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The mammalian fauna of Madura Cave, Western Australia. Part IX, the placental mammals

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ABSTRACT – Placental mammals, recovered in 1955 and 1964 from Madura Cave, N-62, on the Roe Plain in Western Australia, are described here. This material is late Pleistocene and early Holocene in age, based on C14 dates from bone and is part of a much larger fauna previously reported elsewhere. Rodents are the most abundant and diverse group of placental mammals within the Madura Cave fauna, represented by seven taxa including *Leporillus conditor*, *L. apicalis*, *Pseudomys bolami*, *P. gouldii*, *P. australis*, *Pseudomys* sp. cf. *desertor*, and *Notomys* sp. indet. Only two of these taxa are known from the Nullarbor region today and *Leporillus apicalis* is extinct. Bats are also present in the Madura Cave fauna with at least two taxa represented, including *Chalinolobus* sp. cf. *morio*. All specimens are dissociated and fragmentary, probably being derived from disintegrated owl pellets that were originally deposited near the mouth of the cave and then redeposited in the cave sediments during storms. The dingo *Canis familiaris* and rabbit *Oryctolagus cuniculus* are represented by single specimens found on the cave floor. The most significant change in composition of the entire mammalian fauna is recorded between the early Holocene and present day. Although increasing aridity from the late Pleistocene to early Holocene might have been a contributing factor, the dramatic decrease in mammal diversity in the Madura Cave fauna is most probably a result of European settlement and introduced predators.

KEYWORDS: Pleistocene, Holocene, rodents, bats, cave, Western Australia

INTRODUCTION

This report deals with specimens of placental mammals recovered from stratified deposits in Madura Cave, N-62, in Western Australia (Figure 1). Initial work in 1955, resulted in a brief description of the cave and demonstrated its potential for providing a detailed record of late Pleistocene through early Holocene faunal remains (Lundelius 1963). At that time, two stratigraphic units were recognised based on two excavated trenches (1 and 2). The extinct kangaroo, *Sthenurus,* was found in the oldest stratigraphic units in both trenches. Seven additional publications in this series, described the marsupial fossils collected in 1955 and 1964 (Lundelius and Turnbull 1973, 1975, 1978, 1981, 1982, 1984, and 1989). These papers documented 38 taxa representing 10 families of marsupials. The rodent *Leporillus* was reported separately (Lundelius and Turnbull 1999). An additional two genera of rodents, two taxa of bats, a single canid and a single lagomorph are reported here bringing the final mammalian faunal list from Madura Cave to 49 taxa.

Madura Cave is located on the Roe Plain (Figure 1), part of the Nullarbor physiographic region south of the Hampton Tableland. The boundary between the Hampton Tableland of the Nullarbor and the Roe Plain is a series of paleo-sea cliffs known as the Hampton Range (James et al. 2006). The Nullarbor region is an arid to semiarid scrubland with calcareous loamy soils. It averages approximately 200–250 mm of annual rainfall increasing southward toward the coast (Waddell et al. 2010).

Madura Cave formed by dissolution of Neogene limestone. The Northern Tunnel contains at least 2.75 metres of complexly stratified deposits primarily associated with roof collapse and ephemeral run-off into the cave from the main entrance (Lundelius and Turnbull 1973) (Figure 2). In addition to the main entrance, there is at least one sink-hole that connects the cave to the surface near Trench 4, but there is no debris cone underneath it. Lundelius excavated Trench 1 and 2 in 1955 and reported the results in Lundelius (1963). Trenches 3–5 were excavated in 1964. Neither murids nor bats were recovered from Trench 5, but *Leporillus conditor* was found in the upper units of that trench and discussed in Lundeliius and Turnbull (1999). The highest concentrations of murid and bat remains were in Trenches 3, 1, and 4 which are closest to the main entrance (Figure 3).

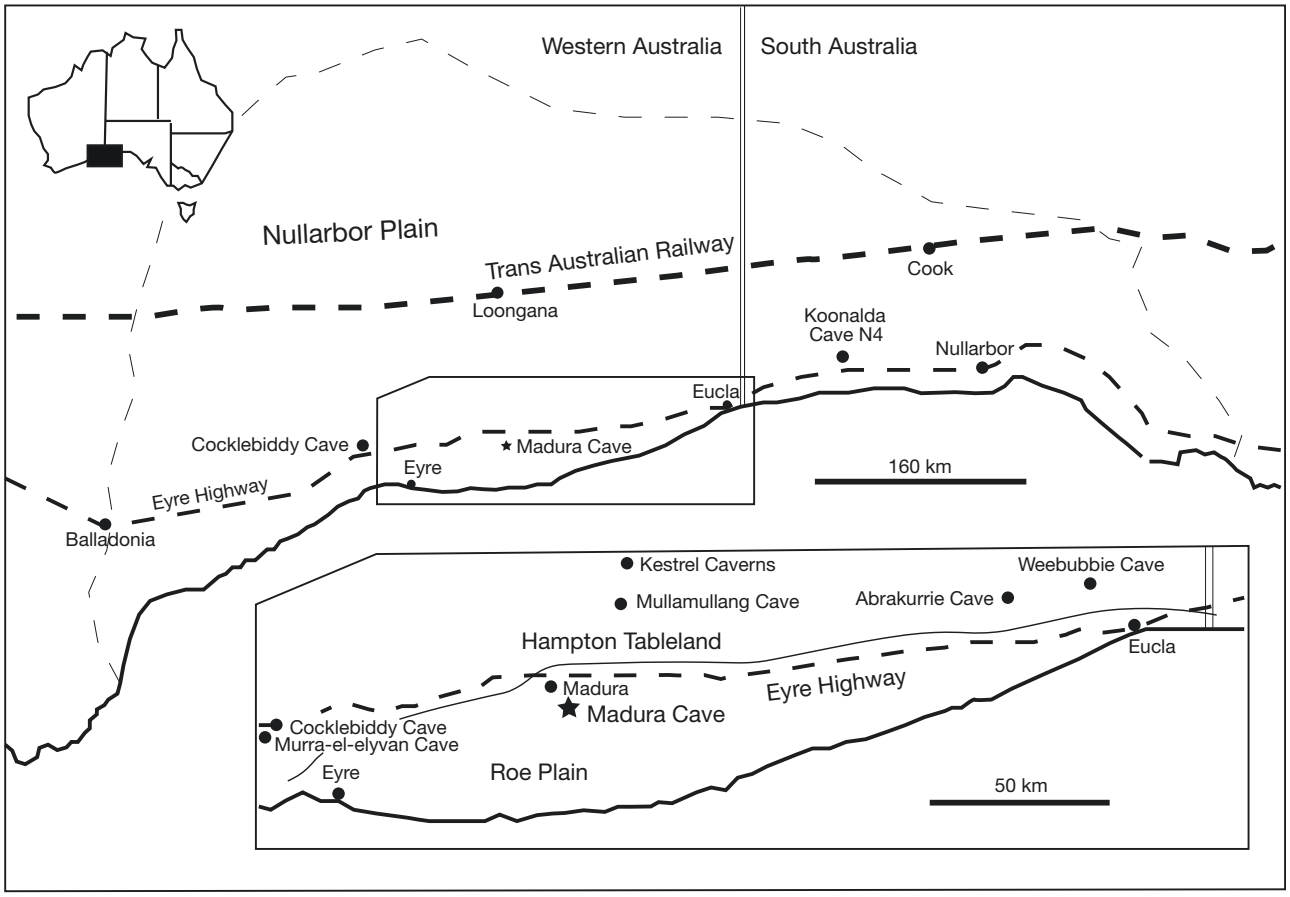

FIGURE 1 Map of the Eucla Basin in Western Australia and South Australia, with detail of the area showing location of the Madura Cave (star) and other caves nearby on the Hampton Tableland (adapted from Lundellius and Turnbull 1973).

This paper represents the final chapter by Lundelius and Turnbull on the fossil mammals from Madura Cave, Western Australia. Much of the field work, and most of the Madura Cave papers, represent the collaborative efforts of Lundelius and Turnbull with assistance, as documented in their previously published acknowledgements as well as this paper. William Turnbull died in 2011 before the work could be completed. Seven papers, published by Lundelius and Turnbull between 1973 and 1989, appeared in Fieldiana, while an eighth paper on the murid *Leporillus* was published in 1999 in the Proceedings of the Linnean Society of New South Wales. The other murids and the bats remained unpublished until now.

Access to specimens, notebooks of descriptions and measurements, and early versions of the manuscript allowed May to collaborate with Lundelius to finish this paper. Many hours were shared in discussion during 2024–25 about questions concerning taxonomy, stratigraphy, and philosophy. At age 97, Prof. Lundelius remained heartily engaged and provided the inspiration to complete this paper. Initial identifications and descriptions of *Pseudomys*, *Chalinolobus*, *Canis* and *Oryctolagus* had been completed by Lundelius and Turnbull, supported by a number of SEM images and

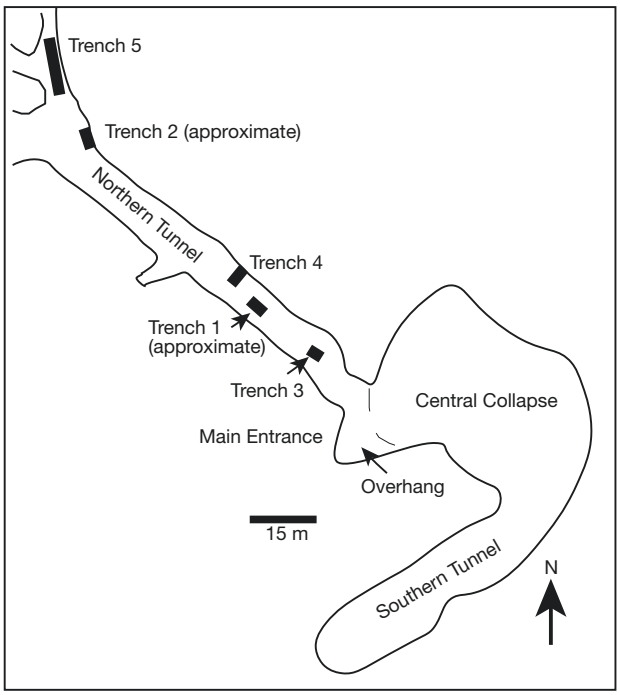

FIGURE 2 Map of Madura Cave with trench locations. Simplified from Lundellius and Turnbull (1973).

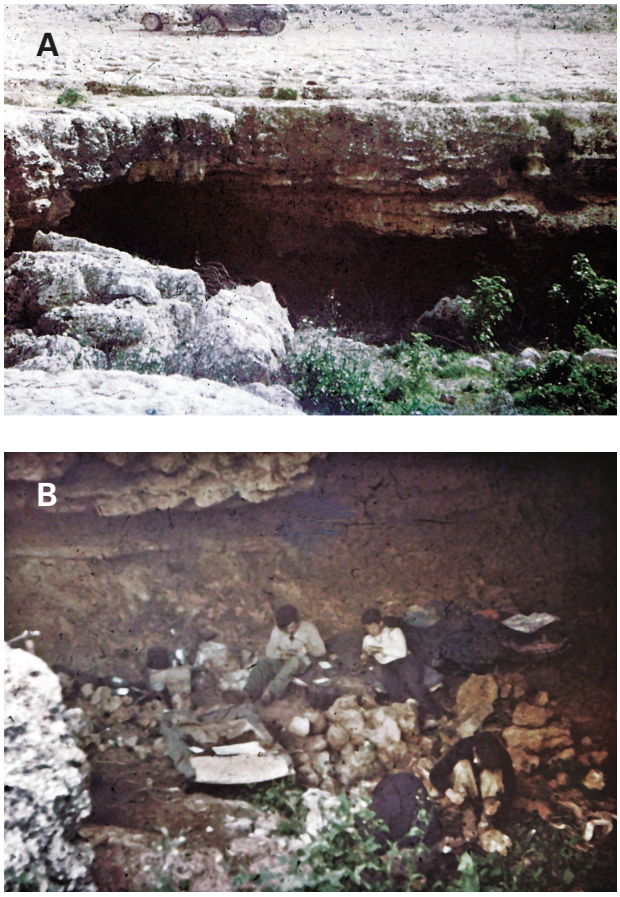

FIGURE 3 A) Main entrance to Madura Cave, 1955. Vehicle and trailer in background for scale; B) Working inside Madura Cave, 1955.

conventional photography. May continued the work on *Notomys* that had been largely absent from draft versions of the manuscript. He revisited the identifications and descriptions of *Pseudomys*, added images from micro-CT, reviewed the bats, and summarised the complete Madura Cave faunal list.

MATERIAL AND METHODS

Material was excavated from Trenches 3–5 in approximately 15 cm intervals within each stratigraphic unit. All matrix was dry sieved in the field and all concentrate, larger than 0.5 mm, was kept. The better specimens were picked in the field and treated with shellac to minimize breakage and loss of teeth. The term 'Madura Cave fauna' is used here to designate the assemblage of all fossil vertebrates recovered from sedimentary units of the cave, including those found on the cave floor at the time of excavation.

For this paper, Trench 1 through Trench 5 are referred to as proper names of localities within Madura Cave. Similarly, units within the stratigraphy are referred to as Units 1–7, as used in previous papers in this series.

Measurements, abbreviations, statistical and dental terminology are either those in standard use or are defined where used. Specimen numbers beginning with 'PM' indicate Field Museum of Natural History, Chicago specimens. Specimen numbers beginning 'TMM 41106-' indicate specimens in the Texas Vertebrate Paleontology Collections at the University of Texas at Austin (TxVP). Dental measurements, for specimens of *Pseudomys* were made using a microscope reticle and/or with calipers. Measurements for *Notomys* were made with a Dino-Lite digital scope and DinoXscope software. Measurements on the bats were based on Scanning Electron Microscope photos and direct caliper measurements.

Abbreviations include: C/c – canine, I/i – incisor, P/p – premolar, M/m – molar (upper and lower as per upper and lower case), L – left, R – right, l – length, w – width, TRL – tooth row length upper, trl – tooth row length lower, CT – computed tomography, SEM – scanning electron microscope, and C14 – Carbon 14.

All CT imaging was performed at The University of Texas at Austin High-Resolution X-ray CT Facility using the following parameters: Zeiss, Flat panel, 80kV, 10W, 0.06s acquisition time, 5 samples per view, detector 210.4 mm, source -28.8 mm, camera bin 1, angles ±180, 4501 views, LE3 filter, dithering, sample drift correction. Single reference. Reconstructed with centre shift -0.949, beam hardening 0.45, theta 0, byte scaling [-0.01, 0.28], binning 1, recon filter smooth (kernel size = 0.7). Total slices = 1,302. Scans are archived at www.morphosource.org. The CT data were visualised and analysed using 3D Slicer version 5.8.1.

REVIEW OF THE STRATIGRAPHY AND RADIOCARBON GEOCHRONOLOGY

The first comprehensive account of the stratigraphy of Madura Cave was presented in Lundelius and Turnbull (1973). The stratigraphic units, lithologies, and C14 dates for each of the trenches are summarised in Figure 4**.** A more detailed description of these data can be found in Lundelius and Turnbull (1973). None of the trenches sampled the full thickness of the cave stratigraphy. Seven C14 dates were obtained on fossil bone scrap (primarily long bones of small mammals with dense cortical bone) from a number of stratigraphic units in Trenches 3 and 4 (Lundelius and Turnbull 1973). The age range of the cave sediments, based on the C14 geochronology, extends from approximately 38,000 BP to 7,500 BP. The distribution of radiometric ages is stratigraphically consistent within each trench. The accuracy of these dates is uncertain, given the relative antiquity of the analytical work, although they have not been superseded by more recent geochronology. C14 dates were reported from the Southern Tunnel of Madura Cave in an unpublished dissertation by Marun (1972). The dates were from charcoal and included values of 7,880 ± 390 BP from 330 cm and 4,260 ± 130 BP from 195 cm. It is unclear how the stratigraphy sampled by Marun (1972) in the Southern Tunnel correlates with that

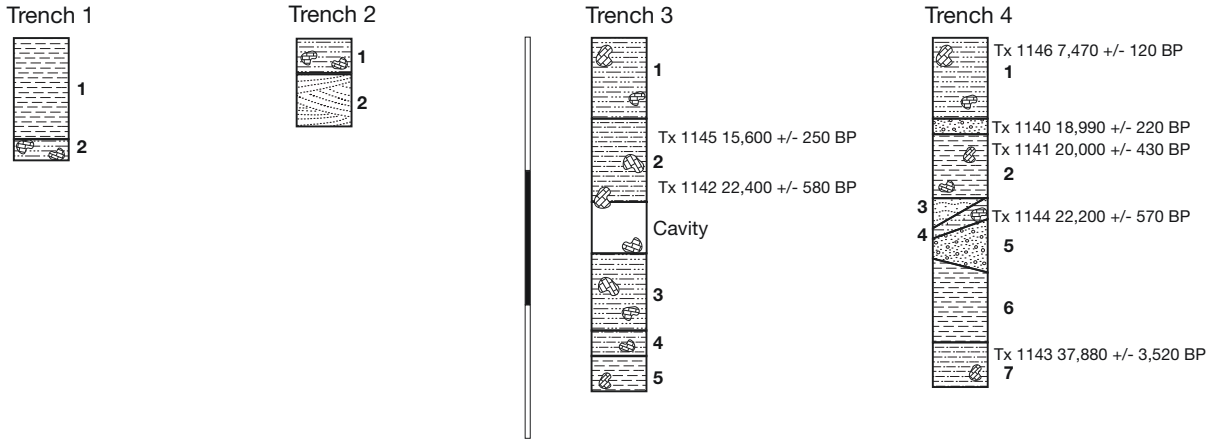

FIGURE 4 Summary of stratigraphic and geochronologic data from Trenches 1–4 in Madura Cave Northern Tunnel. Trench locations shown in Figure 2. Unit numbers are shown adjacent to each column (scale: 1 m).

Trench 1: 1 brown silt, 2 red sandy–silt; Trench 2: 1 red sandy–silt, 2 white cross–bedded sand and dark silt; Trench 3: 1 grey–brown silt, 2 red clay and silt, 3 brownish-red silt, 4 white sandy–silt, 5 red clay. Trench 4: 1 grey–brown silt, 2 red clay with gravel at top, 3 yellow–orange silty sand, 4 dark red clayey–silt, 5 red–grey sand and gravel, 6 white–orange silt and clay, 7 red–orange silty–clay. Trench 5: 1 brownish–grey sandy–silt, 2 orange–red sand and gravel, 3 reddish–brown silt, 4 brown silt and whitish clay, 5 reddish–brown silt, 6 reddish–orange clayey silt. Descriptions of Trenches 1–2 are from Lundelius (1963). Trenches 3–4 are summarised from previous descriptions and figures in Lundelius and Turnbull (1973). The stratigraphic position of radiometric dates designated Tx 1140–1146 are taken from Lundelius and Turnbull (1973).

of Lundelius and Turnbull (1973) in the Northern Tunnel. More recent accelerator mass spectrometry (AMS) dates, obtained directly from dingo bones originally collected by Marun (1972) within the top metre of Madura Cave Southern Tunnel sediments, yielded an age estimate of approximately 3,250 BP (Balme et al. 2018). The majority of rodent and bat fossils reported here are from stratigraphic units associated with C14 ages of approximately 22,000 to 7,500 BP, although a few specimens are from sediments with dates as old as 38,000 BP (Trench 4, Unit 7).

SYSTEMATIC PALAEONTOLOGY

Taxonomic names are based on The Australian Mammal Taxonomy Consortium Australian Mammal Species List AMTC (2024).

Class Mammalia Linnaeus, 1758

Order Rodentia Bowdich, 1821

Family Muridae Illiger, 1811

Subfamily Murinae Illiger, 1811

Rodents are the most common of the placental mammals in the Madura Cave sediments. Cheek tooth terminology is modified from Musser et al. (2005) with upper molar cusps labeled T1–T9 and lower molar morphology designated with standard terms inferring homology (Figure 5).

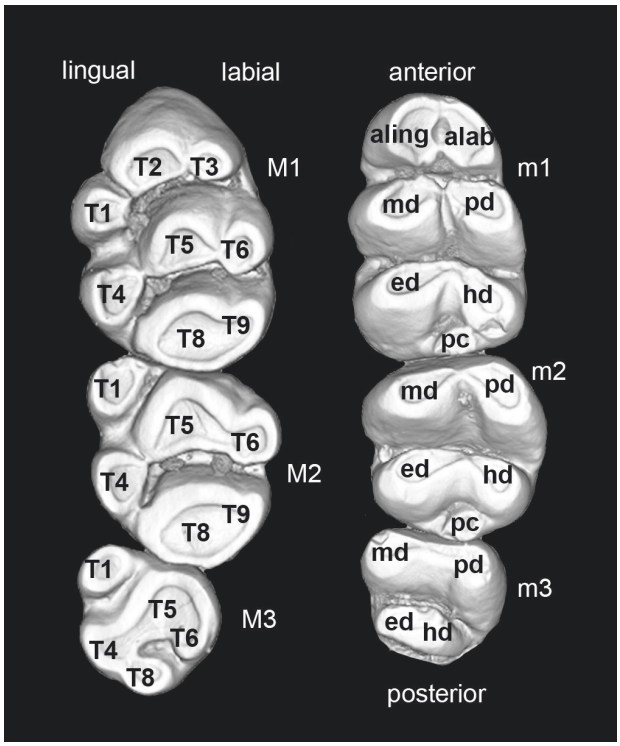

FIGURE 5 Occlusal views of upper (left) and lower (right) cheek teeth of *Notomys* [sp. indet. from Madura Cave] illustrating terminology used for dental descriptions modified from Musser et al. (2005). Abbreviations for lower cheek teeth m1–3: alab, anterolabial cuspid; aling, anterolingual cuspid; ed, entoconid; hd, hypoconid; md, metaconid; pc, posterior cuspid; pd, protoconid.

Genus *Pseudomys* Gray, 1832

The *Pseudomys* group belongs to the tribe Hydromyini within the subfamily Murinae and includes 22 extant species (AMTC 2024). Phylogenetic relationships have been well documented through molecular analysis, but the living species are poorly characterised with respect to those skeletal features that are preserved in the Madura Cave fossils. Species assigned to *Pseudomys* differ from *Leporillus* in their smaller size and more brachyodont cheek teeth. Most *Pseudomys* taxa differ from *Notomys* in lacking the anteriorly projecting zygomatic spine and the broadening of the dorsal part of the zygomatic arch. The zygomatic spine in those species of *Pseudomys* that possess it, is smaller and less prominent than in *Notomys*.

Based primarily on size and morphology of the upper cheek-teeth, four species of *Pseudomys* can be identified in the Madura Cave fauna. These identifications are supported by earlier analysis by A. Baynes (pers. comm.) and by dental descriptions provided by J. Cramb (pers. comm.). One of the species is a very small form of *Pseudomys,* while three fall in the medium size range for the genus. *Pseudomys bolami* is very small with an anterolingual accessory cusp on M1. The cusps of the labial row (T3, T6, T9) are distinct but smaller than the lingual cusps. T2 and T3 are close together and form a loph transverse to the long axis of the tooth, while T1 is on the lingual edge of the tooth and is located well posterior of T2. Three additional species are middle size forms with M1 (l x w) dimensions of 2.3–2.9 mm x 1.5–1.9 mm. The three mid-size species have been identified on the basis of M1 morphology. *Pseudomys australis* lacks an anterolingual accessory cusp on M1 as well as an anterior cingulum. T1 and T2 are approximately aligned, T3 is absent, T6 is small, and T9 is smaller. *Pseudomys gouldii* has a well developed anterolingual accessory cusp and an anterior cingulum, T1 and T4 are posteriorly placed, T3 and T6 are small, but present. *Pseudomys* sp. cf. *desertor* has straight lophs with T1 and T4 placed more anteriorly than in other species. In addition M1 has a well-developed anterior cingulum, but an anterolingual accessory cusp is rare.

Pseudomys bolami Troughton, 1932

(Figures 6–9, Tables 1–4)

MATERIAL EXAMINED

72 specimens (see Appendix 1).

DESCRIPTION

The smallest species of *Pseudomys* from Madura Cave is also the most common. Cheek tooth measurements are within the range of *P. bolami*, one of the smallest extant species of the genus. The incomplete skull (PM 6079, Figure 6) allows for a partial comparison with other small species of *Pseudomys*. The specimen agrees with the description of *P. bolami* given by Kitchener et al. (1984) in the following ways. The nasal bones extend anteriorly slightly beyond the premaxillae. The posterior end of the anterior palatal foramen is broad, rounded, and extends to the level of the first loph of M1, stated by Kitchener et al. (1984) to be characteristic of *P. bolami*. The anterior half of the median palatal septum is inflated. The premaxilla-maxilla septal suture is located near the midpoint of the septum. The anterior margin of the zygomatic plate of the maxillar is slightly concave. There is no anteriorly projecting spine, nor is the dorsal part of the zygomatic arch broadened, as in *Notomys*.

Two specimens (PM 6079, PM 6080) from Trench 1, Unit 1 of Madura Cave preserve the premaxilla and palate (Figure 6). The length of the palate of the Madura Cave specimens falls at the small end of the distribution of *Pseudomys bolami*, *P. hermannsburgensis* and *P. chapmani*. One specimen (PM 6079) allows comparison of the relative lengths of the palate (10.73 mm) and the anterior palatal foramen (4.93 mm) with specimens from other localities. It differs from the Kitchener et al. **(**1984**)** description of *P. bolami* in both average length of the anterior palatal foramen and in the ratio of the anterior palatal foramen length to the palatal length. Specimens of *P. bolami* in the TxVP collection from the Nullarbor region from the surface of Gurneys Cave (TMM 41232) and Jennings Cave (TMM 42121) have shorter palatal lengths than the Madura Cave specimens, but similar lengths of the anterior palatal foramina. The significance of this variability is uncertain, but does not warrant exclusion of the Madura Cave material from *P. bolami*.

The M1 is oval in outline with the cusps inclined posteriorly (Figure 7). Cusps of the labial row (T3, T6, T9) are distinct but smaller than the lingual cusps (T1, T4). Cusps T2 and T3 are close together and form a loph transverse to the long axis of the tooth. Cusp T1 is on the lingual edge of the tooth and is located posterior of T2. When worn, T1, T2 and T3, form a loph that turns abruptly posteriorly at the lingual end. This is in contrast to the very similar *P. hermannsburgensis* in which the longest axes of the cusps T2 and T1 are more closely aligned (A. Baynes pers. comm. 1988) because of the more anterior placement of cusp T1.

Cusp T4 of M1 bears the same relationship to T5 and T6 as does T1 to T2 and T3. Its posterior position results in a posteriorly angled second loph. An accessory cusp is present on the anterolingual corner of the tooth. This is consistent with the description of *P. bolami* by Kitchener et al. (1984). The anterolingual accessory cusp is not as tall as T2.

The large T1 cusp, on the anterolingual corner of M2, is as large as cusp T5. Cusp T6 is the smallest of these and is closely appressed to T5. Cusp T4 lies posterior to

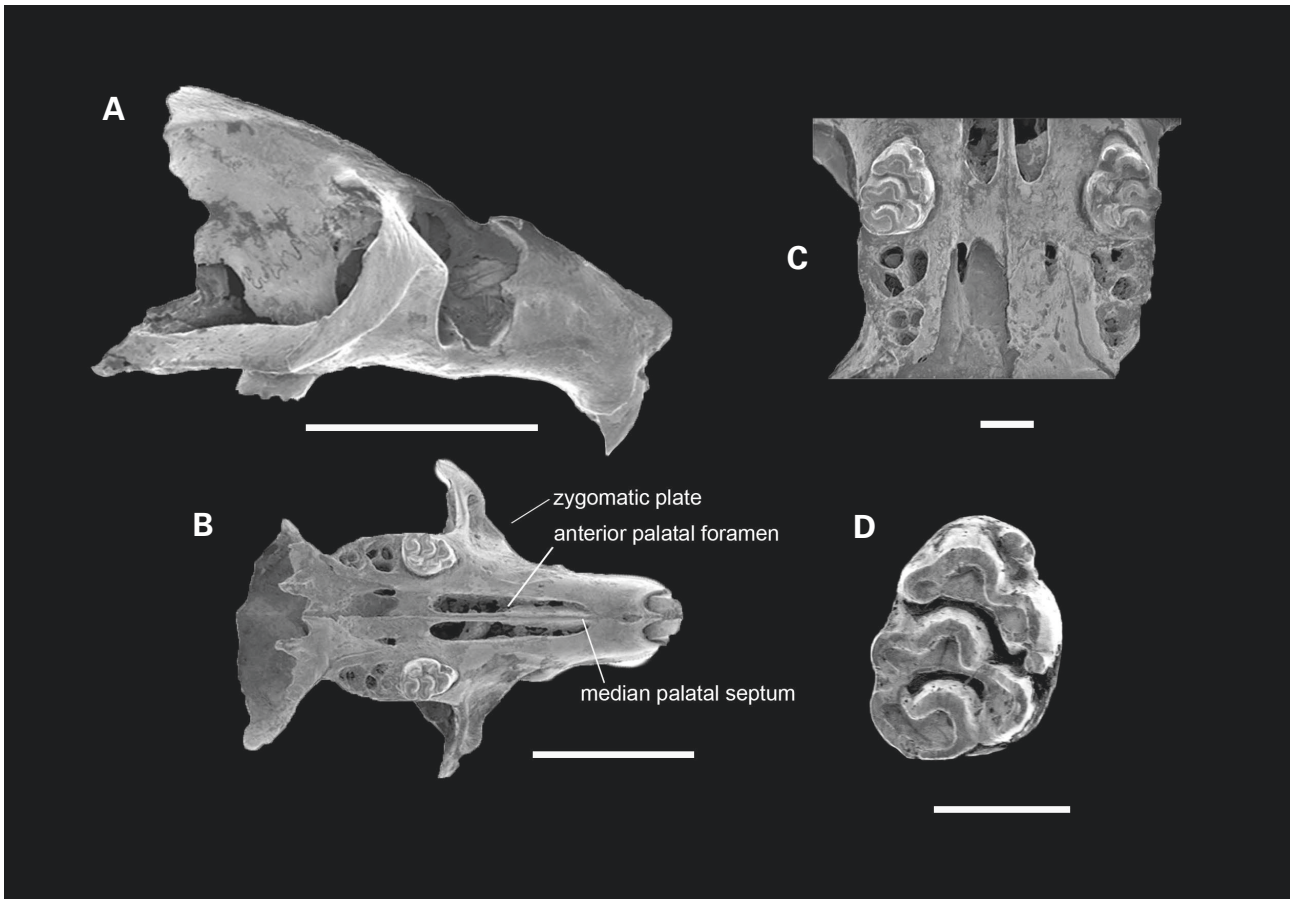

FIGURE 6 *Pseudomys bolami* (PM 6079), Trench 1, Unit 1, partial skull: A) lateral view from right side, anterior to right, scale = 5 mm; B) palatal view, anterior to right, scale = 5 mm; C) palatal view, anterior up, scale = 1 mm; D) R M1, anterior up, scale = 1 mm. (SEM images.)

FIGURE 7 *Pseudomys bolami* (TMM 41106-3520), Trench 4, Unit 1, partial L maxilla with M1–3: A) occlusal view, anterior up; B) arbitrary slice through occlusal view showing roots of M1–3; C) labial view. Scale = 1 mm. (Micro-CT images.)

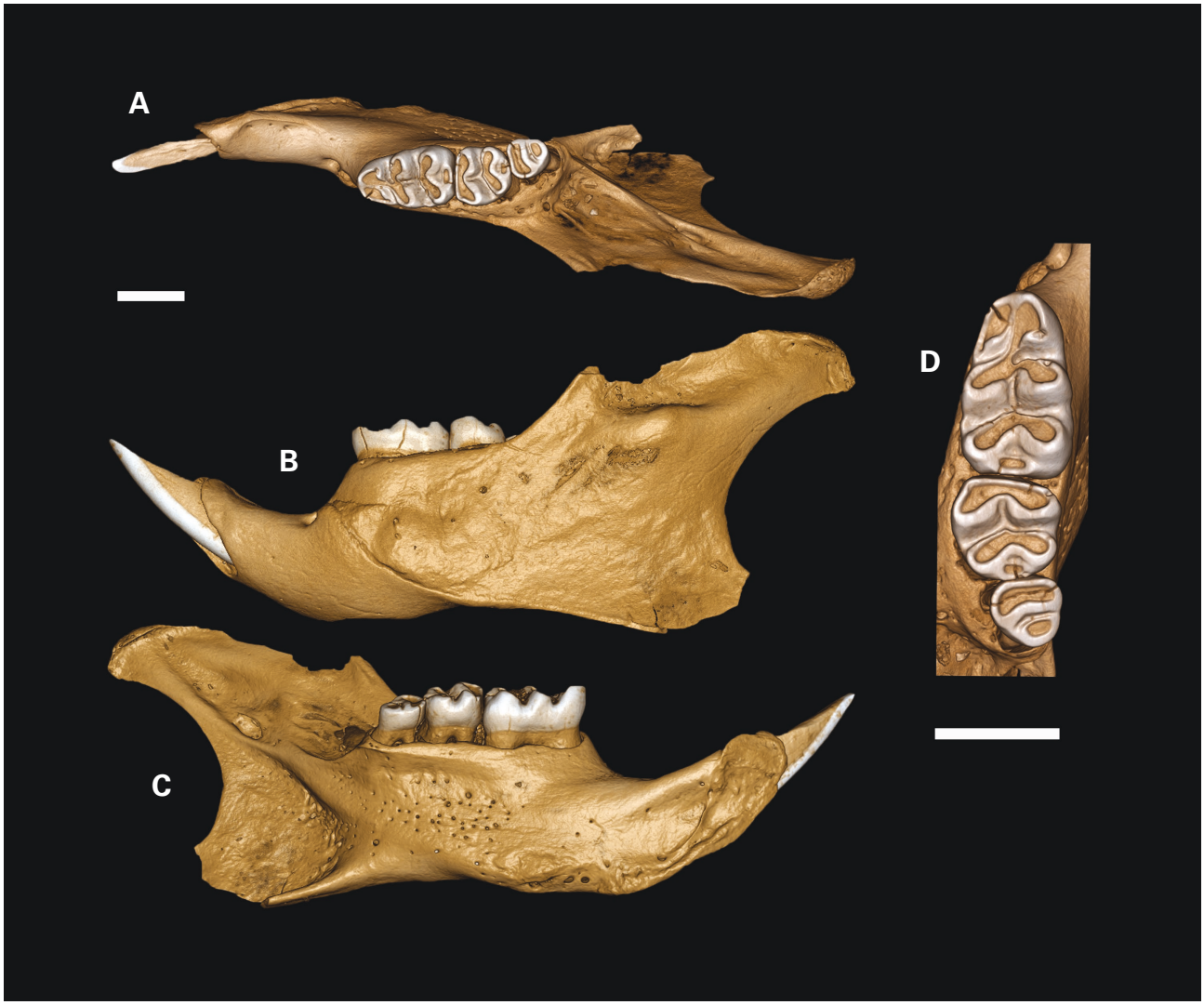

FIGURE 8 *Pseudomys bolami* (TMM 41106-3514), Trench 4, Unit 1, L dentary with i, m1–3: A) dorsal view, anterior to the left, scale = 1 mm; B) labial view, anterior to the left, scale = 1 mm; C) lingual view, anterior to the right, scale = 1 mm; D) occlusal view of m1–3, scale = 1 mm. (Micro-CT images.)

T5 and is joined to it by a ridge. The posterior loph is composed of the central cusp, T8, and is relatively large and oval.

The M3 has a large T1 on the anterolingual corner and a large T5 on the labial side of the median loph. T5 is connected to a posteriorly located T4 to form a loph oriented about 30˚ to the long axis of the tooth. T6 is very small and is close to T5. The posterior end of the tooth has a small cusp T8.

Specimens assigned to *P. bolami* are similar in size to measurements provided in Kitchener et al. (1984), as well as those conducted as part of this study on specimens from the Western Australian Museum (WAM) and data provided by J. Cramb (pers. comm. 2024) (Tables 1–3). M1 dimensions for the Madura Cave specimens, lie near the centre of a series of measurements for *P. bolami*. Five specimens from WAM have a mean length for M1 of 1.75 ± 0.11 mm and width of 1.13 ± 0.06 mm. The observed range in these specimens, of 1.59–1.85 mm x 1.07–1.22 mm, is very similar to the Madura Cave sample. Although the mean length of M1 decreases up section in the Madura Cave stratigraphy, this variation is not statistically significant.

The dentary is somewhat variable in shape as reported by Kitchener et al. (1984). A well developed masseteric scar terminates anteriorly above the mental foramen that is located about one third of the distance between the m1 and the incisor on the dorsolateral edge of the diastema (Figure 8). The capsule for the lower incisor forms a bulge on the labial side of the dentary just below and behind the coronoid process. The coronoid process is short and slender, and is turned sharply posteriorly (missing in Figure 8).

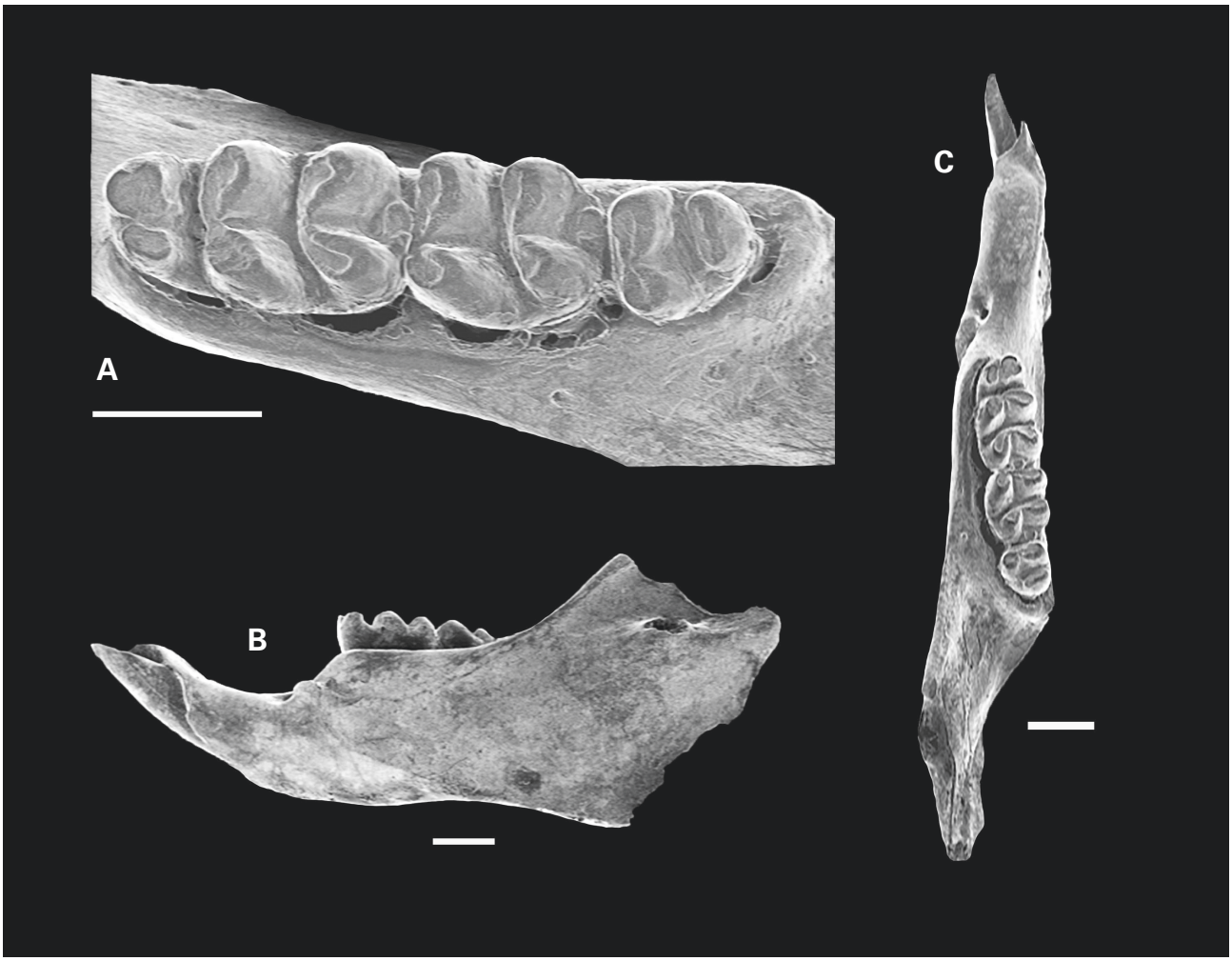

FIGURE 9 *Pseudomys bolami* (TMM 41106-2992), Trench 4, Unit 2, left dentary with i and m1–3; A) occlusal view of m1–3, anterior to the left, scale = 1 mm; B) labial view, anterior to the left, scale = 1 mm; C) occlusal view, anterior up, scale = 1 mm. (SEM images.)

The m1 has two anterior cuspids (alab and aling) that are separate, with the labial cuspid being significantly smaller than the lingual (Figures 8–9). A deep valley separates the anterior cuspids from the protoconid and metaconid. The protoconid is smaller than the metaconid and both second and third lophids are arcuate in occlusal view. The hypoconid and entoconid are subequal in size. There is a small posterior cuspid at the posterior end of the tooth. The protoconid and hypoconid are sub-oval on m2, while the metaconid and entoconid are elongate. As in m1, there is a small posterior cuspid at the posterior end of the tooth. The m3 is small and sub-triangular in shape. The hypoconid and entoconid are merged into a single posterior lophid (Figure 9). The mean m1–3 trl of 3.25 mm (Table 4) is small for species of *Pseudomys*.

DISCUSSION

Pseudomys bolami is the most abundant species of *Pseudomys* in the Madura Cave fauna and specimens are found throughout the stratigraphic section. Those from Unit 7 of Trench 4 represent some of the oldest murids known from the cave, possibly as old as ~38,000 BP based on C14 ages. Mean dimensions of upper cheek teeth suggest a minor decrease in the size of *P. bolami* with decreasing age in the cave stratigraphy, but this variation is not statistically significant. *Pseudomys bolami* is one of the smaller *Pseudomys* species, however, there are as many as ten species of small *Pseudomys* recognised in Australia (Watts and Aslin 1981). Small *Pseudomys* specimens from the Nullarbor Plain were assigned to *P. bolami* by Baynes (1987). The Madura Cave specimens are comparable to those of *P. bolami* in the morphology of M1, especially the shape of the first loph. A single partial skull agrees with the description of *P. bolami* given by Kitchener et al. (1984) in the following ways: 1) the nasal bones extend anteriorly slightly beyond the premaxillae; 2) the posterior end of the anterior palatal foramen extends to the level of the first loph of M1. Measured lengths of the anterior palatal foramen of the Madura Cave specimens are slightly longer than *P. bolami* provided by Kitchener et al. (1984).

TABLE 1 Measurments for upper dentition of *Pseudomys bolami*, Trench 4, Unit 1.

	Mean (mm)	SD	Range (mm)	N
M1–3 l	3.59	0.148	3.23–3.83	22
M1 l	1.82	0.112	1.58–1.99	37
M1 w	1.17	0.053	1.07–1.29	37
M2 l	1.06	0.056	0.97–1.18	33
M2 w	1.07	0.058	0.95–1.19	33
M3 l	0.73	0.070	0.64–0.89	23
M3 w	0.76	0.048	0.69–0.89	24

TABLE 2 Measurments for upper dentition of *Pseudomys bolami*, Trench 3, Unit 2.

	Mean (mm)	Range (mm)	N
M1–3 l	3.61	3.46–3.80	3
M1 l	1.84	1.73–1.96	3
M1 w	1.18	1.13–1.19	3
M2 l	1.05	0.96–1.13	3
M2 w	1.08	1.05–1.13	3
M3 l	0.71	0.69–1.73	3
M3 w	0.82	0.68–0.97	3

TABLE 3 Measurments for *Pseudomys bolami*, Trench 4, Unit 7.

	Mean (mm)	SD	Range (mm)	N
M 1 l	1.89	0.13	1.73–2.06	10
M 1 w	1.23	0.05	1.13–1.29	10

TABLE 4 Measurments for lower dentition of *Pseudomys bolami*, Trench 3, Unit 2.

	Mean (mm)	SD	Range (mm)	N
m1–3 l	3.25	-	3.09–3.41	2
m1 l	1.70	0.08	1.59–1.88	14
m1 w	1.05	0.03	1.00–1.10	14
m2 l	1.04	0.05	0.97–1.10	10
m2 w	1.04	0.04	0.97–1.10	10
m3 l	0.76	-	0.71–0.81	2
m3 w	0.81	-	0.81–0.81	2

The Madura Cave material was originally called *Leggadina hermannsburgensis* by Lundelius (1963). *Pseudomys bolami* was later recognised as distinct from *P. hernannsburgensis* by the more posterior placement of cusp T1 on M1 resulting in an anterior loph that is angled posteriorly, as well as an elongated accessory cusp. When worn, T1, T2, and T3 form a loph whose lingual end turns abruptly posteriorly, in contrast to the situation in *P. hermannsburgensis*.

The Madura Cave specimens differ from *P. chapmani* in the geometry of the anterior palatal foramen relative to the length of the palate. The specimens differ from most other small *Pseudomys* by having an accessory cusp on the anterolingual margin of M1. While *P. delicatulus* and *P. novaehollandiae* have an accessory cusp on the anterior edge of the M1 in some specimens, those taxa do not exhibit the distinct posterior angulation of the first loph of M1. With the exception of *P. delicatulus*, the lengths of the palate of these species are longer than in the Madura Cave specimens, based on measurements made by E.L.L. at WAM.

Specimens of this taxon were reported by Baynes (1987) from numerous caves along the southern margin of the Nullarbor Plain as well as across the central Nullarbor and Carlisle Plain. The present day distribution map for *P. bolami* includes much of the southern parts of South Australia and Western Australia including the Nullarbor Plain (Baker and Gynther 2023).

Pseudomys australis **Gray, 1832**

(Figure 10, Table 5)

MATERIAL EXAMINED

21 specimens (see Appendix 1).

DESCRIPTION

This material represents a medium sized species of *Pseudomys* with M1 dimensions of approximately 2.5 x 1.7 mm (Table 5). The anterior palatal foramen is narrow and terminates posteriorly in a relatively sharp point. M1 lacks an anterolingual accessory cusp and has no anterior cingulum. T1 is approximately aligned with T2 rather than being posteriorly displaced (Figure 10). T3 is very reduced, or absent, on M1; T6 is small and T9 is smaller. M3 is sub-triangular in outline with a well-developed T1.

DISCUSSION

Pseudomys australis is represented by 6 specimens from Trench 1, Unit 1, and 15 specimens from Trench 3, Unit 2. It is not recognised in sediments older than about 22,000 BP from Madura Cave. Only a single dentary with m1 has been tentatively assigned to this

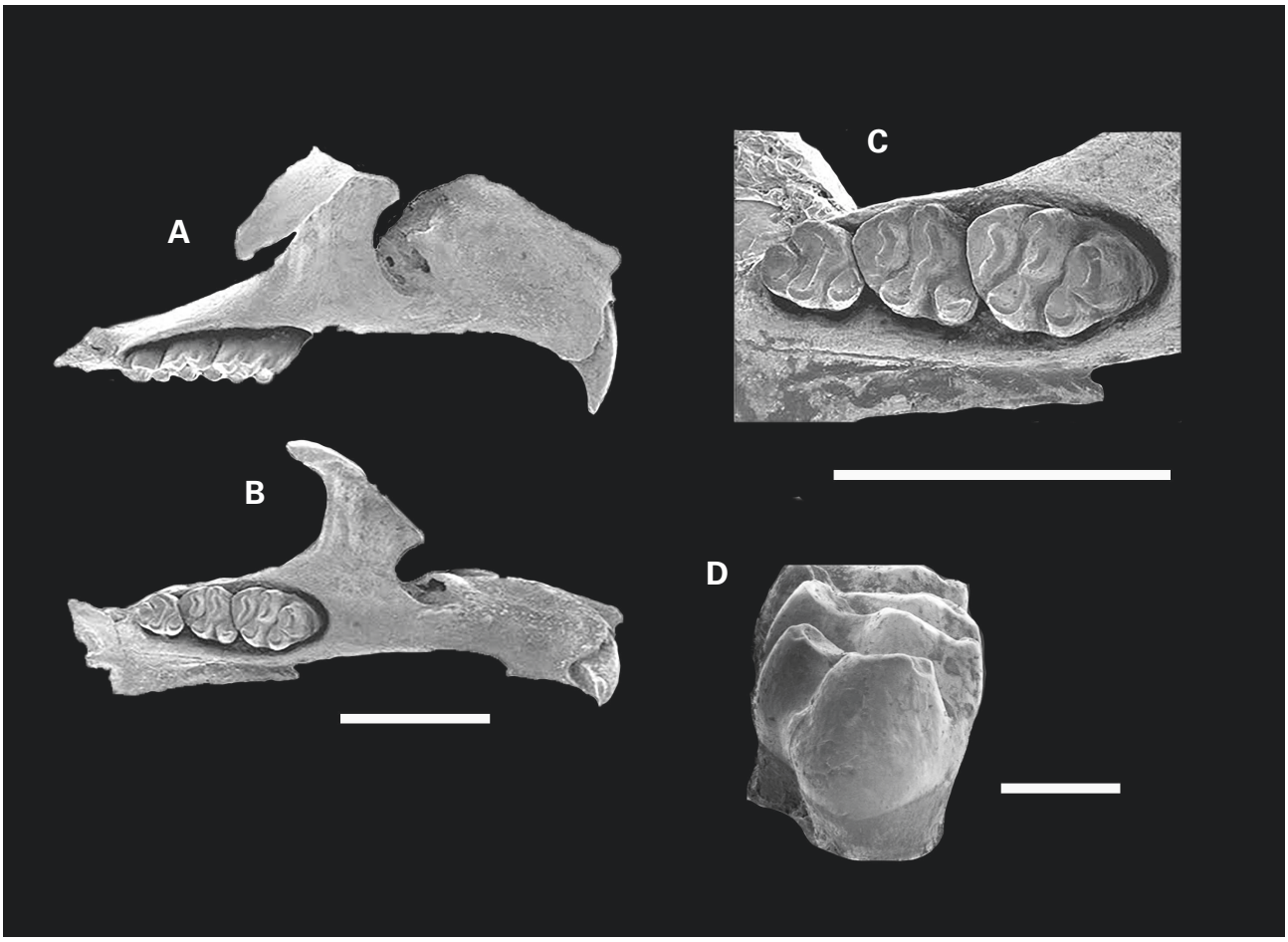

FIGURE 10 *Pseudomys australis* (PM 6110), R maxilla and premaxilla with I, M1–3; A) labial view, anterior to the right, scale = 5 mm; B) occlusal view, anterior to the right, scale = 5 mm; C) occlusal view of M1–3, anterior to the right, scale = 5 mm; D) anterior view of M1, lingual to the left, scale = 1 mm. (SEM images.)

taxon, so the description and identification is largely based on the size and morphology of M1. Although morphologically similar to specimens from other populations of *P. australis* and *P. shortridgei*, the average M1 dimensions of 2.49 mm ± 0.17 mm by 1.71 mm ± 0.1 mm are relatively small and significantly smaller than *P. shortridgei*. Measurements of M1 for *P. australis* compiled by J. Cramb (pers. comm. 2024) exhibit the largest size range of any species of *Pseudomys*. Distinguishing features of M1 on *P. australis* include the lack of an anterolingual accessory cusp with no anterior cingulum, the alignment of T1 and T2 and the highly reduced, or absent, T3 with a small T6. The Madura Cave material is morphologically similar to *P. shortridgei* in the alignment of T1 and T2. However, it lacks the anterior cingulum seen in the latter and T1 on M3 is larger. It is identified as *P. australis* based on M1 morphology, but is smaller than *P. australis* from other localities. The pointed shape of the posterior end of the anterior palatal foramen is also consistent with *P. australis* (A. Baynes pers. comm. 2025). The present day range of *P. australis* is restricted to central and eastern South Australia, western New South Wales and southern Northern Territory, although its prior range included the Nullarbor Plain (Baker and Gynther 2023).

TABLE 5 Upper cheek tooth dimensions for *Pseudomys australis* from Trench 1, Unit 1 and Trench 3, Unit 2.

	Mean (mm)	SD	Range (mm)	N
M1 l	2.49	0.17	2.28–2.85	15
M1 w	1.71	0.10	1.52–1.87	15
M2 l	1.50	0.08	1.38–1.62	12
M2 w	1.54	0.08	1.40–1.66	12
M3 l	1.16	0.14	0.92–1.29	7
M3 w	1.20	0.07	1.13–1.32	7

Pseudomys gouldii (Waterhouse, 1839)

(Figure 11, Table 6)

MATERIAL EXAMINED

9 specimens (see Appendix 1).

DESCRIPTION

The upper cheek teeth are relatively brachyodont with cusps that slope posteriorly. The sizes of the upper cheek teeth are similar to *Pseudomys australis* and other mid-sized *Pseudomys* (Table 6). A well developed accessory cusp is present on the anterolingual corner of M1 along with an anterior cingulum (Figure 11). The accessory cusp has been noted as a characteristic feature of *P. gouldii* (e.g. Watts and Aslin 1981), but careful examination of the original figure of this taxon by Waterhouse (1839) shows no such cusp (*Mus gouldii*, plate 34, figure 18a). T1 and T4 are posteriorly placed while T3 and T6 are small but present on M1. There is also a small anterolabial accessory cusp on M2 of the Madura Cave specimens. The posterior end of the anterior palatal foramen is rounded. The anterior edge of the zygomatic plate is concave and there is a spine at the top as in *Notomys*. However, the zygomatic arch is not broadened as in *Notomys* (Figure 11). *Pseudomys gouldii* differs from the other medium sized taxa of *Pseudomys* primarily in M1 morphology.

DISCUSSION

Pseudomys gouldii is relatively rare in the Madura Cave fauna (9 specimens), but is recognised on the basis of size, M1 morphology, and the narrow, rounded shape of the posterior end of the anterior palatal foramen (A. Baynes pers. comm. 2025). *Pseudomys fieldi* is now considered a junior synonym of *P. gouldii* (Roycroft et al. 2021). Suggestions that *P. gouldii* had become extinct are superseded by the occurrence of a population on Bernier Island in Shark Bay, Western Australia previously assigned to *P. fieldi*. While *P. gouldii* was once widespread across the southern half of Australia, its natural range is now restricted to this single island (Roycroft et al. 2021). The presence of *P. gouldii* in Madura Cave shows that in the late Pleistocene and early Holocene, this range included the Nullarbor Plain.

TABLE 6 Measurements of upper cheek teeth of *Pseudomys gouldii* from Madura Cave.

	Mean (mm)	SD	Range (mm)	N
M1 l	2.46	0.14	2.32–2.60	3
M1 w	1.63	0.04	1.60–1.67	3
M2 l	1.41	0.09	1.50–1.52	4
M2 w	1.51	0.01	1.50–1.52	4
M3 l	1.12	0.07	1.05–1.19	3
M3 w	1.16	0.06	1.11–1.23	3

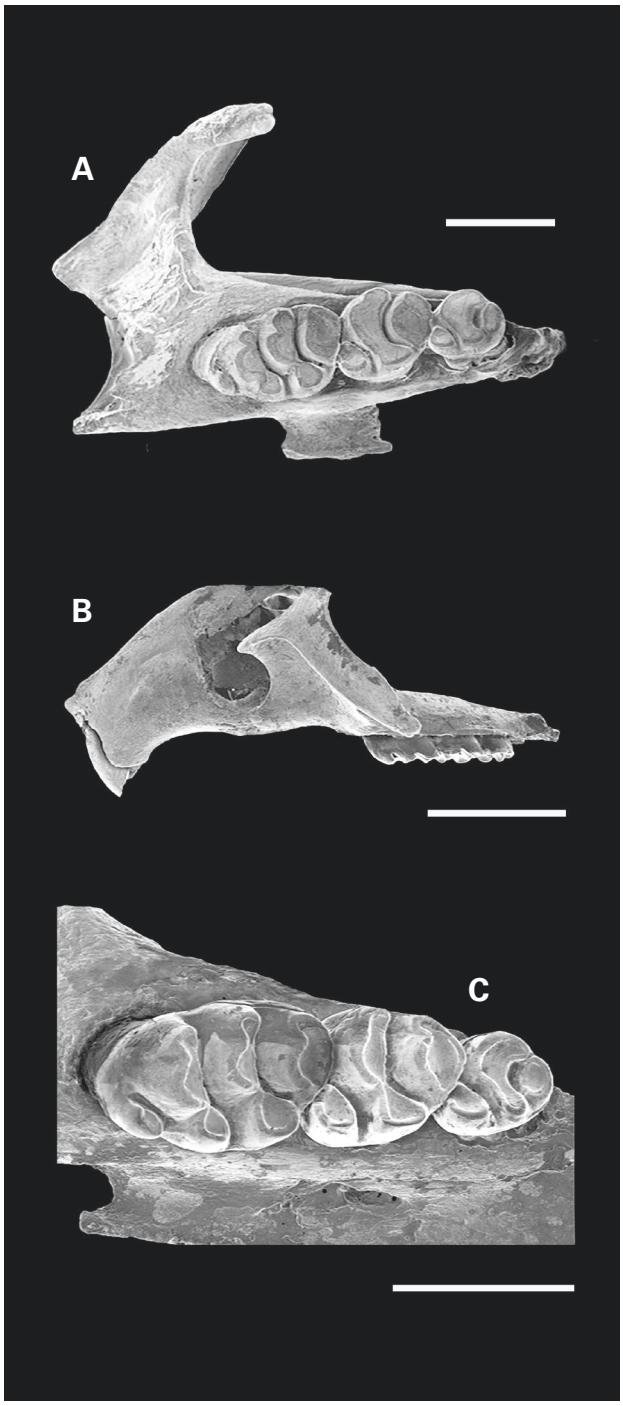

FIGURE 11 *Pseudomys gouldii* (TMM 41106-1992): A) L maxilla with M1–3, occlusal view anterior up, scale = 2 mm. *Pseudomys gouldii* (PM 6114): B) partial skull with M1–3 lateral view, anterior to the left, scale = 5 mm; C) occlusal view of M1–3, anterior to the left, scale = 2 mm. (SEM images.)

Pseudomys sp. cf. *desertor* Troughton, 1932

(Figure 12, Table 7)

MATERIAL EXAMINED

60 specimens (see Appendix 1).

DESCRIPTION

A medium sized mouse, larger than *Pseudomys gouldii*, with brachydont M1 and posteriorly angled cusps (Table 7). The lophs on M1 are straight, as T1 and T4 are not displaced posteriorly as in many other species of *Pseudomys* (Figure 12). An anterior cingulum is usually present on M1, while the anterolingual accessory cusp is usually absent. A few specimens (TMM 41106-3956, TMM 41106-3930, Figure 12B), have a small accessory cusp on the anterior margin. The shape of M1 in the Madura Cave sample is variable, but the cusp morphology compares well with specimens of *P. desertor*, including those at WAM examined by E.L.L. The length of M1 is consistent with measurements compiled by J. Cramb (pers. comm. 2024) although the mean width is greater.

TABLE 7 M1 dimensions for *Pseudomys* sp. cf. *desertor*, Trench 4, Units 4–5.

	Mean (mm)	SD	Range (mm)	N
M1 l	2.57	0.167	2.22–2.81	37
M1 w	1.75	0.001	1.64–1.87	36

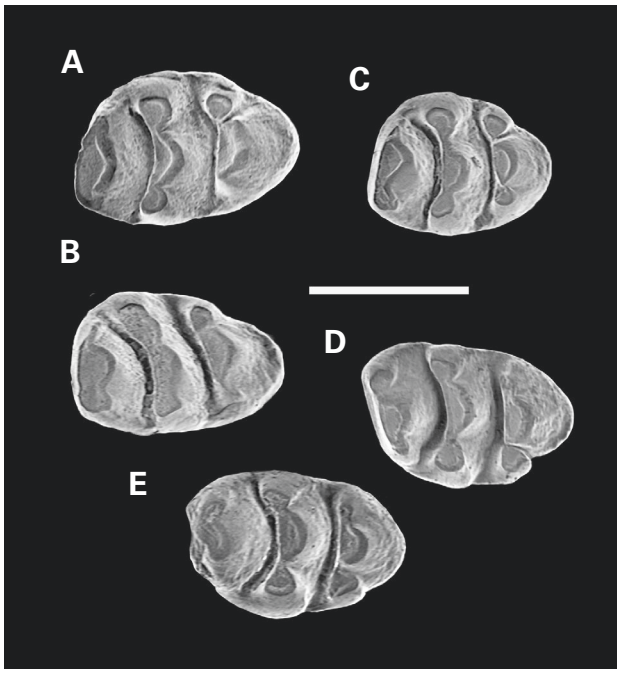

FIGURE 12 *Pseudomys* sp. cf. *desertor*, anterior to the right: A) TMM 41106-4046, L M1; B) TMM 41106-3930, L M1; C) TMM 41106-3922, L M1; D) TMM 41106-4044, R M1; E) TMM 41106-3950, R M1. Scale = 2mm. (SEM images.)

DISCUSSION

Nearly all of the specimens assigned to *Pseudomys* sp. cf. *desertor* are isolated upper first molars. Whereas this may reflect an anatomy prone to separation of the teeth from the maxilla after death, the observation of differential preservation of maxilla with teeth vs isolated teeth is fully addressed by Baynes et al. (2019). M1 is the diagnostic tooth for this taxon, so lacking associated upper cheek teeth in maxillae, and associated maxillae with dentaries, assignment of additional cheek teeth to this taxon is uncertain. *Pseudomys* sp. cf. *desertor* is recognised by the presence of relatively straight lophs on M1 and the presence of a well-developed anterior cingulum. In addition, this taxon usually lacks an anterolingual accessory cusp on M1. *Pseudomys desertor* is widespread across the arid and semi-arid environments of central Australia.

Genus *Notomys* Lesson, 1842

Notomys sp. indet.

(Figures 13–21, Tables 8–10)

Rodents of the genus *Notomys* are most easily distinguished, from other similarly sized rodents in Australia, by having the anterior edge of the zygomatic plate deeply concave with a prominent anterior zygomatic spine at its dorsal end. The radius of curvature of the anterior edge of the zygomatic plate increases ventrally (A. Baynes pers. comm. 2025). The dorsal part of the zygomatic arch is very broad and is abruptly constricted about half way along its length. The interorbital area is relatively broad. *Pseudomys* sometimes exhibits an anterior zygomatic spine (e.g. *P. nanus*, *P. australis)*, but it is never as well developed as in *Notomys* and these taxa lack the assymetric concavity of the anterior edge of the zygomatic plate and the dorsal broadening of the zygomatic arch.

MATERIAL EXAMINED

126 specimens (see Appendix 1). Approximately 1100 specimens from Madura Cave have been tentatively identified as *Notomys*. A full listing of these specimens can be viewed via an online search at https://specify-portal.tacc.utexas.edu/vpl/ using ‘advanced search’, filtered with ‘Catalog Number contains’ 41106, and ‘Genus =’ *Notomys*. A subset of specimens listed in Appendix 1 are those measured and studied for this paper. Specimens were selected based on condition,

completeness, state of wear, and stratigraphic location. The sample includes specimens from Trench 3, Units 1–2 and Trench 4, Units 1–5, with an age range of approximately 22,000 BP to 7,500 BP based on previously published C14 dates. Considering size and dental morphology, all of the specimens of *Notomys* are considered to represent a single species. A complete analysis of all 1,100 specimens would result in a better understanding of intraspecific variability and potentially morphological variation over time.

DESCRIPTION

Notomys is recognised on the basis of the morphology of the zygomatic arch and the well developed anterior zygomatic spine. The dentary exhibits a masseteric scar that terminates on the posterolabial margin of the diastema above a well-developed mental foramen. Dorsal and ventral ridges of the scar form a narrow angle. Detailed dental morphology is described below, however, individual cheek teeth, or even partial maxillae and dentaries, can be difficult to separate from *Pseudomys*.

Dental measurements are provided in Tables 8–9 and plotted in Figure 13. These data suggest that *Notomys* is represented by a single species in the Madura Cave sediments. Some variability in the length of M1 is almost certainly attributable to the shape of the tooth with a posteriorly sloping anterior edge. This causes length measurements to vary slightly with state of wear. Regardless, the dimensions of all cheek teeth cluster tightly and statistical analysis indicates approximately normal distributions. Based on specimens with complete M1–3, the mean TRL (M1–3) of the Madura Cave *Notomys* (4.68 mm ± 0.19 mm, N = 39) is smaller than all extant species of *Notomys*. Mean upper TRLs of the smallest species range from 5.0 mm (*N. fuscus*, *N. aquilo*) to 5.2 mm (*N. cervinus, N. mitchellii*) (Vakil et al. 2023). The largest specimens from Madura Cave overlap with smaller specimens of this group. The Madura Cave *Notomys* is smaller than *N. longicaudatus* and *N. amplus*. It is also smaller than *N. robustus* from South Australia, as well as *N. magnus* from northeastern Queensland (Mahoney et al. 2008; Vakil et al. 2023). Based on specimens with a complete m1–3, the mean trl for *Notomys* from Madura Cave is 4.90 mm ± 0.40 mm, N = 13.

There are no consistent trends in size vs. stratigraphic position. The mean length of M1 varies from 2.12 ± 0.15 mm (Unit 4) to 2.08 ± 0.16 mm (Unit 2) in Trench 4, and from 2.16 ± 0.07 mm (Unit 2) to 2.19 ± 0.10 mm (Unit 1) in Trench 3. Neither were any stratigraphic trends in morphologic variation observed. Therefore, all specimens of *Notomys* are interpreted as a single species.

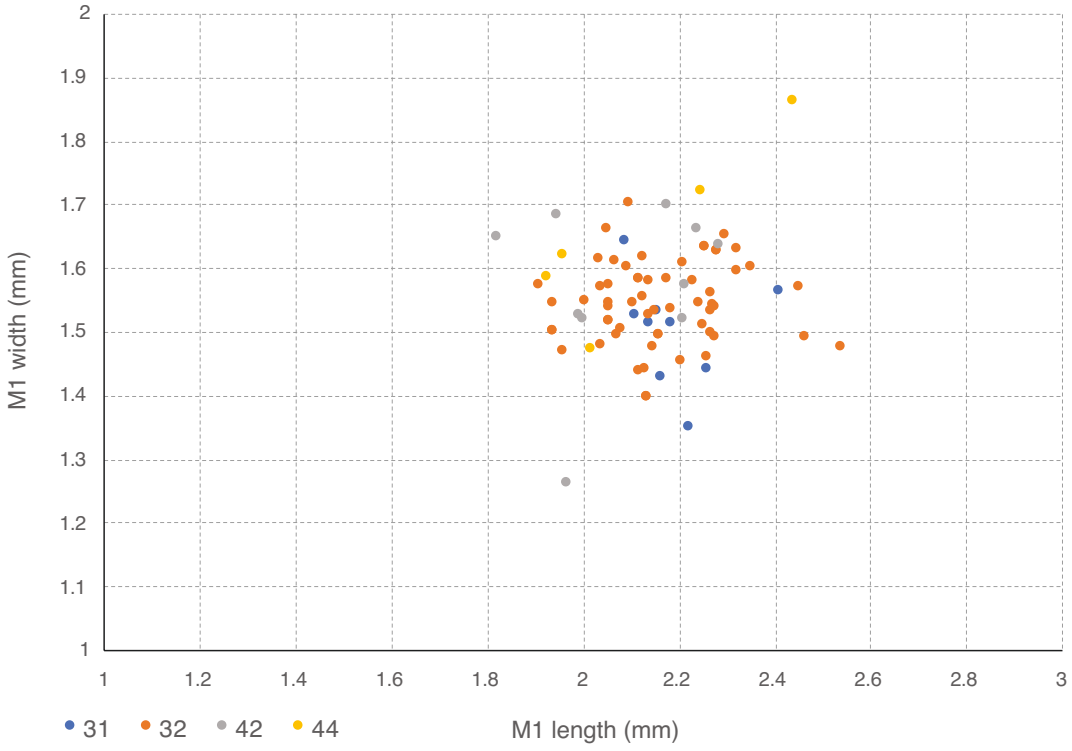

FIGURE 13 Graph of M1, l x w for *Notomys* sp. indet. Blue = Trench 3, Unit 1; Orange = Trench 3, Unit 2; Grey = Trench 4, Unit 2; Yellow = Trench 4, Unit 4.

The most complete cranial specimens from Madura Cave are TMM 41106-341 and TMM 41106-342, both from Trench 3, Unit 2. The anterior palatal foramina are long and taper slightly toward the anterior (Figure 14). The posterior termination is approximately aligned with the T1–3 loph on M1. The ratio of foramen to diastema length is approximately 0.71. The premaxilla-maxilla suture occurs just anterior to the midpoint of the anterior palatal foramina. The posterior palatal foramina are relatively large and elongate and are located at the anterior edge of the palatine (Table 10). The anterior portion of the zygomatic arch is broad with a concave zygomatic plate and a well-developed anterior zygomatic spine (Figures 14–19).

A series of images shown in Figures 16–20 illustrates maxillae of *Notomys* sp. indet. with variable cheek tooth wear. Arbitrary slices, through some of the CT volumes, clearly illustrate three roots on M1, three roots on M2, and three roots on M3, although the anterior two roots on the last are fused together. The concave anterior edge of the zygomatic plate and the anterior zygomatic spine, imaged in these figures, are characteristic of *Notomys*. The M1 is oval in shape with T1 and T4 displaced posteriorly. The lingual cusps (T1, T4) are distinct and larger than the labial (T3, T6). The posterior loph (T8–T9) is wide and inflated antero-posteriorly. There is no evidence for an anterior cingulum or accessory cusps. The posterior loph of M3 is relatively small and oval in shape and connects to the medial loph with wear. It is most similar to the small posterior loph in *N. mitchellii* but narrower than in both *N. longicaudatus* and *N. alexis*.

The dentary and lower cheek teeth of *Notomys* sp. indet. are illustrated in Figure 21. The first two lophs on m1 are separated by a deep valley and not joined by a low cristid as in *N. cervinus*. The m1 and m2 have very distinct posterior cuspids as in *N. cervinus* and *N. mitchellii*. This cuspid is absent, or very weakly developed, in *N. longicaudatus* and *N. alexis*. The lower cheek teeth have two roots each. The dorsal and ventral crests of the masseteric scar form a relatively acute angle terminating in a rugose tip above the mental foramen. The mental foramen is located on the posterolabial portion of the diastema. The average length of the diastema is 3.71 mm (SD = 0.43, N = 11).

FIGURE 14 *Notomys* sp. indet. (TMM 41106-342), Trench 3, Unit 2, partial skull with slightly worn L and R M1–3, L I and partial R I: A) lateral view, anterior to the left; B) oblique anterior view showing anterior zygomatic spine and broad concave zygomatic plate, medial groove on anterior margin of incisor; C) dorsal view, anterior to the left; D) palatal view, anterior to the left, showing anterior and posterior palatal foramina. AZS: anterior zygomatic spine. Scale = 5 mm. (Micro-CT images.)

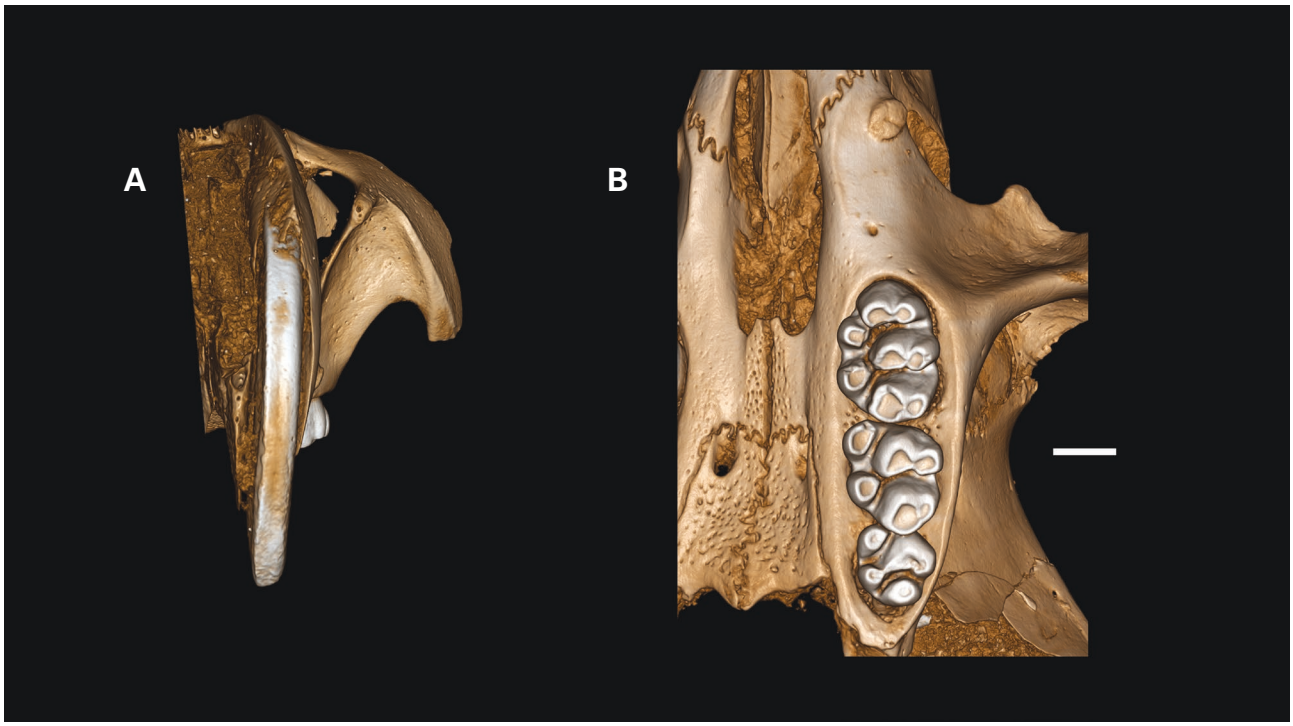

FIGURE 15 *Notomys* sp. indet. (TMM 41106-342): A) anterior view showing shallow groove along anterior margin of left incisor; B) occlusal view showing morphology of L M1–3, anterior up. Scale = 1 mm. (Micro-CT images.)

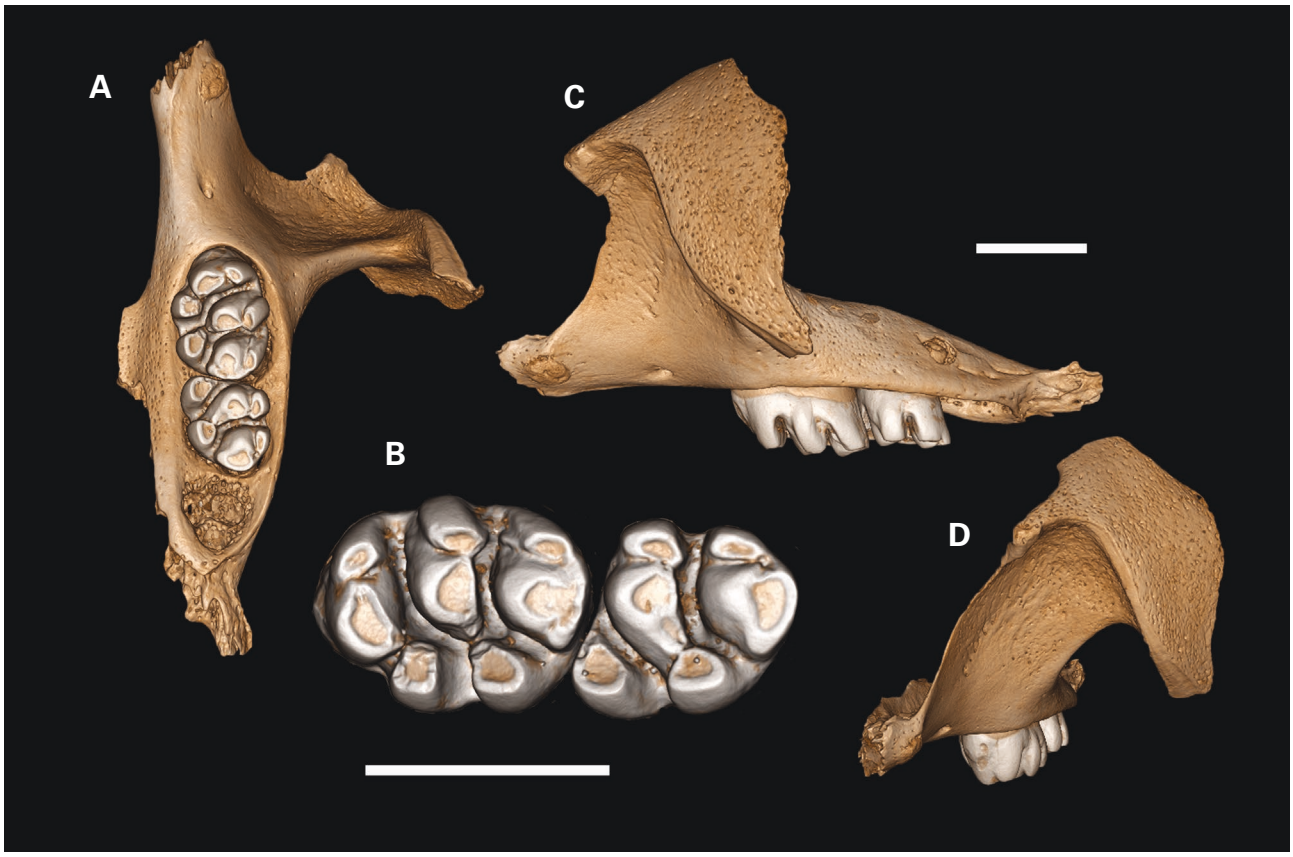

FIGURE 16 *Notomys* sp. indet. (TMM 41106-2008), Trench 3, Unit 2, L maxilla with slightly worn M1–2; A) occlusal view, anterior up, showing zygomatic spine and broad zygomatic plate, scale = 2 mm; B) close up of M1–2, anterior to left, scale = 2 mm; C) labial view, anterior to left, scale = 2 mm; D) anterior view showing zygomatic spine and concave zygomatic plate, scale = 2 mm. (Micro-CT images.)

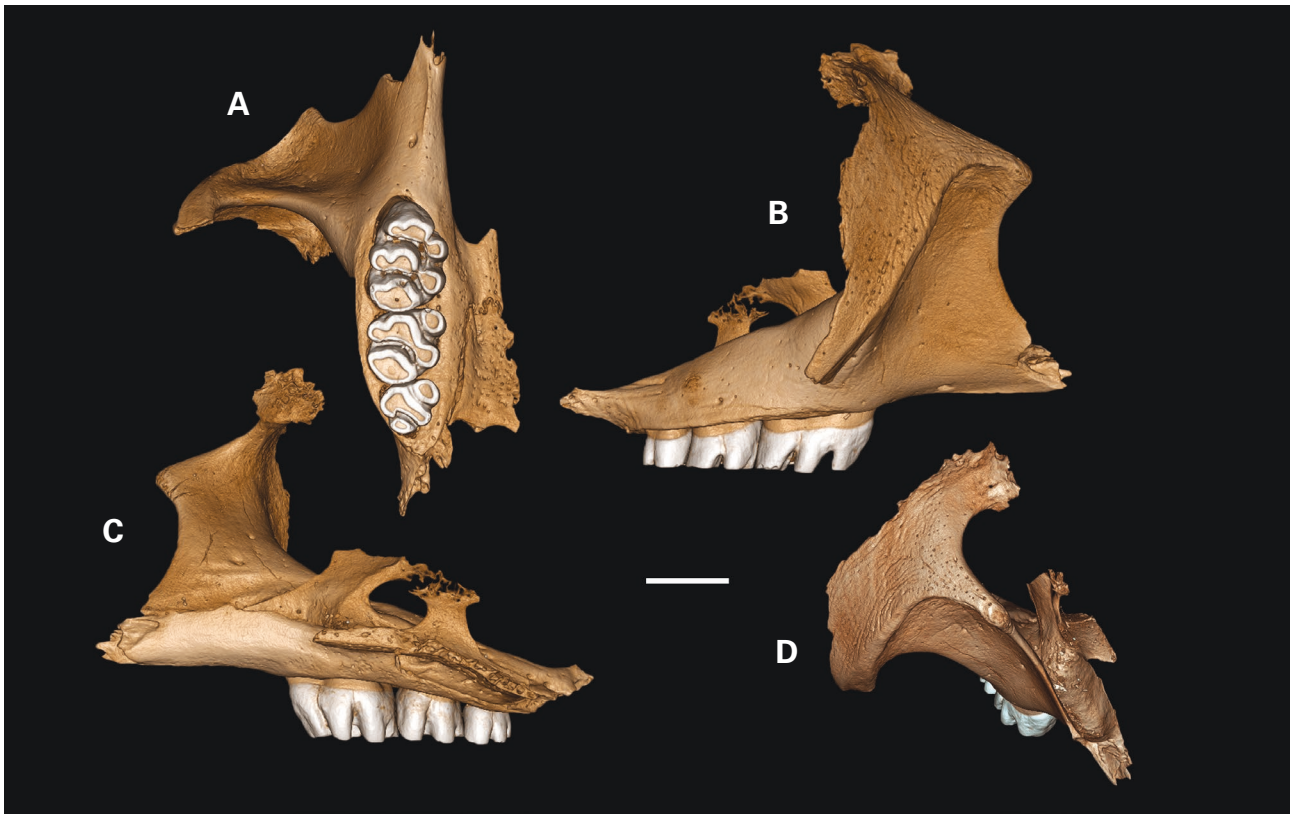

FIGURE 17 *Notomys* sp. indet. (TMM 41106-3717), Trench 1, top 30 cm, R maxilla with moderately worn M1-3: A) occlusal view, anterior up, showing zygomatic spine and broad zygomatic plate; B) labial view, anterior to right; C) lingual view, anterior to left; D) anterior view showing zygomatic spine and concave zygomatic plate. Scale = 2 mm. (Micro-CT images.)

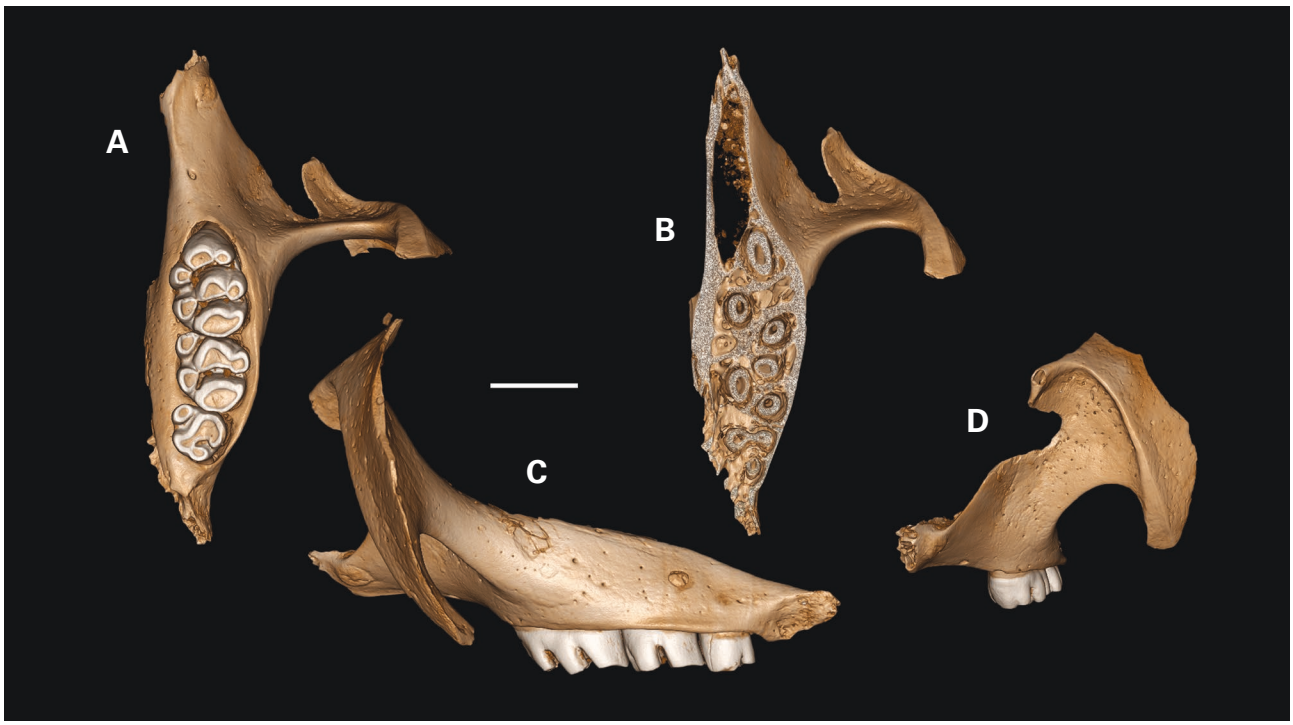

FIGURE 18 *Notomys* sp. indet. (TMM 41106-2012), Trench 3, Unit 2, L maxilla with moderately worn M1–3; A) occlusal view, anterior up; B) arbitrary slice through occlusal view showing three roots for each of M1–3, anterior roots of M3 are fused; C) labial view, anterior to left; D) anterior view showing broken zygomatic spine and zygomatic plate. Scale = 2 mm. (Micro-CT images.)

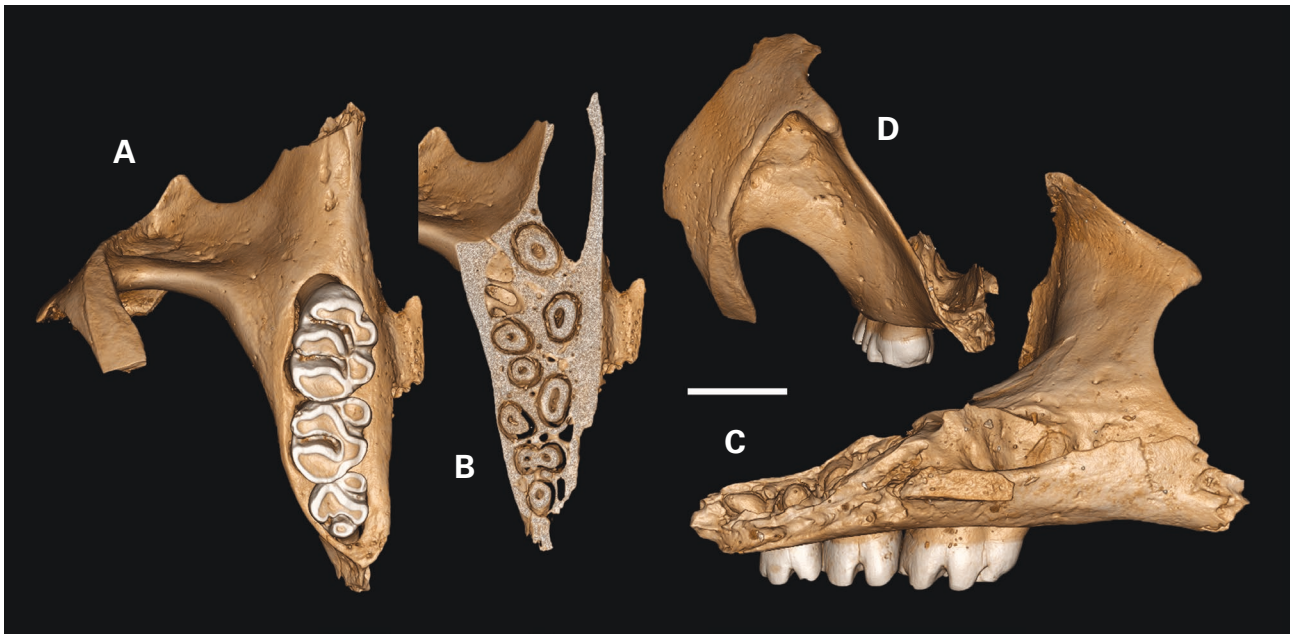

FIGURE 19 *Notomys* sp. indet. (TMM 41106-5657), Trench 3, Unit 2, R maxilla with worn M1–3: A) occlusal view, anterior up, showing zygomatic spine and broad zygomatic plate; B) arbitrary slice through occlusal view showing three roots for each of M1–3, anterior roots of M3 are fused; C) lingual view, anterior to right; D) anterior view showing zygomatic spine and zygomatic plate. Scale = 2 mm. (Micro-CT images.)

FIGURE 20 *Notomys* sp. indet. (TMM 41106-2183), Trench 3, Unit 2, R maxilla with well-worn M1–3: A) occlusal view, anterior to right; B) arbitrary slice through occlusal view showing three roots for each of M1–3 (note the anterior roots of M3 are fused at this level); C) labial view, anterior to right. Scale = 2 mm. (Micro-CT images.)

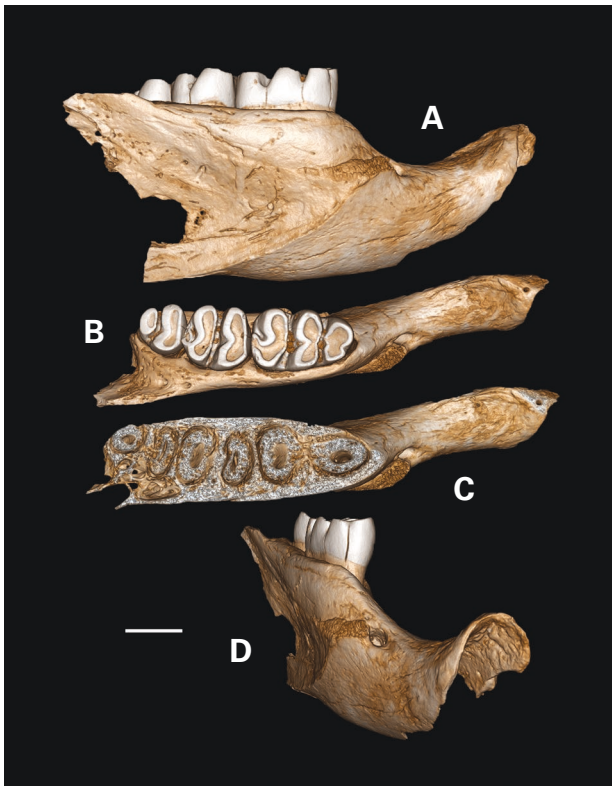

FIGURE 21 *Notomys* sp. indet. (TMM 41106-1204), Trench 3, Unit 2, R dentary: A) labial view, anterior to right; B) occlusal view, anterior to right; C) arbitrary slice through occlusal view showing two roots for m1–3, anterior to right; D) oblique anterolabial view showing anterior termination of the masseteric scar above mental foramen. Scale = 2 mm. (Micro-CT images.)

TABLE 8 Dimensions of *Notomys* sp. indet. cheek teeth from Madura Cave, all units.

	Mean (mm)	SD	Range (mm)	N
M1 l	2.15	0.14	1.82–2.54	87
M1 w	1.54	0.09	1.26–1.86	87
M2 l	1.51	0.12	1.24–1.88	71
M2 w	1.42	0.10	1.18–1.71	71
M3 l	1.07	0.07	0.95–1.28	51
M3 w	1.10	0.07	0.93–1.25	51
m1 l	2.17	0.30	1.51–2.50	41
m1 w	1.34	0.21	0.87–1.58	41
m2 l	1.33	0.23	0.85–1.64	22
m2 w	1.32	0.24	0.88–1.62	21
m3 l	1.14	0.17	0.97–1.53	11
m3 w	1.11	0.10	0.95–1.22	11

TABLE 9 M1 length statistics for *Notomys* sp. indet. from Madura Cave by trench and stratigraphic unit.

Trench/Unit	3/1	3/2	4/2	4/4–5
Mean (mm)	2.19	2.16	2.08	2.12
Median (mm)	2.16	2.14	2.09	2.02
SD	0.10	0.07	0.16	0.15
N	9	64	10	5

TABLE 10 Skull dimensions in mm for *Notomys* sp. indet. as defined by Musser et al. 2005.

Length of the rostrum	10.83
Width of the rostrum	4.42
Interorbital width	6.34
Width between zygomatic spines	8.06
Width across the nasals	3.23
Length of the nasals	9.54
Length of the anterior palatal foramina	5.69
Max. width of the anterior palatal foramina	2.22
Length of diastema	7.95
Length of bony palate	4.78
Width between posterior palatal foramina	1.58
Width of zygomatic plate	3.96
TRL (M1–3)	4.85

DISCUSSION

Based on size and dental morphology, *Notomys* sp. indet. compares most closely with *N. fuscus*, *N. cervinus* and *N. mitchellii*. However, in addition to being smaller than these taxa, it differs in details of dental morphology. *Notomys* sp. indet. differs from *N. cervinus* in the separation of the anterolabial and anterolingual cuspids from the protoconid and metaconid on m1. T1 is more strongly connected to T2, and T9 is less distinct on M1. The T4–T6 loph is better developed on M3, but T8 is much smaller than in *N. cervinus*. However, like *N. cervinus*, the Madura Cave *Notomys* exhibits a shallow groove on the anterior margin of the upper incisors (Figures 14–15) (Watts and Aslin 1981). The anterior groove on the upper incisor was considered diagnostic of *N. cervinus* and *N. macrotis* by Watts and Aslin (1981). The latter taxon is not well known, but appears to have a larger skull with anterior palatal foramina that broaden posteriorly. M1 measurements for *N. macrotis* in Mahoney (1975) are 2.8 x 1.9 mm with a TRL of 5.5 mm and trl of 5.5 mm. This is significantly larger than *Notomys* sp. indet. from Madura Cave (2.15 mm x 1.54 mm, TRL = 4.90, trl = 4.68). *Notomys* sp. indet. is distinct from both *N. cervinus* and *N. macrotis* even though it exhibits an anterior groove on the upper incisor.

Notomys sp. indet. from the Madura Cave fauna differs from *N. mitchellii* in having a more distinct T6 on M1 and a broader T8–T9 posterior loph. T8–T9 is also broader on M2 than in *N. mitchellii*. The M3 of these two taxa is similar with a very small posterior loph (T8). The posterior cuspids on m1 and m2 are better developed than in *N. mitchellii* and the anterolabial and anterolingual cuspids on m1 are more equal in size. *Notomys* sp. indet. differs from *N. fuscus* in having a much larger T3 on M1 and in lacking the accessory cusp adjacent to T6. T6 on M2 is relatively larger than in *N. fuscus* and T8 on M3 is rounder in occlusal view. *Notomys fuscus* appears to lack the posterior cuspids on m1 and m2 as seen in *Notomys* sp. indet. and the posterior lophid (entoconid-hypoconid) on m3 is more reduced, relative to the anterior lophid.

A single species of *Notomys* is present and very abundant in the Madura Cave fauna. Fossils of this taxon range in age from approximately 22,000–7,500 BP based on the available C14 data. On the basis of size and dental morphology, *Notomys* sp. indet. can be distinguished from all other species of the genus and perhaps deserves a separate name. Among the rodents in the Madura Cave fauna, *Notomys* sp. indet. is the second most abundant species behind *Leporillus conditor* (Lundelius and Turnbull 1999). Several species of *Notomys* are extant on the Nullarbor Plain and adjacent areas (Boscacci et al. 1987). *Notomys mitchellii* is known from southern Western Australia, southern South Australia, and north-western Victoria. *Notomys alexis* is known from the arid zone in central Australia. *Notomys fuscus* was previously recorded on the Nullarbor, but is now

restricted to eastern South Australia (Baker and Gynther 2023). *Notomys longicaudatus*, although now probably extinct, was previously widespread across the central arid zone north of the Nullarbor Plain. *Notomys cervinus* was identified from Horseshoe Cave on the Hampton Tableland northeast of Madura by Archer (1974) while the range is now restricted to the Lake Eyre Basin of South Australia and south-western Queensland (Baker and Gynther 2023).

Genus *Leporillus* Thomas 1906

Specimens of the genus *Leporillus* are abundant. *Leporillus conditor* is represented by ~1,800 specimens from all stratigraphic units, including Unit 7, and all trenches, including Trench 5. *Leporillus apicalis* is much less abundant and is only known from Units 1–2 in Trenches 1–4. The *Leporillus* material has been described in an earlier publication (Lundelius and Turnbull 1999) and is not repeated here.

Order Lagomorpha Brandt, 1855

Genus *Oryctolagus* Lilljeborg, 1871

Oryctolagus cuniculus (Linnaeus,1758)

MATERIAL EXAMINED

TMM 41106-29, partial left dentary p3–4. This specimen was recovered from the surface of the cave floor.

DISCUSSION

TMM 41106-29 demonstrates that at least some of the surface material is 'recent' in age. Following the introduction from Europe, rabbits spread across the Nullarbor Plain in the 19th century. They were reported at Eucla in 1894 (Long 1974) and at Eyre on the Roe Plain in 1896 (Mason 1897; Brooker 1977).

Order Carnivora Bowdich, 1821

Family Canidae Fischer de Waldheim, 1817

Genus *Canis* Linnaeus, 1758

Canis familiaris Linnaeus, 1758

(Figure 22)

MATERIAL EXAMINED

TMM 41106-21, R dentary c, p1–4, m1–2, alveoli for m3 and i1–3. Collected from the floor surface in Madura Cave.

DESCRIPTION

The dentary is elongate, deepest beneath m1 and has the usual form of a long jawed canid (Figure 22). There is a pronounced masseteric fossa that extends posteriorly, from beneath the m3 to the condyle. The pit shallows gently in an arc-shaped bend, about at the level of the condyle. The coronoid process is rounded, and extends above the condyle for about the same distance as the condyle is above the bottom of the angular process. The angular process is stout and extends posteriorly for about one cm to end just beneath the condyle. There is a thin, sharp ridge along its ventral edge. A shallow smooth fossa lies on its dorso-lingual surface. This fossa is bounded by a ridge that forms the lower part of the angular notch. It is bounded lingually by a sharp ridge that extends from the posterior end of the process to the lingual surface of the dentary below and behind the mandibular foramen. The mandibular foramen is slit-like. The mental foramen is oval, and is situated midway to the ventral edge of the dentary beneath p1 and p2.

The teeth of this adult show moderate wear. Alveolar length from the front of p1 to the rear of the alveolus of m3 is 73 mm. Other dental measurements include: c = 10.0 mm (l), 7.6 mm (w); p1= 4.1 mm (l); p2 = 8.8 mm (l); p3 = 9.6 mm (l); p4 = 11.9 mm (l); m1= 21.0 mm (l); m2 = 9.5 mm (l).

On the lingual side of the dentary, the symphysis provided a ligamentous attachment for its counterpart and extends back to the level of the rear of p2. The coronoid process is thickest anteriorly and thins posteriorly. It is gently recurved, and its hooked posterior end reaches back to the front of the condyle. The angular process is deflected lingually and there is a distinct scar for the internal pterygoid muscle. The deep temporalis attachment scar covers the medial face of the coronoid process to its base at the level of the alveolar margin, and extends nearly to the anteromedian edge of the condyle.

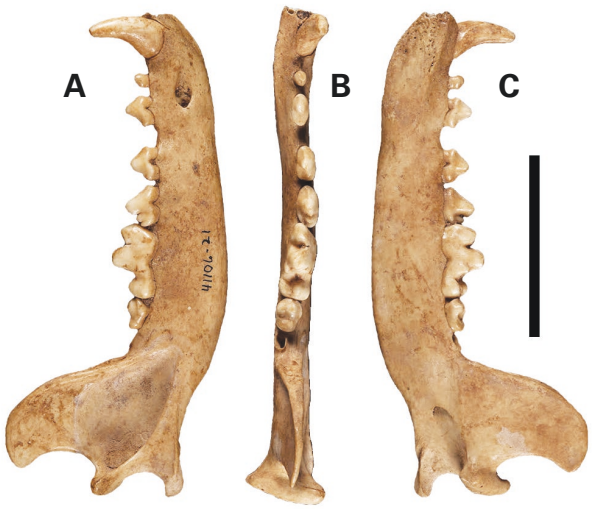

FIGURE 22 *Canis familiaris* (TMM 41106-21), R dentary with c, p1–4, m1–2, alveoli for m3 and i1–3; A) labial view; B) occlusal view; C) lingual view. Anterior up. Scale = 50 mm.

There are four small diastemae: between p2 and p3 is the largest, followed in descending size by c and p1, then p1 and p2, and by a minute one between p3 and p4.

DISCUSSION

The differentiation of dingo from domestic dogs is difficult and the subject of some debate. Eleven skull characters have been used to separate the two canids (Macintosh 1975). The depth of the medial fossa of the angular process and the diastema between the p2 and p3 are from the dentary. The diastema between p2 and p3 was present in all dingoes examined by Macintosh (1975) and was absent in all domestic dogs examined by him. A survey of 15 domestic dog skulls in the TxVP collection showed that 4 had a p2–p3 diastema, but not as well developed as in the Madura Cave specimen. The depth of the medial fossa of the angular process in the TxVP sample of domestic dogs was variable.

In summary the Madura Cave specimen has a very well-developed diastema between the p2 and p3. The medial fossa on the angular process is distinct but, since Macintosh (1975) did not describe criteria for scoring its development, it cannot be reliably compared. The mandibular foramen is slit–shaped in TMM 41106-21, differing from the TxVP sample of dogs. In view of these characters, we conclude that the Madura Cave specimen is a dingo. Additional dingo specimens from within the stratigraphic section in the Southern Tunnel of Madura Cave (see Figure 2), are the oldest known record of dingos from Australia based on C14 (AMS) dates (Balme et al. 2018).

Order Chiroptera Blumenbach, 1779

A small number of specimens, identified as bats, were found in the excavations in Madura Cave. Based on size, all of the material is identified as Yangochiroptera. Six specimens include partial skulls, maxillae and upper dentitions with a sufficient suite of morphological characters to permit identification. Size and morphology suggest that all of the upper dentitions are from a single species. A group of dentaries and lower dentitions is associated with this taxon based on size, although no uppers and lowers were found in clear association. At least one additional taxon is significantly larger, but represented only by dentaries and lower dentitions of unremarkable character. Fossil bats were recovered from multiple trenches, and are most common in stratigraphic Units 1 and 2. Two isolated teeth of Yangochiroptera indet. were recovered from Trench 4, Unit 4–5. Dental terminology follows Martinez (2010). Dental measurements for the Madura Cave bats were made with an reticle for single teeth and with calipers for multi-tooth dimensions.

Suborder Yangochiroptera Springer et al. 2001

Family Vespertilionidae Gray, 1821

Genus *Chalinolobus* Peters,1866

Chalinolobus sp. cf. *morio* (Gray, 1841)

(Figures 23–25, Tables 11–12)

MATERIAL EXAMINED

12 specimens (see Appendix 1).

DESCRIPTION

Specimens of a small bat are characterised by having a single, small alveolus for P2 situated lingually between C and P4. P1 and P3 are absent. The hypocone is reduced and the metacone is large especially on M1. M3 is relatively large (Figure 23). Lower molars are myotodont (hypoconulid isolated from postcristid). The mental foramen is located on the labial side of the dentary beneath the canine and p3.

TABLE 11 Dimensions in mm of upper cheek teeth for *Chalinolobus* sp. cf. *morio*. Estimates based on alveoli designated with 'a'.

Specimen	P4 l	P4 w	M1–3	M1 l	M1 w	M2 l	M2 w	M3 l	M3 w
PM 6076 L	0.82	1.18	-	1.41	1.39	-	-	-	-
PM 6076 R	0.87	1.02	3.19	1.26	1.21	1.22	1.36	1.26	1.41
TMM 41106-485	0.80	1.14	3.13a	1.30a	1.34a	1.36	1.55	1.40	1.62
PM 61077 L	1.04	1.13	3.11a	-	-	1.34	1.36	1.34	1.40
PM 61077 R	0.85	1.10	3.11	1.32	1.27	1.29	1.44	1.32	1.41
PM 61054	0.932	1.18	3.33	1.46	1.36	1.40	1.55	1.29	1.49
Mean	0.89	1.13	3.21	1.36	1.31	1.32	1.45	1.32	1.47
SD	0.09	0.06	0.11	0.09	0.08	0.07	0.10	0.05	0.09

TABLE 12 Dimensions in mm of lower cheek teeth for *Chalinolobus* sp. cf. *morio*. Estimates based on alveoli designated with 'a'.

Specimen	m1–3 l	m1 l	m2 l	m3 l
TMM 41106-484	3.55	1.35	1.24	1.26
PM 61032	3.11a	0.98a	1.23	-
PM 61033	3.10a	1.10a	1.18	0.82a
PM 61034	3.19a	1.16a	1.20	0.98a
PM 61035	3.07a	0.95a	1.01a	0.88a
PM 61046	3.12a	1.03a	1.03a	0.89a

DISCUSSION

A small bat from the Madura Cave fauna is represented by 12 specimens, including both upper and lower dentitions. P2 is has fallen out in all specimens, but is represented by a single, small alveolus positioned lingually between C and P4. This character is observed in vespertilionid bats belonging to the genera *Chalinolobus*, *Pipistrellus* and *Falsistrellus*. Other Microchiropoterans are known to have reduced P2, such as *Tadarida*, *Chaerephon*, *Emballonura*, *Hipposideros, Rhinolophus* and *Rhinonicteris*. All specimens of these taxa, that we examined, have the P2 situated labially rather than lingually.

Additional characters of the upper molars, and the size of these specimens, compare well with

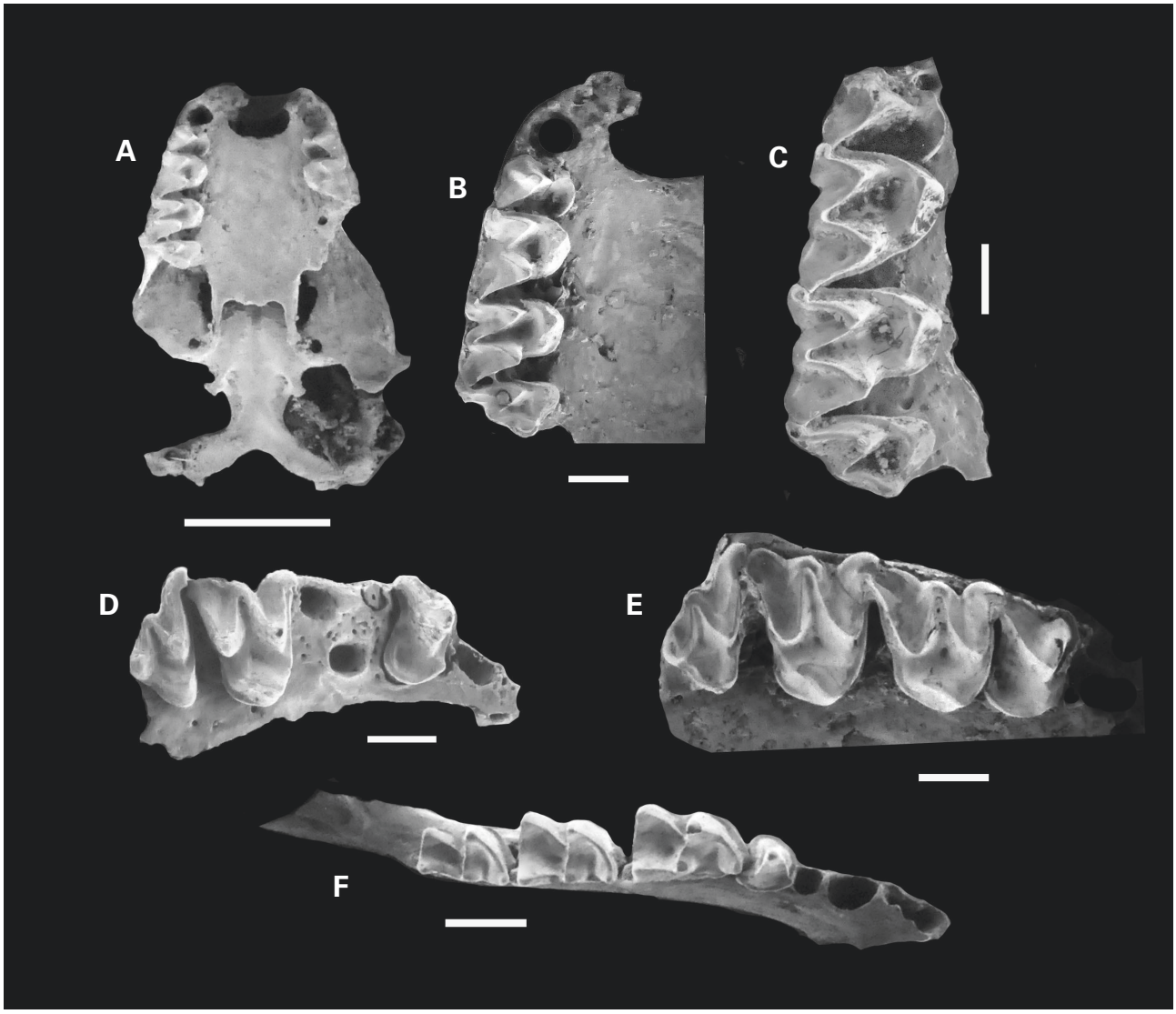

FIGURE 23 *Chalinolobus* sp. cf. *morio*: A) PM 6076, Trench 1, Unit 1, partial skull, palatal view, anterior to top (scale: 5 mm); B) PM 6076, occlusal view right P4–M3, anterior to the top, scale= 1 mm; C) PM 61054, Trench 4, Unit 2, R maxilla with alveolus for P2, P4–M3, anterior to the top, scale= 1 mm; D) TMM 41106-485, right maxilla with P4, M2–3, anterior to the right, scale= 1 mm; E) PM 61077, Trench 1, Unit 1, partial right maxilla with occlusal view of P4–M3, anterior to the right, scale= 1 mm; F) TMM 41106-484, Trench 2, Unit 1, L dentary with p4–m3, anterior to the right, scale = 1 mm. (SEM images).

Chalinolobus morio. The size is also similar to *C. picatus*, but the palate of *C. picatus* has broad transverse grooves and ridges while the palate of *C. morio* and *C. gouldii* are smooth. The Madura Cave specimens have smooth palates (Figure 23). *Chalinolobus morio* is smaller than *C. gouldii* and both M1 and M2 are more triangular, due to the smaller hypocone. *Chalinolobus* was described by Miller (1907) as lacking a hypocone, however, the hypocone is variably developed in extant species and its presence was noted in *C. gouldii*, *C. dwyeri*, and *C. morio* by Martinez (2010). The Madura Cave specimens fall in the M1 length range of *C. morio* and *C. dwyeri*, but are longer than *C. picatus* (Figure 24). The l x w trend is different from the modern species of *Chalinolobus,* with the M1 being narrower relative to length. *Chalinolobus dwyeri* is only distinguished dentally from *C. morio* and *C. picatus* by size (Martinez, 2010). The dimensions of the lower cheek teeth of *Chalinolobus* sp. cf. *morio* are similar to *C. morio* and *C. picatus* (Figure 25).

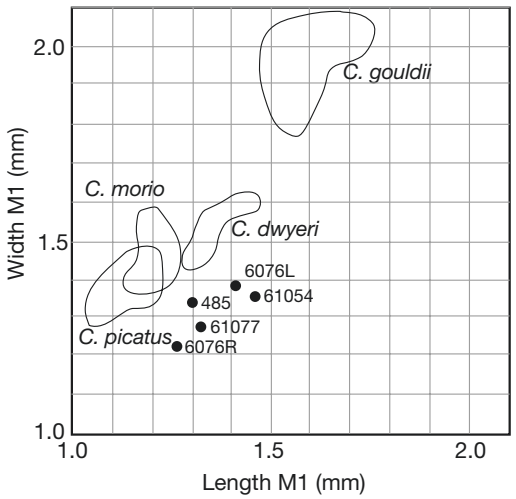

FIGURE 24 Measurements for M1 of *Chalinolobus* sp. cf. *morio* from Madura Cave (dots with specimen numbers). Enclosed regions illustrate the range of M1 dimensions for species of *Chalinolobus* from Martinez (2010).

Boscacci et al. (1987) recorded eight species of bats on the Nullarbor Plain including *Chalinolobus morio* and *Chalinolobus gouldii*. The current range of *Chalinolobus morio* includes southern Western Australia, south-eastern Australia, Tasmania, and isolated areas through the central part of the country. The current range of *Chalinolobus dwyeri* includes south-eastern Queensland and north-eastern New South Wales. It was recognised in the Pleistocene Mount Etna fauna of eastern-central Queensland (Martinez 2010).

***Yangochiroptera* sp. indet.**

(Figure 26, Table 13)

MATERIAL EXAMINED

Four specimens (see Appendix 1).

DESCRIPTION

Four dentaries, with partial lower dentitions, loosely cluster in a size range significantly larger than *Chalinolabus morio* (Figure 25, Table 13). All lower molars are myotodont with no outstanding characters. The mental foramen is located on the labial side of the dentary beneath the canine and p3. The most complete specimen is PM 6078, which has a sub-cylindrical articular condyle that tapers slightly medially (Figure 26).

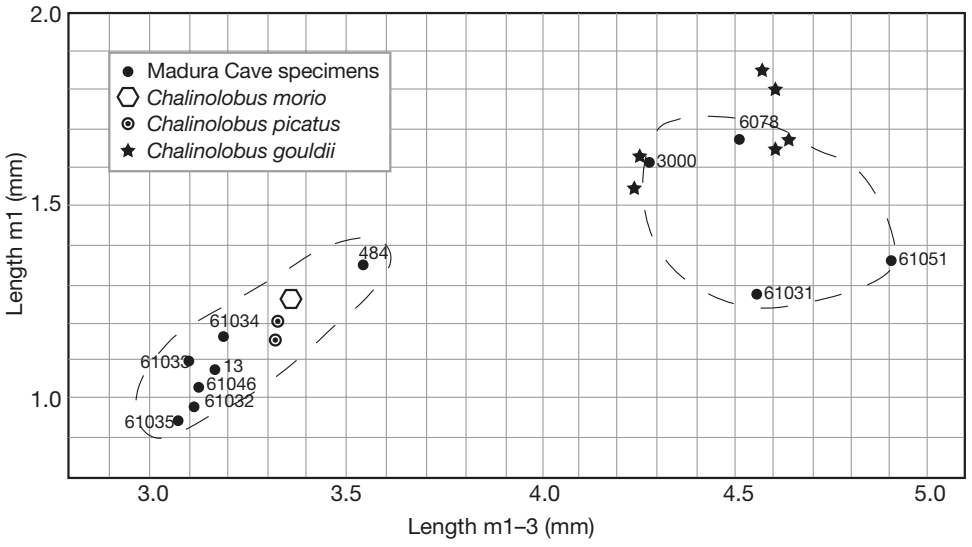

FIGURE 25 Bivariate plot of m1 length vs m1–3 length for bats from Madura Cave. Madura Cave specimens are numbered and shown by solid dots. Values for specimens of *Chalinolobus morio*, *Chalinolobus picatus*, and *Chalinolobus goudii* as per embedded legend.

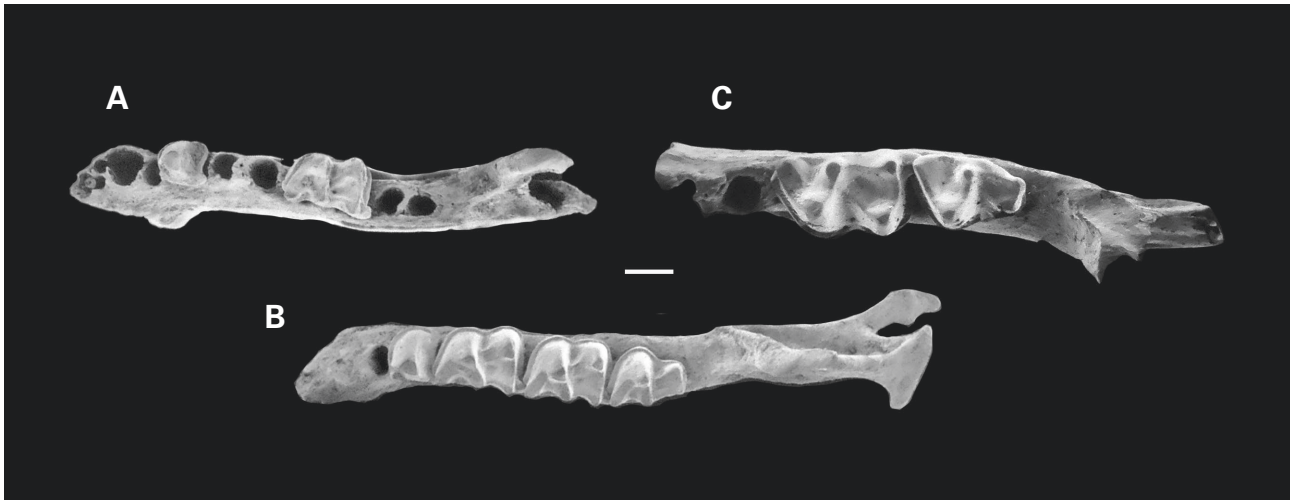

FIGURE 26 *Yangochiroptera* sp. indet., dentaries and lower dentitions: A) PM 61031, R dentary with p4 and m2; B) PM 6078, R dentary with p4–m3; C) PM 61051, partial L dentary with m2–3. Anterior to the left in all. Scale = 1 mm. (SEM images).

DISCUSSION

At least two taxa of yangochiropteran bats were present in the Madura Cave fauna from about 22,000 to 7,500 BP. *Chalinolobus morio* is still found in the area (Boscacci et al. 1987). A second taxon, represented only by lower dentitions, partially overlaps the size range of *C. gouldii*, but, lacking associated upper dentitions, we offer no identification. There is a significant range in size of these lower dentitions, as shown in Figure 26. Based on comparison of Figure 26 with specimens in the collection at WAM, N.L. McKenzie (pers. comm. 2025) has suggested that PM 6078 and PM 61031 represent two different species of *Nyctophilus*, while PM 61051 is an example of the molossid *Austronomus*.

TABLE 13 Measurements in mm for *Yangochiroptera* sp. indet. Estimates based on alveoli designated with 'a'.

Specimen	m1–3 l	m1 l	m2 l	m3 l
PM 6078	4.51	1.66	1.65	1.47
PM 61051	5.10a	1.35a	1.95	1.51
PM 61031	4.55a	1.27a	1.82	1.23a
TMM 41106-3000	4.29	1.61	1.46	1.36

GENERAL DISCUSSION

Sedimentary strata in the Northern Tunnel of Madura Cave span at least the last 38,000 years. The limestone floor of the cave was never reached during excavations. The stratigraphy is complex and lithostratigraphic correlation between nearby trenches is difficult. The sedimentary strata within the cave were deposited through a combination of ephemeral stream deposits and cave collapse. Our trenches did not encounter material dated between 7,500 BP and the present time, other than the surface specimens. The post-7,500 BP gap may be partly represented by archaeological excavations in the Southern Tunnel (Milham and Thompson 1976). Most of the taxa, mentioned from the Southern Tunnel, are the same as those identified from the Northern Tunnel, with the addition of the macropodid *Osphranter rufus* (*'Megaleia rufa')*. The rabbit and dingo specimens were found on the present floor of the cave. Additional work, on other dingo material from shallow deposits in the Southern Tunnel of Madura Cave, yielded age estimates based on C14 (AMS) of approximately 3,250 BP (Balme et. al. 2018).

The Madura Cave strata contain remains of vertebrates that provide a record of the fauna living on the Roe Plain during the late Pleistocene and early Holocene. The marsupials and one genus of rodent were reported earlier and we now add the remaining placental record. Included are five additional species of rodents, two of bats, one each of *Oryctolagus* and *Canis*. Most of the rodents and bats, were recovered from Units 1 and 2 (Holocene and Pleistocene). The record of *Notomys* sp. indet. continues back to Unit 4–5. *Pseudomys desertor* is apparently absent from Unit 1, but present in Units 2–7 extending back to ~38,000 BP.

As the final chapter of our work on the Madura Cave fauna, it is useful to review the entire faunal list. The marsupials were summarised by Lundelius and Turnbull (1989). The faunal list (Table 14) has been updated for taxonomic changes that have occurred in the past 35 years. It also includes the placental mammals bringing the total number of taxa to 49.

TABLE 14 Fossil mammal fauna from the Northern Tunnel of Madura Cave, Western Australia. R: recent fauna of the Nullarbor Plain; Unit 1: Holocene (~7,500 BP); Units 2–3: ~5,000–22,000 BP; Units 4–5: ~22,000–30,000 BP; Units 6–7: ~38,000 BP.

[1] *Antechinomys spenceri* in Lundelius and Turnbull (1975).
[2] *Dasyuroides byrnei* in Lundelius and Turnbull (1978) according to Newman-Martin et al. (2023),
[3] *Isoodon obesulus* in Lundelius and Turnbull (1981) according to Travouillon and Phillips (2018),
[4] *Caloprymnus campestris* in Lundelius and Turnbull (1984) according to McNamara (1997),
[5] *Bettongia penicillata* in Lundelius and Turnbull (1984) according to Haouchar et al. (2016),
[6] *Macropus robustus* in Lundelius and Turnbull (1989),
[7] *Megaleia rufa* in Milham and Thompson (1976).

Order	Family	Taxon	R	1	2–3	4–5	6–7
Dasyuromorphia	Dasyuridae	cf. *Planigale* sp.			●	●	●
		Sminthopsis crassicaudata	●	●	●	●	●
		Sminthopsis murina group		●	●	●	●
		Antechinomys laniger[1]		●	●	●	●
		Antechinus flavipes			●	●	●
		Phascogale calura		●	●	●	
		Phascogale tapoatafa		●	●		
		cf. *Parantechinus apicalis*		●			
		Dasycercus cristicauda		●	●	●	●
		Dasycercus archeri[2]		●	●	●	●
		Dasyurus geoffroii		●	●	●	●
		Sarcophilus harrisii		●	●		
	Thylacinidae	*Thylacinus cynocephalus*			●		
	Myrmecobiidae	*Myrmecobius fasciatus*		●			
Peramelemorphia	Peramelidae	*Perameles* sp. indet.	●	●	●	●	●
		Isoodon fusciventer[3]		●	●	●	●
	Chaeropodidae	*Chaeropus ecaudatus*		●	●	●	●
	Thylacomyidae	*Macrotis lagotis*		●	●	●	●
Diprotodontia	Thylacoleonidae	*Thylacoleo* sp.		●			
	Vombatidae	*Lasiorhinus* sp. cf. *latifrons*	●		●	●	●
	Phascolarctidae	*Phascolarctos cinereus*		●			
	Phalangeridae	*Trichosurus vulpecula*			●		
	Pseudocheiridae	*Pseudocheirus peregrinus*			●		
	Burramyidae	*Cercartetus concinnus*	●		●	●	●
	Potoroidae	*Potorous platyops*		●	●	●	●
		Bettongia pusilla[4]		●	●	●	●
		Bettongia lesueur		●	●		
		Bettongia penicillata Clade I[5]		●	●	●	
	Macropodidae	*Sthenurus* sp. indet.			●	●	
		Lagorchestes hirsutus		●	●	●	
		Lagostrophus fasciatus		●	●		
		Onychogalea lunata		●	●		
		Protemnodon sp. indet.			●		
		Petrogale sp. indet.		●	●		
		Macropus fuliginosus	●	●			
		Macropus titan			●	●	●
		Osphranter robustus[6]	●		●	●	
		Osphranter rufus[7]	●	●			

Order	Family	Taxon	R	1	2–3	4–5	6–7
Rodentia	Muridae	*Leporillus conditor*		●	●	●	●
		Leporillys apicalis		●	●		
		Pseudomys bolami	●	●	●		
		Pseudomys gouldii		●	●		
		Pseudomys australis		●	●		
		Pseudomys sp. cf. *desertor*			●	●	●
		Notomys sp. indet.		●	●	●	
Chiroptera	Vespertilionidae	*Chalinolobus* sp. cf. *morio*	●	●	●		
		Yangochiroptera sp. indet.		●	●	●	
Carnivora	Canidae	*Canis familiaris*	●				
Lagomorpha	Leporidae	*Oryctolagus cuniculus*	●				

Based on analysis of the marsupial fauna, Lundelius and Turnbull (1989) interpreted the major change in faunal composition to have occurred between the Pleistocene (Units 2–7) and Holocene (Unit 1). Much of the change was interpreted to predate environmental perturbations associated with European settlement. However, Simpson Similarity Indices (Simpson 1960) have now been calculated for the same stratigraphic groupings defined in Lundelius and Turnbull (1989) utilising the entire Madura Cave faunal list (except for the rabbit and dingo).

The Simpson Similarity Indices for faunal comparison between Units 6–7 vs Units 4–5, and between Units 4–5 vs Units 2–3 are very high (100%). The similarity index between Unit 1 and Unit 2–3 is 83%, indicating significant change, but a high degree of similarity between the Pleistocene and Holocene faunas. Taxa present in the Pleistocene, but apparently absent from the early Holocene, include cf. *Planigale, Antechinus flavipes*, *Thylacinus cynocephalus*, *Myrmecobius fasciatus*, *Lasiorhinus* sp. cf. *latifrons*, *Cercartetus concinnus, Sthenurus* sp., *Protemnodon* sp., *Osphranter robustus,* and *Pseudomys* sp. cf. *desertor*. Three of these taxa are known from the present Nullarbor Plain fauna suggesting that their absence in Unit 1 may have been a preservation/sampling issue. In that case, the faunal change from Units 2–3 to Unit 1, would be even less dramatic. Based on the entire faunal list, faunal change had begun during the transition from the Pleistocene to Holocene. However, the most significant change in the Madura Cave area occurred between the early Holocene and present faunas. A Simpson Similarity Index of ~43% is calculated between Unit 1 and the present fauna of the Nullarbor Plain based on restricting the present taxon count to current known ranges (Boscacci et al. 1987; Baker and Gynther 2023).

Mammalian diversity within the Madura Cave fauna was much higher than in the present fauna of the Nullarbor Plain. Approximately 20% of the taxa known from the Madura Cave sedimentary units are now extinct. Forty percent are threatened, according to the IUCN 3.1 classification, and have limited ranges that do not include the Nullarbor Plain. Boscacci et al. (1987) noted minor differences in faunal composition between the Nullarbor Plain and the Roe Plain.

The placental mammals contribute little to our understanding of factors influencing faunal evolution in the Madura Cave area. *Chalinolobus morio* is known through large parts of Australia and roosts in trees as well as caves (Baker and Gynther 2023). The species of *Notomys* recovered from Madura Cave cannot be confidently identified as any of the extant species. The current range of *Pseudomys bolami* includes the arid lands of the Nullarbor Plain, however, *P. desertor* is now restricted to the arid and semi-arid central parts of Australia and north into the dry-tropical savannas (Baker and Gynther 2023). The absence of *P. desertor* from Unit 1 may indicate a change in local environment near the Pleistocene – Holocene boundary. However, *P. desertor* is very rare in the Madura Cave fauna and may never have been present in significant numbers. *Pseudomys gouldii*, although once widespread across southern Australia, is now found naturally on a single island in Shark Bay, Western Australia (Roycroft et al. 2021). The current range of *P. australis* is restricted primarily to the eastern half of South Australia, although records indicate a prior distribution along coastal areas of the Great Australian Bight (Baker and Gynther 2023). Abundance and distribution of *P. australis* has been correlated with changes in food resources associated with rainfall events, as well as predation by feral cats and red foxes (Pavey et al. 2014). There is no consistent, climate-change related pattern reflected in the geographic ranges of fossil placental mammals from Madura Cave. Higher aridity in the late Pleistocene – early Holocene may be consistent with the relatively small sizes of some of the Madura Cave rodents (e.g. *Pseudomys australis*, *Notomys* sp. indet.) and the presence of *Pseudomys* sp. cf. *desertor*. The climate of the Nullarbor Plain was more arid in the late Pleistocene compared to the late Holocene, based on interpretation of mammals from Allen's Cave by Baynes (1994).

The rodent ranges have almost certainly been influenced by habitat destruction imposed by European settlement, agriculture, and introduced predators (Baynes 1979; Burbidge and McKenzie 1989; Vakil et al. 2023). The rapid loss of mammal diversity documented at Madura Cave between the early Holocene and present day is similar to other records from southern Australia (Bilney et al. 2010; McDowell and Medlin 2010, Start et al. 2011; Fusco et al. 2016).

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APPENDIX 1 Specimens examined in this study.

Specimen	Material examined
Pseudomys bolami	
Trench 1, top 30 cm	
PM 6079	partial skull L, R M1
PM 6080	R maxilla and premaxilla I, M1–3
PM 6081	R maxilla and premaxilla I, M1–3
PM 6082	R maxilla M1–3
PM 6083	R maxilla M1–3
PM 6084	L maxilla M1–3
PM 6085	L maxilla M1–3
PM 6086	L maxilla M1–3
PM 6087	L maxilla M1–3
PM 6088	R maxilla M1–3
PM 6089	L maxilla M1–3
Trench 3, Unit 1	
TMM 41106-450	L edentulous maxilla
TMM 41106-455	L maxilla M3
TMM 41106-466	R maxilla M1
Trench 3, Unit 2, Level 1	
TMM 41106-3790	L maxilla M1–3
Trench 3, Unit 2, Level 2	
TMM 41106-1785	L dentary m1–2
TMM 41106-1786,	L dentary m1
TMM 41106-1788	L dentary i, m1–2
TMM 41106-1789	L dentary m1–2
TMM 41106-1791	L dentary m1–2
TMM 41106-1792	L dentary i, m1
Trench 4, Unit 1, Level 1, top 30 cm	
TMM 41106-3501	L dentary m1
TMM 41106-3502	R dentary m1
TMM 41106-3503	R dentary i, m1–2
TMM 41106-3504	R dentary i, m1–3
TMM 41106-3505	R dentary m1–2
TMM 41106-3507	R dentary i, m1–2
TMM 41106-3508	R dentary i, m1
TMM 41106-3509	L dentary m1
TMM 41106-3510	R dentary m1
TMM 41106-3511	R dentary m1
TMM 41106-3513	L dentary m1–2
TMM 41106-3514	L dentary i, m1–3
TMM 41106-3515	L dentary i
TMM 41106-3516	R dentary m1
TMM 41106-3517	R edentulous maxilla
TMM 41106-3518	R edentulous maxilla
TMM 41106-3519	R maxilla M2
TMM 41106-3520	L maxilla M1–3

Specimen	Material examined
Trench 4, Unit 1	
TMM 41106-451	L maxilla M1
TMM 41106-452	L maxilla M1–3
TMM 41106-453	L maxilla M1–2
TMM 41106-454	L maxilla M1–3
TMM 41106-455	L maxilla M3
TMM 41106-456	L maxilla M2
TMM 41106-457	L maxilla M1
TMM 41106-458	L maxilla M1–3
TMM 41106-459	L maxilla M1–2
TMM 41106-460	R maxilla M1–3
TMM 41106-461	L maxilla M1–3
TMM 41106-463	L maxilla M1–3
TMM 41106-464	L maxilla M2
TMM 41106-466	R maxilla M1
TMM 41106-467	R maxilla M1–2
TMM 41106-468	R maxilla M1–2
TMM 41106-469	R maxilla M2
TMM 41106-470	R maxilla M2
TMM 41106-471	R maxilla M2
TMM 41106-472	R maxilla M2
TMM 41106-473	R maxilla M2
TMM 41106-474	R maxilla M2
Trench 4, Unit 2, top 30 cm	
TMM 41106-2995	L dentary i, m1
TMM 41106-2996	R dentary i, m1–3
TMM 41106-2997	R dentary i, m1–2
TMM 41106-2998	L dentary m1–2
TMM 41106-2999	R dentary m1–3
TMM 41106-3521	L maxilla M1–2
Trench 4, Unit 2	
TMM 41106-2990	R dentary i, m1
TMM 41106-2991	R dentary i, m1–2
TMM 41106-2992	L dentary i, m1–3
TMM 41106-2993	L dentary i, m1–3
TMM 41106-2994	R dentary i, m1–3
Pseudomys australis	
Trench 1, Unit 1	
PM 6110	R maxilla and premaxilla I, M1–3
PM 6112	R maxilla M1–2
PM 6113	L maxilla and premaxilla M1–2
PM 6115	L maxilla M1–3
PM 6116	R maxilla M1–2
PM 25364	R maxilla M1–2
TMM 41106-3815	R dentary m1

Specimen	Material examined
Trench 3, Unit 2	
TMM 41106-3543	L maxilla M1
TMM 41106-3545	L maxilla M1
TMM 41106-3546	L maxilla M2–3
TMM 41106-3547	L maxilla M2–3
TMM 41106-3548	L maxilla M3
TMM 41106-3553	L maxilla M1
TMM 41106-3554	L maxilla M1
TMM 41106-3555	L maxilla M1
TMM 41106-3556	L maxilla M1
TMM 41106-3557	L maxilla M2
TMM 41106-3558	L maxilla M1
TMM 41106-3559	L maxilla M1–2
TMM 41106-3560	L maxilla M2
TMM 41106-3561	L maxilla M1
Pseudomys gouldii	
Trench 1, top 30 cm	
PM 6114	L premaxilla and maxilla M1–3
PM 25365	R premaxilla and maxilla I, M3
Trench 1, top 76 cm	
PM 26178	L dentary m1
Trench 3, Unit 1, Level 1	
TMM 41106-1555	R maxilla M1–3
TMM 41106-1556	R maxilla M2–3
TMM 41106-1560	R maxilla M2–3
Trench 3, Unit 2	
TMM 41106-1984	L maxilla M2
TMM 41106-1992	L maxilla M1–2
TMM 41106-3547	L maxilla M2–3
Pseudomys* sp. cf. *desertor	
Trench 3, Unit 2, Level 1	
TMM 41106-2071	R maxilla M2–3
Trench 3, Unit 2, Level 2	
TMM 41106-3551	L edentulous maxilla
Trench 4, Unit 2, top 30 cm	
TMM 41106-3528	L maxilla
TMM 41106-4060	R M1
Trench 4, Unit 2, Level 2	
TMM 41106-4069	R M1
TMM 41106-4072	R M1
TMM 41106-4073	L M1
TMM 41106-4074	L M1

Specimen	Material examined
Trench 4, Unit 3	
TMM 41106-3974	L M1
TMM 41106-3979	R M1
TMM 41106-3984	L M1
Trench 4, Units 4–5	
TMM 41106-3911	R M1
TMM 41106-3912	L M1
TMM 41106-3913	R M1
TMM 41106-3914	R M1
TMM 41106-3915	R M1
TMM 41106-3919	L M1
TMM 41106-3920	L M1
TMM 41106-3922	L M1
TMM 41106-3928	R M1
TMM 41106-3930	L M1
TMM 41106-3933	R M1
TMM 41106-3935	R M1
TMM 41106-3939	L M1
TMM 41106-3940	R M1
TMM 41106-3945	R M1
TMM 41106-3947	R M1
TMM 41106-3948	L M1
TMM 41106-3950	L M1
TMM 41106-3953	R M1
TMM 41106-3956	L M1
TMM 41106-3962	R M1
TMM 41106-3964	L M1
TMM 41106-3965	R M1
TMM 41106-3968	L M2
TMM 41106-4018	L M1
TMM 41106-4019	L M1
TMM 41106-4021	R M1
TMM 41106-4029	R M1
TMM 41106-4030	L M1
TMM 41106-4031	R M1
TMM 41106-4033	L M1
TMM 41106-4035	L M1
TMM 41106-4037	L M1
TMM 41106-4040	L M1
TMM 41106-4041	R M1
TMM 41106-4044	R M1
TMM 41106-4045	L M1
TMM 41106-4046	L M1
TMM 41106-4050	R M1
TMM 41106-4051	R M1
TMM 41106-4057	R M1
Trench 4, Unit 7, Level 2	
TMM 41106-3907	L M1

Specimen	Material examined
***Notomys* sp. indet.**	
Trench 1, top 30 cm	
TMM 41106-3717	R maxilla M1–3
Trench 3, Unit 1	
TMM 41106-442	L dentary m1–2
TMM 41106-443	L dentary m1–3
TMM 41106-444	L dentary m1–2
TMM 41106-445	L dentary m1–3
TMM 41106-449	L dentary m1
TMM 41106-1557	R maxilla M1–3
TMM 41106-1558	R maxilla M1–3
TMM 41106-1559	R maxilla M1–2
TMM 41106-1561	R maxilla M1–3
TMM 41106-1566	R maxilla M1–2
TMM 41106-1569	R maxilla M1–3
TMM 41106-1570	R maxilla M1–3
TMM 41106-1571	R maxilla M1–2
TMM 41106-1578	R maxilla M1–2
TMM 41106-1614	L maxilla M2
Trench 3, Unit 2	
TMM 41106-341	partial skull L and R M1–3
TMM 41106-342	partial skull L and R M1–3
TMM 41106-360	L maxilla M1–3
TMM 41106-1996	L maxilla M3
TMM 41106-1997	L maxilla M2–3
TMM 41106-1998	L maxilla M1–3
TMM 41106-2000	L maxilla M1–3
TMM 41106-2001	L maxilla M3
TMM 41106-2002	L maxilla M1–3
TMM 41106-2003	L maxilla M2–3
TMM 41106-2004	L maxilla M1–3
TMM 41106-2005	L maxilla M1–3
TMM 41106-2006	L maxilla M1–3
TMM 41106-2008	L maxilla M1–2
TMM 41106-2011	L maxilla M1–3
TMM 41106-2012	L maxilla M1–3
TMM 41106-2013	L maxilla M1–2
TMM 41106-2014	L maxilla M1–3
TMM 41106-2015	L maxilla M1–3
TMM 41106-2110	L maxilla M1–3
TMM 41106-2111	L maxilla M1–2
TMM 41106-2112	L maxilla M1–3
TMM 41106-2115	L maxilla M1–3
TMM 41106-2119	L maxilla M1–3
TMM 41106-2120	L maxilla M1–3
TMM 41106-2122	L maxilla M1–3
TMM 41106-2125	L maxilla M1–3
TMM 41106-2179	R maxilla M1–2
TMM 41106-2181	R maxilla M1–2
TMM 41106-2182	R maxilla M2–3
TMM 41106-2183	L maxilla M1–3
TMM 41106-2184	L maxilla M1–3
TMM 41106-2185	R maxilla M1–3
TMM 41106-2187	R maxilla M1–2
TMM 41106-2188	R maxilla M1–3
TMM 41106-2189	R maxilla M1
TMM 41106-2190	R maxilla M1–2
TMM 41106-2191	L maxilla M1 and 3
TMM 41106-2193	R maxilla M1–2
TMM 41106-2196	R maxilla M1–2
TMM 41106-2197	R maxilla M1–3
TMM 41106-3553	L maxilla M1
TMM 41106-3554	L maxilla M2
TMM 41106-3555	L maxilla M1
TMM 41106-3556	L maxilla M1
TMM 41106-3557	L maxilla M2
TMM 41106-3559	L maxilla M1–2
TMM 41106-3560	L maxilla M2
TMM 41106-3561	L maxilla M1
TMM 41106-3622	R maxilla M3
TMM 41106-3625	R maxilla M1
TMM 41106-3627	R maxilla M1
TMM 41106-3628	R maxilla M1
TMM 41106-3630	R maxilla M1
TMM 41106-3631	R maxilla M1
TMM 41106-3632	R maxilla M1
TMM 41106-3633	R maxilla M1
TMM 41106-3634	R maxilla M1
TMM 41106-3635	R maxilla M1
TMM 41106-3636	R maxilla M1
TMM 41106-3637	R maxilla M1
TMM 41106-3639	R maxilla M1
TMM 41106-3640	R maxilla M2–3
TMM 41106-3641	R maxilla M2–3
TMM 41106-3642	R maxilla M2–3
TMM 41106-3643	R maxilla M2–3
TMM 41106-3662	L dentary i, m1–3
TMM 41106-3663	L dentary i, m1–3
TMM 41106-3664	R dentary i, m1–3
TMM 41106-3666	L dentary i, m1–3
TMM 41106-3667	R dentary i, m1–3
TMM 41106-3674	R dentary i, m1–3
TMM 41106-3684	R dentary i, m1–2
TMM 41106-3686	R dentary m1
TMM 41106-3687	R dentary i, m1–2
TMM 41106-3705	L dentary m1
TMM 41106-3707	L dentary m1
TMM 41106-5657	R maxilla M1–3
TMM 41106-5657.2	R maxilla M1–3
TMM 411106-3558	L maxilla M1

Specimen	Material examined
Trench 4, Unit 2	
TMM 41106-994	L maxilla M1–3
TMM 41106-998	L maxilla M1–2
TMM 41106-1000	L maxilla M1
TMM 41106-1001	L maxilla M1–2
TMM 41106-1041	L dentary m2
TMM 41106-1045	L dentary m1
TMM 41106-1046	L dentary m1
TMM 41106-1047	L dentary m1
TMM 41106-1049	L dentary m1
TMM 41106-1051	L dentary m1
TMM 41106-1173	R maxilla M1
TMM 41106-1174	R edentulous maxilla
TMM 41106-1175	R maxilla M1
TMM 41106-1176	R maxilla M1–3
TMM 41106-1182	L dentary i, m1–2
TMM 41106-1183	L dentary m1
TMM 41106-1196	L maxilla M1
TMM 41106-2903	M1
TMM 41106-2904	M1
Trench 4, Unit 3	
TMM 41106-1185	L dentary i, m1
Trench 4, Unit 4–5	
TMM 41106-1204	R dentary m1–3
TMM 41106-1205	R dentary m1
TMM 41106-1215	R dentary m1
TMM 41106-1223	R dentary m1
TMM 41106-1242	R maxilla M1–2
TMM 41106-1243	R maxilla M1
TMM 41106-1244	R maxilla M1
TMM 41106-1245	R maxilla M1–2
TMM 41106-1246	R maxilla M2
TMM 41106-1247	R maxilla M1–2

Specimen	Material examined
Chalinolobus* sp. cf. *morio	
Trench 1, Unit 1	
PM 6076	partial skull L P4–M1, R P4–M3
PM 6077	partial skull L P4, M2-3, R P4–M3
PM 26165	partial skull L M2–3
PM 61043	R dentary fragment m2–3
PM 61077	L maxilla P4–M3
Trench 2, Unit 1	
TMM 41106-484	L dentary p4–m3
TMM 41106-485	partial skull R P4, M1–3, L P4, M2–3
PM 61032	R dentary p4, m2–3
PM 61033	L dentary m2
PM 61034	R dentary m2
PM 61035	L dentary p4
Trench 4, Unit 2	
PM 61054	R maxilla P4–M3
***Yangochiroptera* sp. indet.**	
Trench 1, Unit 1	
PM 6078	R dentary p4–m3
PM 61031	R dentary p4 and m2
Trench 3, Unit 2	
TMM 41106-3000	R dentary p4–m3
PM 61051	L dentary m2–3
Trench 4, Unit 4–5	
PM 26282	R m2
PM 26283	R m2