

# A new late Pleistocene diprotodontid (Marsupialia) from Pureni, Southern Highlands Province, Papua New Guinea

T.F. Flannery<sup>1</sup> & M. Plane<sup>2</sup>

A new zygomatic diprotodontid, *Hulitherium tomasettii* gen. et sp. nov., from 38 000-year-old swamp sediments at Pureni, Southern Highlands Province, Papua New Guinea is the largest mammal yet known from the Quaternary of New Guinea. Possibly the sister taxon to species of *Zygomaturus*, the new genus is represented by a partial

skull and parts of the postcranial skeleton. Estimated to have weighed 75–200 kg, *H. tomasettii* was probably a browser. Its hindlimb morphology suggests that it had a greater joint mobility than is known in any other diprotodontid, and this in turn hints that it was probably not graviportal.

## Introduction

The Pleistocene vertebrate fauna of New Guinea is only slowly becoming known. The first extinct late Pleistocene taxa (3 new macropodid species) from New Guinea were described by Flannery & others (1983). However, Holocene *Thylacinus* remains had been reported earlier (Van Deusen, 1963). Flannery & others (1983) have also reported on the existence of taxonomically unallocated diprotodontid postcranial remains and an I<sub>1</sub> fragment from Nombe rockshelter.

Three diprotodontid species have previously been described from New Guinea: *Nototherium watutense* Anderson, 1937, *Kolopsis rotundus* Plane, 1967, and *Kolopsoides cultridens* Plane, 1967. These taxa, however, are known only from the Pliocene Otibanda Formation of centralstern Papua New Guinea. Pleistocene diprotodontids have until now remained virtually unknown.

Here we describe a new zygomatic diprotodontid, *Hulitherium tomasettii*, from late Pleistocene swamp deposits at Pureni, Southern Highlands Province, Papua New Guinea. We suggest that it represents a new genus, and speculate on its lifestyle.

## Discovery of the fauna

In 1967, improvements were made to the Pureni Mission airstrip: it was lengthened and widened to comply with regulations and improve safety. During excavation of a bank on the southwestern side of the airstrip, a section was exposed, 15–20 m long and up to 3.8 m high. At the base of this excavation a layer rich in bones and plant material was uncovered. The local Huli tribesmen who were employed using hand tools were greatly excited and frightened by the discovery, bones always being associated with ancestors. A certain amount of damage was caused by the poking and prodding of these 'tabu' objects with shovels and digging sticks before the local priest, the late Father Bernard Tomasetti, realised the scientific worth of the material and salvaged most of it.

In 1969, Williams and Plane investigated the Quaternary stratigraphy of the area and made field studies of the Pureni and other sites (Williams & others, 1972). Further vertebrate and plant fossil material was collected and an auger hole was sunk on the Pureni vertebrate site (Fig. 1).

In addition to the remains of *Hulitherium tomasettii*, the Pureni local fauna includes a taxonomically unallocated right dentary fragment of a murid with I<sub>1</sub> and M<sub>2</sub> (this specimen

is, however, phenetically similar to *Rattus* and *Melomys* species), a partial cranium of *Phalanger carmelitae*, and limb bones of a small cassowary (T. Rich, personal communication).

## Quaternary stratigraphy

From a Quaternary perspective the basement rocks in the Pureni area are a thick sequence (at least 2000 m) of marine limestone, with interbedded siltstone, thin-bedded soft mudstone and siltstone, and subordinate calcareous sandstone of late Oligocene to Pliocene age. (Llewellyn & Zehnder, 1955; Williams & others, 1972).

In the mid Pleistocene these marine sediments were intruded and overlain by lavas which also dammed and partly filled the former valley of the Tagari River. McDougall (in Williams & other, 1972) obtained relatively good concordance for three whole-rock dates for the lavas of Mt Iumu (Fig. 1) at about 850 000 year B.P. Subsequent volcanic episodes draped the lavas and earlier sediments with mid-Pleistocene to Holocene pyroclastic rocks and their weathering products. The source of these agglomerates, fine ash, and sediments of pyroclastic origin is thought to be Mount Rentoul and Mount Sisa. Organic layers are interbedded with these rocks, indicating lengthy quiescent periods between volcanic episodes, and Doma Peaks, which local folklore suggests may have erupted in known memory, is not extinct.

Holocene swamp deposits at Haibuga (Fig. 1), at Tarifuga and Mogorofuga to the northwest of Pureni, and Wabafuga to the west are the most recent deposits in the area, and comprise peat, clay, and ash bands.

## Haibuga basin stratigraphy and palaeoecology

The surface exposures at Pureni and at Telabo footbridge were mapped in detail (Williams & others, 1972) and both sections were traced subsurface by augering. Although these sites are nearly 2 km apart, accurate barometer readings, close agreement of the sediment types and <sup>14</sup>C dates, and their deposition in the same small sedimentary basin lend confidence to the correlation of the sections, which is the basis for the Quaternary stratigraphy of the fossiliferous rocks of the Haibuga basin.

We are fortunate in that both sections contain good pollen spectra and, from these samples, Powell (in Williams & others, 1972) outlined a rough sequence of events that enables us to put *Hulitherium tomasettii* in its vegetative and climatic context:

'Locally, conditions changed from open water with marginal conifers to grass-swamp surrounded by conifers and to bog forest on the site itself. Regionally, conditions ameliorated

authors listed alphabetically

<sup>1</sup>The Australian Museum, 6–8 College St., Sydney, N.S.W. 2000

<sup>2</sup>Division of Continental Geology, Bureau of Mineral Resources, GPO Box 378, Canberra, ACT

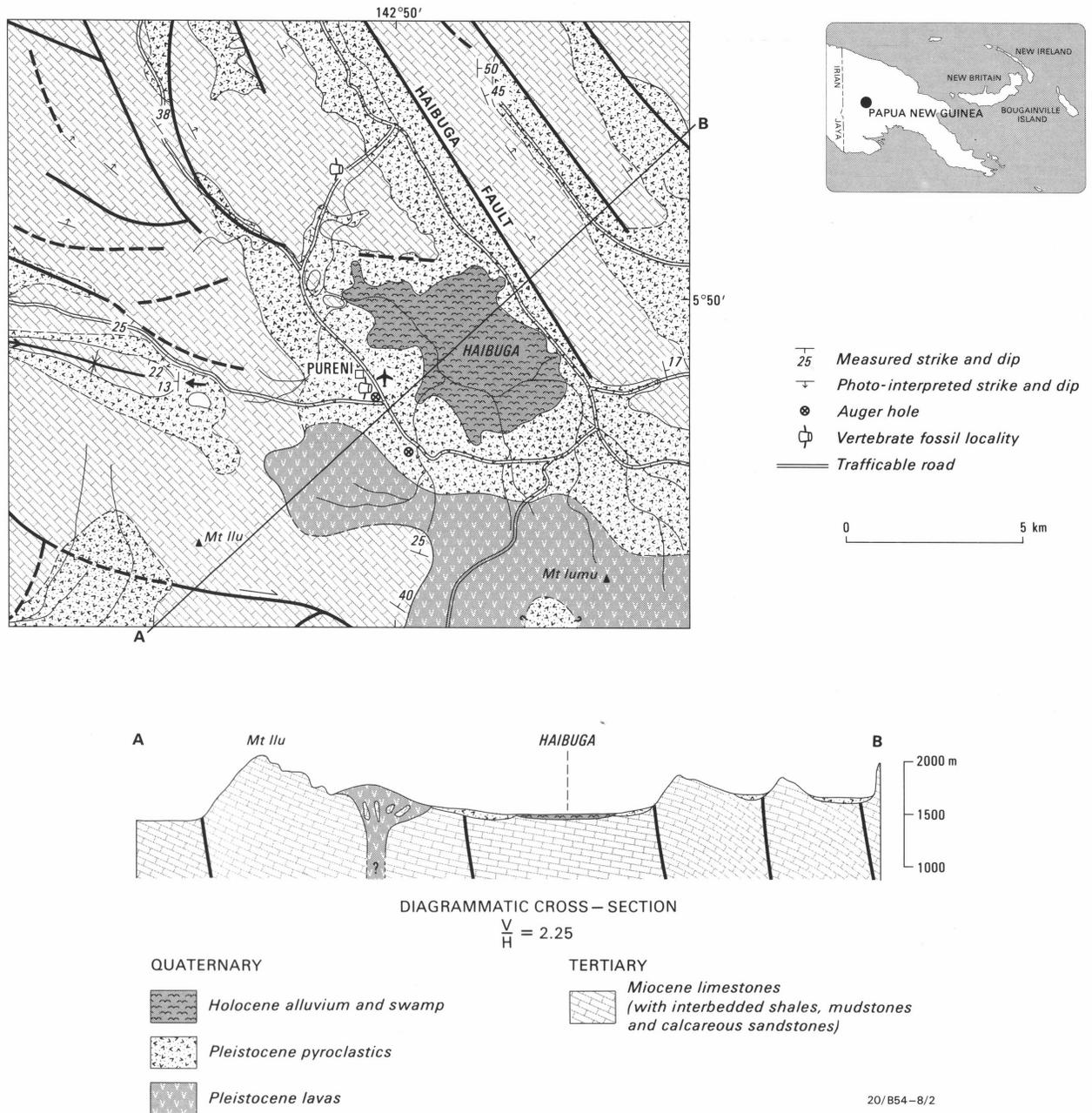


Figure 1. Geology of Purení area, Papua New Guinea. Modified from Williams & others (1972).

from rather cool with mixed forest dominant and subalpine grassland nearby, to mild with beech forest dominant on the slopes and mixed forest and subalpine grassland further away, and to relatively warm with oak forest and oak-beech forest dominant. In all cases, however, the extrapolated environment was colder than that experienced at the present time in this area.'

### Systematic palaeontology

#### Diprotodontidae Gill, 1872

#### Zygomaturinae Stirton, Woodburne & Plane, 1967

#### *Hulitherium* gen. nov.

**Derivation of generic name.** Named for the Huli people of the Purení area to honor their discovery of the animal.

**Genotypic species.** *Hulitherium tomasettii*

**Generic diagnosis.** *Hulitherium tomasettii* is a zygomaturine diprotodontid that can be distinguished from other members of its subfamily in the following ways. It is unique among close relatives in that the palate is deeply arched and the capitulum of the femur is placed directly above its shaft. It possesses high-vaulted frontals that are otherwise seen only in the species of *Plaisiodon* and *Zygomaturus*, and a reduced paracrista on  $M_2$  and an anterodorsally directed maxillary-premaxillary suture, features otherwise seen only in the species of *Zygomaturus*. It differs from the species of *Kolopsoides* and *Kolopsis* in having a lower posterointernal cusp on  $P_3$ .

Further, it differs from *Raemeotherium yatkolai* in being much larger, in having less-rectangular molars and less-crenulate molar enamel. It differs from *Kolopsoides cultridens* in possessing a double-rooted rather than triple-rooted  $P_3$ , less-developed cristids obliqua on lower molars, and squarer molars; and from *Plaisiodon centralis* in having

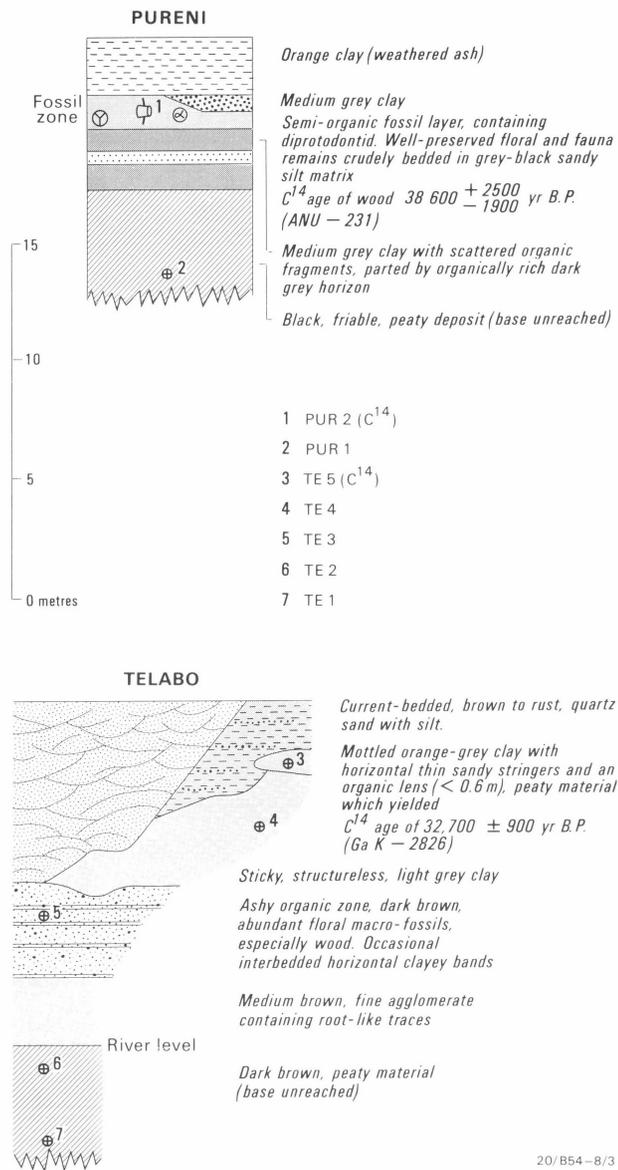


Figure 2. Auger section, Pureni vertebrate site.

broader nasals, and less-developed parastyles and metastyles on upper molars.

*Hulitherium tomasettii* differs from *Zygomaturus keani* and *Z. gilli* in being smaller, in having the cristids obliqua of  $M_{3-5}$  less-developed, and (from *Z. keani* only) in having better developed parastyles and metastyles on  $M_{2-5}$ . It further differs from *Z. gilli* in having the cristids obliqua of  $M_{2-5}$  less developed, and in having the paracone and metacone of  $P^3$  closer buccally.

*Hulitherium tomasettii* differs from *Zygomaturus trilobus* in having premaxillae that are not laterally expanded at the nares, the frontal bulge rising at a less acute angle from the nasals, the palate between the upper incisors less deeply excavated, a better developed groove at the palate mid-line, and in having the paracone and metacone of  $P^3$  closer at their buccal margin.

***Hulitherium tomasettii*, gen. nov. et sp. nov.**  
(Figs. 3–7, Table 1)

**Holotype.** CPC 25718; a partial skeleton, including a partial cranium that is almost complete anterior to the frontal-

parietal contact. A fragment of the enamel cap of a left  $P^3$ , nearly complete  $M^3$ s and  $M^4$ s, and fragments of  $M^5$ s, posterior fragments of the right and left dentaries, including most of the left angle, a fragment of a right  $P_3$ , and broken enamel caps of left and right  $M_{2-5}$  are preserved. The right  $M_5$  fits perfectly into the posterior alveolus of the right dentary fragment.

Postcranial remains consist of: the left side of the atlas and the centrum of a cervical vertebra; the right humerus, which is almost complete, lacking only a central section of the shaft; a distal fragment of the left humerus; the left femur, represented by the proximal end, preserved as far distally as the termination of the lateral rugose area, an extension of the greater trochanter; the proximal and distal ends of the right femur; the right tibia, with only the distal end missing; and fragments of a radius (distal end) and fibula.

**Type locality.** Excavated bank on southwestern side of Pureni Mission airstrip, Wabag 1:250 000 Sheet area  $5^{\circ}50'S$ ,  $142^{\circ}49'E$ , Southern Highlands District, Papua New Guinea.

**Age.** Late Pleistocene: a  $^{14}C$  determination on a log in the bed that contained the diprotodontid remains gave an age of  $38\ 600 \pm 2500$  years B.P.; sample ANU-231 (Williams & others, 1972).

**Etymology.** Named specifically for the late Father Bernard Tomasetti, a man of learning and culture, who ensured not only that the remains were preserved, but that they were brought to the attention of appropriate workers.

**Specific diagnosis.** The generic diagnosis will serve as that for the species until further species are recognised.

**Description. Dentition:**  $P^3$ . A small fragment of the buccal face of the  $P^3$  is preserved. It includes the posterobuccal portion of the paracone and the anterobuccal portion of the metacone. The paracone and metacone apparently formed a single crest buccally, and are only separated by a shallow, ill-defined depression.

$M^2$ . The  $M^2$  is not represented by any certainly identifiable fragments.

Table 1. Measurements (mm) of the holotype of *Hulitherium tomasettii*.

Length of $I^1$ alveolus	19.3
Length of $I^2$ alveolus	10.2
Length of $I^3$ alveolus	10.0
Length of $P^3$ - $M^5$ alveoli	110.9
Length of $P^3$ - $I^3$ diastemal length	37.6
Length of right $M^3$	24.8
Length of right $M^4$	28.0
Length of right $M_3$	24.8
Length of left $M_4$	27.9
Anterior width of left $M_4$	20.2
Posterior width of left $M_4$	19.1
Length of right $M_5$	29.3
Anterior width of right $M_5$	21.4
Posterior width of right $M_5$	~20.3
Width of palate at anterior of $P^3$	38.7
Width of palate at anterior of $M^2$	41.0
Height of rostrum at anterior of $M^2$	54.1
Minimum interorbital width	41.0
Width of proximal epiphysis of humerus	69.0
Length of proximal epiphysis of humerus	60.0
Width of distal epiphysis of humerus	94.8
Diameter of head of femur	45.6
Maximum width of shaft of femur	75.6
Maximum depth of shaft of femur	32.0
Width of femur across distal condyles	73.0
Width of femur proximal epiphysis of tibia	63.8
Length of femur proximal epiphysis of tibia	55.6



30 mm



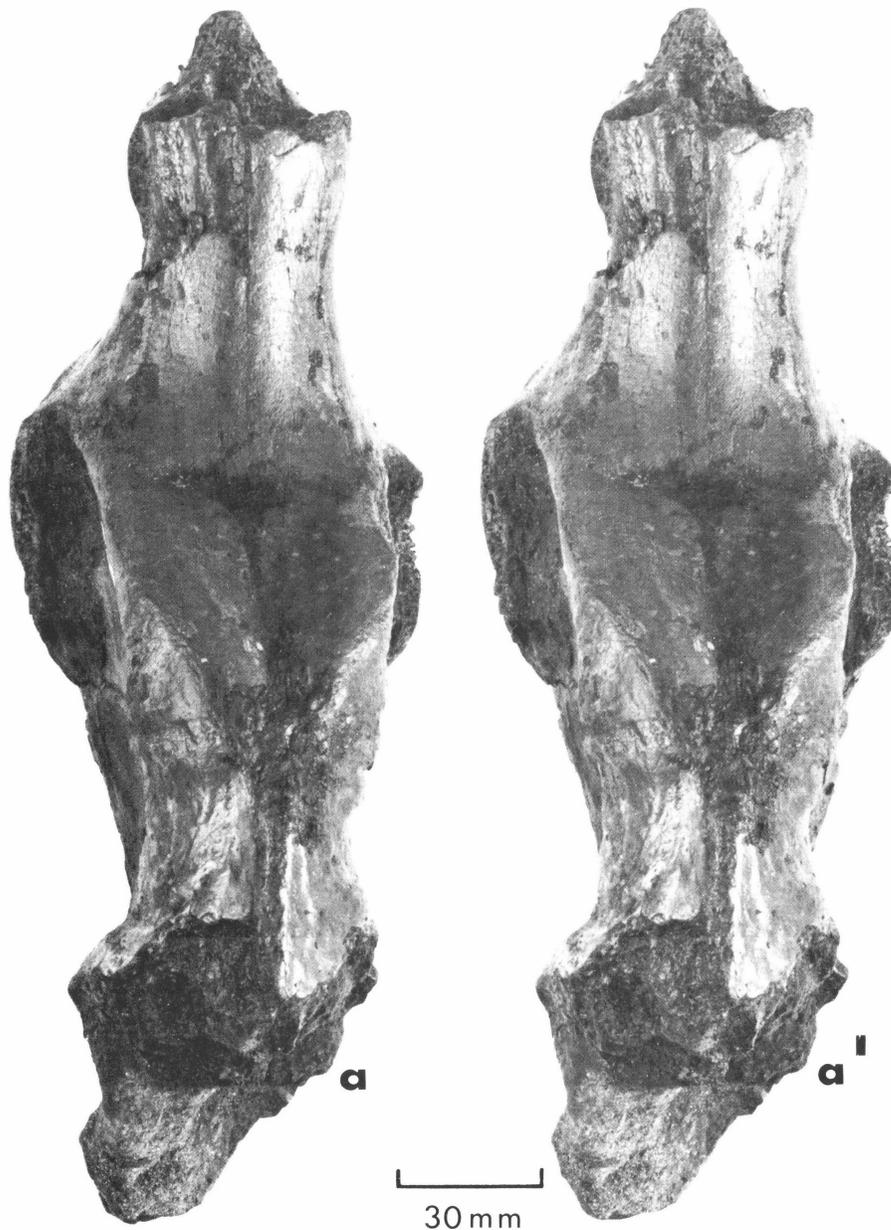


Figure 4. Stereo dorsal view of cranium of *Hulitherium tomasettii* gen. et sp. nov.

M<sup>3</sup>. The M<sup>3</sup> is represented by a right enamel cap, lacking only the buccal part of the hypoloph and the posterobuccal portion of the protoloph, and fragments of a left enamel cap. The enamel of the anterior face of the protoloph is crenulated to a greater degree than other parts of the crown. The anterior cingulum is broad and terminates lingually against the anterolingual flank of the protocone. On the buccal edge of the anterior cingulum a prominent parastyle is present, which is connected to the base of the paracone by a slight ridge. A basal cingulum is present in the lingual end of the interloph valley, which extends between the posterolingual base of the protocone and the anterolingual base of the hypocone. The posterior cingulum is narrower than the anterior cingulum. It commences at the posterolingual face of the hypocone, and continues to the posterobuccal corner of the tooth, where the crown is broken away. The posterior cingulum does not appear to have extended beyond the point of breakage. A prominent metastyle (which is smaller than the parastyle) is present near the posterobuccal corner of the tooth. It is

connected to the base of the metacone by a small crest. A rounded midlink extends basally from the apex of the protocone and terminates in the interloph valley. There is no trace of a midlink on the anterior face of the hypoloph.

M<sup>4</sup>. Both partial M<sup>4</sup>s lack the buccal end of the protoloph, the posterobuccal face of the protoloph, and the lingual corner of the hypoloph. The M<sup>4</sup> differs from M<sup>3</sup> in the following ways. It is less worn and larger, and the parastyle and metastyle are reduced in size. In addition the anterobuccal portion of the M<sup>4</sup> (an area not preserved on M<sup>3</sup>) possesses a slight cuspule placed basal and slightly lingual to the apex of the metacone in the interloph valley. This structure may be a remnant of a premetacrista.

M<sup>5</sup>. Only fragments of M<sup>5</sup> remain. A portion of the anterior face of the right protoloph indicates that M<sup>5</sup> was not fully erupted and that the parastyle was slightly smaller than that of M<sup>4</sup>.

Figure 3. a, lateral view, and b–b'; stereo occlusal view of partial cranium of holotype of *Hulitherium tomasetti* gen. et sp. nov.

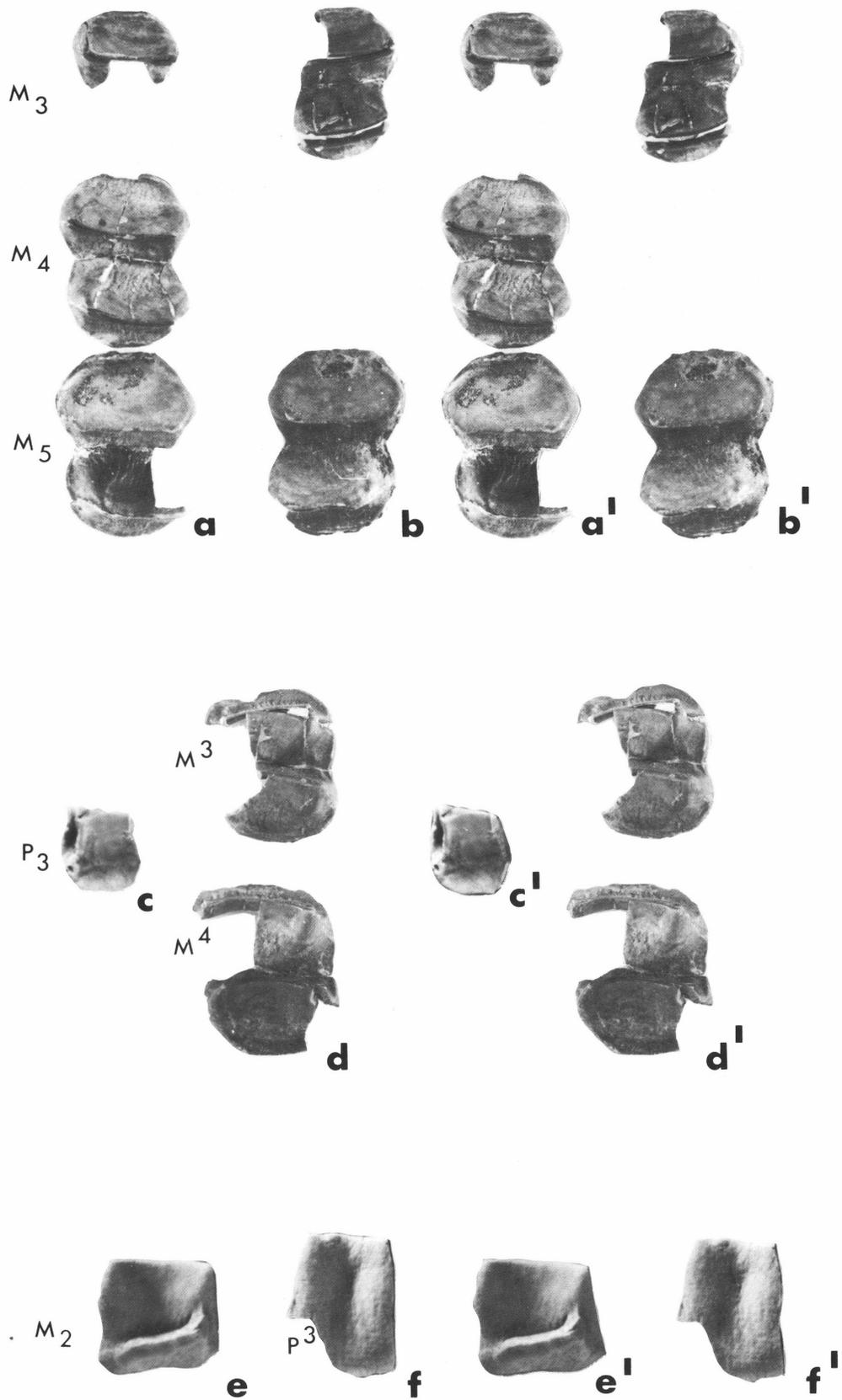


Figure 5. Holotype of *Hulitherium tomasettii* gen. et sp. nov.

a-a', stereo occlusal view of partial left M<sub>3-5</sub>, xl; b-b', stereo occlusal view of right M<sub>3</sub> and M<sub>5</sub>, xl; c-c', stereo occlusal view of posterointernal corner of right P<sub>3</sub>, x2; d-d', stereo occlusal view of partial right M<sub>3-4</sub>, xl; e-e', stereo anterior view of anterior face of protolophid left M<sub>2</sub>, x2; f-f', stereo view of central portion of buccal face of right P<sub>3</sub>, x2.

P<sub>3</sub>. A small fragment represents the posterolingual portion of a left P<sub>3</sub>. A small posterobasal cusp is united with a larger posterobuccal cusp by a ridge. A horizontal crest with a well-developed facet extends anteriorly from near the posterobuccal crest. A small fossette is enclosed behind the ridge joining the two posterior cusps.

M<sub>2</sub>. A fragment of the anterior face of the protolophid and a portion of the anterobuccal face of the hypolophid, both from the left M<sub>2</sub> are preserved. The anterior cingulum is confined to an area lingual to the paracristid. It is highest buccally, and slopes basally towards the anterobuccal margin of the tooth, becoming narrower as it descends. It terminates near the base of the metaconid. The paracristid is very poorly developed relative to that of other zygomaticurines, forming a rounded crest that descends from the apex of the protoconid. The anterobuccal face of the hypoconid shows that a moderately well-developed cristid obliqua was present, which ascended to about half the height of the hypoconid.

M<sub>3</sub>. Fragments of the left and right M<sub>3</sub> are enough to reconstruct an almost complete (composite) enamel cap. The anterior cingulum extends across the central portion of the anterior face of the protolophid, but terminates before reaching the buccal or lingual margin of the tooth. It is narrower than the posterior cingulum, and no evidence of buccal or lingual basal cingula is preserved. The posterior cingulum is highest in the centre, sloping basally, buccally, and lingually, and not quite reaching the buccal and lingual margins of the tooth. The cristid obliqua is extremely poorly defined. It originates at the apex of the worn hypoconid, and terminates at the base of the interloph valley, about one-third of the distance from the buccal margin of the tooth. A slight bulge at the apex of the protoconid suggests the presence of a paracrista, and a similar feature at the apex of the entoconid suggests the presence of preentocrista.

M<sub>4</sub>. The left M<sub>4</sub> is preserved as an almost complete enamel cap. The right M<sub>4</sub> is represented by fragments only. It differs from M<sub>3</sub> in being markedly larger and less worn, the anterior cingulum is less-developed, and the enamel is slightly more crenulate in appearance.

M<sub>5</sub>. Both left and right M<sub>5</sub>s are preserved almost complete, both lacking only the lingual corner of the entoconid. They differ from M<sub>4</sub> in the following ways: both are unworn and apparently were not fully erupted; the anterior cingulum is less-developed, and the cristid obliqua terminates further buccally in the interloph valley; the hypolophid is markedly narrower than the protolophid.

The skull. Both zygomatic arches, the posterior face of the cranium, the basicranial region, part of the left maxilla and parts of the nasals are missing. The alveoli for I<sup>1-3</sup> indicate that I<sup>1</sup> was much larger than I<sup>2-3</sup>, and that I<sup>3</sup> was larger than I<sup>2</sup>. The alveoli for P<sup>3</sup> also indicate that this tooth was double-rooted. The palate between the cheektooth rows is deeply arched, an unusual feature among diprotodontids. It is flat near the midline, but rises sharply towards the cheektooth rows. It thus forms a flat-topped arch shape in cross section. The palate is non-fenestrated and narrows anteriorly. Anterior to P<sup>3</sup> the palate narrows sharply, but broadens slightly as it approaches the incisor region. A deep sulcus separates the left and right sides of the palate anterior to the premolars.

The rostrum is markedly narrow, and subovate in cross section. It does not broaden appreciably anteriorly, as is the case in *Zygomaturus trilobus*. The premaxillaries lack the anterolateral expansions seen in *Z. trilobus*. The

premaxillary/maxillary sutures on the sides of the skull slope anterodorsally. The nasals are broadest posteriorly, and the nasal-frontal suture is almost linear, and is transversely oriented, being situated at the base of the frontal bulge.

The infraorbital canal opens onto the facial region dorsal to and anterior of the P<sup>3</sup>. The nasal septum is broken away, but it seems unlikely from what remains that it would have been as large as in *Z. trilobus*.

The frontals rise sharply from the plane of the nasals, and are dished mesially, the frontal depression being parallel with the midline of the skull. The orbits are situated low on the skull, their ventral rims being about 3 cm dorsal to the P<sup>3</sup> alveolus. A very low sagittal crest is formed on the frontals dorsal to the posterior end of the cheektooth row.

Only posterior fragments of the left and right dentaries remain. The left dentary fragment is almost complete posterior to M<sub>5</sub>, but lacks much of the ascending ramus and condyle. The angle of the dentary is extremely broad, and the pterygoids were thus probably massive. A well-developed ridge is present on the ventral edge of the buccal area of masseter attachment. The horizontal ramus of the dentary is relatively shallow, being about 57 mm deep below M<sub>5</sub>.

**Postcranial skeleton:** Atlas. The left side is preserved. The ventral portion was incomplete, as in all other marsupials. This element appears to have been surprisingly slightly built relative to the size of the skull. The cranial condyle articulation is antero-posteriorly short and tall relative to that of many marsupials (eg. vombatids, macropodoids).

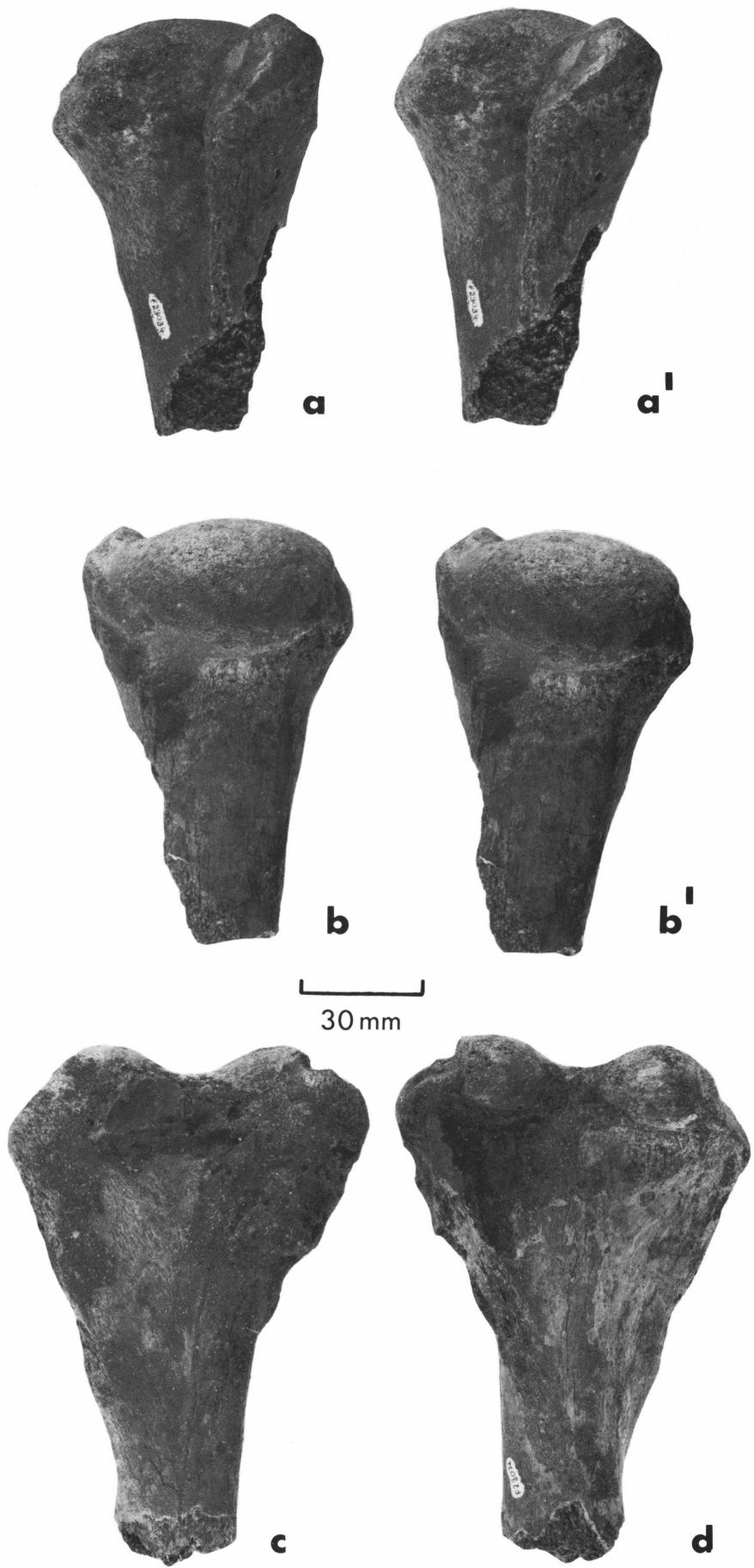
Cervical vertebra. The centrum of a cervical vertebra is preserved. It is anteroposteriorly very short (16 mm), and all processes are broken away. However, the shortness of the centrum indicates that the neck of *H. tomsettii* was short.

Humerus. The right humerus lacks only a central portion of the shaft, and thus the proximal and distal parts can no longer be joined. The proximal articular surface appears to have allowed a considerable degree of movement. There is approximately 180° of articular surface in an anteroposterior direction, but much less laterally. The pectoral ridge is well developed, terminating proximally in the ectotuberosity, which stands slightly above the proximal articular surface. The deltoid crest and tuberosity for insertion of the *Latissimus dorsi* and *Teres major* are not preserved, if they were ever present.

The middle portion of the shaft is extremely narrow and delicate (being 32 mm wide at its narrowest) and is slightly anteroposteriorly compressed (being 23 mm deep at the narrowest point). An entepicondylar tubercle is small. The distal epiphysis is similar to that seen in macropodoids, with the lateral and medial condyles having arcuate articular surfaces that span about 180° of arc.

Radius. The distal fragment of a radius is preserved. However, it lacks an epiphysis and little of its original morphology is discernible.

Femur. The distal and proximal fragments of the femur can no longer be joined, as a segment from the middle of the shaft is missing. The proximal femur fragment exhibits some highly unusual features. The head of the femur is positioned directly above the mesial edge of the shaft, and projects prominently above the rest of the bone. The head is hemispherical, and the articular surface (when entire) probably consisted of approximately two-thirds of a sphere.



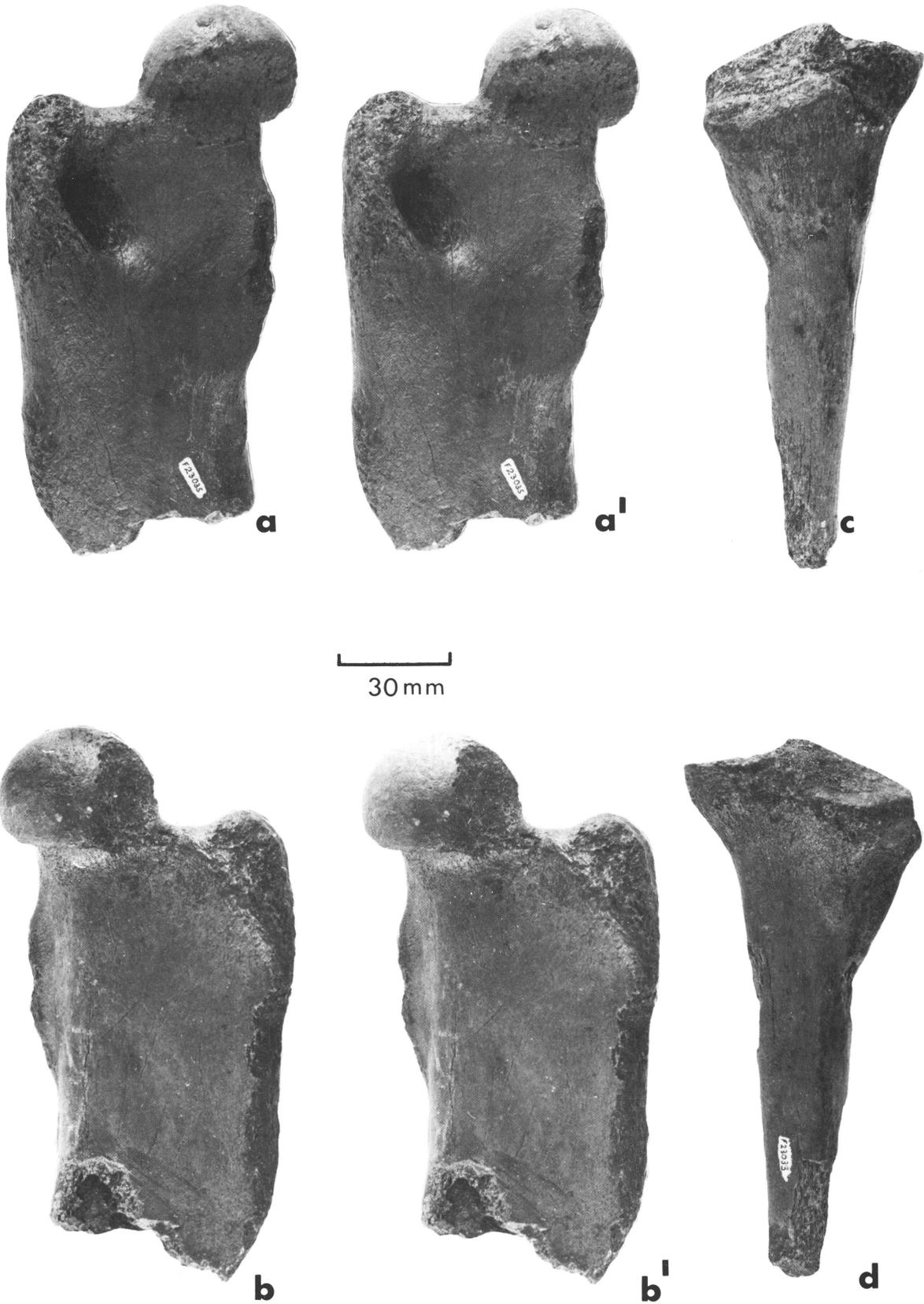


Figure 7. a–a', stereo view of posterior face, and b–b', anterior face of proximal left femur fragment; c, anterior face, and d, posterior face of right tibia of *Hulitherium tomasettii* gen. et sp. nov.

Figure 6. a–a', stereo view of anterior face, and b–b', posterior face of right proximal humerus fragment; c, posterior face, and d, anterior face of distal right humerus fragment of *Hulitherium tomasettii* gen. et sp. nov.

The neck is short but narrow, and the globular head forms a prominent bulge. The greater trochanter projects anteriorly, and thus there is a concavity on the shaft distal to it. The muscle insertion tract that runs along the lateral edge of the bone distal to the greater trochanter is very extensive, extending 130 mm along the shaft. The trochanteric fossa is shallow and subovate. The lesser trochanter is prominent and placed on the posteromedial margin of the bone. The shaft of the femur is markedly compressed anteroposteriorly, being 55 mm broad, but only 19 mm deep at the point where the lateral muscle insertion tract terminates.

The distal femur fragment is broken away approximately 50 mm proximal to the condyles. The lateral condyle is broader than the medial one. The conical process of the medial condyle forms a marked prominence. Much of the rest of the morphology of this fragment is obscured by abrasion and adhering matrix. A fragment of bone situated near the dorsolateral part of the distal end of the humerus (and joined to it by encrusting matrix) may represent the remains of a lateral sesamoid.

**Tibia.** The tibia is gracile, and broken away at its distal end. It appears, however, that it lacks only its distal epiphysis and a small portion of shaft.

The external condylar depression of the proximal epiphysis is a concave facet and longer than broad. The internal condylar depression, however, is more planar and slopes away posteriorly and mesially. The non-articular surface of the proximal epiphysis anterior to the articular surfaces slopes steeply away anteriorly. The proximal tibial-fibular facet is almost planar and is subovate in shape. The shaft is oval in cross section.

**Fibula.** The fragment tentatively identified as part of a fibula preserves almost no external bone surface. However, it is flattened and expands anteroposteriorly at one end (probably the proximal end).

## Discussion

**Relationships.** *Hulitherium tomasettii* is clearly a zygomatuline diprotodontan most closely similar to the species of *Plaisiodon* and *Zygomaturus*. A unique feature it shares with these taxa is the presence of highly vaulted frontals. Furthermore, *Hulitherium tomasettii* shares some unique features with the species of *Zygomaturus*, including (1) the presence of an anterodorsally directed maxillary/premaxillary suture; (2) having the palatine surface of the rostrum extremely 'pinched in'; and (3) having a very reduced paracristid on  $M_2$ .

Apart from *Zygomaturus trilobus*, the previously described species of *Zygomaturus* are extremely poorly known, and it is not possible to determine in many cases if the condition seen in *Hulitherium tomasettii* is shared with other zygomatulines. This applies particularly to aspects of the skull and postcranial morphology. Thus, although the relationship of *Hulitherium tomasettii* to some species of *Zygomaturus* is unknown, we place it in its own genus for the following reasons.

1 — In many features, *Hulitherium tomasettii* is more plesiomorphic than *Z. trilobus*. Thus, it seems possible that *Hulitherium tomasettii* may be the sister taxon of the species of *Zygomaturus* if other forms are similar to *Z. trilobus*, (as they appear to be on cranial morphology).

2 — the postcranial morphology of *Hulitherium tomasettii* is markedly different from that of *Z. trilobus*, indicating an apparently long period of specialisation in *H. tomasettii*. It thus appears unlikely that *H. tomasettii* is simply a dwarf, rainforest-dwelling form of *Zygomaturus* that developed during the Pleistocene in New Guinea. Rather, it seems more likely that *H. tomasettii* diverged from the species of *Zygomaturus* long before, in the late Tertiary.

**Functional morphology and habitat.** Some aspects of the morphology of *Hulitherium tomasettii* are highly unusual. These include the highly arched palate and the morphology of the proximal end of the femur. The presence of the highly arched palate in *H. tomasettii* is unique among diprotodontans. However, a similar condition exists in other mammals, and Nowak & Paradiso (1983) have noted that the palate of the sloth bear (*Ursus ursinus*) is highly arched. This adaptation, plus a gap between the front incisors, allows the bear to feed on termites, which make up the major portion of its diet.

We have been unable to find close analogues among living mammals to the hind limb morphology of *Hulitherium tomasettii*. The head of the femur clearly would allow for a great degree of movement to take place. The functional significance of the shaft of the femur being placed immediately below the head remains unknown. The humerus-ulnar articulation also would allow for a far greater degree of mobility than in other diprotodontids.

38 000 years ago the Puren area was colder than at present, and the vegetation fossilised at the site is more typical of that found today at altitudes of about 2100 m. Thus, *Hulitherium tomasettii* would have inhabited cool, mossy upland forest. This kind of habitat is occupied elsewhere in the world by large herbivores in the 60–200 kg weight range, including the giant panda in China, mountain gorilla in Africa, and spectacled bear in South America. It is possible that *H. tomasettii* represents a marsupial ecologically equivalent to these placental species. Certainly the greater limb mobility suggested for *H. tomasettii* indicates that the species was probably not graviportal, as were other known diprotodontids. The bear-like or panda-like posture of *H. tomasettii* in our reconstruction is certainly possible, given these data and the femur/humerus morphology.

**Extinction.** *Hulitherium tomasettii* is the largest mammal yet known from the late Pleistocene of New Guinea. Compared with similarly proportioned placentals, *Hulitherium tomasettii* probably weighed between 75 and 200 kg. Its habitat apparently included mid-montane rainforests very similar to relict stands that survive in the Puren area to the present.

There is no evidence of a human presence in the late Pleistocene fossiliferous sediments at Puren. At Nombe rockshelter in Simbu Province (6°08'S, 145°10'E), however, a fragmentary  $I^1$  and some postcranial remains of a diprotodontid are associated with abundant evidence of a human presence (Flannery & others, 1983; Gillieson & Mountain, 1983). Radiocarbon dating of flowstones associated with the Nombe fossils gave ages ranging from 24 000 to 14 000 years B.P. (Gillieson & Mountain, 1983). Unfortunately, there are few elements in common between the Puren and Nombe diprotodontids. However, a partial humerus and almost complete tibia from Nombe are superficially similar to those of *Hulitherium tomasettii*, but come from a slightly smaller but less gracile animal. Here, then, is evidence that *Hulitherium*-like diprotodontids co-existed with humans in the highlands of New Guinea and,



Figure 8. Artist's reconstruction of *Hulitherium tomasettii*.  
Reproduced by permission of the artist, Peter Schouten.

given the lack of evidence for massive environmental change, it may well be that human predation was a factor in the extinction of these fascinating diprotodontids.

### Summary

*Hulitherium tomasettii* is a zygomaturine diprotodontan, as yet known only from a partial skull and parts of the postcranial skeleton from 38 000-year-old swamp deposits at Pureni, Southern Highland Province, Papua New Guinea. The morphology of the femur and humerus suggest that the limbs were highly mobile relative to those of other diprotodontids. *Hulitherium tomasettii* was a browser, and inhabited montane rainforest. Man may have contributed to its extinction.

### Acknowledgements

We acknowledge the late Father Bernard Tomasettii and his successor at Pureni Mission, Father Bill Trauba for their great help to the authors during their visits to the Pureni site. Kate

Lowe of the Australian Museum and Richard Brown of the BMR produced the photographic plates. We are most grateful for the wonderful reconstruction that Peter Schouten has done of *Hulitherium* and thank him for permission to reproduce it.

### References

- Flannery, T.F., Mountain, M.J., & Aplin, K., 1983 — Quaternary kangaroos (Macropodidae; Marsupialia) from Nombe rock shelter, Papua New Guinea, with comments on the nature of megafaunal extinction in the New Guinea highlands. *Proceedings of the Linnaean Society of New South Wales*, 107(2), 75–98.
- Gillieson, D., & Mountain, M.J., 1983 — Environmental history of Nombe rock shelter, Papua New Guinea highlands. *Archaeology in Oceania*, 18, 53–62.
- Nowak, R.M., & Paradiso, J.L., 1983 — Walker's mammals of the world. *John Hopkins University Press, Baltimore*.
- Van Deusen, H.M., 1963 — First New Guinea record of *Thylacinus*. *Journal of Mammalogy*, 44, 279–280.
- Williams, P.W., McDougall, I., & Powell, J.M., 1972 — Aspects of the Quaternary geology of the Tari-Koroba area, Papua. *Journal of the Geological Society of Australia*, 18, 333–347.