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Wildlife Research

Supplementary Material

Subfossils suggest worse-than-realised losses of small-bodied mammals in northern Australia

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Supplementary Material

Pertinent remarks on the taxonomy of the fauna identified from Millennium, Three-Avenue and Swiftlet caves at Broken River. All samples are now curated in the collections of the Queensland Museum, Brisbane, Australia. Abbreviations are as follows: QMF: Queensland Museum Fossil; QMMO: Queensland Museum Mollusc collection.

Phylum Mollusca

Gastropoda

The following land snails were recovered from surface deposits of the three caves included in the study. Colour notes of species are based on freshly dead shells from the Queensland Museum collections in most cases.

Helicinidae

Pleuropoma brecanrio (Broken River droplet-snail) **QMF61894** (Supplementary Figure S1A)

Shell tiny, brown, top-shaped with an angulate periphery. Protoconch sculptured with low spiral cords, teleoconch with prominent spiral cords. Apertural lip thickened, operculum present. Shell diameter approximately 4 mm.

Remarks. Similar to *P. extincta* from the Chillagoe-Palmerville limestones but differs by its smaller size and fewer spiral cords on the teleoconch. The only operculate land snail recovered in the deposits.

Pupillidae

Gyliotrachela australis (eastern trumpetsnail) **QMF61895** (Supplementary Figure S1B)

Shell tiny, dark brown, conically trochoidal with a strongly angulate body whorl. Sculpture of spiral threads and weak axial growth threads. Aperture ovate, trumpet-like with a strongly flared

lip, detached from the shell and deflected upward with parietal and palatal teeth. Umbilicus open. Shell height approximately 3 mm.

Remarks. Distinguished by a combination of conically trochoidal shell with a detached trumpet-like aperture.

Glyptopupoides egregia (ribbed pupasnail) **QMF61896** (Supplementary Figure S1C)

Shell tiny, waxy brown, cylindrical elongate with moderately spaced sculpture comprising a combination of weak axial ribs and spiral threads. Aperture ovate without teeth or lamellae, lip moderately reflected. Shell height approximately 4 mm.

Remarks. Distinguished by a combination of tiny, axially ribbed shell that lacks barriers.

Pumilicopta bifurcata (many-toothed pupasnail) (No image available)

Shell minute, greyish white, conically pupiform, smooth with weak axial growth threads. Whorls strongly rounded. Aperture subquadrate with numerous barriers comprising a long parieto-angular barrier, several smaller barriers and several accessory nodes are situated just outside the lower lip. Lip strongly reflected. Umbilicus tiny. Shell height approximately 2 mm.

Remarks. Readily identified by a combination of tiny white shell with numerous apertural barriers. Unfortunately, the single specimen of this species identified from Millennium Cave was misplaced prior to being photographed.

Subulinidae

Eremopeas tuckeri (Tucker's awlsnail) **QMF61897** (Supplementary Figure S1D)

Shell small, narrowly elongate and tapering, translucent cream to dull white; sutures crenulated and strongly impressed; apex blunt, nipple-like and sculptured with fine, spiral lines. Teleoconch sculpture comprising prominent, coarse, regular, arcuate growth lines. Shell height approximately 8 mm.

Remarks. Distinguished by the small narrowly elongate and tapering shell.

Rhytididae

Scagacola einasleigh (Einasleigh carnivorous snail) **QMF61898** (Supplementary Figure S1E)

Shell medium-sized, creamy yellow to brown, sub-discoidal with a very low spire. Protoconch relatively smooth with oblique striations at the end, teleoconch sculptured with bold ribs above, becoming degenerate on the body whorl and giving rise to prominent, discontinuous spiral striae at the end. Umbilicus wide V-shaped. Shell diameter 18.5 mm.

Remarks. Distinguished by a combination of larger size, boldly ribbed teleoconch and widely open umbilicus.

Punctidae

Punctid sp. (Supplementary Figure S1F)

Shell tiny, depressedly turbinate with an elevated spire. Protoconch with sparse cord-like spiral lirae, teleoconch with weakly curved radial ribs and fine spiral striae. Umbilicus wide U-shaped. Shell diameter approximately 2 mm.

Remarks. Distinguished by a combination of tiny shell with elevated, spirally sculptured spire and widely open umbilicus.

Charopidae

Excaliburopa greenvaleiana (Greenvale pinwheel snail) **QMF61899** (Supplementary Figure S1G)

Shell tiny, orange-brown, discoidal with a flat to slightly elevated spire, whorls tightly coiled, sutures deeply impressed. Protoconch sculpture finely cancellate comprising a lattice of fine spiral cords and curved radial ribs, teleoconch with moderately spaced, prominent radial ribs c. 130 on the last whorl. Umbilicus very wide V-shaped. Shell diameter approximately 2.5 mm.

Remarks. Distinguished by a shell with cancellate protoconch sculpture and prominent radial ribbing on the teleoconch.

Charopid sp. 1 (Supplementary Figure S1H)

Shell tiny, white, sub-discoidal with an elevated spire, whorls evenly coiled with impressed sutures. Protoconch with moderately spaced radial ribs, teleoconch with numerous, moderately spaced prominent radial ribs. Umbilicus very wide V-shaped. Shell diameter approximately 2 mm.

Remarks. Distinguished by a shell with the radial sculpture on both the protoconch and teleoconch.

Charopid sp. 2 (Supplementary Figure S1I)

Shell tiny, white, discoidal with a flat to slightly depressed spire, whorls shouldered with deep sutures. Protoconch sculpture of radial ribs, teleoconch with very closely spaced radial ribs and fine spiral threads. Umbilicus wide cup shaped. Shell diameter approximately 3.5 mm.

Remarks. Distinguished by a shell with shouldered whorls, radially sculptured protoconch and radially ribbed teleoconch.

Helicodiscidae

Stenopylis coarctata **(**white microdisc snail) **QMF61900** (Supplementary Figure S1J)

Shell tiny, translucent white, discoidal; whorls sculptured with fine, widely spaced spiral threads. Aperture with a very prominent bulbous parietal lip. Umbilicus widely open, saucer shaped. Shell diameter approximately 2 mm.

Remarks. Distinguished by a tiny white shell with a large thickened apertural lip and widely open umbilicus.

Helicarionidae

Tarocystis greenvale (Greenvale glass-snail) **QMF61901** (Supplementary Figure S1K)

Shell medium-sized, pinkish-translucent in appearance and discoidal in outline with a slightly elevated and stepped spire; whorls slightly rounded and shouldered; coarse sculpture consisting of widely spaced spiral grooves on the protoconch and early teleoconch, grading to dense, microscopically fine spiral threads on later whorls. Umbilicus narrow. Shell diameter approximately 14 mm.

Remarks. Distinguished by a glassy, macroscopically smooth, discoidal shell with fine spiral microsculpture.

Camaenidae

Lamprellia zebina (Burdekin zebra snail) **QMF61902** (Supplementary Figure S1L)

Shell very large, pale yellow with a varying number of reddish-brown spiral bands continuous on the apertural lip, globose with a low to high domed spire. Whorls rounded, angulate in juveniles. Protoconch with weak, curved radial ridges, teleoconch possessing a sculpture of very fine to coarse pustules. Lip strongly reflected. Umbilicus closed to slightly open. Shell diameter approximately 40 mm.

Remarks. Distinguished by a large globose shell with reddish-brown spiral bands.

Phylum Chordata

Anura

Litoria sp. **QMF61903** (Supplementary Figure S2A)

An isolated, fragmented right ilium has been assigned to the genus *Litoria* on the basis of the presence of an ovoid dorsal protuberance, the absence of a dorsal ilial crest and the presence of a large acetabular fossa (see Tyler 1976; Lauck and Tyler 1999; Hocknull 2005). Species-level

diagnosis was made challenging, owing to the closely resembling ilial morphology of several species within the genus.

Sauropsida

Squamates were mostly identified to their familial level but wherever possible, to their generic and specific levels, too. They are represented (and identified) chiefly by their maxillary and mandibular fragments, vertebrae and isolated teeth.

Agamidae

Diporiphora group 2. *sensu* Hocknull 2002 cf. *D. australis* **QMF61904** (Supplementary Figure S2B)

Maxillary and associated mandibular fragments have been assigned to this group on the basis of features such as a residual to absent narial ridge, presence of one large pleurodont caniniform tooth, presence of a notch anterior to the pleurodont tooth and its overall small size. Five to six (or maybe even seven) small acrodont teeth are present along with seven large acrodont teeth. The pleurodont tooth is only slightly bigger than the first small acrodont tooth and this could either reflect ontogeny or sexual dimorphism (Cooper *et al*. 1970). The group includes multiple species, and it has recently been expanded to include members previously assigned to genus *Amphibolurus* (see Melville *et al*. 2019), thereby rendering precise taxonomic assignment of the Broken River specimens difficult. However, *D. australis* is common in the region today (Hocknull pers. comm.) and is therefore the most likely candidate.

Agamidae gen. et sp. indet. QMF61905 (Supplementary Figure S2C)

A single isolated, cylindrically pointed acrodont tooth has been assigned to the agamid family but could not be resolved beyond the family level for want of more diagnostic material. It is clearly larger than the teeth of the specimen ascribed to *Diporiphora* group 2, above.

Gekkonidae gen. et sp. indet. QMF61906 (Supplementary Figure S2D)

Several isolated gecko lower jaws were recognised on the basis of their uniformly placed, sharply pointed teeth, presence of a closed Meckelian grove and the possession of a relatively straight ventral border of the dentary (Daza *et al.* 2015). They could not be resolved beyond their family level for want of specimens displaying diagnostic features, among the examined fossils.

Scincidae

Egernia sp. indet. **QMF61907** (Supplementary Figure S2E)

A single, isolated lower jaw fragment has been assigned to the skink genus *Egernia*, based on the presence of a V-shaped opening of the splenial notch (where the splenial articulates with the dentary), teeth that flare at the crown, and the presence of the inferior alveolar foramen positioned posterior of the midway point along the dentary, lingually (Hollenshead *et al.* 2011). Two species, *E. hosmeri* and *E. striolata* occur in the Broken River region, today.

Scincidae sp. indet. QMF61908 (Supplementary Figure S2F)

Fragmented lower jaws of scincid lizards are identified on the basis of their closely spaced, uniform, blunt teeth (relative to the sharply pointed teeth of gekkonid lizards). Their taxonomy could not be resolved beyond the family level.

Serpentes indet. QMF61909 (Supplementary Figure S2G)

Snakes are represented by isolated, backwards-facing (aglyphous) teeth and isolated vertebrae. The vertebrae are most likely precloacal based on their shape (short and wide) and the presence of a swollen neural spine that is flattened at the apex (Syromyatnikova *et al.* 2021). Additionally, the majority of the vertebral column of snakes and their fossil record primarily consist of precloacal vertebrae (Polly and Head 2004). The vertebrae, however, could not be resolved beyond the suborder level.

Aves

Aves gen. et sp. indet. **QMF61910** (Supplementary Figure S2H)

A possible barn owl is represented by femora and possible isolated claws. The barn owl femur is characterised by its medium size, a moderately developed, strong trochanter, straight shaft, a wide rotular groove, a conspicuous popliteal area on the distal portion and a strongly developed fibular condyle (Madan *et al.* 2017). Although the femur shows all characteristic features of the barn owl, the identification remains tentative because the overall length of the femur is nearly half the length (~ 25 mm) of the length of the femur of an adult barn owl (~50 mm) (see Madan *et al*. 2017). Alternatively, the specimen could belong to a species of an adult Old World quail (*Coturnix*) or buttonquail (*Turnix*) (Trevor Worthy, pers. comm.).

Mammalia

Marsupialia

Dasyuridae

D. geoffroii **QMF61911** (Supplementary Figure S3A)

Quoll specimens are represented by fragmented maxillae, mandibles and isolated molars. Most *Dasyurus* maxillae and mandibles have only two premolars on each side (premolar $P^{3}/_{3}$ is absent), as against some members of Dasyuridae that have three (Merrilees and Porter 1979; Beck *et al*. 2022). They are assigned here to the western quoll (*D. geoffroii*) on the basis of their size, although distinguishing that species from the similarly sized *D. viverrinus* and *D. dunmalli* can be challenging. However, *D. geoffroii* once inhabited Queensland and went extinct between 1884 and 1907. *D. viverrinus* was only ever reported from fossil assemblages in Russenden Cave and Eastern Darling Downs in southeastern Queensland (Archer and Hand 1984; Archer *et al.* 1984; Wakefield 1967, 1972). Its mainland distribution was restricted to southeast Australia, from which it disappeared in the 1960s. Furthermore, a morphological comparison of the specimens recovered here and those described as *D. viverrinus* in Jones and Rose (2001) demonstrates slight labio-lingual constriction in the molars of the latter. Additionally, *D. dunmalli* possesses a small, additional third premolar (or its alveolus) on its mandible and has

been recorded so far from the Pliocene of Chinchilla (Bartholomai 1971) and Bluff Downs in northern Queensland (Wroe and Mackness 1998). The material described here however, is sufficient to be confidently distinguished from the smaller *D. hallucatus* and the much larger Spotted-tailed Quoll (*D. maculatus*) (Baynes and McDowell 2010). It is also unlikely to belong to the Bronze Quoll (*D. spartacus*), since this taxon is exclusively endemic to the Trans-Fly Plains of Papua New Guinea (Van Dyck 1987). Additionally, the specimens described here are morphologically similar to those ascribed to *D. geoffroii* in Smits and Evans (2012) and are therefore considered to belong to that species.

Antechinus sp. indeterminate **QMF61912** (Supplementary Figure S3B)

Isolated molars were assigned to *Antechinus* using characters discussed in Cramb and Hocknull (2010), primarily the presence of posterior cingula on M^{1-3}. The material, however, is too inadequate to be identified beyond the generic level.

Sminthopsis murina **QMF61913** (Supplementary Figure S3C)

Dunnarts are represented by maxillary and mandibular fragments. They are distinguished from the genus *Antechinus* on the basis of following characters: the inner angles formed by the first three upper molars in species of *Sminthopsis* are more acute than in species of *Antechinus* and the teeth are usually smaller in the former than the latter (Archer 1981). The slender-tailed dunnart (*S. murina*) is easily distinguishable from *S. macroura* by the absence of entoconids on M_{1-3}. As Price *et al*. 2020 note, it is difficult to distinguish them from other species of *Sminthopsis* that lack the entoconids (see also Cramb *et al.* 2009); nevertheless, they have been assigned to *S. murina* in this study on the basis of their size and occurrence in the area, today.

Sminthopsis macroura **QMF61914** (Supplementary Figure S3D)

The stripe-faced dunnart is represented by a single isolated lower jaw fragment and is easily recognizable by its possession of a conspicuous entoconid on M_{1-3} that does not contact the

hypocristid (Archer 1981). All other *Sminthopsis* spp. from the Broken River surface deposits seem to lack entoconids.

Sminthopsis sp. **QMF61915** (Supplementary Figure S3E)

A few isolated, upper molars show the absence of a continuous anterior cingula and highly reduced/absent stylar cusp C. They are larger in size than the other commonly occurring *S. murina* and *S. macroura* in the deposits. Based on their morphology and size, they could potentially belong to the Julia Creek dunnart (*S. douglasi*), although, as noted by Archer (1981), distinguishing it from *S. virginiae* on the basis of craniodental characters alone, can be difficult.

Phascogale tapoatafa **QMF61916** (Supplementary Figure S3F)

The brush-tailed phascogale is represented by fragmented maxillae, mandibles and isolated teeth. The taxon is identified by the presence of posterior cingula on the upper molars, the presence of buccal cingula on M^{1-3} and the overall size of the teeth relative to other dasyurids. The mandibles are identified by strong buccal cingulids on the lower molars and crowded premolars (Merrilees and Porter 1979). *P. tapoatafa* is distinguished from *P. pirata*, *P. calura* and *Phascogale* sp. from Mount Etna (Hocknull 2005; Hocknull *et al.* 2007) by its large size and strong buccal cingulids.

Planigale ingrami **QMF61917** (Supplementary Figure S3G)

The long-tailed planigale is represented by maxillary and mandibular fragments. As Archer (1976) pointed out, the most diagnostic character for the identification and separation of different species of *Planigale* was the presence/absence of $P^{3}/_{3}$ and their relatively small size compared to other dasyurids. The specimens from Millennium Cave have a mean lower molar row measurement of 4.25 mm and fall well within the range of *P. ingrami* (see Archer 1976).

Potoroidae

Aepyprymnus rufescens **QMF61918** (Supplemental Figure S4A)

A single, isolated upper molar (M^1 or M^2) has been assigned to the subfamily of bettongs, potoroos and rat-kangaroos on the basis of its size and bunolophodont morphology. It is unlikely to belong to the genus *Potoroo*, owing to the absence of any conspicuous swelling on the antero-buccal edge of the molar and the absence of any angularity of the antero-buccal edge (Merrilees and Porter 1979). The length of the Broken River molar specimen (4.15 mm) is greater than its width (3.74 mm). It is therefore unlikely to belong to *Bettongia*, since in that genus, the molar width is either equal to the molar length (as in *B. lesueur* and *B. tropica*) or greater than the molar length (as in *B. penicillata*) (Merrilees and Porter 1979). In either case, the Broken River specimen is far outside the known historical range and extant distributions of any *Bettongia* species (see Claridge *et al.* 2007). There is no description of the molars of the genus *Aepyprymnus* in literature but a comparison of the Broken River specimen with photographs of *Aepyprymnus* skulls shows it is likely to belong to that genus, based on its slightly elongated bunolophodont molars. The monospecific rufous bettong (*Aepyprymnus rufescens*) is widely distributed in Queensland (Claridge *et al.* 2007) and occurs locally, in the Broken River region, today. We have therefore, tentatively assigned our specimen to this species.

Peramelidae

Isoodon peninsulae **QMF61919** (Supplemental Figure S4B)

The Cape York brown bandicoot appears to be the most common bandicoot in the Broken River region (see Price *et al.* 2020). Isolated upper molars from Millennium and Three-Avenue caves have been assigned to *I. peninsulae*. Diagnostic features of the taxon, distinguishing it from *I. auratus, I. fusciventer, I. obesulus* and *I. macrourus* are given in Price *et al*. 2020 and include the preparacrista of M^1 being buccally oriented then posterobuccally oriented, presence of a styler crest, presence of a small anterior cingulum on M^2 not connected to the preprotocrista and the presence of a small anterior cingulum.

Pseudocheiridae

Pseudocheirus peregrinus **QMF61920** (Supplemental Figure S4C)

Isolated upper and lower molars were assigned to the common ringtail possum on the basis of characters listed in Archer *et al.* (1997), chiefly the presence of strongly bladed preentocristid on M_1, reduced metaconid on M_1, absence of a notch between the postmetacristid and metastylid, highly reduced buccal shelf and the absence of a protostylid basin on M_1. Additionally, the molars are comparable in size to those of *P. peregrinus* mentioned in Archer *et al*. (1997).

Phalangeridae

Trichosurus sp. indet. **QMF61921** (Supplemental Figure S4D)

A brush-tailed possum is represented by an isolated upper molar that is bunodont. It is distinguished from the pseudocheirids by its bunodont molars. It is further distinguished from potoroids where the overall morphology of the tooth is somewhat intermediate between being bunodont and bilophodont (bunolophodont) and in which the occlusal surface of molars bears four tubercles in two prominent transverse pairs. The species remains unknown because *Trichosurus* spp. have a general lack of diagnostic dental features that distinguish between species (Hocknull 2005) although, *T. vulpecula* is locally extant and is therefore, the most likely candidate.

Macropodidae

Petrogale sp. **QMF61922** (Supplemental Figure S4E)

Macropodid remains are relatively rare in the Broken River fossil deposits and a partial right maxilla and an isolated bilophodont lower molar from Millennium Cave could potentially belong to a rock wallaby (*Petrogale* sp.). Identifying features are mentioned in Merrilees and Porter (1979) and include the presence of a permanent premolar that resembles those of species belonging to the genus *Setonix* but narrower anteriorly, presence of cusps on the permanent premolar that are narrower and inclined buccally and the presence of M^1 that is small and has an angular, buccally-oriented anterior corner to the anterior shelf, and the presence of an M1 with a wide anterior shelf. Although, additional material is wanting for more constrained taxonomic

identification, morphological comparison with the skulls of Herbert's rock-wallaby (*P. herberti*) and the allied rock-wallaby (*P. assimilis*) shows similarities with regards to the overall size of the maxillary fragment and the total molar row. The latter two species belong to the informal group *P. penicillata* complex that occurs in northeastern Queensland and also includes five other species of rock-wallaby: Cape York rock-wallaby (*P. coeninsis*), unadorned rock-wallaby (*P. inornata*), Godman's rock-wallaby (*P. godmani*), mareeba rock-wallaby (*P. mareeba*) and Mount Claro rock-wallaby (*P. sharmani*) (Beck *et al*. 2022). It is therefore likely that the Millennium Cave rock-wallaby also belonged to this same group.

Petauridae

Petaurus norfolcensis **QMF61923** (Supplemental Figure S4F)

Gliders are represented by isolated teeth, maxillary and mandibular fragments. The general morphology of these is consistent with that of the squirrel glider, with molar rows that are proportionally longer than those of *P. breviceps* and *P. biacensis* but shorter than those of *P. australis*, *P. gracilis* and *P. abidi* (Pledge 1992; Price *et al.* 2020).

Placentalia

Muridae

Leggadina forresti **QMF61924** (Supplemental Figure S5A)

Forrest's mouse (or desert short-tailed mouse) is represented in the surface deposits of the Broken River region by an isolated molar and a maxillary fragment. Diagnostic characters of the species are listed in Cramb et al. (2018) and primarily include an enlarged M^1, presence of strongly developed accessory cusp on M^1 (with respect to those of other species such as *L. gregoriensis* and *L. webbi*), relatively small size (compared to the dentitions of *L. macrodonta* and *L. irvini*) and the presence of a relatively straight buccal margin of the anterior palatial foremen compared to that of *L. lakedownensis.*

Conilurus albipes **QMF61925** (Supplemental Figure S5B)

Distinguishing characters of the white-footed rabbit-rat are given in Cramb & Hocknull (2010). These include: the absence of a T3 on M^1 and proportionally narrower molars (compared to *C. capricornensis*). It also differs from *C. penicillatus* in being larger. As noted by Price *et al.* (2020), the Broken River specimens are the northernmost records for this taxon.

Conilurus capricornensis **QMF61926** (Supplemental Figure S5C)

The Capricorn rabbit rat is represented in Millennium Cave by isolated molars, isolated incisors, maxillary and mandibular fragments, tibiae, a single proximal femur, an isolated patella, calcanea and astragali, although only the dentition was utilised for statistical counts because some of the fragmented postcranial elements could potentially belong to *C. albipes*. *C. capricornensis* is a large species of *Conilurus* and has proportionately lower and broader cusps than *C. albipes* (Cramb and Hocknull 2010, Price *et al.* 2020). Its upper molars are easily recognised by their size, presence of a prominent T3 on M^1 (unlike *C. albipes*) and the presence of an anterior cingulum on M^1. The palate possesses a posteriorly narrow anterior palatal foramina while the lower molars are characterised by the presence of anterolingual cusp on M_1 that does not project posteriorly and a reduced to absent posterior cingulid on M_{1-2} (Cramb and Hocknull 2010).

Zyzomys argurus **QMF61927** (Supplemental Figure S5D)

Rock rats are characterised by a combination of small size and the presence of a well-developed T7 on M^{1-2}. Fragmented maxillae with first upper molars and isolated first upper molars have been assigned to the common rock rat based on the small size of M^1 (the species is the smallest within the genus), lingual cusps on M^1 which are proportionally larger than those of other species within the genus, and poorly developed buccal cusps.

Melomys cervinipes **QMF61928** (Supplemental Figure S5E)

The fawn-footed mosaic-tailed rat is represented in the surface deposits by isolated molars. The mosaic-tailed rats (*Melomys*) and giant naked-tailed rats (*Uromys*) are generally distinguished on

the basis of the presence of well-developed lingual cusps on M^{1-2} (but lacking a T7), presence of more than three roots on M^1, presence of worn-down molar cusps that join to form flat-topped lophs and the presence of fine ornament on molar enamel (Watts and Aslin 1981). *M. cervinipes* is distinguished from the grassland mosaic-tailed rat, *M. burtoni* by the presence of four roots on M^1 (the latter has five), although distinguishing it from *M. capensis* (which also has four roots on M^1) can be challenging. However, the mean width of the specimens from the surface deposits is closer to those of *M. cervinipes* and considering that they have been previously reported from the Broken River region, both as fossils (see Price *et al*. 2020) and living, this species is therefore considered to be the most likely candidate.

Pseudomys australis **QMF61929** (Supplemental Figure S5F)

The plains mouse is represented by isolated first upper molars that are proportionately narrow, tapering posteriorly, possessing cusps that are relatively tall compared to those of *P. gracilicaudatus* (but shorter than those of *P. oralis*), a heavily reduced T3 and the absence of an anterior accessory cusp (Martinez and Lidicker 1971, Watts and Aslin 1981). Furthermore, the specimens described here were measured to be well within the size range of *P. australis* specimens from the Queensland Museum (see Supplementary Table 2).

Pseudomys gracilicaudatus **QMF61930** (Supplemental Figure S5G)

The eastern chestnut mouse is represented in the surface deposits by maxillae and isolated molars. Watts and Aslin (1981) list the diagnostic features of the eastern chestnut mouse. These include the presence of broad molars and the presence of a well-developed accessory cusp on M^1, characters also shared by *P. nanus*. On the basis of the known distributions of the taxa, *P. gracilicaudatus* is the more likely contender for the fossil material described here.

Pseudomys gouldii **QMF61931** (Supplemental Figure S5H)

The Gould's mouse is identified based on a combination of the following features of M^1: relatively narrow crown comparted to *P. gracilicaudatus*, accessory cusp variable in size but

commonly forming a link between the bases of T1 and T2, reduced to absent T3, well-developed cusps of the middle loph, a noticeable larger T4 relatively to T1, and a posteriorly tapering T8-T9.

Pseudomys sp. cf. *P. delicatulus* **QMF61932** (Supplemental Figure S5I)

As noted by Price *et al*. (2020), small species of *Pseudomys* are difficult to distinguish. Two extant species have been recorded from tropical Queensland: *P. delicatulus* and *P. patrius*. A fragmented maxilla from Millennium Cave with very worn M^1 has been assigned to *P. delicatulus* because it preserves the posterior-most portion of the anterior palatial foramen that extends past the anterior margin of M^1. Presence of accessory cusp on the anterior loph of M^1 is variable as noted by Watts and Aslin (1981). Additional isolated first upper molars have been assigned to *P. delicatulus* on the basis of their small size although the occurrence of *P. patrius*, or other small *Pseudomys* species cannot be completely excluded. Furthermore, the latter two species are slightly different in size, relative to *P. delicatulus*. They can be detected in the presence of abundant material to measure, but it can still be challenging to assign specimens to either of them.

Notomys magnus **QMF61933** (Supplemental Figure S5J)

An isolated maxillary fragment from Swiftlet Cave has been assigned to the extinct Large Hopping-mouse based on its large size, presence of well-developed buccal cusps, a deep cleft between the bases of cusps of T1 and T4 of M^1 and a relatively narrow posterior loph (T8-T9) of M^{1-2} (Vakil *et al*. 2023). It differs from the other commonly found larger-bodied *Notomys* taxon in these deposits, *N. longicaudatus* in having better-developed buccal cusps and a narrower posterior loph. *Notomys magnus* is only known from remains in cave deposits in the Broken River region (see Price *et al.* 2020; Vakil *et al.* 2023).

Notomys longicaudatus **QMF61934** (Supplemental Figure S5K)

The long-tailed hopping mouse is represented in the surface deposits by isolated molars that are distinguished by their large size, broad T8-T9 complex on M^1 and the presence of an anterior accessory cusp on M^1, although the latter is a variable feature. Although, distinguishing isolated *Notomys* molars from *Pseudomys* molars can be challenging, the specimens described here have a mean width (molar dimensions) closer to those of *N. longicaudatus* and hence, have been assigned to that species.

Notomys sp. 1 **QMF61935** (Supplemental Figure S5L)

An isolated maxillary fragment from Swiftlet Cave has been assigned to the genus *Notomys* on the basis of its broadened anterior half of the zygomatic arch (deeper than those of larger-bodied *Pseudomys* species such as *P. higginsi*) and concave anterior edge of the zygomatic plate. However, its species-level assignment has been challenging. It is clearly a larger-bodied *Notomys* and differs from other larger-bodied *Notomys* such as: *N. robustus*, in the absence of a close association between cusps T1 and T4 of M^1 (Mahoney *et al.* 2007); *Notomys amplus*, in the presence of prominently bulging T1 and a prominent T6; *Notomys magnus*, in the absence of a relatively narrow posterior loph (Vakil *et al.* 2023) and *Notomys longicaudatus*, in the absence of a very broad posterior loph. It is somewhat intermediate in character between *N. magnus* and *N. longicaudatus* but resembles the latter, more. It is possible that it could be a hitberto unknown large-bodied *Notomys* species or merely an aberrant *N. longicaudatus* specimen. In the absence of adequate material, no further comment can be made at present.

Rattus lutreola **QMF61936** (Supplemental Figure S5M)

The swamp rat is represented in the surface deposits by maxillary fragments and isolated first upper molars. The molars of the swamp rat can be readily distinguished from those of other species of *Rattus* by their relatively large size.

Rattus sordidus/tunneyi/villosissimus/colletti group **QMF61937** (Supplemental Figure S5N)

On the basis of morphology and molecular phylogenetics, four out of seven native species of *Rattus* form a natural group. Further identification amongst the fossils of these species, represented by maxillary fragments, is made challenging due to complications in measuring their molars (see also Price *et al.* 2020). However, *R. colletti* has slightly smaller molars than the rest and is mainly restricted to the Northern Territory and is therefore unlikely to be a candidate *R. sordidus* and *R. tunneyi* are likely to occur in the region today, based on their extant distributional records. *R. villosissimus* although not recorded currently in the area, is known to expand its range during favourable conditions and therefore, cannot be ruled out.

Chiroptera

Miniopteridae

Miniopterus australis **QMF61938** (Supplemental Figure S6A)

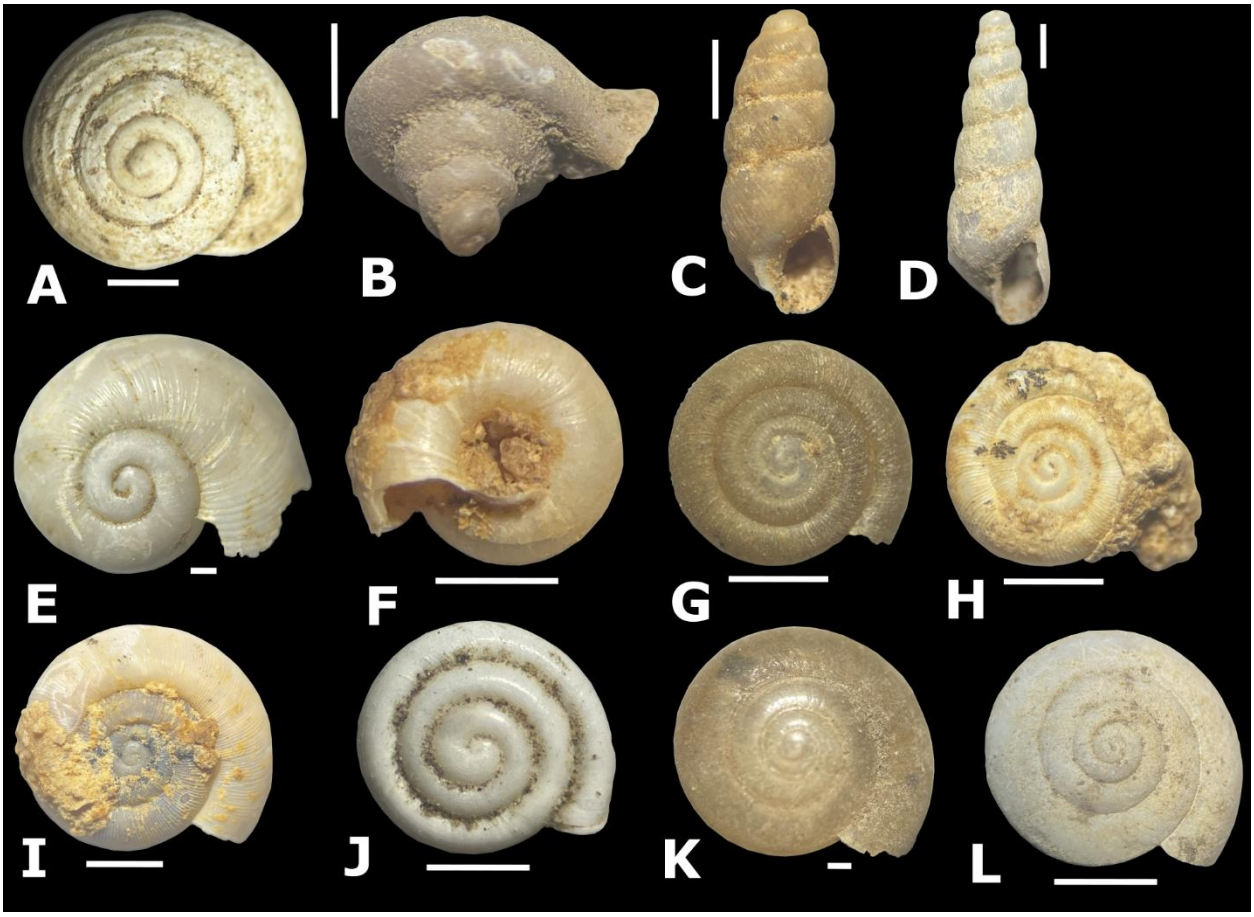
Craniodental characters for the taxonomic identification of the little bent-wing bat are given in Martinez (2010). This taxon is represented here by a single maxillary fragment. *M. australis* is distinguished from the large bent-wing bat based on the dimensions of its M^1, particularly its maximum width (Martinez 2010). It is further distinguished based on its small size from *M. orianae*, which is known from the Broken River fossil record (see Price *et al.* 2020). Furthermore, a few additional isolated molars and lower jaw fragments could potentially belong to this taxon, but the specimens are insufficient.

Megadermatidae

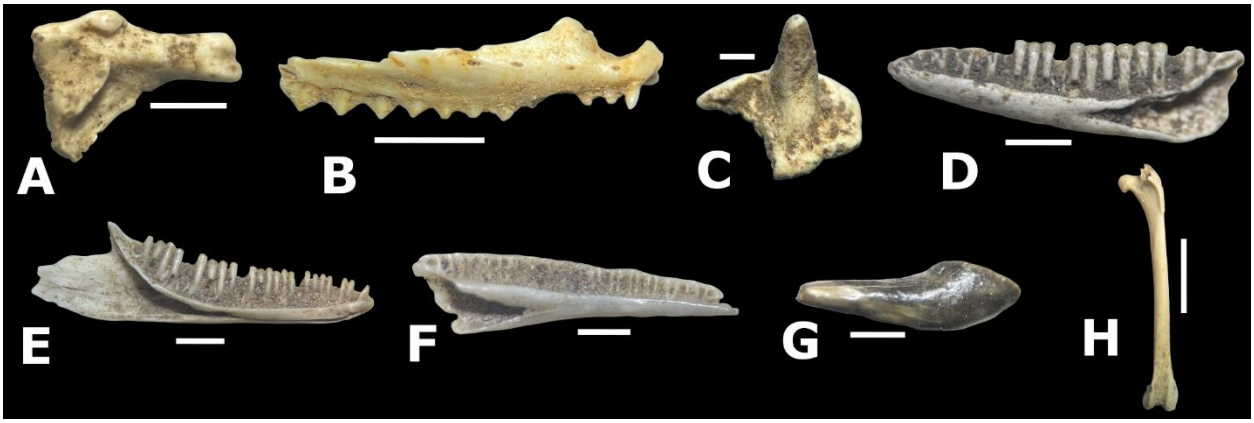
Macroderma gigas **QMF61939** (Supplemental Figure S6B)

A single isolated chiropteran lower molar has been assigned to the ghost bat on the basis of its well-developed posterolingual “heel” (Martinez 2010). *M. gigas* can be distinguished from all other Australian microchiropteran species based on its size alone and as a result, this taxon cannot be confused with any other Australian bat (Martinez 2010). The ghost bat occurs locally in the Broken River region, today.

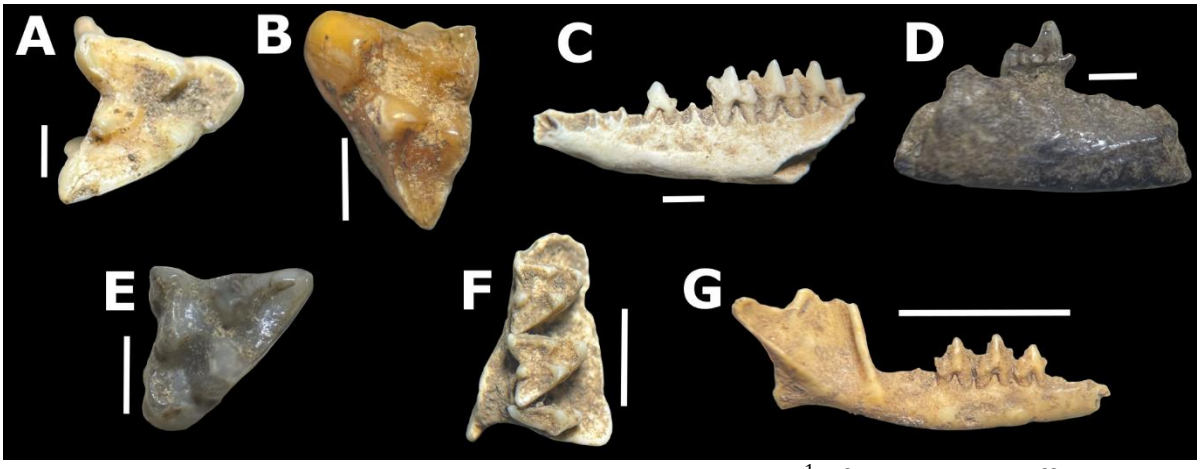
Supplemental Material Figures.



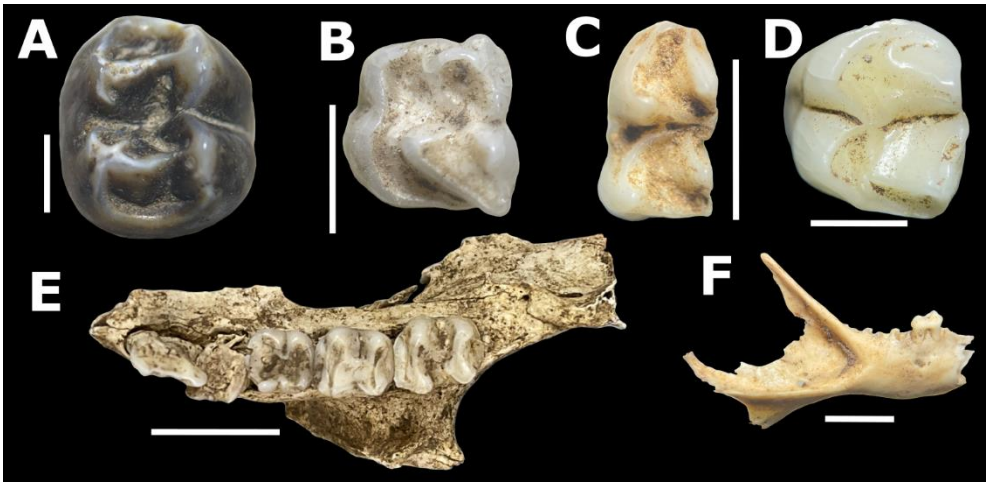
Supplemental Figure S1: Land snails. **A) QMF61894** *Pleuropoma brecanrio*; **B) QMF61895** Dorsolateral view of *Gyliotrachela australis* showing the conically trochoidal shell; **C) QMF61896** *Glyptopupoides egregia*; **D) QMF61897** *Eremopeas tuckeri*; **E) QMF61898** *Scagacola einasleigh*; **F) QMMO87860** Punctid sp. **G) QMF61899** *Excaliburopa greenvaleiana*; **H) QMMO87861** Charopid sp. 1; **I) QMMO87862** Charopid sp. 2; **J) QMF61900** *Stenopylis coarctata*; **K) QMF61901** *Tarocystis greenvale*; **L) QMF61902** *Lamprellia zebina*. Scale bars: 1 mm for A-K; 20 mm for L.



Supplemental Figure S2: Anurans, sauropsids and aves. **A) QMF61903** Right ilial fragment of *Littoria* sp.; **B) QMF61904** Right maxilla of *Diporiphora australis*; **C) QMF61905** An isolated tooth of an agamid; **D) QMF61906** Right lower jaw of a gecko showing the closed Meckelian groove; **E) QMF61907** *Egernia* sp. indet. right lower jaw; **F) QMF61908** Right lower jaw of a skink; **G) QMF61909** Tooth of a snake, showing the aglyphous form; **H) QMF61910** Femur of a possible subadult barn owl *Tyto* sp. Scale bars: 1 mm for A, C-F and G; 2 mm for B; 8.2 mm for H.



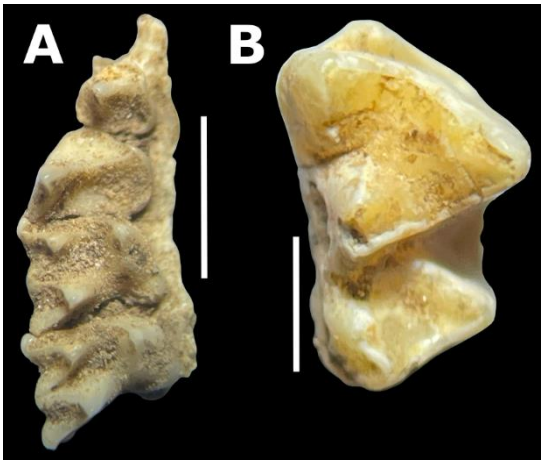
Supplemental Figure S3: Dasyurids. **A) QMF61911** Right M^1 of *Dasyurus geoffroii*; **B) QMF61912** Left M^1 of *Antechinus* sp.; **C) QMF61913** Left dentary of *Sminthopsis murina*; **D) QMF61914** Right dentary of *Sminthopsis macroura*; **E) QMF61915** Right M^1 of *Sminthopsis* sp.; **F) QMF61916** Right maxilla showing M^2-M^4 of *Phascogale tapoatafa*; **G) QMF61917** Right dentary of *Planigale ingrami*. Scale bars: 1 mm for A-E; 4 mm for F; 2 mm for G.



Supplemental Figure S4: Bettongs, bandicoots, possums, gliders and macropods. **A) QMF61918** Upper molar (M^1/M^2) of *Aepyprymnus rufescens*; **B) QMF61919** Left M^2 of *Isoodon peninsulae*; **C) QMF61920** Left lower molar of *Pseudocheirus peregrinus*; **D) QMF61921** Upper molar of *Trichosurus* sp., showing its bundodont form; **E) QMF61922** right maxilla of *Petrogale* sp.; **F) QMF61923** Partial right dentary of *Petaurus norfolcensis.* Scale bars: 2 mm for A, B and D; 3 mm for C; 1 cm for E; 5 mm for F.

Supplemental Figure S5: Murids. **A) QMF61924** Left M^1 of *Leggadina forresti*; **B) QMF61925** Lower molar of *Conilurus albipes*; **C) QMF61926** Left dentary (lingual view) of *Conilurus capricornensis*; **D) QMF61927** Left M^1 *of Zyzomys argurus*; **E) QMF61928** Left M^1 of *Melomys cervinipes*; **F) QMF61929** Right M^1 of *Pseudomys australis*; **G) QMF61930** Left maxilla of *Pseudomys gracilicaudatus*; **H) QMF61931** Left M^1 of *Pseudomys gouldii*; **I)**

QMF61932 Left M^1 of *Pseudomys delicatulus*; **J) QMF61933** Left maxilla of *Notomys magnus*; **K) QMF61934** Right M^1 of *Notomys longicaudatus*; **L) QMF61935** Right maxilla of *Notomys* sp. 1; **M) QMF61936** Left maxilla of *Rattus lutreola*; **N) QMF61937** Partial left maxilla of *Rattus* sp. with only M^1 preserved. Scale bar: 1 mm for all specimens.



Supplemental Figure S6: Chiropterans. **A) QMF61938** Right maxilla of *Miniopterus australis*; **B) QMF61939** Right lower molar of *Macroderma gigas*. Scale bar = 2 mm.

Supplemental Table S1: Small-bodied, non-volant mammalian taxa recovered from surface deposits, Beehive Cave (from Price *et al.* 2020) and recorded as extant (from Wildnet Database and Queensland Globe).

Small-bodied non-volant taxa	Surface deposits	Beehive	Extant (within 5 km)	Extant (within 50 km)
Sminthopsis murina	x	x		
Sminthopsis macroura	x	x		x
Antechinus sp. indet.	x	x		
Phascogale tapoatafa	x	x		
Planigale ingrami	x	x		x
Isoodon peninsulae	x	x		
Petaurus norfolcensis	x	x		
Trichosurus sp. indet.	x	x	x	x
Rattus lutreolus	x	x		

Rattus sordidus/tunneyi/villosissimus/colletti group.	x	x		
Conilurus albipes	x	x		
Melomys cervinipes	x	x		
Pseudomys australis	x	x		
Pseudomys gracilicaudatus	x	x		x
Pseudomys sp. cf. P. delicatulus	x	x		
Pseudomys gouldii	x	x		
Leggadina forresti	x	x		x
Notomys magnus	x	x		
Notomys longicaudatus	x	x		
Dasyurus geoffroii	x			
Pseudocheirus peregrinus	x			
Petrogale sp.	x			
Conilurus capricornensis	x			
Zyzomys argurus	x			
Aepyprymnus rufescens	x		x	x
Notomys sp. 1	x			
Chaeropus yirratji		x		
Isoodon sp. 2		x		
Pseudomys desertor		x		
Zyzomys sp. 1		x		
Petauroides volans minor			*x*	x
Hydromys chrysogaster				x
Mesembriomys gouldii				x
Isoodon macrourus				x

Supplementary Table S2: Dental (molar) measurements of *Pseudomys australis* specimens examined for this research. Abbreviations – NMV: Museums Victoria specimen; JM, QMF: Queensland Museum Fossil; QML: Queensland Museum Locality. *Mean value of QMF61929, QML1821-1823.

		Upper M1 Length	Upper M1 Width
Pseudomys.australis	NMVC4885	3	1.87
	JM8249	2.78	1.6
	JM8248	2.9	1.77
	*QMF61929, QML1821,	2.81	1.65

QML1822,
QML1823

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