Received: 20 April 2022 | Accepted: 11 September 2022

DOI: 10.1002/pan3.10410

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE

Interpreting the mammal deposits of Cloggs Cave (SE Australia), GunaiKurnai Aboriginal Country, through community-led partnership research

Matthew C. McDowell[1,2,3] | Bruno David[1,2] | Russell Mullett[4] | Joanna Fresløv[4] | GunaiKurnai Land and Waters Aboriginal Corporation[4] | Jean-Jacques Delannoy[1,5] | Jerome Mialanes[1,2] | Cath Thomas[4] | Jeremy Ash[1,2] | Joe Crouch[1,2] | Fiona Petchey[1,6] | Jessie Buettel[1,3] | Lee J. Arnold[1,7]

[1]ARC Centre of Excellence for Australian Biodiversity and Heritage, Canberra, Australian Capital Territory, Australia; [2]Monash Indigenous Studies Centre, Monash University, Clayton, Victoria, Australia; [3]School of Natural Sciences, University of Tasmania, Hobart, Tasmania, Australia; [4]GunaiKurnai Land and Waters Aboriginal Corporation, Kalimna West, Victoria, Australia; [5]Laboratoire EDYTEM, Université Savoie Mont Blanc, Le Bourget du Lac Cedex, France; [6]Radiocarbon Dating Laboratory, University of Waikato, Hamilton, New Zealand and [7]School of Physical Sciences, Environment Institute, and Institute for Photonics and Advanced Sensing (IPAS), University of Adelaide, Adelaide, South Australia, Australia

Correspondence
Matthew C. McDowell
Email: matt.mcdowell@monash.edu

Funding information
Australian Research Council Centre of Excellence for biodiversity and Heritage, Grant/Award Number: CE170100015

Handling Editor: Darryl Jones

Abstract

1. Palaeontological animal bone deposits are rarely investigated through research partnerships where the local First Nations communities have a defining hand in both the research questions asked and the research processes. Here we report research undertaken through such a partnership approach at the iconic archaeological site of Cloggs Cave (GunaiKurnai Country, East Gippsland), in the southern foothills of SE Australia's Great Dividing Range.
2. A new excavation was combined with detailed chronometric dating, high-resolution 3D mapping and geomorphological studies. This allowed interpretation of a sequence of stratigraphic layers spanning from a lowermost excavated mixed layer dated to between 25,640 and 48,470 cal BP, to a dense set of uppermost, ash layers dated to between 1460 and 3360 cal BP. This long and well-dated chronostratigraphic sequence enabled temporal trends in the abundant small mammal remains to be examined.
3. The fossil assemblage consists of at least 31 taxa of mammals which change in proportions through time. Despite clear evidence that the Old Ancestors repeatedly carried vegetation into the cave to fuel cool fires (no visible vegetation grows in Cloggs Cave), we observed little to no evidence of cooking fires or calcined bone, suggesting that people had little involvement with the accumulation of the faunal remains. Small mammal bones were most likely deposited in the cave by large disc-faced owls, *Tyto novaehollandae* (Masked Owl) or *Tyto tenebricosa* (Sooty Owl).

4. Despite being well dated and largely undisturbed, the Cloggs Cave assemblage does not appear to track known Late Quaternary environmental change. Instead, the complex geomorphology of the area fostered a vegetation mosaic that supported mammals with divergent habitat preferences. The faunal deposit suggests a local ancestral landscape characterised by a resilient mosaic of habitats that persisted over thousands of years, signalling that the Old Ancestors burned landscape fires to encourage and manage patches of different vegetation types and ages within and through periods of climate change.

KEYWORDS
biogeographic change, climate change, East Gippsland, first nations landscapes, GunaiKurnai, owl accumulation, partnership research, small mammals

1 | INTRODUCTION

Palaeontological and archaeological research have many levels of significance, that is, findings that are considered worthy of attention. But what is deemed significant, and by whom?

To most palaeontologists, significance lies in the temporal, taxonomic, taphonomic and palaeobiogeographic occurrence of an animal's remains. For archaeologists, significance is usually found also in the cultural practices of the past, such as how and why plant and animal species were obtained; the exploitation of habitats for subsistence resources; and the stories passed down through the ages that embody the cultural significance of sites and landscapes. Both disciplines aim to garner information from the objects they discover to construct evidence-based narratives that attempt to interpret past events, spatial patterns and temporal trends. Many important sites, such as Cloggs Cave in GunaiKurnai Aboriginal Country, East Gippsland (SE Australia) (Figure 1), are comprised not just of palaeontological and archaeological deposits, but more importantly consist of the homelands of First Nations peoples whose ancestors, and current generations, have long called home, and for whom buried deposits are living ancestral presences (for Australian Aboriginal notions of 'Country', see below). The findings and significance of such deposits cannot thus simply be treated as 'natural' assemblages, but rather as part of the cultural landscape of First Nations Traditional Owners. For many Traditional Owner groups, for such assemblages to be studied, research partnerships are required, for example between palaeontologists, archaeologists and geomorphologists and the community members whose Country the sites lie in and whose past and present connect them to it.

Palaeontological and archaeological research provide fundamental tools to reveal details about past, present and future landscapes. So, too, does community connections to Country, for knowledge held by First Nations Traditional Owners include rights to ancestral places, traditions, stories and memories about those places, all signalling fundamental relations between people and with place. Consequently, it seems self-evident that, where respectful partnerships that include ethical rights to ancestral lands and waters have been established, and where such research has been deemed socially and culturally acceptable by First Nations peoples as Traditional Owners of sites and landscapes, palaeontologists, archaeologists and Traditional Owners collaborate to maximise the depth of new knowledge and understanding that can be achieved when working together on Country. An important dimension of such equitable and respectful relations is: who sets the agenda such as the research questions, and under what terms does the research take place? In other words, who determines what is significant, at the start of a project (e.g. which site or landscape will be investigated and why; where will funding be applied for and under what terms?), during a project (e.g. who will work on a project? Where will the laboratories be based? What analyses will be done? And which samples will be sent off, sometimes for destructive analyses?) and at the 'end' of a project (e.g. which results will be presented and to whom, in what order and under whose authorship?). While these varied dimensions stretch across a project's duration, all aspects should, as far as possible, be discussed collaboratively before the project begins, as a prelude or segue to its viability.

It is worth noting that what is significant to palaeontologists and archaeologists may or may not be of interest to Traditional Owners, and vice versa. Such differences may relate to geographical scale (e.g. local, regional, national vs. global issues); social connections (e.g. socially distant vs. descendant communities); temporal scale (specific events and activities vs. time-averaged temporal trends); temporal focus (the deep past vs. recent times); topic and its approach (e.g. continuity and change; past social circumstances vs. adaptationist explanatory frameworks). For Traditional Owners generally, ancestral connections between people and place, considered in culturally appropriate cosmological and ethical contexts, as well as technical excellence, are key dimensions of good, acceptable research. Sometimes, First Nations peoples will have no problem with a research agenda that is not of immediate concern to community members. At other times they may. Listening to such concerns and appropriately planning projects in good partnerships requires a willingness to enter into project discussions from the start, to hear, and to engage in ongoing communication that involves local community members and outside researchers meeting, visiting and experiencing places together. For Traditional Owners, spending time on Country

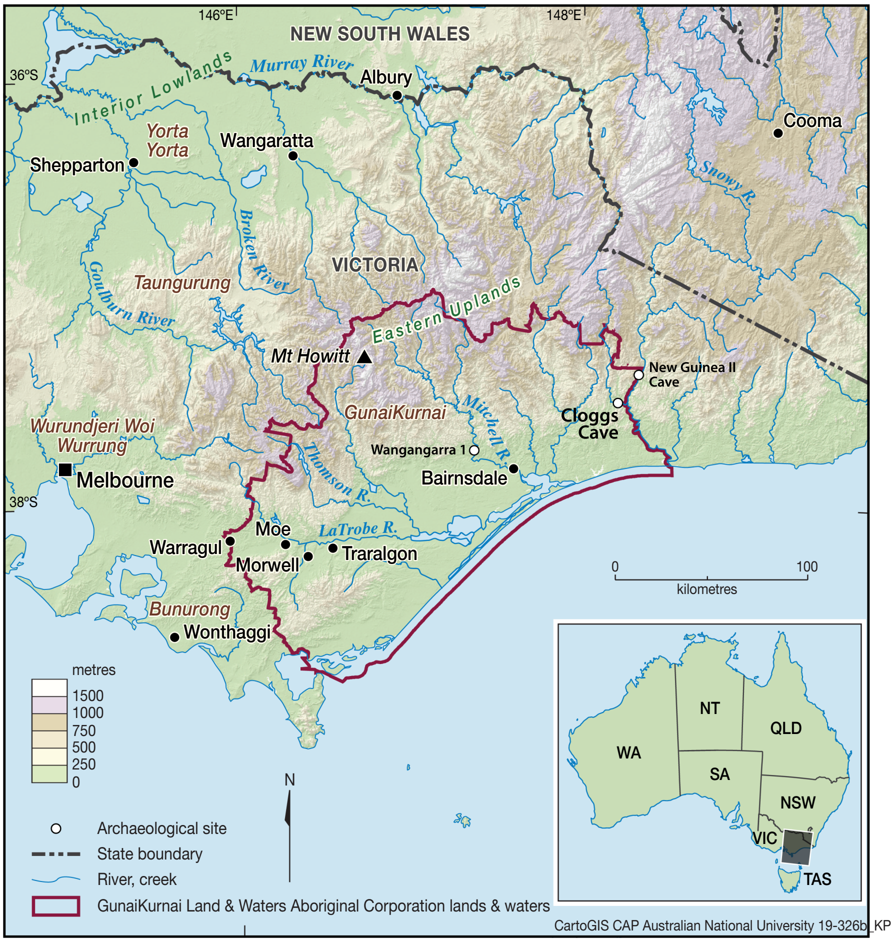

FIGURE 1 Study region, showing the location of Cloggs Cave and other excavated archaeological sites in GunaiKurnai Country.

is fundamental to valuing species and ecosystems. The stories and memories from visiting different parts of the landscape create a 'natural history' knowledge and literacy that supplements the scientific evidence, and that is founded on the cultural significance of taxa, places and human relations with each. Research through representative community organisations facilitates such processes, and the navigation of potential difficulties towards their solution. Such a way of scientific enquiry has recently been nationally framed as a CARE (Collective benefit, Authority to control, Responsibility, Ethics) approach.

1.1 | Cloggs Cave, GunaiKurnai Country, East Gippsland (SE Australia)

An important question, or perspective, that is rarely (if ever) addressed in Australian palaeontology and archaeology concerns how animal bone deposits are deemed 'natural' versus 'cultural' in local Aboriginal world views (for international anthropological literature on this topic, see e.g. Bradley, 2010; David, Fresløv, Mullett, Delannoy, et al., 2021; Descola, 2013; Morphy, 1989; Taylor, 1996). For GunaiKurnai First Nations peoples, the notion of Country refers not just to places with archaeological deposits, but rather to the entire ancestral landscape. Country was and continues to be shaped by the Old People, or Old Ancestors, as the ancestors are respectfully referred to by community members, who gave their descendants their languages, territories, dances, songs, kinship systems, rituals and Law. Country was frequented by the Old Ancestors who may have passed away but whose spirits remain. What is 'natural' in an ancestral landscape that has been formed and is populated by the Old People (and where the Old People may be deceased but have not passed *away*)? How, then, do and should palaeontologists, archaeologists and geomorphologists, for example, treat deposits of what is usually for them regarded as 'naturally' deposited animal bones? And what about individual sites, like Cloggs Cave, where archaeological signs of human presence are accompanied by 'naturally' accumulated animal bone deposits?

Cloggs Cave, a small limestone cave perched 72.3 m above sea level in the foothills of the Australian Alps, in the Middle Devonian-aged Buchan Group limestone within GunaiKurnai Aboriginal Country (David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al., 2021; Delannoy et al., 2020; VandenBerg et al., 1996), has been identified as an archaeologically significant site since the early 1970s (Figure 2). As part of her pioneering PhD research, Josephine Flood excavated a 2.4 m-deep pit in, and shallower pits outside, the cave's accumulated sediments,

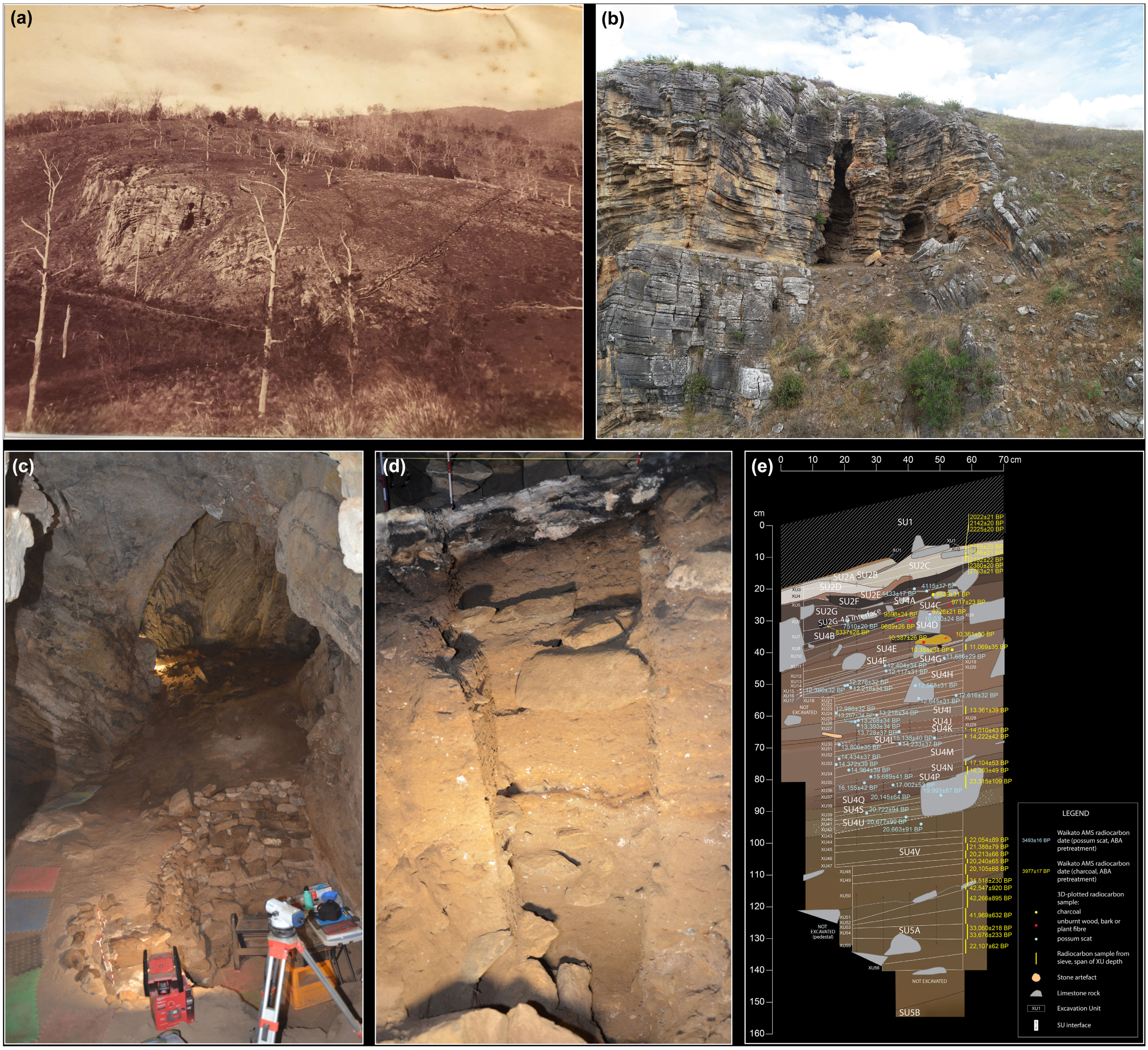

FIGURE 2 Cloggs Cave. (a) The Cloggs Cave cliff-line c. 1890–1900; Cloggs Cave's entrance is the small, vertical dark area near upper mid-section of the cliff (photographer unknown; photo courtesy of the State Library of Victoria). (b) Cloggs Cave's hourglass-shaped entrance. The rockshelter is the recess a short distance to the right of the entrance (photo by Jean-Jacques Delannoy). (c) Cloggs Cave, Square R31 excavation in progress. The large pit is from the 1971–1972 excavations. Square R31 is the lit area extending from the left-hand wall of the large pit (photo by Bruno David). (d) Square R31 after completion of excavation (photo by Bruno David). (e) Square R31 section drawing, with carbon dates back-plotted (graphic by Bruno David).

to investigate the subsistence economy and material culture of the Old Ancestors. Flood discovered a small number of culturally manufactured artefacts inside the cave, a rich small vertebrate faunal assemblage, complex stratigraphy (see Delannoy et al., 2020), and in the deepest layers, bones and teeth of the extinct giant short-faced kangaroo, *Sthenurus orientalis* (now synonymous with *Simosthenurus occidentalis*), and *Macropus giganteus titan* (a species related to the extant Grey Kangaroo) (Flood, 1973, 1980; Hope, 1973; see also David, Arnold, et al., 2021). Given Flood's research focus on Aboriginal patterns of occupation and subsistence, and a paucity or absence of animal food refuse in the deposit, little effort was invested in analysing and interpreting the animal bone assemblage beyond an unpublished analysis conducted by Hope (Appendix XIV in Flood, 1973).

In 2019–2020, the GunaiKurnai Land and Waters Aboriginal Corporation, representing the Aboriginal Traditional Owners of Cloggs Cave and its landscape, requested new archaeological excavations to resolve outstanding questions about the antiquity of the Cloggs Cave assemblage from the original excavations and to provide a better understanding of the cave and its (cultural) sequence, in particular so that questions and research processes of significance to the community could be addressed. Using culturally and scientifically appropriate contemporary practices, the new excavations and mapping yielded a small number of stone artefacts including flaked tools, a grindstone used to process both Bogong moths and minerals, stone arrangements employed in rituals and an accessible rock ceiling in a shallow alcove where stalactites had been broken and apparently crushed by people (David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al., 2021; Delannoy et al., 2020; Stephenson et al., 2020). Consistent with Hope's earlier but unpublished findings, abundant small vertebrate remains were again found, providing an excellent opportunity to learn more about the palaeontological, archaeological and GunaiKurnai cultural significance of the cave and what it meant to the Old Ancestors. Here we present the results of the faunal analyses to systematically ask: (1) is there any archaeological evidence of people having brought or processed animals in the cave; (2) what can the recently excavated animal bones from Cloggs Cave tell us about local and regional faunal distributions in the past; and (3) what can the bone deposit tell us about the site and its landscape over time?

2 | METHODS

2.1 | Ethics

As this research has been conducted with the full support of the GunaiKurnai Land and Waters Aboriginal Corporation and does not require animal experimentation, Ethics approval were not required.

2.2 | Excavation and stratigraphy

Flood's original excavations inside the cave revealed a complex stratigraphy containing a very rich small vertebrate faunal assemblage consisting largely of owl roost remains and occasional stone artefacts (for methods and results, see Flood, 1973, 1974, 1980; Hope, 1973). The excavation and dating methods used in our new study are described in David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al. (2021), David, Arnold, et al. (2021) and Stephenson et al. (2020). The stratigraphy and geomorphology of the cave are described in Delannoy et al. (2020) and David, Arnold, et al. (2021), and artefacts and archaeological sequences are described in David, Fresløv, Mullett, Delannoy, et al. (2021), David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al. (2021), Mialanes et al. (in press) and Stephenson et al. (2020). The key points of methodology for this paper are that in 2019–2020, three 50 × 50 cm squares were excavated against the cleaned walls of the unfilled (exposed) 1971–1972 pit. Contiguous Squares P34–P35 were dug against the southeast wall of the pit, Square R31 against the northeast wall. Excavations proceeded in typically <2 cm-thick 'spits' or excavation units (XUs) following the stratigraphy. All excavated sediments were bagged without sieving and taken to the Monash University archaeology laboratories, where they were wet-sieved in 2 mm mesh, air-dried, and from which all ≥2 mm-long artefacts, bone and other nonlimestone rock materials were manually sorted with tweezers and kept. A small sediment sample of each XU of each square was also kept for sediment analyses (e.g. pH, Munsell colour, particle size analysis, organic carbon analysis) prior to wet sieving. Pollen samples were collected at 5 cm depth-intervals by pushing new sample phials into the sediment profile after completion of each of the Squares P34–P35 and R31 excavations. eDNA samples were collected from each XU in Square R31 during excavation, and again from the side walls of the sequence under full protective gear (to avoid contamination by the collector) following completion of the excavation. These latter results will be presented elsewhere.

The subject of the present paper is the faunal bone remains from Square R31. The square was excavated from c. 20 cm to 153 cm depth against the northeast wall of Flood's 1971–1972 pit (the missing top c. 20 cm of the deposit, representing Stratigraphic Unit [SU] 1, had been removed in the 1970s, and the underlying sediments protected by plastic sheeting covered with a protective layer of imported sediment). The entire excavated deposit was well stratified, and radiocarbon ages of 43,412–46,763 cal BP (42,547 ± 920 BP, Wk-51,144, at 95% probability range) near the base are corroborated by an OSL age of 46,930 ± 4150 years for underlying deposits to the side nearby (David, Arnold, et al., 2021). The Bayesian analysis of 69 AMS radiocarbon and two single-grain optically stimulated luminescence (OSL) ages indicates that the Square R31 excavated sequence begins at its deepest levels with the mixed SU5A, dated to between 25,640 and 48,470 cal BP, and ends with an uppermost series of ash layers (SU2A–SU2D) dated to between 1460 and 3360 cal BP (all the Bayesian-model ages cited are given at 95% probability ranges) (David, Arnold, et al., 2021; David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al., 2021; Mialanes et al., in press; Stephenson et al., 2020). While the chronostratigraphy has good integrity, the sediment sequence contains many distinct layers. Minimal reworking has occurred, except for the lowermost SU5A of Square R31, which consists of sediments mixed by massive roof-fall. Beneath SU5A is SU5B, the well-stratified deposit that contains the in situ megafaunal remains excavated by Flood in 1971–1972 along the northeast wall slightly below and to the south of the base of Square R31. Here an OSL age of 51,830 ± 5510 years was obtained from the location of the *Simosthenurus occidentalis* remains (see David, Arnold, et al., 2021; Delannoy et al., 2020).

2.3 | Faunal analyses

Following laboratory sorting, all the animal bones from the ≥2 mm fraction were air-freighted to McDowell at the University of Tasmania for analysis. Diagnostic bones (whole and part skulls, maxillae, dentaries and/or teeth, reptile vertebrae, frog ilia and bird bones) were identified using published descriptions and comparative material held by the Tasmanian Museum and Art Gallery. All specimens were identified to the lowest taxonomic level possible (usually species for mammals, but rarely past order for reptiles and birds). Bones and teeth were also assessed for quality of preservation, burning, breakage, taxonomy, species activity schedule, species body mass and ecological characteristics (see Appendix S1). The number of identified specimens (NISP) was calculated for each species, then converted to relative abundance (Ri%) and ecological guild abundance (i.e. species that use resources or habitats in similar ways) to facilitate comparisons between samples (see McDowell et al., 2012, 2015; McDowell, Eberhard, et al., 2022). Species were grouped into habitat guilds (see Appendix S1; Figure 3), plotted on a linear timescale and overlain with palaeotemperature records derived from oxygen isotopic ratios measured from the Vostok ice core (Jouzel et al., 1987, 1993, 1996). This was done to investigate temporal trends relative to environmental conditions and climate change.

Diagnostic bones were dominated by mammals, though bird, frog and reptile bones were also excavated (Tables 1 and 2). Compared with mammals, bird and reptile bones have fewer diagnostic features, making them more difficult to identify beyond family. Because birds and reptiles were rarely identified to species, richness, relative and guild abundance and temporal trends are based on mammals only.

2.4 | Taphonomy

When bones are found to be concentrated in cave sediments, a predator is often responsible. Each predator accumulates a uniquely biased sample of the community it preyed upon. Prey characteristics can therefore be used to identify the predator. An investigation of Cloggs Cave's taphonomy can tell us a lot about the agent of bone accumulation. Here we assess bone breakage, preservation, degree of burning, prey species activity schedule and prey species body size. Animal body size was divided into three categories, small = <1 kg, medium-sized = 1–5 kg and large = >5 kg animals, to help understand how the fauna, or their remains, may have entered the cave (see Appendix S1 for details).

3 | RESULTS

3.1 | Species composition

The fauna recovered from Square R31 is dominated by small mammals and, despite being very close to a permanent watercourse, lacks mussel shells. We note that there are numerous mussel shells brought by Aboriginal people hundreds and thousands of years ago in the rockshelter outside the cave, but there are none in the cave deposit. While the volume of each XU making up the Square R31 excavation is small, the number of specimens yielded is fairly large. McDowell identified 4886 diagnostic specimens that represent at least 31 taxa (one echidna; five carnivorous marsupials; at least two bandicoots; two pygmy possums; one sugar glider; one feathertail glider; one ringtail possum; one potoroo; one extant long-faced kangaroo; one extinct short-faced kangaroo; nine rodents; at least one insectivorous bat; at least two frogs; at least three lizards and several unidentified birds; Tables 1 and 2). The vast majority of bones identified to genus and/or species (97.4%) consist of nocturnal mammals that have a maximum body mass of 200 g or less. Species with a maximum body mass that exceeds 900 g were predominantly represented by juveniles. Two murid rodents encountered during this research (*Pseudomys higginsi*, Long-tailed Mouse; and *P. fumeus*, Smoky Mouse) proved difficult to differentiate. Some *P. higginsi* specimens were identified with confidence, but the majority of specimens were identified as undifferentiated *P. fumeus/higginsi*. Both species occupy open forest with dense heath to grassy understorey and have similar dietary preferences that include seeds, fruits and hypogeal fungi (Van Dyck & Strahan, 2008; Walton, 1988). Consequently, for the purposes of this paper we combine specimens attributed to these two species during analysis.

3.2 | Taphonomy

The concentrated nature of the bone deposit indicates that predators were involved, rather than autochthonous deaths. While

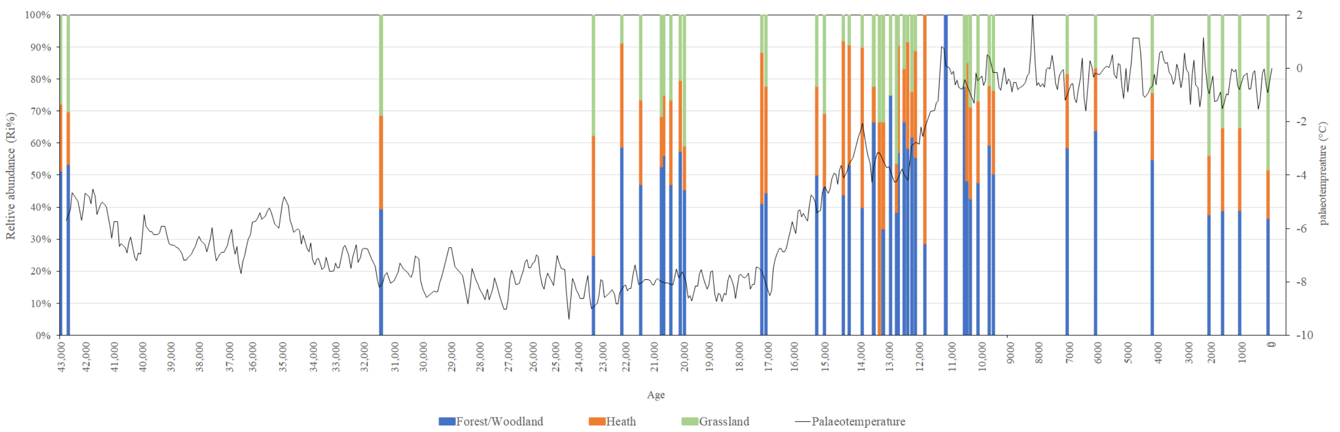

FIGURE 3 Relative abundance of mammal species (combined into habitat guilds) recovered from Cloggs Cave Square R31 excavation units. Stacked columns show how changes in guild relative abundance relate to palaeotemperature (black line).

TABLE 1 Number of identified specimens (NISP) by species, Cloggs Cave Square R31.

Scientific name	Common name	Grouped stratigraphic units (SUs)								
		SU4V-5A	SU4U	SU4Q-4S	SUL4-4P	SU4I-4 L	SU4D-4H	SU4A-4C	SU2	SU1
Tachyglossus aculeatus	Short-beaked Echidna	1								
Dasyurus viverrinus	Eastern Quoll	24	2		6	2	76	19	5	
Antechinus minimus	Swamp Antechinus	24	2	5	19		28	20	9	
Antechinus swainsonii	Dusky Antechinus	18	2	9	23	3	64	32	3	
Antechinus sp. indet.	Unknown Antechinus							1		
Phascogale tapoatafa	Brush-tailed Phascogale	6	2	1	1	1	7	2		
Sminthopsis leucopus	White-footed Dunnart								3	
Sminthopsis sp. indet.	Uknown Dunnart	2					40	60	82	8
Isoodon obesulus	Southern Brown Bandicoot						3	8		
Perameles sp. indet.	Unknown Barred Bandicoot	6	1	3			16	20	2	
Peramelidae sp. indet.	Unknown Bandicoot	33			11	1	26	22	4	1
Cercartetus nanus	Eastern pygmy Possum	1					1	3	2	
Petaurus breviceps	Sugar Glider	6		1	2	2	4	15	13	1
Pseudocheirus peregrinus	Common ringtail Possum	1					8	2	2	
Acrobates pygmaeus	Feather-tailed Glider	3					1			
Potorous cf. *tridactylus*	Long-nosed Potoroo								1	
Potoridae sp. indet.	Unknown Potoroo						4	2		
Notamacropus rufogriseus	Red-necked Wallaby				1					
Macropus sp. indet.	Unknown Macropodid kangaroo	5								
Macropodidae sp. indet.	Unknown long-faced kangaroo	1								
Procoptodon gilli	Short-faced kangaroo (extinct)	2			1		33	14	9	
Conilurus albipes	White-footed Rabbit-rat	2								
Hydromys chrysogaster	Water Rat	174	13	9	16	2	346	176	104	7
Mastacomys fuscus	Broad-toothed Mouse	216	8	20	55	3	150	30		2
Pseudomys cf. *fumeus/higginsi*	Smoky or Long-tailed Mouse	25	2		5	1	10	11	58	6
Pseudomys cf. *gracilicauatus*	Eastern chestnut Mouse	3					16	5	8	1
Pseudomys higginsi	Long-tailed Mouse	3	1				7	1		

(Continues)

TABLE 1 (Continued)

Scientific name	Common name	Grouped stratigraphic units (SUs)								
		SU4V-5A	SU4U	SU4Q-4S	SUL4-4P	SU4I-4 L	SU4D-4H	SU4A-4C	SU2	SU1
Pseudomys novaehollandiae	New Holland Mouse	24	1		17		448	351	42	8
Pseudomys cf. *oralis*	Hastings River Mouse	84	6	11	27		121	49	80	
Pseudomys sp. indet.	Unknown false mouse	1					159	93	53	8
Rattus fuscipes	Bush Rat	83	5	7	27	6	331	147	70	8
Rattus lutreolus	Swamp Rat	3			2		2	1	4	
Chiroptera sp. indet.	Unknown bat	1					1			
Agamidae sp. indet.	Unknown dragon	1		1			1		2	
Scincidae sp. indet.	Unknown skink								1	1
Varanus sp. indet.	Unknown goanna	12	1				39	73	24	
Anura sp. indet.	Unknown frog							1		
Aves spp. indet.	Unknown birds (more than one)	3					11	13	15	
Total NISP		768	46	67	213	21	1953	1171	596	51

most bones came from nocturnal small mammals, the agents of accumulation caused little mechanical or digestive damage to the bones of their prey. Although the remains of the Eastern Quoll *Dasyurus viverrinus* were found in the assemblage, there is no evidence of mastication by mammalian predators. Few of the mammals identified are considered human food species. Body size analysis shows that small mammals (<1 kg) occur in every XU, but larger animal (>1 kg) remains are rare. The rare instances of bones from medium-sized and large animals are usually represented by juveniles. In contrast, small mammal bones are abundant. Figure 4 shows a complete murid skull photographed in situ in the exposed stratified section c. 1.5 m from Square R31. The various bones in this murid skull and many others like it excavated from Square R31 remain articulated and intact. Along with the presence of abundant small and often whole mammal bones in discrete stratigraphic layers, their presence in near-laminar strata demonstrates the chronostratigraphic integrity of the bone assemblage. Almost all bones are well-preserved but brittle, but with some breakage. Almost all of the breaks observed are fresh, suggesting they occurred during excavation or transport of the excavated deposit. Furthermore, none of the bones examined show evidence of cut marks, deliberate breakage, crushing/chewing or digestion. Almost all bones are burnt but very few are burnt past black. Square R31's stratigraphy includes numerous ash layers from deliberately lit fires in the cave, especially in the upper layers (SU2A–SU2D) dating to 1460–3360 cal BP. Most of these fires burnt to ash indicating that the material burnt was not substantial enough to produce macrocharcoal, nor enough heat to prepare meat foods. Two to 2.5 m away in Square P35, the ash layers continue unabated. Here the fires had burnt around a standing stone, indicating ritual activities (for details, see David, Fresløv, Mullett, Delannoy, et al., 2021; David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al., 2021; Mialanes et al., in press).

4 | DISCUSSION

4.1 | Taphonomy

Masked Owl's almost exclusively prey on small terrestrial and scansorial mammals that mostly weigh 25–125 g (Kavanagh, 2002). In contrast, Sooty Owls prey on a much wider range of species, encompassing arboreal, terrestrial and scansorial mammals weighing 25–900 g including species that exceed their own body weights (Kavanagh, 2002). As 97.4% of the Cloggs Cave assemblage was comprised of mammals with an adult body weight of 200 g or less, and prey with an adult body weight of 900 g were rare and predominantly represented by juveniles, the Cloggs Cave assemblage was most likely accumulated by Masked Owls.

While Cloggs Cave was clearly used by the Old Ancestors, few of the excavated bones were from large mammals (e.g. kangaroos) and none appear to have been processed as food. In contrast, Flood (1973) reported copious amounts of bone from food

TABLE 2 Relative abundance (Ri%) by species, Cloggs Cave Square R31.

		Grouped stratigraphic units (SUs)								
Common name	Scientific name	SU4V-5A	SU4U	SU4Q-4S	SUL4-4P	SU4I-4 L	SU4D-4H	SU4A-4C	SU2	SU1
Short-beaked Echidna	*Tachyglossus aculeatus*	0.13								
Eastern Quoll	*Dasyurus viverrinus*	3.13	4.35		2.82	9.52	3.89	1.62	0.84	
Swamp Antechinus	*Antechinus minimus*	3.13	4.35	7.46	8.92		1.43	1.71	1.51	
Dusky Antechinus	*Antechinus swainsonii*	2.34	4.35	13.43	10.80	14.29	3.28	2.73	0.50	
Unknown Antechinus	*Antechinus* sp. indet.							0.09		
Brush-tailed Phascogale	*Phascogale tapoatafa*	0.78	4.35	1.49	0.47	4.76	0.36	0.17		
White-footed Dunnart	*Sminthopsis leucopus*								0.50	
Uknown Dunnart	*Sminthopsis* sp. indet.	0.26					2.05	5.12	13.76	15.69
Southern Brown Bandicoot	*Isoodon obesulus*						0.15	0.68		
Unknown Barred Bandicoot	*Perameles* sp. indet.	0.78	2.17	4.48			0.82	1.71	0.34	
Unknown Bandicoot	Peramelidae sp. indet.	4.30			5.16	4.76	1.33	1.88	0.67	1.96
Eastern pygmy Possum	*Cercartetus nanus*	0.13					0.05	0.26	0.34	
Sugar Glider	*Petaurus breviceps*	0.78		1.49	0.94	9.52	0.20	1.28	2.18	1.96
Common ringtail Possum	*Pseudocheirus peregrinus*	0.13					0.41	0.17	0.34	
Feather-tailed Glider	*Acrobates pygmaeus*	0.39					0.05			
Long-nosed Potoroo	*Potorous* cf. *tridactylus*								0.17	
Unknown Potoroo	Potoridae sp. indet.						0.20	0.17		
Red-necked Wallaby	*Notamacropus rufogriseus*				0.47					
Unknown Macropodid kangaroo	*Macropus* sp. indet.	0.65								
Unknown long-faced kangaroo	Macropodidae sp. indet.	0.13								
Short-faced kangaroo (extinct)	*Procoptodon gilli*	0.26			0.47		1.69	1.20	1.51	
White-footed Rabbit-rat	*Conilurus albipes*	0.26								
Water Rat	*Hydromys chrysogaster*	22.66	28.26	13.43	7.51	9.52	17.72	15.03	17.45	13.73
Broad-toothed Mouse	*Mastacomys fuscus*	28.13	17.39	29.85	25.82	14.29	7.68	2.56		3.92
Smoky or Long-tailed Mouse	*Pseudomys* cf. *fumeus/ higginsi*	3.26	4.35		2.35	4.76	0.51	0.94	9.73	11.76
Eastern chestnut Mouse	*Pseudomys* cf. *gracilicauatus*	0.39					0.82	0.43	1.34	1.96
Long-tailed Mouse	*Pseudomys higginsi*	0.39	2.17				0.36	0.09		

(Continues)

TABLE 2 (Continued)

Common name	Scientific name	Grouped stratigraphic units (SUs) SU4V-5A	SU4U	SU4Q-4S	SUL4-4P	SU4I-4 L	SU4D-4H	SU4A-4C	SU2	SU1
New Holland Mouse	*Pseudomys novaehollandiae*	3.13	2.17		7.98		22.94	29.97	7.05	15.69
Hastings River Mouse	*Pseudomys* cf. *oralis*	10.94	13.04	16.42	12.68		6.20	4.18	13.42	
Unknown false mouse	*Pseudomys* sp. indet.	0.13					8.14	7.94	8.89	15.69
Bush Rat	*Rattus fuscipes*	10.81	10.87	10.45	12.68	28.57	16.95	12.55	11.74	15.69
Swamp Rat	*Rattus lutreolus*	0.39			0.94		0.10	0.09	0.67	
Unknown bat	*Chiroptera* sp. indet.	0.13					0.05			
Unknown dragon	Agamidae sp. indet.	0.13		1.49			0.05		0.34	
Unknown skink	Scincidae sp. indet.								0.17	1.96
Unknown goanna	*Varanus* sp. indet.	1.56	2.17				2.00	6.23	4.03	
Unknown frog	*Anura* sp. indet.							0.09		
Unknown birds (more than one)	Aves spp. indet.	0.39					0.56	1.11	2.52	
	Total Ri%	100	100	100	100	100	100	100	100	100

FIGURE 4 An in situ complete murid skull together with abundant small mammal bones in a discrete stratigraphic layer exposed at Cloggs Cave near square R31.

remains in the rockshelter area and entrance passage (see Delannoy et al., 2020, p. 11) outside the cave, indicating that the open area in front of the cave was an important occupation site, in contrast to the cave that was not used for animal food preparation or consumption.

Bones from the upper layers of Square R31 have been subjected to repetitive low-temperature burning, a process that can only be attributed to people. Bones excavated from the upper 23 XUs were consistently burnt brown-black (350–400°C) (Marques et al., 2018), but very few were burnt grey or calcined. This indicates that bones were rarely subjected to the higher temperatures (600–800°C) that are usually achieved in hearths used for cooking meat. These findings are consistent with Hope's (1973) observations based on material excavated by Flood in 1971–1972.

4.2 | Fauna

Some of the species recovered from Square R31 show strong trends of species abundance change over time (Figure 5). *Pseudomys fumeus*/*P. higginsi*, and to a lesser extent, *A. swainsonii* (Dusky Antechinus) became less abundant through time. *P. novaehollandiae* (New Holland Mouse) was initially present in low numbers (SU4U–SU5A, dating within 24,070–48,470 cal BP), followed by a period of absence (SU4M–SU4U, dating within 16,770–25,740 cal BP). Its abundance then rose dramatically (SU4A–SU4M, dating within 5310–18,970 cal BP) to contribute more than 30 Ri% but then fell to 10 Ri% (SU2–SU4C, dating within 1460–11,580 cal BP). *Sminthopsis* sp. cf. *S. leucopus* (White-footed Dunnart) increases slightly in abundance over time (SU2–SU4H, dating within 1460–15,960 cal BP). *Rattus fuscipes* (Bush Rat), *R. lutreolus* (Swamp Rat) and *P. oralis* (Hastings River Mouse) were stochastically present or absent in low numbers initially (SU4M–SU5A, dating within 16,770–48,470 cal BP), but increased in abundance towards present (SU2–SU4P, dating within 1460–23,450 cal BP; Figure 5b). *Mastacomys fuscus* (Broad-toothed Mouse) was abundant in SU4U–SU5A which accumulated within 24,070–48,470 cal BP just before the Last Glacial Maximum

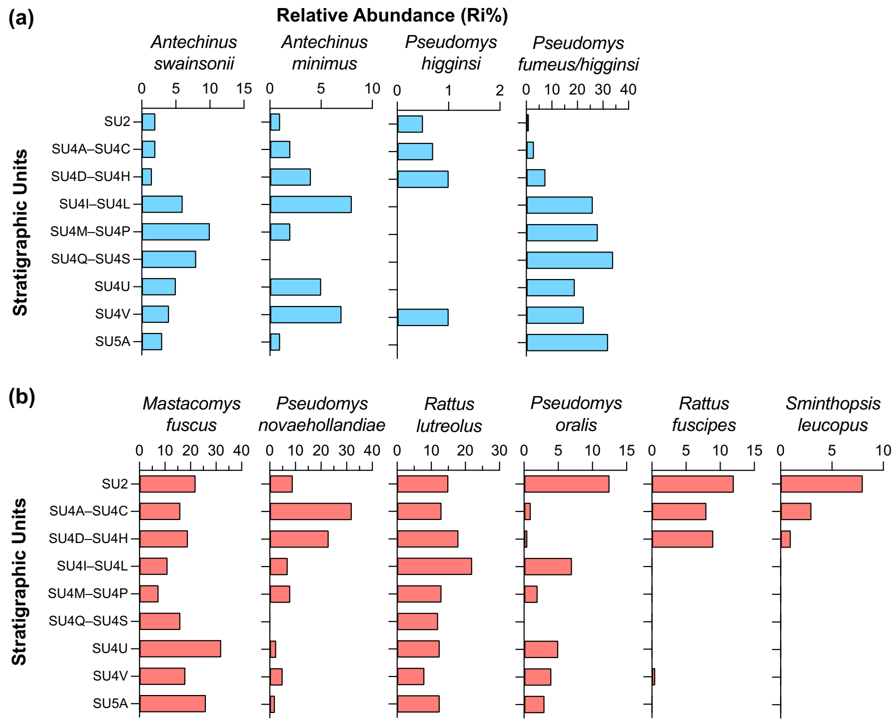

FIGURE 5 Cloggs Cave Square R31 species abundance through time. (a) Species that become less abundant in the Holocene. (b) Species that become more abundant in the Holocene. Ri% for *Sminthopsis* spp. was derived by adding the Ri% of *Sminthopsis leucopus* and indeterminate *Sminthopsis* sp.

(peak of the last Ice Age), but became less common in SU4M–SU4P, dating within 16,770–23,450 cal BP. It then increases in relative abundance from the end of the peak of the last Ice Age, or end of the last glacial maximum (LGM), to the top of the excavation, dating to c. 1460 cal BP.

Pseudomys higginsi (long-tailed mouse) is presently restricted to Tasmania. It has been collected from several fossil assemblages on mainland Australia, such as Wombeyan Caves in NSW (Hope, 1982), Pyramids Cave in eastern Victoria (Wakefield, 1972b) and Mitchell River National Park also in eastern Victoria (Roberts et al., 2020) and King and Flinders Islands in Bass Strait (Driessen & Rose, 1999) and Kangaroo Island (McDowell, 2013; McDowell et al., 2015). On the southeastern Australian mainland, it was previously thought that *P. higginsi* became extinct in the Late Pleistocene (e.g. Theden-Ringl et al., 2020; Wakefield, 1972a). Unfortunately, these fossil assemblages are poorly dated and *P. higginsi* is difficult to separate from *P. fumeus*, making it difficult to assess when and why *P. higginsi* became extinct on mainland Australia. Nevertheless, recent archaeological excavations at Wangangarra 1 rockshelter, and now Cloggs Cave, both in GunaiKurnai Country, have revealed their bones in Middle to Late Holocene contexts. Therefore, *P. higginsi* may have survived on mainland Australia until much later than previously thought.

Pseudomys higginsi prefers cool temperate rainforest, wet sclerophyll forest, wet scrub and alpine boulder fields/scree slopes (Van Dyck & Strahan, 2008). In contrast, *M. fuscus* prefers grassland. For many thousands of years in the past, *M. fuscus* was more widespread than today, but is thought to have retreated to higher altitudes as Holocene global warming intensified (Green, 2002; Green et al., 2008; Woinarski et al., 2014). If *P. higginsi* still occupied the region, it too would have retreated to higher altitudes, only to face elevated competition with *M. fuscus* and other native mammals. The minimum body weight of *M. fuscus* (97–145 g; see Appendix S1) exceeds the maximum body weight of *P. higginsi* (50–90 g; see Appendix S1). Therefore, interspecies confrontations would almost certainly have resulted in the demise of *P. higginsi*, driving it to local extinction, perhaps hundreds of years prior to the arrival of Europeans.

4.3 | Megafauna

A single adult premolar of *Procoptodon gilli*, the smallest of the short-faced kangaroos, was found in XU50 at the SU4V–SU5A interface, in the mixed sediments dating to 24,760–48,470 cal BP. This represents the third megafauna species recovered from Cloggs Cave. The tooth had no dental wear and lacked roots, indicating it had not yet erupted and was still developing inside the 'crypt' when the animal it originated from died. Finding an isolated tooth at this stage of development indicates the parent skull had experienced high energy transport and was broken, releasing the tooth. This is consistent with both the condition of the tooth and features of the mixed layer it was recovered from.

4.4 | Habitat guilds

To aid interpretation of faunal change over time, species were combined based on their habitat guilds (see Appendix S1), then presented in 100% stacked columns on a linear time-scale (Figure 3). We expected grassland and perhaps heath-dwelling species to dominate sedimentary layers deposited prior to and during the LGM. We then expected to see grassland species get largely replaced by woodland/forest species as climate warmed after the last Ice Age (see McDowell, David, et al., 2022). The fauna preserved in Cloggs Cave did not conform to that model. Instead, forest/woodland species make up 25%–75% (excluding XU13, where forest/woodland species make up 100%) of species recovered from every SU of the assemblage prior to and including the LGM, when global temperatures were substantially lower than today. Surprisingly, the abundance of grassland species increased in layers deposited during the Late Holocene, contributing almost 50 Ri% of the assemblage, at a time when woodland/forest species would be expected to dominate the landscape.

In fact, it suggests that each guild was more or less present during deposition of every SU, even though deposition occurred during the transition from the cool dry glacial conditions of the LGM (peak of the last Ice Age), to the relatively warm and humid interglacial conditions that followed in the Early Holocene (Barrows et al., 2002; Byrne, 2008). These findings are consistent with those of Hope (1973), who, from the 1971–1972 excavations, found no change in Cloggs Cave's fauna over time. Instead, Cloggs Cave's heterogeneous fauna suggests grassland, heath and woodland/forest habitats were largely or constantly present over the past 25,640 to 1460 cal BP, a period of time known to include the LGM as well as the subsequent period of rapid global warming (see McDowell, 2013; McDowell, David, et al., 2022). This suggests that the vegetation surrounding Cloggs Cave was unusually varied and persistent. These results can be explained by three potential scenarios: (1) the fossil assemblage may have been reworked (i.e. mixed); (2) the complex geomorphology of the region surrounding the cave supported a diverse range of vegetation types over which owls could hunt; (3) the diverse range of vegetation types fostered by the region's complex geomorphology surrounding Cloggs Cave was persistently managed by the Old Ancestors to maintain a mosaic of vegetation patches over which owls could hunt. We cannot determine which of Scenarios 2 or 3 applies to our study, because both scenarios result in comparable bone assemblages. However, the expansion of grassland during the Middle Holocene (beginning at the SU2E–SU2F interface) cannot be easily explained except through anthropic landscape management of the surrounding region by the Old Ancestors.

David, Fresløv, Mullett, GunaiKurnai Land and Waters Aboriginal Corporation, et al. (2021), David, Arnold, et al. (2021) and Mialanes et al. (in press) demonstrated great chronostratigraphic integrity of the Square R31 sequence at Cloggs Cave, except for the deepest excavated layer (SU5A) dating to 25,640–48,470 cal BP. Scenario 1 can therefore be dismissed for the past c. 25,640 years. Much of the vegetation immediately surrounding Cloggs Cave has been cleared for grazing since the mid to late 1800s (see Figure 2a), but even within a few hundred metres of the cave the relic woodlands/forests remain. Cloggs Cave is also <5 km west of the southern boundary of the Snowy River National Park, which preserves 20 different vegetation communities. These include Snow Gum woodlands, Ash and Manna Gum forests, heathlands and native grasslands (see https://theaustralianalpsnationalparks.org/the-alps-partnership/the-parks/snowy-river-national-park/#nature, accessed 6 September 2021). As the vegetation types preferred by each habitat guild represented at Cloggs Cave occur close to the Cave today and were probably also present in the past, Scenarios 2 and 3 are both plausible, implying that the generations of owls responsible for accumulating the Square R31 assemblage were able to hunt over a range of habitats. This does not definitively confirm or refute vegetation management by patchwork burning, also known as 'firestick farming' (Jones, 1969), by the Old Ancestors, but it does confirm that a patchwork of vegetation communities occurred within the home range of the owl species that accumulated the Square R31 assemblage. The most logical explanation to account for the unexpected range of prey species habitat preferences would indeed be a patchwork landscape, and its persistence over very long periods of time, and cutting across periods of climate change, suggests that it was repeatedly managed by the Old Ancestors. It is ethnographically well known that Aboriginal peoples across Australia used, and in some parts of Australia continue to use, cool fires to manage vegetation communities, indicating that the entire Australian landscape is an artefact of a very long history of Aboriginal and Torres Strait Islander management policies, strategies and practices.

The largest home range reported for the Masked Owl is 2000 ha (Minimum Convex Polygon estimates), or 2500 ha (Kernel Estimator method; Young et al., 2020), which implies a hunting radius of 2.5–2.8 km. A Masked owls roost is not necessarily in the centre of its home range, nor should we assume an owl's home range is circular. Masked owls are known to hunt both on the perch and on the wing, and frequently hunt at forest edges, small forest patches, riparian zones along watercourses and drainage lines in open pasture (Cooke et al., 2006; Debus, 1993; Kavanagh & Murray, 1996; Young et al., 2020). This led McNabb et al. (2003) to describe them as intrinsic edge-hunters. It is therefore logical that they would take prey from forest–grassland ecotones (i.e. from the edge of the two habitats), resulting in a fossil assemblage with a mixed habitat signal.

5 | CONCLUSION

We began this study at the request of GunaiKurnai Land and Waters Aboriginal Corporation who wanted to better understand the history preserved at Cloggs Cave, including what the faunal remains could teach us about how the cave was used by the Old Ancestors and what the environmental conditions of the landscape outside the cave were like when the animal bones were deposited. We asked three questions of the faunal deposits:

1. Is there any archaeological evidence of people having brought or processed animals in the cave?
2. What can the recently excavated animal bones from Cloggs Cave tell us about local and regional faunal distributions in the past?
3. What can the bone deposit tell us about the site and its landscape over time?

The faunal remains recovered from Cloggs Cave were, for the most part, in excellent chrono-stratigraphic order. Each XU and SU has fine-grained chronological resolution and the absolute and relative age of each XU and SU is well understood. It is therefore of great interest to find that even though the faunal remains excavated from Square R31 were evidently in situ, the ecology of the animal remains recovered does not simply reflect the temporal pattern of known major climatic conditions including the LGM (see Figure 3). If *site-based* patterns of faunal change do not conform well to known *global* climate change events such as the LGM and are known to be in situ, other factors that control species community composition must be in effect. The most parsimonious way to achieve a highly diverse fauna within c. 2.8 km of Cloggs Cave is to maintain a mosaic of habitats that support a diverse range of species from diverse habitat guilds.

While the maintenance of a range of short-spaced habitats may be partly driven by the region's complex geomorphology, this would provide refugia at best and should still be largely controlled by climate change. Therefore, the active management of Country by the Old Ancestors since at least 2130–7290 cal BP that includes the SU2E–SU2F interface is implied by the Cloggs Cave faunal guild record. The presence of a patchwork of habitats for the entire period covered by the Cloggs Cave Square R31 sequence suggests that such active management of Country may well have had an even much longer history going back to pre-LGM times.

The vast majority of animal remains recovered from the Cloggs Cave Square R31 faunal assemblage indicate that masked owls were the primary agents of accumulation. We found little to no evidence that people were using Cloggs Cave as an animal-processing site. Our excavation yielded very few large animal bones that might provide evidence of carcass processing. The animal remains recovered from the Square R31 assemblage indicate that past local and regional faunal distributions were highly diverse and changed very little through time, to the point that active management was probably required to maintain the diverse range of habitats that defied global climate change events. The R31 bone assemblage tells us that the regional geomorphology and biogeography preserved numerous microhabitats that provided refuge to a range of species that would not otherwise have been able to persist over time.

In respect to undertaking research in and on cultural landscapes—and here we note that all landscapes are cultural, so the term 'cultural landscape' is somewhat tautologic, and is here used to emphasise the point—it seems self-evident that where respectful partnerships based on equitable power relations have been established, and where such research has been deemed socially and culturally acceptable by, and even better, of interest and value to Traditional Owners of sites and Country, new knowledge that can variably benefit everyone—local community land managers and Healthy Country programs, academic curiosity, educational programs, biodiversity conservation practices—can be achieved. Under such a research partnership, the findings of the faunal analyses at Cloggs Cave have indeed developed considerable new knowledge that may not have been synthesised without the establishment of such a respectful and culturally collaborative partnership.

AUTHOR CONTRIBUTIONS

Matthew C. McDowell, Bruno David, Russell Mullett, Joanna Fresløv, GunaiKurnai Land and Waters Aboriginal Corporation, Jean-Jacques Delannoy, Jerome Mialanes, Cath Thomas, Jeremy Ash; Joe Crouch; Fiona Petchey, Jessie Buettel and Lee J. Arnold co-wrote the paper; The GunaiKurnai Land and Waters Aboriginal Corporation initiated and oversaw the research and are the Traditional Owners of Cloggs Cave; Bruno David, Russell Mullett, Joanna Fresløv, Jean-Jacques Delannoy, Jerome Mialanes, Cath Thomas, Jeremy Ash; Joe Crouch and Lee J. Arnold conducted fieldwork and collected samples at the site; Matthew C. McDowell identified the animal bones excavated from the site and used them to interpret environmental conditions around the site through time; Lee J. Arnold conducted OSL dating on sediments from the site; Jean-Jacques Delannoy undertook geomorphological research and cartography at the site; Fiona Petchey conducted 14C dating of samples from the site.

ACKNOWLEDGEMENTS

Thank you to the GunaiKurnai Elders Council; Jess Shapiro of GKLaWAC for assisting with this paper; the Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage (project CE170100015) for funding; the School of Natural Sciences at the University of Tasmania, the Monash Indigenous Studies Centre at Monash University, and EDYTEM at the Université Savoie Mont Blanc for research support; and Martin and Vicky Hanman of Buchan for assistance. Thank you also to Tim Ziegler, Collection Manager, Vertebrate Palaeontology, at Museums Victoria.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data deposited in the Dryad Digital Repository https://doi.org/10.5061/dryad.kh1893298 (McDowell, David, et al., 2022).

ORCID

Matthew C. McDowell https://orcid.org/0000-0001-8009-4171
Bruno David https://orcid.org/0000-0002-8567-6135
Jean-Jacques Delannoy https://orcid.org/0000-0002-2815-4920
Jerome Mialanes https://orcid.org/0000-0002-6790-7542
Cath Thomas https://orcid.org/0000-0002-6320-9923
Jeremy Ash https://orcid.org/0000-0003-0306-6307
Joe Crouch https://orcid.org/0000-0003-2825-0370
Fiona Petchey https://orcid.org/0000-0002-3308-9983
Jessie Buettel https://orcid.org/0000-0001-6737-7468
Lee J. Arnold https://orcid.org/0000-0001-9603-3824

REFERENCES

Barrows, T. T., Stone, J. O., Fifield, L. K., & Cresswell, R. G. (2002). The timing of the last glacial maximum in Australia. *Quaternary Science Reviews*, *21*, 159–173.

Bradley, J., with Yanyuwa Families. (2010). *Singing saltwater country: Journey to the songlines of Carpentaria*. Allen & Unwin.

Byrne, M. (2008). Evidence for multiple refugia at different time scales during Pleistocene climatic oscillations in southern Australia inferred from phylogeography. *Quaternary Science Reviews*, *27*, 2576–2585.

Cooke, R., Wallis, R., Hogan, F., White, J., & Webster, A. (2006). The diet of powerful owls (*Ninox strenua*) and prey availability in a continuum of habitats from disturbed urban fringe to protected forest environments in South-Eastern Australia. *Wildlife Research*, *33*, 199–206.

David, B., Arnold, L. J., Delannoy, J.-J., Fresløv, J., Urwin, C., Petchey, F., McDowell, M. C., Mullett, R., GunaiKurnai Land and Waters Aboriginal Corporation, Mialanes, J., Wood, R., Crouch, J., Berthet, J., Wong, V. N. L., Green, H., & Hellstrom, J. (2021). Late survival of megafauna refuted for Cloggs Cave, SE Australia: Implications for the Australian Late Pleistocene megafauna extinction debate. *Quaternary Science Reviews*, *253*, 106781.

David, B., Fresløv, J., Mullett, R., Delannoy, J.-J., Petchey, F., GunaiKurnai Land and Waters Aboriginal Corporation, Mialanes, J., Russell, L., Wood, R., Arnold, L., McDowell, M., Berthet, J., Fullagar, R., Wong, V. N. L., Green, H., Urwin, C., Metz, L., Crouch, J., & Ash, J. (2021). Paradigm shifts and ontological turns at Cloggs Cave, Gunaikurnai Country, Australia. In O. Moro Abadia & M. Poor (Eds.), *Ontologies of rock art: Images, relational approaches and indigenous knowledge* (pp. 135–160). Routledge.

David, D., Fresløv, J., Mullett, R., GunaiKurnai Land and Waters Aboriginal Corporation, Delannoy, J.-J., McDowell, M., Urwin, C., Mialanes, J., Petchey, F., Wood, R., Arnold, L. J., Stephenson, B., Fullagar, R., Crouch, J., Ash, J., Berthet, J., Wong, V. N. L., & Green, H. (2021). 50 years and worlds apart: Rethinking the early Holocene abandonment of Cloggs Cave (East Gippsland, SE Australia) five decades after its initial archaeological excavation and in light of GunaiKurnai world views. *Australian Archaeology*, *87*(1), 1–20.

Debus, S. J. S. (1993). The mainland masked owl *Tyto novaehollandiae*: A review. *Australian Bird Watcher*, *15*, 168–191.

Delannoy, J.-J., David, B., Fresløv, J., Mullett, R., GunaiKurnai Land and Waters Aboriginal Corporation, Green, H., Berthet, J., Petchey, F., Arnold, L. J., Wood, R., McDowell, M., Crouch, J., Mialanes, J., Ash, J., & Wong, V. N. L. (2020). Geomorphological context and formation history of Cloggs Cave: What was the cave like when people inhabited it? *Journal of Archaeological Science: Reports*, *33*, 102461.

Descola, P. (2013). *Beyond nature and culture*. The University of Chicago Press.

Driessen, M. M., & Rose, R. K. (1999). *Pseudomys higginsi*. *Mammalian Species*, *623*, 1–5.

Dufty, A. C. (1994). Habitat and spatial requirements of the Eastern Barred Bandicoot (*Perameles gunnii*) at Hamilton, Victoria. *Wildlife Research*, *21*, 459–472.

Flood, J. (1973). *The moth hunters: Investigations towards a prehistory of the south-eastern highlands of Australia* (Unpublished Ph.D. thesis). The Australian National University.

Flood, J. (1974). Pleistocene man at Cloggs Cave: His tool kit and environment. *Man*, *9*, 175–188.

Flood, J. (1980). *The moth hunters: Aboriginal prehistory of the Australian Alps*. Australian Institute of Aboriginal Studies.

Ford, F., Cockburn, A., & Broome, L. (2003). Habitat preference, diet and demography of the smoky mouse, *Pseudomys fumeus* (Rodentia: Muridae), in South-Eastern New South Wales. *Wildlife Research*, *30*, 89–110.

Green, K. (2002). Selective predation on the broad-toothed rat, *Mastacomys fuscus* (Rodentia: Muridae), by the introduced red fox, *Vulpes vulpes* (carnivora: Canidae), in the Snowy Mountains, Australia. *Austral Ecology*, *27*, 353–359.

Green, K., Stein, J. A., & Driessen, M. M. (2008). The projected distribution of *Mastacomys fuscus* and *Rattus lutreolus* in South-Eastern Australia under a scenario of climate change: Potential for increased competition? *Wildlife Research*, *35*, 113–119.

Helgen, K. M., Wells, R. T., Kear, B. P., Gerdtz, W. R., & Flannery, T. F. (2006). Ecological and evolutionary significant of sizes of giant extinct kangaroos. *Australian Journal of Zoology*, *54*, 293–303.

Holland, G. J., & Bennett, A. F. (2007). Occurrence of small mammals in a fragmented landscape: The role of vegetation heterogeneity. *Wildlife Research*, *34*, 387–397.

Hope, J. H. (1973). Appendix XIV: Analysis of bone from Cloggs Cave, Buchan, N.E. Victoria. In J. Flood (Ed.), *The moth hunters: Investigations towards a prehistory of the south-eastern highlands of Australia* (Unpublished Ph.D. thesis). The Australian National University.

Hope, J. H. (1982). Fossil vertebrates from Wombeyan Caves. *Sydney Speleological Society Occasional Paper*, *8*, 155–164.

Jones, R. (1969). Fire-stick farming. *Australian Natural History*, *16*(7), 224–228.

Jouzel, J., Barkov, N. I., Barnola, J. M., Bender, M., Chappellaz, J., Genthon, C., Kotlyakov, V. M., Lipenkov, V., Lorius, C., Petit, J. R., Raynaud, D., Raisbeck, G., Ritz, C., Sowers, T., Stievenard, M., Yiou, F., & Yiou, P. (1993). Extending the Vostok ice-core record of palaeoclimate to the penultimate glacial period. *Nature*, *364*, 407–412.

Jouzel, J., Lorius, C., Petit, J. R., Genthon, C., Barkov, N. I., Kotlyakov, V. M., & Petrov, V. M. (1987). Vostok ice core: A continuous isotope temperature record over the last climatic cycle (160,000 years). *Nature*, *329*, 403–408.

Jouzel, J., Waelbroeck, C., Malaize, B., Bender, M., Petit, J. R., Stievenard, M., Barkov, N. I., Barnola, J. M., King, T., Kotlyakov, V. M., Lipenkov, V., Lorius, C., Raynaud, D., Ritz, C., & Sowers, T. (1996). Climatic interpretation of the recently extended Vostok ice records. *Climate Dynamics*, *12*, 513–521.

Kavanagh, R. P. (2002). Comparative diets of the powerful owl (*Ninox strenua*), sooty owl (*Tyto tenebricosa*) and masked owl (*Tyto novaehollandiae*) in southeastern Australia. In I. Newton, R. P. Kavanagh, J. Olsen, & I. Taylor (Eds.), *Ecology and conservation of owls* (pp. 175–191). CSIRO Publishing.

Kavanagh, R. P., & Murray, M. (1996). Home range, habitat and behaviour of the masked owl *Tyto novaehollandiae* near Newcastle, New South Wales. *Emu*, *96*, 250–257.

Le Mar, K., & McAruthur, C. (2005). Comparison of habitat selection by two sympatric macropods, *Thylogale billardierii* and *Macropus rufogriseus* rufogriseus, in a patchy eucalyptus-forestry environment. *Austral Ecology*, *30*, 674–683.

Mallick, S. A., Hocking, G. J., & Driessen, M. M. (1997). Habitat requirements of the eastern barred bandicoot, *Perameles gunnii*, on agricultural land in Tasmania. *Wildlife Research*, *24*, 237–243.

Marques, M. P. M., Mamede, A. P., Vassalo, A. R., Makhoul, C., Cunha, E., Gonçalves, D., Parker, S. F., & Batista de Carvalho, L. A. E. (2018). Heat-induced bone diagenesis probed by vibrational spectroscopy. *Scientific Reports*, *8*(1), 15935.

McDowell, M. C. (2013). *Late quaternary faunal responses to environmental change and isolation on a large Australian land-bridge Island* (Unpublished Ph.D. thesis). Flinders University.

McDowell, M. C., Baynes, A., Medlin, G. C., & Prideaux, G. J. (2012). The impact of European colonization on the late-Holocene non-volant mammals of Yorke Peninsula, South Australia. *The Holocene*, *22*, 1441–1450.

McDowell, M. C., Eberhard, R., Smith, T. R., Wood, R., Brook, B. W., & Johnson, C. N. (2022). Climate change without extinction: Tasmania's small-mammal communities persisted through the Last

Glacial Maximum–Holocene transition. *Quaternary Science Reviews*, *291*. https://doi.org/10.1016/j.quascirev.2022.107659

McDowell, M. C., & Medlin, G. C. (2009). Mammal remains, including the white-footed rabbit-rat *Conilurus albipes*, from the Fleurieu Peninsula, South Australia. *The South Australian Naturalist*, *83*, 26–28.

McDowell, M. C., Prideaux, G. J., Walshe, K., Bertuch, F., & Jacobsen, G. E. (2015). Re-evaluating the Late Quaternary fossil mammal assemblage of Seton Rockshelter, Kangaroo Island, South Australia, including the evidence for late-surviving megafauna. *Journal of Quaternary Science*, *30*, 355–364.

McDowell, M. C., David, B., Mullett, R., Fresløv, J., GunaiKurnai Land and Waters Aboriginal Corporation, Delannoy, J.-J., Mialanes, J., Thomas, C., Ash, J., Crouch, J., Petchey, F., Buettel, J., & Arnold, L. J. (2022). Data from: Interpreting the mammal deposits of Cloggs Cave (SE Australia), GunaiKurnai Aboriginal Country, through community-led partnership research. *Dryad Digital Repository*, https://doi.org/10.5061/dryad.kh1893298

McNabb, E., McNabb, J., & Barker, K. (2003). Post-nesting home range, habitat use and diet of a female masked owl *Tyto novaehollandiae* in western Victoria. *Corella*, *27*, 109–117.

Mialanes, J., David, B., Stephenson, B., Fresløv, J., Mullett, R., GunaiKurnai Land and Waters Aboriginal Corporation, Metz, L., Delannoy, J.-J., Crouch, J., McDowell, M., Petchey, F., Green, H., & Ash, J. (in press). The *mulla-mullung*'s *bulk*: GunaiKurnai perspectives on the stone artefacts of Cloggs Cave, GunaiKurnai Country, southeastern Australia. In C. Smith (Ed.), *The Oxford handbook of global indigenous archaeologies*. Oxford University Press.

Morphy, H. (Ed.). (1989). *Animals into art*. Allen & Unwin.

Prideaux, G. J. (2004). Systematics and evolution of the sthenurine kangaroos. *University of California Publications in Geological Sciences*, *146*, i–xvii, 1–623.

Roberts, G. L., Mullett, R., David, B., Fresløv, J., GunaiKurnai Land and Waters Aboriginal Corporation, Mialanes, J., Petchey, F., McDowell, M., Wong, V. N. L., Szabó, K., Stoessel, D., Krusic-Golub, K., & Russell, L. (2020). Community research in a public place: Wangangarra 1 rockshelter, Mitchell River National Park, East Gippsland (Australia). *Australian Archaeology*, *86*, 176–197.

Short, A. D. (1988). The South Australia coast and Holocene Sea-level transgression. *Geographical Review*, *78*, 119–136.

Stephenson, B., David, B., Fresløv, J., GunaiKurnai Land and Waters Aboriginal Corporation, Arnold, L. J., Delannoy, J.-J., Petchey, F., Urwin, C., Wong, V. N. L., Fullagar, R., Green, H., Mialanes, J., McDowell, M., Wood, R., & Hellstrom, J. (2020). 2000 year-old Bogong moth (*Agrotis infusa*) aboriginal food remains, Australia. *Scientific Report*, *10*, 22151.

Taylor, L. (1996). *Seeing the inside: Bark paintings in western Arnhem Land*. Clarendon Press.

Theden-Ringl, F., Hope, G. S., Hislop, K. P., & Keaney, B. J. (2020). Characterizing environmental change and species' histories from stratified faunal records in southeastern Australia: A regional review and a case study for the early to middle Holocene. *Records of the Australian Museum*, *72*, 207–223.

Van Dyck, S., & Strahan, R. (Eds.). (2008). *The mammals of Australia*. Reed New Holland.

VandenBerg, A. H. M., Hendrickx, M. A., Willman, C. E., Magart, A. P. M., Oranskaia, A., Rooney, S., & White, A. J. R. (1996). *The geology and prospectivity of the Orbost 1:100,000 map area, eastern Victoria*. Victorian initiative for minerals and petroleum report 25. Department of Natural Resources and Environment.

Wakefield, N. A. (1972a). Studies in Australian Muridae: Review of *Mastacomys fuscus*, and description of a new subspecies of *Pseudomys higginsi*. *Memoirs of the National Museum of Victoria*, *33*, 15–31.

Wakefield, N. A. (1972b). Palaeoecology of fossil mammal assemblages from some Australian caves. *Proceedings of the Royal Society of Victoria*, *85*, 1–26.

Walton, D. W. (Ed.). (1988). *Zoological catalogue of Australia, volume 5: Mammalia*. Australian Government Printing Service.

Watts, C. H. S., & Aslin, H. J. (1981). *The rodents of Australia*. Angus & Robertson Publishers.

Woinarski, J., Burbidge, A., & Harrison, P. (2014). *Action plan for Australian mammals 2012*. CSIRO Publishing.

Young, D., Bell, P., & Mooney, N. (2020). Home-range, habitat use and diet of the Tasmanian masked owl '*Tyto novaehollandiae castanops*'. *Australian Field Ornithology*, *37*, 132–140.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: McDowell, M. C., David, B., Mullett, R., Fresløv, J.; GunaiKurnai Land and Waters Aboriginal Corporation, Delannoy, J.-J., Mialanes, J., Thomas, C., Ash, J., Crouch, J., Petchey, F., Buettel, J., & Arnold, L. J. (2022). Interpreting the mammal deposits of Cloggs Cave (SE Australia), GunaiKurnai Aboriginal Country, through community-led partnership research. *People and Nature*, *00*, 1–15. https://doi.org/10.1002/pan3.10410