by the cave streams. The reduction in clastic load and stream flow permitted precipitation of the flowstone. Piping has since removed some of the sands from beneath the flowstone and a few roof-fall blocks lie scattered on its surface beneath a high level entrance.

Table 1 Radiocarbon assays of various excavation and stratigraphical units

¹⁴ C code no. (ANU)	Excavation unit	Depth below surface (cm)	Stratigraphical unit	Results (yr BP)
2781	A2	3–5	16 top	14,840 ± 930
2782	A8	23–26	13	17,020 ± 310
2783	A10/11	32–39	10	15,670 ± 530
2784	A17/18	79–87	5	Samples too mineralized
2785	A20	94–96	3	19,770 ± 850

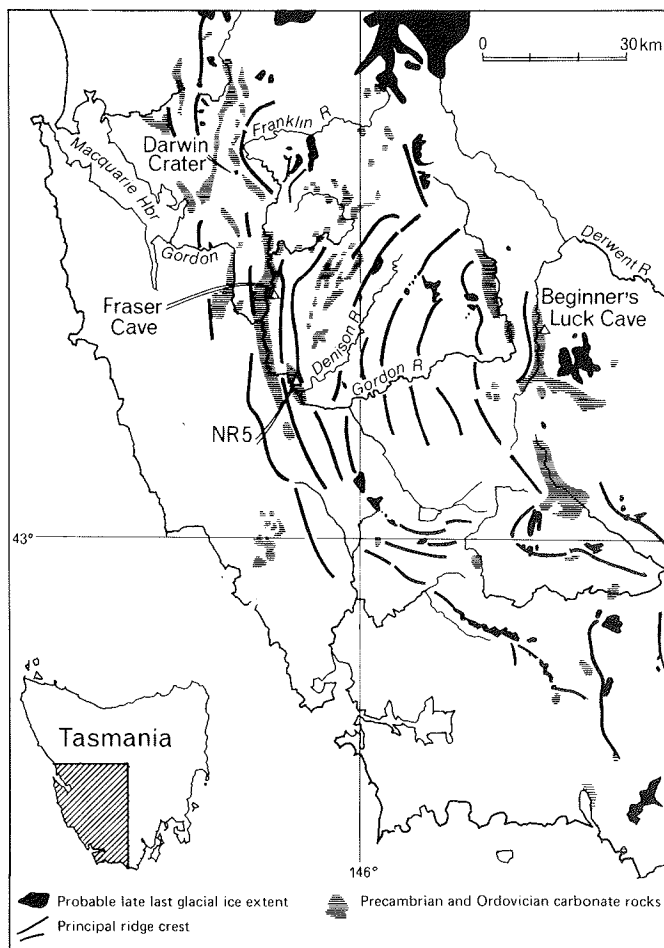


Fig. 1 Map of south-west Tasmania showing main structural features and outcrops of carbonate rocks; also location of glaciers at ~18 kyr ago.

Excavation stratigraphy and chronology

Within the main entrance chamber, and forming a talus at its mouth, is a poorly sorted clastic deposit between 1 and 3 m thick. At a distance of 12 m in from the entrance on the western side of the chamber, this deposit forms a flowstone-capped bank some 0.7 m high. Numerous stone tools, burnt bones and charcoal protrude from the slightly eroded edge of this bank. A small pilot excavation, was undertaken into this face to ascertain the stratigraphical and chronological context of the archaeological remains and to obtain samples for palaeo-environmental analysis. The excavation pit was 1 m wide and reached the rock floor at a maximum depth of 1.30 m. It revealed a complex stratigraphy as shown in Fig. 3. All of the excavated material was wet-sieved using a 3-mm mesh. The charcoal was floated off and stone artefacts and bone material were removed for analysis.

The stratigraphy of these entrance facies may be broadly differentiated into three main complexes. The basal alluvial deposits are similar to those which occur elsewhere in the cave. Gravels are interbedded with lenses of fine sand, while cut and fill structures are common. The lowermost gravel is encrusted by manganese, which indicates the presence of a surface vegetation sufficient to mobilize the mineral before its burial by 10–15 cm of fine laminated sands (unit 2). The most stratigraphically recent gravel (unit 3) has a mean calibre of ~2 cm and contains numerous bone fragments, stone tools and charcoal. A charcoal sample which was obtained from this unit was radiocarbon assayed at $19,770 \pm 850$ yr BP (ANU 2785) (Table 1).

Alluvial sedimentation was subsequently overwhelmed by a major influx (units 6–10) of angular limestone rubble in a loamy

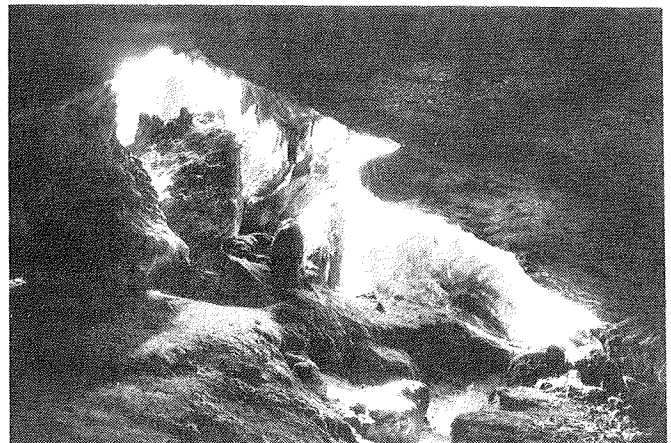


Fig. 2 The entrance chamber of Fraser Cave.

matrix, the rubble stones having a maximum calibre of 10–15 cm. We believe that these units are the product of mechanical weathering in cold climatic conditions. Interspersed between the rubble layers, which are rich in bones and stone tools, are lenses of fine laminated sands (units 5, 7 and 9). These do not contain any cultural debris, and indicate episodic wetness. A radiocarbon assay of charcoal from the upper horizon of this rubble in unit 10 gave a date of $15,670 \pm 530$ yr BP (ANU 2783).

The subsequent black hearth and rubble complex retains much of its general character. The matrix in which the rubble occurs is heavier and richer in clay, which seems to indicate generally damper conditions. Stone tools and bone are extremely abundant and the clay forming the lower boundary of the complex is baked red by prehistoric fires. A radiocarbon assay of $17,020 \pm 310$ yr BP (ANU 2782) was obtained from a hearth unit (unit 13) in the base of this complex. This inversion with the stratigraphically lower sample ANU 2783 cannot presently be explained but further samples will be submitted from the top of this limestone rubble to gain greater precision as to its age.

The top date for the hearth and rubble complex was obtained only 3–5 cm below the surface and gave a result of $14,840 \pm 930$ yr BP (ANU 2781). This dates the uppermost of the horizons which contain tools. Capping this complex is a layer of sterile sand which is 1–3 cm thick, the surface of which is cemented by a crust of calcium carbonate.

The radiocarbon dates indicate the presence of man in Fraser Cave from ~20 kyr BP until ~15 kyr BP. These dates are consistent with the sedimentological evidence which suggests that this occupation corresponded in time to the Last Glacial Maximum. Although it is difficult to separate climatic and anthropogenic effects, the abundance of charcoal in the basal alluvial sequence beneath the entrance facies of Fraser Cave begs the question as to the role that humanly induced fires may have played in destabilizing the slope mantle in the vicinity of the site.

The onset of conditions of extreme cold in western Tasmania is reflected by slope instability at Henty Bridge on the coast-facing margin of the West Coast Range, dated at $23,860 \pm 890$ yr BP (Gak-5594)¹⁰. In the central part of the West Coast Range, 55 km north of Fraser Cave conditions of maximum cold occurred about 5 kyr later. Drifted wood in proglacial silts which immediately predate the arrival of glacial outwash gravels from the Dante Rivulet Valley has been radiocarbon assayed at $18,800 \pm 500$ yr BP (ANU 2533). These dated silts overlie intact flowering specimens of the alpine cushion plant *Donatia novae zelandiae* which imply depression of the treeline to below 230 m (ref. 11). Here a temperate depression of 5.8 °C is indicated by reconstruction of glacial snow-line altitudes. A slightly greater figure of 6.3 °C is indicated 35 km further inland to the east in the headwaters of the Franklin River, where the glacial snowline was depressed to ~1,040 m. In this latter area,

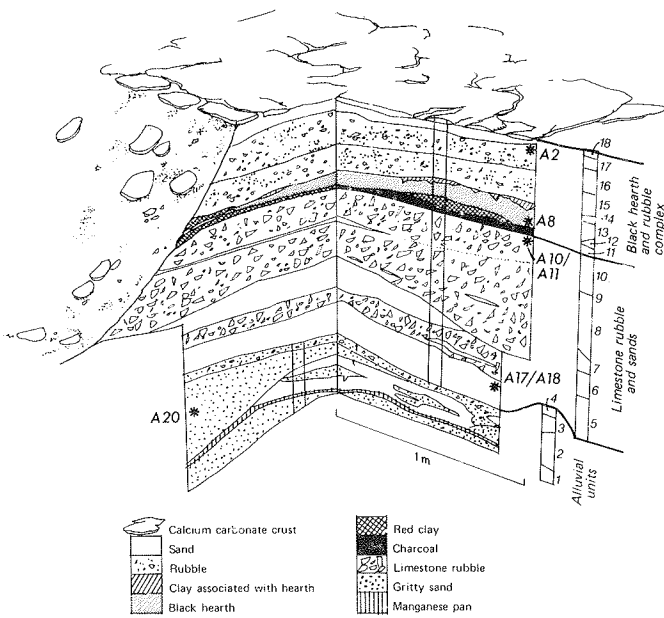


Fig. 3 Stratigraphical section of excavated archaeological deposits at Fraser Cave, showing main units and location of radiocarbon samples.

diffluent ice from the glacier system in the Derwent Valley on the margin of the central plateau ice cap breached the Derwent-Franklin divide and spilled into the Franklin headwaters (Fig. 1). Here it merged with local ice which accumulated in the lee of a snowfence aligned north-south to form a valley glacier which flowed 12 km down the upper Franklin River valley¹¹. Minor cirque and valley glaciers also arose further downstream in the Franklin catchment, notably within the Frenchmans Cap massif 25 km north of Fraser Cave (Fig. 1). Deglaciation appears to have been complete in Tasmania by ~10 kyr BP. The angular limestone rubble in Fraser Cave was produced in cold climatic conditions during this glacial stage and the radiocarbon dates which bracket the rubble and occupation probably broadly delineate the period of maximum cold.

Archaeological remains

Although the total excavation measured ~0.67 m³ in volume, some 75,000 stone flakes and tools were recovered as shown in Table 2. This sample is estimated to be << 1% of the total artefact-bearing deposit. Because only ~100 stone artefacts were recovered *in situ* from the only other directly dated Pleistocene sites in Tasmania, namely Beginner's Luck Cave on the Florentine River (Figs 1 and 4) and Cave Bay Cave^{12,13} on present-day Hunter Island (Fig. 4), it can be appreciated that the Fraser Cave assemblage has the potential to transform our present knowledge of Tasmanian late Pleistocene stone technology. The oldest artefact was a single flake recovered from within the basal stratigraphical unit 1, which indicated some occupation probably before 20 kyr BP. However, several hundred flakes and worked tools together with much charcoal were found within the succeeding sands and gravels of unit 3. In almost all the succeeding units, especially the limestone rubble layers, there are numerous stone tools, the only sterile layers being the sand lenses (units 5, 7, 9). In the uppermost complex, there are superimposed hearths with lenses of red-baked clay and abundant charcoal flecks. Occupation ceased suddenly after unit 16 which is dated to ~15 kyr ago. Then the deposit was covered by a thin flow stone, and there is no indication of subsequent human occupation or use of the cave.

The raw materials used for making the stone tools were mostly cobbles of fine-grained siliceous rocks, which could be obtained easily from glacial outwash gravels in the Franklin river-bed nearby. An exception to this lies in a small number of stone tools made from Darwin Glass, which is an impactite associated with a large meteorite crater in the tributary Andrew

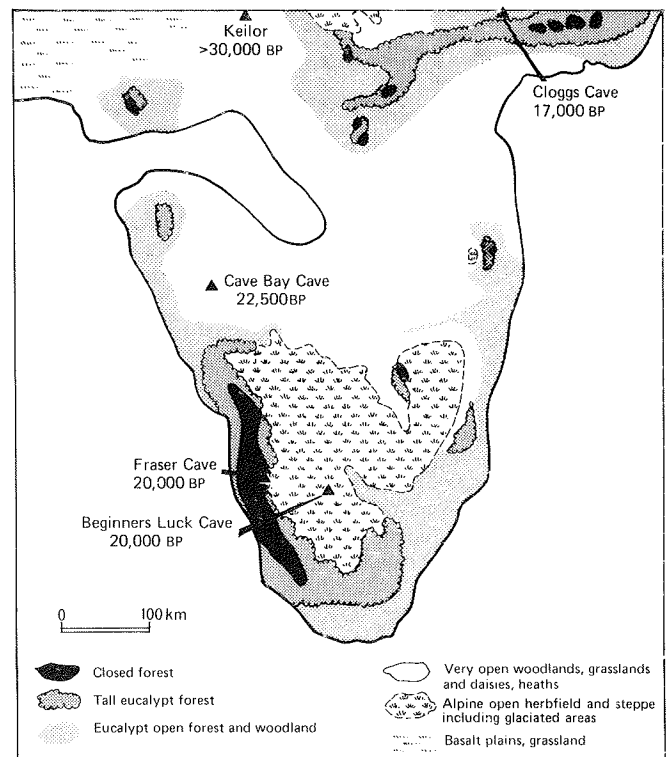


Fig. 4 General reconstruction of major vegetation types and coastline of the Bassian-Tasmanian peninsula at ~18 kyr ago, adapted from ref. 27. Location of prehistoric sites shown with their basal radiocarbon dates.

River Valley 25 km to the north-west (Fig. 1). A westward splash pattern away from the Franklin River has been demonstrated for this material¹⁴, which suggests that these pieces of glass are manuports. Darwin Glass artefacts appear in the sequence from the unit 8 rubble upwards indicating that a considerable mineralogical knowledge of this geologically complex region of south-west Tasmania had been achieved by this time.

Typologically, the tools consist mostly of steep-edge scrapers and domed core-scrapers with steep edges that are often at right angles and show extensive stepped flaking. There are also small round 'thumbnail' scrapers and many retouched flakes. In general this assemblage bears a close resemblance to the tools from the lowest levels of the South Cave, Rocky Cape, on the north coast of Tasmania which have been dated to between 8 and 6 kyr ago¹⁵. The Fraser Cave sequence thus fills a large part of a crucial gap between the base of Rocky Cape and the brief palimpsest of the 20-22-kyr old occupation of Cave Bay Cave^{12,13,16}. From these sites we now have an almost continuous sequence extending from the stone tool technology of the ethnographically recorded Aborigines of the early part of the last century back to just before the Last Glacial Maximum in Tasmania. The Fraser Cave assemblage is also typologically similar to near contemporary industries on the Australian mainland, such as the Lake Mungo assemblage which is dated to ~25 kyr BP (refs 17, 18). All these tools belong to what has been termed the 'Australian core tool and scraper tradition'. It has long been assumed that Tasmanian stone industries were derived from this technological tradition at a time when Tasmania formed part of the single land mass of Greater Australia¹⁹. The Fraser Cave assemblage confirms this. After the post-glacial inundation of Bass Strait, this tradition continued in Tasmania with only slow internal evolutionary changes towards a reduction of average size of tools. On the mainland, however, there were transformational changes associated with the introduction or invention in mid-recent times and later of a variety of small gum-hafted tools such as backed microliths, points and adzes^{20,21}.

Table 2 Occurrence and size of stone flakes, tools and bone fragments

Stratigraphical complex	Stratigraphical units	Vol (m ³)	Stone flakes and tools				Bone fragments		
			Weight		No.		Total	Weight	
			(kg)	(kg m ⁻³)	> 1 cm in length	< 1 cm in length		(kg)	(kg m ⁻³)
Black hearths and rubble	16-11	0.133	10.9	82	900	15,200	16,100	6.0	45
Limestone rubble	10-5	0.318	58.0	182	6,800	51,200	58,000	28.5	90
Alluvial units	4-3	0.089	1.6	18	250	450	700	0.07	8
		0.54	70.5		7,950	66,850	74,800	35.2	

Ochre fragments were found in almost all units above the limestone rubble (unit 6) showing that this pigment was being carried into the cave at this time. Despite an intensive search, no signs of rock art were seen on the walls of the cave.

Bone fragments were found in all of the units which contained stone tools (Table 2), and were absent in culturally sterile layers. From a preliminary analysis based on mandible and maxilla counts, ~90% of the bones are of the large wallaby *Macropus rufogriseus* and about 8% are of the wombat *Vombatus ursinus*. The remaining 2% consist of Tasmanian Devil *Sarcophilus harrisii* and various small mammals. Both Bowdler¹⁶ and Balme²² have independently proposed criteria for distinguishing cave bone accumulations which have resulted from non-human predation such as that by owls and Tasmanian Devils, as opposed to the middens of human hunters. For the latter they suggest an overwhelming preponderance of one or two large game species; a substantial number of bones showing calcination or other evidence of fire; and bones, especially long bones, which have been smashed to obtain the marrow. The fulfillment of these criteria, together with the easy access into and out of Fraser Cave, demonstrate that this bone assemblage is a human midden.

From our preliminary analysis, there do not seem to be any representatives of extinct megafaunal species. This is consistent with the revised analysis of the Beginner's Luck site where the 20-kyr old stone artefacts are associated with bones of modern fauna, mostly *Macropus rufogriseus*, with only one cuboid of a large macropod, cf. *M. titan*⁵. The Fraser Cave assemblage supports the view that by the time of the Last Glacial Maximum, most or all elements of Tasmania's megafauna were already extinct, and that the animals living in these glacial valleys were modern. Such evidence, which contradicts a previously held view^{23,24}, has important implications in the debate concerning a climatic or human causation for the extinction of the 'giant' marsupials. The faunal evidence from the cave also dispels a previous theory that the Last Glacial hunter-gatherers of the Tasmanian peninsula were incapable of systematic hunting of medium-sized land game but were effectively restricted to the width of one band's territory from the coast^{13,25,26}. At the time of its occupation, Fraser Cave would have been ~60 km in a direct line across rugged, snow-bound mountains or 100 km down the most practicable river route from the contemporary coastline (Figs 1 and 4).

The inhabitants of Fraser Cave hunted game with a tight targetting strategy which concentrated on wallabies. These would have been obtained from the open valley slopes which were perhaps cloaked by sub-Antarctic herbfield vegetation. The evidence from the cave suggests a high biomass of these animals having existed in the region during glacial times. The rain-forest may have existed within gallery refugia along the main rivers and possibly in areas closer to the lower coastline including the exposed trough of what is now Macquarie Harbour. This is indicated schematically in Fig. 4 which we derive

from a general reconstruction of the full Last Glacial vegetation by Hope²⁷. We argue that as the climate ameliorated, and conditions became wetter, these forests emerged from their glacial refugia, and despite any effects of man and his fire sticks, re-occupied the higher valley slopes of the Franklin and Gordon rivers. This dense rain-forest habitat was not conducive to hunters, and so Fraser Cave was abandoned, not to be occupied for the next 15 kyr.

Hunters close to southern ice

In addition to the great richness of this site, its significance must be seen in the context of the human colonization of the western rim of the Pacific. The colonization of Australia-New Guinea across the water barriers of Wallacea occurred some time before 40 kyr BP (refs 19, 28). Between at least 50 kyr BP and ~24 kyr BP, the sea was lower than its present level²⁹, but it may not have been low enough to expose the entire Bassian bridge hence the final southward movement of the Australian colonists was stemmed^{25,28}. Then with the onset of the Last Glacial Maximum, the sea dropped below the crucial 60-m isobath, and exposed a dry route to the Tasmanian peninsula. That man immediately seized this opportunity to expand his range is shown by the near contemporary basal occupation of 22.5 kyr BP at Cave Bay Cave^{13,16}, and from possibly slightly earlier than 20 kyr BP at Fraser Cave and Beginner's Luck Cave⁵. In southern Tasmania, these hunters were then the most southerly human beings on Earth. It would not be until 10 kyr BP that equivalent areas in Fuego-Patagonia were to be occupied by man^{30,31}. At 18 kyr ago, the Tasmanians alone were as close to the great Antarctic ice sheet, then only some 1,000 km further to the south³² as some Upper Palaeolithic hunters of Europe, were to the northern ice sheets. The Tasmanian hunters probably lived in tundra environmental conditions similar to those which existed in parts of northern Europe. The specific targetting onto reindeer by the European hunters bears comparison with the similar emphasis on wallabies by the sub-Antarctic palaeo-Tasmanians.

South-west Tasmania therefore offers a fascinating southern analogue for the study of hunters of the Last Glacial Maximum. However, the future of the Franklin-Gordon archaeological sites is threatened by plans now being implemented of the Tasmanian Hydro-Electric Commission to inundate these valleys. This would flood Fraser Cave together with other unstudied sites which have been located within recent months in the wake of the original discoveries.

Our exploratory work in the field in 1981 was supported by the Australian National University, the Tasmanian National Parks and Wildlife Service and the Tasmanian Wilderness Society. We thank our colleagues during the excavation; Barry Blain, Bob Burton, Steve Harris and Greg Middleton; and Hendrick Gout for free helicopter transport of our finds. John Head paid special attention to our dating needs and Winifred Mumford drew the figures.

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