

## A Taxonomic Revision of the *Sminthopsis murina* Complex (Marsupialia, Dasyuridae) in Australia, including Descriptions of Four New Species

D.J. Kitchener\*, J. Stoddart† and  
J. Henry\*

### Abstract

*Sminthopsis murina* (sensu, Archer 1981) comprises five species: *Sminthopsis murina* (Waterhouse, 1838) is redefined and four new species (*S. dolichura*, *S. gilberti*, *S. griseoventer*, *S. aitkeni*) are described on morphological criteria. A system of species identification for individuals using these criteria is provided through discriminant analysis.

Phenetic and phylogenetic analyses of skull and body morphology for 25 geographic groupings only partly support this taxonomic classification. The reasons for the lack of congruence between these classifications and those of traditional mammalian taxonomy are discussed.

### Introduction

The small carnivorous marsupial *Sminthopsis*, differs from other dasyurid genera by possession of the following combination of characters (Archer 1981): squamosal – frontal bones contact on the side wall of the brain case; false palate has vacuities within the palatine bones; nasals only slightly expanded posteriorly; upper molars lack posterior cingula; third pre-molars only slightly reduced or subequal in size to P2; I<sup>1</sup> longer crowned than I<sup>2</sup>; metacristids and hypocristids are transverse to the long axis of the lower checktooth row; supratragus of external ear curled, and narrow hind feet with reduced postinterdigital pads.

Resolution of the taxonomic status of all forms within *Sminthopsis* will not be an easy task. This is a legacy of the fact, noted first by Thomas (1888), that the smaller species of this genus present 'unusual difficulty in their discrimination' because of 'the close resemblance existing between the skulls and teeth of different species.' Archer (1981) clearly recognised this difficulty; in addition to recognising twelve species of *Sminthopsis*, he drew attention to several populations that may prove to be unique. Archer also noted that most species of *Sminthopsis* exhibit geographic variation. In the case of *S. murina* (Waterhouse, 1838), he considered the variation to be clinal, and synonymised *S. murina albipes* (Waterhouse, 1842), *S. murina fuliginosa* (Gould, 1852), and *S. murina tatei* Troughton, 1965 with *S. murina*. However, he employed these names to 'qualify the form of the species occurring in the vicinity of the type locality or having the particular morphological form' but emphasised that his use of these names was not to be interpreted as recognition of their subspecific status (Archer 1981: 94). He considered that *S. murina fuliginosa* occupied Western

\*Department of Mammalogy, Western Australian Museum, Francis Street, Perth, Western Australia 6000.

†Department of Zoology, University of Western Australia, Nedlands, Western Australia 6009.

Australia and South Australia west of the Flinders Range; the typical form was to the east of this Range up to approximately 28°S; *S. murina 'tatei'* was restricted to north-eastern Queensland; and that a fourth form, allied to *S. murina 'fuliginosa'*, occupied Kangaroo I., South Australia. He did not recognise *S. murina albipes* as distinct from the typical form.

Recent collections from south-western Western Australia gave rise to the suspicion that some of the morphological variation noted by Archer (1981), such as body size, presence or absent of entoconids on  $M_{1-3}$ , premolar and molar row lengths, was not clinal but rather indicative of different taxa. Subsequent electrophoretic study of *S. murina* (*sensu* Archer 1981) supports this belief (Baverstock in press.).

Currently, the principles of mammalian taxonomy largely follow the biological species concept (Mayr, 1963), but use a variety of procedures to transform systematic data into classifications. While the biological species concept stresses the isolation of gene pools, different classificatory procedures attempt to recognise this isolation through different criteria. In this paper we primarily employ the traditional approach of mammalian taxonomists in seeking to find disjunct characteristics of morphology which indicate a lack of gene flow between taxa. However, we contrast this traditional taxonomy with a numerical study of morphometric characters which employs both phenetic and phylogenetic analyses after an examination of the statistical properties, primarily covariation, of these characters. This appraisal includes all representatives of *S. murina* (*sensu* Archer, 1981) available to us.

### Methods

Twenty-two measurements of skull characters and six of external body characters, including weight, were recorded from 131 sexed adult *Sminthopsis* listed under Specimens Examined for each species. Our description follows the terminology of Archer (1981). Cranial and external points used for measurements also follow Archer (1981). Abbreviation for these measurements, in millimetres, are as follows: MAXL, maximum skull length; BASCRANL, basicranial length; MSKW, maximum skull width, MSKH, maximum skull height, ZYHT, zygomatic height measured at the mid-point of the squamosal; BUL, bullae length; OBUL, outside bullae distance; INBUL, inside bullae distance;  $C^1-M^4$ ,  $M^1-M^4$ ,  $M^1-M^3$ ,  $I_1-M_4$ ,  $M_1-M_3$  crown lengths;  $LM^3-RM^3$ , width outside crowns; INORB, minimum interorbital width; IPVAC, inter-palatal vacuity distance; NASL, nasal length; CRANW, cranial width;  $DCI_{I_1}$ , dentary condyle to  $I_1$ ; ANGCON, tip of angular process to articular condyle; CONRAM, articular condyle to anterior border of ascending ramus; WT, weight in grams; NV, nose to vent; TV, tail tip to vent length; HF, hind foot length; EAR, ear height from notch; TRAG, tragus height. Colour pelage, when capitalised, follows Ridgway (1912).

Specimens were regarded as adult if  $M^1$  were fully erupted. Only adults were included in our statistical appraisal.

*Univariate statistics.* Means and standard deviations were computed for all skull and external body characters and weight. The latter variable was not employed in systematic analyses because it was absent from many animal records.

Preservation of biological specimens may alter external morphology. Because some of the specimens dealt with in this study were treated differently prior to measurement, we compared, for each species, external measurements taken from live animals with those from

---

<sup>1</sup>Type specimens for all but *S. murina tatei* are lodged in the British Museum (Natural History) and are not available for loan.

specimens preserved in ethyl alcohol. This comparison using T-tests and a pooled variance estimate, revealed no consistent differences for any variables. Therefore measurements from both live animals and preserved specimens are grouped together. Comparisons between sex and species groups were performed with a two-way analysis of variance.

*Multivariate statistics.* Principal components analysis, employing an orthogonal solution without iteration, and discriminant analysis, using the criterion of maximising Wilk's Lambda, were performed from SPSS routines (Nie *et al.* 1975) on the Western Australian Regional Computing Centre's Cyber 170-720.

Phenetic and cladistic analyses were carried out on a geographic grouping of specimens. These geographic groupings correspond to the major Structural Elements of the 'BMR Earth Science Atlas of Australia' (Canberra, 1979). The Western Australian Structural Elements are further subdivided according to the phytogeographic regions of Beard (1980). Cladistic analysis used the Wagner 78 programme as supplied by J.S. Farris, State University of New York at Stony Brook. Raw population means of the geographic groupings, hereafter referred to as operational taxonomic units or OTU's, were used as characters and Wagner trees rooted either through the mid-point of the branch connecting the two most divergent OTU's, or with outgroups. *Ningau'i ridei*, *Sminthopsis granulipes*, *S. crassicaudata* and *S. macroura* were used either singly or in groups as outgroups. In an attempt to transform the continuous morphometric variables into characters more akin to the discrete genes controlling their expression, means were ranked in ascending order and those separated by less than one average standard deviation grouped. Groupings were then coded in an additive binary fashion (Sneath and Sokal 1973) and these characters used to generate additional Wagner trees as alternatives to those produced from raw means.

As a further alternative to the above trees, Wagner analysis was performed using a data set comprised of the original variables transformed in an attempt to produce size-free values. This transformation consisted of regressing raw values against MAXL (this variable showed the highest loading on the 'size factor' of the factor analysis when averaged for males and females) over the entire data set and then using residuals to characterise individuals (Humphries *et al.* 1981).

Registration numbers of specimens from the Western Australian Museum (WAM), South Australian Museum (SAM) and Australian Museum (AM) are prefixed by M. Specimens from the National Museum of Victoria, Queensland Museum, CSIRO Wildlife Research Collections, and British Museum of Natural History collection are prefixed by C, J, CM and BM (NH) respectively.

The specimens examined are listed by regional groupings which are located in Figure 3; those not judged adult are denoted by J in parenthesis after the specimen number. (S) and (K) indicate skin and skull respectively; all other specimens have body in alcohol and skull separate.

### Systematics

#### *Sminthopsis murina* (Waterhouse, 1838)

(Figures 1, 2a; Table1)

*Phascogale murina* Waterhouse 1838, Proc. Zool. Soc. (Lond.) **5**: 76. North of Hunter's River, N.S.W.

*Phascogale albipes* Waterhouse 1842, Proc. Zool. Soc. (Lond.) **10**: 48. Port Adelaide, South Australia.

*Sminthopsis murina tatei* Troughton 1965, Proc. Linn. Soc. N.S.W. **89**: 309-321. Tolga, north-east Queensland.

Type specimens: *Phascogale murina* Waterhouse, 1838.

### Holotype

British Museum BM (NH) 55.12.24. 95, male, skin and skull. Type locality: Waterhouse (1838: 76) 'Hab. North of Hunter's River, New South Wales.' Thomas (1888: 305), 'Hunter R., N.S.W.' Archer (1981: 84) 'Label on type skin – Hunter's R., N.S.W.'

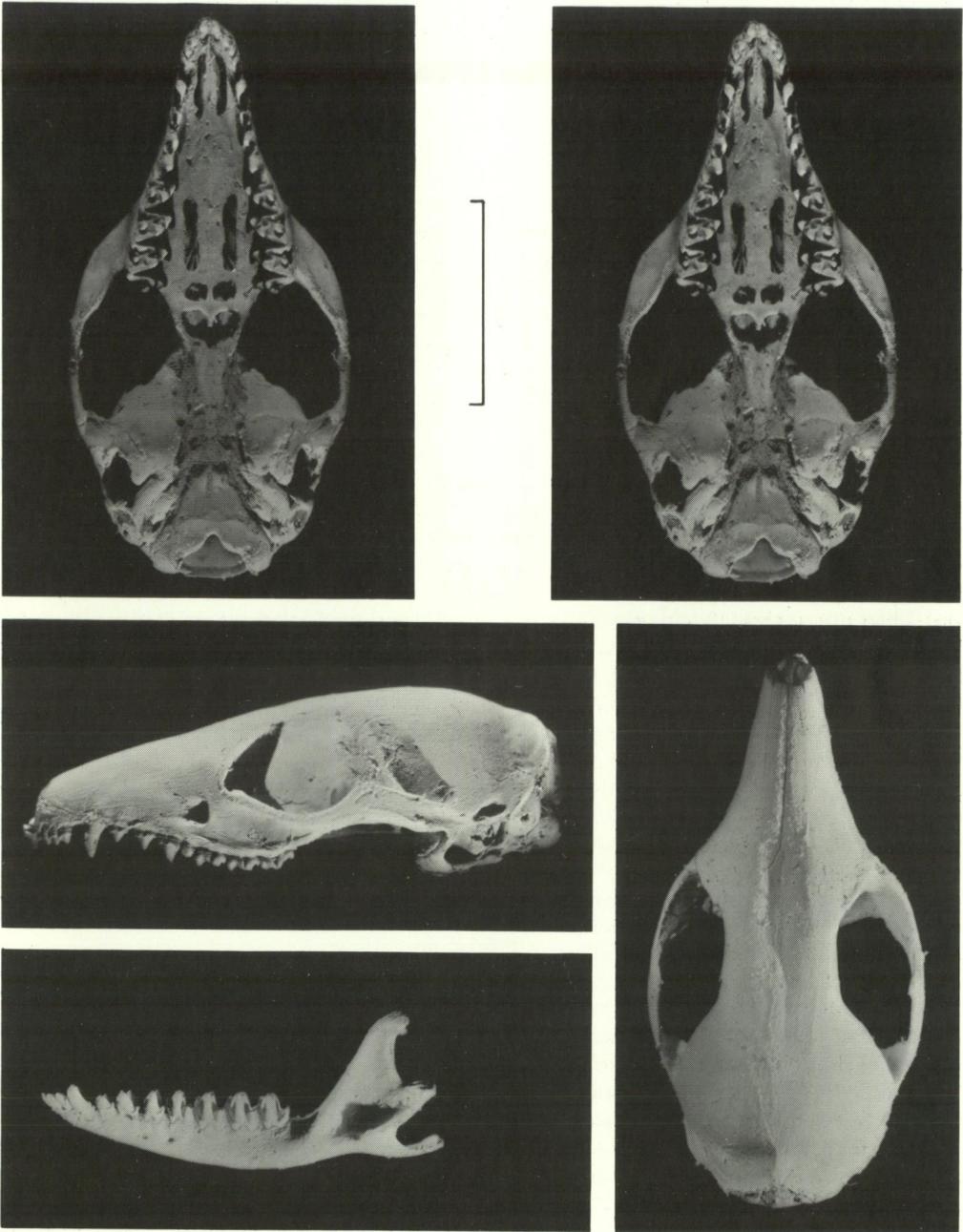
### Diagnosis

Differs from *S. dolichura* as follows (measurements are means, in millimetres): generally shorter tail (77.7 v. 92.8) such that its tail to vent length is less than or only slightly longer than its nose to vent length; a dorsal pelage that is brownish rather than a light fuliginous colour; 10 to eight nipples, whereas *S. dolichura* always has eight; a generally larger skull, particularly maximum length (25.7 v. 25.0), and maximum width (13.7 v. 13.1), longer DC-I<sub>1</sub> (18.6 v. 17.9); wider LM<sup>3</sup>-RM<sup>3</sup> (8.1 v. 7.6); M<sup>3</sup> metacristid normally longer rather than shorter than its crown length. Differs from *S. gilberti* as follows: both shorter hind feet (16.7 v. 17.9) and ears (18.1 v. 21.1); a dorsal pelage that is not a light fuliginous colour; *S. gilberti* normally has eight and occasionally six nipples; C<sup>1</sup>-M<sup>2</sup> shorter (9.7 v. 10.2); crown height of P<sup>1</sup> and P<sup>2</sup> subequal rather than greater than their length and M<sup>2</sup> metacristid normally longer rather than shorter than its crown length. Differs from *S. griseoventer* as follows: dorsal pelage not a light fuliginous colour and a ventral pelage that is a white rather than a 'grizzled' grey colour; *S. griseoventer* normally has eight and occasionally six nipples; C<sup>1</sup>-M<sup>2</sup> shorter (v. 10.2); dP<sup>2</sup> with three major cusps not two as in *S. griseoventer* (StD absent); M<sup>2</sup> metacristid normally longer rather than shorter than its crown length; C<sub>7</sub> normally taller rather than subequal or shorter crowned than P<sub>5</sub>; entoconid on M<sub>5</sub> and M<sub>5</sub> absent or small rather than medium to large; and a generally shorter IPVAC (3.3 v. 4.0). Differs from *S. aitkeni* as follows: dorsal pelage not a dark fuliginous colour; a ventral pelage that is white rather than light grey; generally shorter tail (v. 96.0); smaller maximum skull height (7.1 v. 7.7); shorter C<sup>1</sup>-M<sup>2</sup> (9.7 v. 10.8); M<sup>2</sup> metacrista normally longer rather than shorter than its crown length; C<sub>7</sub> normally taller rather than subequal or shorter crowned than P<sub>5</sub>; entoconids on M<sub>5</sub> and M<sub>5</sub> small to absent rather than medium to large; and generally shorter IPVAC (v. 4.2). If the above diagnosis fails to identify a specimen then it may be distinguished from *S. dolichura*, *S. gilberti*, *S. griseoventer* and *S. aitkeni* by the discriminant function analysis presented herein. Differs from other species of *Sminthopsis* in the way that *S. murina* (*sensu* Archer, 1981) differs from these species (see Archer, 1981).

### Description

#### Pelage

Colour varies little over the range of the species. Dorsal pelage, including that on forearms and hind feet and sides of the body is Fuscous Black at the base, tipped with a mixture of Hair Brown, Drab and Clay Colour; the dominant dorsal colour depends on which colour at the tip of the hairs predominates – usually it is Clay Colour (light brown). The head and neck is a darker Saecardo's Umber which does not extend to the face, apart from small patches around the eyes. Colour of the face and cheeks is that of the predominant dorsal colour, usually Clay Colour. Small lighter coloured patches of Olive Buff to Vinaceous Buff behind the ears. Hairs of the underparts are Deep Violet Gray for the basal half or two-thirds and tipped with white – which is the overall colour. Pes, manus and ventral fur of forearm is white. The dorsal and ventral surfaces of the tail are the colour of their respective body pelage surfaces.



**Figure 1** Skull and left dentary of *S. murina*, AM M6753. The ventral aspects of the skull are stereopairs, scale line, 10 mm.

## Tail

Tail to vent length averages 77.7, which is slightly shorter than the average nose to vent length of 79.3. Tail invariably thin.

## Hind foot

Interdigital pads fused near their base; each pad covered with granules with a medial anteroposterior row of enlarged granules which generally increase in size anteriorly. The apical granule of the fourth interdigital pad frequently the largest and often fused with its proximal granule. In J16475, Mt Molloy, north-eastern Queensland, the apical and proximal granules of the second interdigital pad are also fused; apparent striae frequently present on enlarged granules. Hallucal granules always present; Metatarsal granules absent. Post hallucal granule rarely present. In J21317, Mt Molloy, north-eastern Queensland, two small post hallucal granules fuse to form a small rectangular pad.

## Nipple Number

Kreffft (1867) stated that *Antechinus albiges* (considered by us and Krefft [1867] to be *S. murina*) were 'common on the lower Murray and near Sydney, (and) has ten mammae in the pouch'. Of the specimens examined by us, those from Mt Molloy, north-eastern Queensland, had eight (N = 7) or six (N = 1) nipples, while those from other parts of their distribution had ten (N = 4) or eight (N = 2) nipples.

## Dentition

I<sup>1</sup> taller-crowned than I<sup>2</sup>; I<sup>2</sup> generally shorter-crowned than I<sup>3</sup> but occasionally subequal; I<sup>1</sup> generally subequal but sometimes larger-crowned than I<sup>2</sup>; width of I<sup>2</sup> < I<sup>3</sup> < I<sup>1</sup>. C<sup>1</sup> usually caniniform but occasionally (e.g. C15791) slightly premolariform, conspicuously taller crowned than P<sup>1</sup>; C<sup>1</sup> crown usually taller than P<sup>1</sup> but occasionally subequal. Crown height P<sup>1</sup> and P<sup>3</sup> longer than their crown length; P<sup>2</sup> taller than its crown length; crown height P<sup>1</sup> < P<sup>3</sup> > P<sup>2</sup>; premolar size generally increases gradually posteriorly; anterior and posterior cingular cusps on P<sup>1</sup> to P<sup>2</sup> small to moderate, with posterior cusp usually larger than anterior cusp; buccal and lingual cingula slight and frequently absent on P<sup>2</sup>; postero-lingual cingulum frequently slightly enlarged on P<sup>3</sup>. dP<sup>1</sup> (e.g. C15891) has three roots and three main cusps: a paracone, a subequal or slightly shorter stylar cusp D, and a taller metacone; protocone low and rudimentary; two tiny cusps on the anterobuccal cingulum variably present and may represent StA and StB; metacristid variably developed but obvious. Anterior cingula on M<sup>1</sup> to M<sup>4</sup> confined to the anterobuccal corner. StC slight to moderate and frequently present on M<sup>3</sup> only. StE small to moderate, occasionally present on M<sup>3</sup> and rarely present on M<sup>1</sup> and M<sup>2</sup>. Metacrista of M<sup>3</sup> usually longer or subequal to, rarely shorter than, its crown length. Diastema between C<sub>7</sub> and I<sub>7</sub>. Contact between C<sub>7</sub> and I<sub>7</sub> variable. Usually no contact between P<sub>1</sub>, P<sub>3</sub> and P<sub>4</sub> but contact between P<sub>4</sub> and M<sub>7</sub> variable. C<sub>7</sub> premolariform, usually its crown higher than that of P<sub>3</sub> although rarely subequal. Crown heights of P<sub>1</sub>, P<sub>3</sub> and P<sub>4</sub> variable; most commonly they increase from P<sub>1</sub> to P<sub>3</sub>, although frequently P<sub>3</sub> tallest with P<sub>4</sub> taller or subequal to P<sub>7</sub>. Moderate posterior cingular cusps on P<sub>7</sub> to P<sub>4</sub> and C<sub>7</sub>; smaller anterior cingular cusps on P<sub>7</sub> to P<sub>4</sub> in all but most worn teeth. Narrow buccal and lingual cingula usually present on P<sub>7</sub> and P<sub>3</sub>, occasionally on P<sub>4</sub>. C<sub>7</sub> with narrow lingual cingulum and occasionally a narrow buccal cingulum. I<sub>7</sub> with moderate-sized posterior lobe, absent from I<sub>3</sub> to I<sub>7</sub>. dP<sub>4</sub> (e.g. C15891) has two roots and one main cusp – the protoconid; posterior flank of protoconid with variably developed minor cusp – possibly a metaconid. Posterior cingular

cuspid connected to metaconid of  $dP_1$  by a crest. Parastylids present on  $M_{2-4}$  but absent from  $M_1$ . Entoconids commonly absent but when present tiny or small and usually on  $M_2$  and  $M_3$ . Talonid wider than trigonid only on  $M_1$ . Anterior cingula on  $M_1$  to  $M_4$ , and posterior cingula on  $M_1$  to  $M_3$  narrow; cingula always absent at base of protoconid. Paraconid smaller than or subequal to metaconid on  $M_4$ .

### Skull and Dentary

Nasals expand slightly posteriorly. Frontals with shallow mesial depressions. Lacrimal foramina on or just posterior to anterior rim of orbit. Length of premaxillary vacuity variable but normally extends posteriorly to a point level with cusp of  $P^1$ , rarely only to anterior root of  $P^1$ ; maxillary vacuity varies in length but generally extends anteriorly to a point level with anterior edge of  $M^1$ , but frequently to a point level with posterior root of  $P^1$ . Minimal to absent dorsolateral expansion of lacrimal rim over orbit. Alisphenoid bulla small, broadly exposing ectotympanic ring. Mastoid process uninflated. Periotic bulla small. Foramen pseudovale large. Alisphenoid bar between sphenorbital foramen and foramen rotundum usually moderate, but in several specimens (e.g. CM147) is so wide that laterally the internal openings of foramen rotundum completely obscured. Anterior border of ascending ramus and posterior edge of dentary divergent: distance between articular condyle and tip of ascending ramus shorter than distance between articular condyle and tip of angular process.

### Distribution and Habitat

*Sminthopsis murina* is widely distributed in eastern Australia, mostly in areas receiving an annual median rainfall in excess of 600 mm, but occasionally in areas receiving between 300-400 mm. In south Australia it is not known from localities west of the Flinders Ranges (Figure 3).

Archer (1981) has reviewed the habitat of *Sminthopsis murina* (*sensu stricto*). As with *S. dolichura*, *S. gilberti* and *S. griseoverter*, it occupies a wide range of habitats including open woodland and sclerophyll forest, wet fringes close to rainforest, grasslands and partly cleared land.

### Remarks

Other holotypes from within the range of *S. murina* are *Sminthopsis murina tatei* and possibly *Sminthopsis albipes*. There is some doubt as to the type locality of *S. albipes*. Waterhouse (1842) gives it as 'Port Adelaide.' However, Thomas (1888: 305) states that this locality appears to mean the southern part of Australia, i.e. Victoria. Iredale and Troughton (1934: 10) give Port Adelaide or Port Lincoln, South Australia, as possible localities; Archer (1981) reports that the label attached to the holotype states 'South Australia.' The type locality of *Sminthopsis murina tatei* is given by Troughton (1965: 3, 6) as 'Tolga on the Atherton Tableland, at approximately 2,460 ft, north-eastern Queensland.'

The description of the holotype of *S. albipes*, particularly the reference to a brownish pelage on the upper parts of the body and the tail being considerably shorter than the length from snout to base of tail ( $\pm 81.3$  cf. 99.1 mm) are applicable to *S. murina* in South Australia and not *S. dolichura* or *S. aitkeni*. Furthermore, illustrations of the holotype (Archer [1981] Figure 14) show entoconids to be very small or absent; the cranial measurements he presents

are also within the range for *S. murina*. The dark colour of the tail of *S. albipes* referred to by Waterhouse in his type description as a feature which distinguishes *S. albipes* from *S. murina*, is not considered by us to be diagnostic for any of the species discussed herein. For these reasons we follow Archer (1981), Tate (1947), Thomas (1888) and Krefft (1867) in not recognising *albipes* as a form distinct from *S. murina*.

*Sminthopsis murina tatei* is stated by Troughton (1965) to have a larger pes and longer tail than any intermediate mainland form of *S. murina* but that 'its dimensions are in general agreement with *fuliginosa*.' Archer (1981) examined an extensive series of specimens from Mt Molloy, north-east Queensland, approximately 64 km north of the type locality of *S. murina tatei*, which is at Tolga, including specimens closely resembling those mentioned by Tate (1947) and Troughton (1965) as *S. murina tatei*. Archer concluded that 'no cranial or dental characters are found to consistently separate *tatei* from *fuliginosa*.' We examined the same series from Mt Molloy and discuss this form in the General Discussion.

### Specimens Examined

#### *Hodgkinson Fold Belt group* (HFB)

Tolga, 17°13'S, 145°29'E, 1♂, AM M7157 (holotype *S. murina tatei*). Mt Molloy, 16°41'S, 145°20'E, 4♂, 7♀, J16648, J16475, J16647, J1013, J16478, J16476, J16479, J15896, J15895, J21316, J21317.

#### *New England Fold Belt group* (NEF)

Wallaby Ck, 28°37'S, 152°25'E, 4♂, CM143(S), CM145, CM558, CM147. 5 km E Deepwater, 29°26'S, 151°51'E, 1♂ CM8993. Queens Lake State Forest, 31°38'S, 152°44'E, 2♂, AM M11441, AM M10862. Rockhampton, 23°22'S, 150°32'E, 1♂, J.1472. Nr Brisbane, 27°28'S, 153°01'E, 1♂, AM.M8565. 12 km S Dungowan, 31°20'S, 151°07'E, 1♂, SAM M9409. Dungowan, 31°13'S, 151°07'E, 1♀, SAM M9690.

#### *Clarence-Moreton Basin group* (CMB)

Bundylung Res., 29°07'S, 153°26'E, 1♀, CM3732 (S), Mt Brown, 28°30'S, 152°30'E, 1♂, CM382 (S).

#### *Sydney Basin group* (SYB)

Kurrajong, 33°34'S, 150°40'E, 2♂, AM M6639, AM6753.

#### *Surat Basin group* (SB)

Pillaga Scrub via Coonabarabram, 30°21'S, 148°53'E, 1♂, CM3926 (S).

#### *Lachlan Fold Belt group* (LFB)

Gundaroo, 35°02'S, 149°16'E, 1♂, CM6019 (S). Nr Mt Buninyong, 37°39'S, 143°56'E, 1♀, C15891 (j). Kinglake Nat. Pk, 37°30'S, 145°18'E, 1♀, C12644. Christmas Hills, 37°39'S, 145°19'E, 1♀, C14022. Murrumbateman, 34°58'S, 149°02'E, 1♀, CM6011. 15 km SW Edenhope, 37°02'S, 141°17'E, 1♂, C24357. Fraser Nat. Pk, 37°12'S, 146°00'E, 1♂, C13942. Buxton, 37°25'S, 145°43'E, 1♂, C23173. 15 km N. Casterton, 37°00'S, 141°24'E, 1♂, C14020 (S).

#### *Otway Basin group* (OB)

Bannockburn, 38°03'S, 144°10'E, 1♀, C15791. Big Heath Nat. Pk, 37°05'S, 140°40'E, 1♂, SAM M7682.

#### *Murray Basin group* (MB)

25 km W Rainbow, 35°43'S, 141°30'E, 1♀, C14027 (S). 4 km W Jumby East Dam, 35°56'S, 139°42'E, 1♀, SAM M10896. Haylands, 34°14'S, 139°38'E, 1♀, SAM M10251. Victor Harbour, 35°33'S, 138°37'E, 1♀, SAM M7536 (S). Billiatt Nat. Pk (NW), 34°55'S, 140°30'E, 1♀, SAM M8636 (S). Birthday Tank, 34°54'S, 141°36'E, 1♂, C10920. 1.7 km N Birthday Tank, 34°47'S, 141°36'E, 1♂, C15826.

**Table 1** Skull and body characters for the five species of *Sminthopsis*. Values are means, with standard deviations in bold and sample size in brackets for (a) males, (b) females.**(a) Males**

Character	<i>S. murina</i>	<i>S. dolichura</i>	<i>S. gilberti</i>	<i>S. griseoventer</i>	<i>S. aitkeni</i>
MAXL	26.38 <b>1.30</b> (26)	25.23 <b>0.90</b> (49)	27.59 <b>0.72</b> (10)	26.66 <b>0.98</b> (21)	27.97 <b>1.27</b> (3)
BASCRANL	23.95 <b>1.36</b> (26)	23.08 <b>0.98</b> (49)	25.07 <b>0.59</b> (9)	24.11 <b>0.98</b> (21)	24.75 <b>1.77</b> (2)
MSKH	7.26 <b>0.31</b> (26)	6.87 <b>0.22</b> (49)	7.41 <b>0.20</b> (10)	7.42 <b>0.25</b> (21)	7.85 <b>0.35</b> (2)
MSKW	14.22 <b>1.06</b> (24)	13.19 <b>0.71</b> (50)	14.77 <b>0.62</b> (10)	14.30 <b>0.74</b> (21)	14.30 <b>0.56</b> (3)
ZYHT	1.40 <b>0.25</b> (26)	1.20 <b>0.18</b> (50)	1.39 <b>0.16</b> (10)	1.36 <b>0.17</b> (20)	1.33 <b>0.15</b> (3)
BUL	5.04 <b>0.19</b> (26)	5.25 <b>0.18</b> (50)	5.17 <b>0.19</b> (9)	5.00 <b>0.14</b> (19)	4.95 <b>0.21</b> (2)
OBUL	9.35 <b>0.45</b> (26)	9.16 <b>0.34</b> (49)	9.93 <b>0.35</b> (8)	9.59 <b>0.44</b> (15)	9.75 <b>0.64</b> (2)
INBUL	3.31 <b>0.30</b> (25)	3.08 <b>0.21</b> (48)	3.66 <b>0.15</b> (7)	3.42 <b>0.25</b> (12)	3.70 <b>0.14</b> (2)
C <sup>1</sup> -M <sup>2</sup>	9.85 <b>0.45</b> (26)	9.42 <b>0.31</b> (50)	10.38 <b>0.22</b> (10)	10.34 <b>0.34</b> (20)	11.03 <b>0.47</b> (3)
M <sup>1</sup> -M <sup>2</sup>	5.27 <b>0.17</b> (26)	5.18 <b>0.14</b> (50)	5.56 <b>0.16</b> (10)	5.40 <b>0.16</b> (21)	5.80 <b>0.17</b> (3)
M <sup>1</sup> -M <sup>3</sup>	4.60 <b>0.17</b> (26)	4.51 <b>0.13</b> (50)	4.88 <b>0.18</b> (10)	4.76 <b>0.15</b> (21)	5.13 <b>0.15</b> (3)
LM <sup>3</sup> -RM <sup>3</sup>	8.20 <b>0.54</b> (26)	7.57 <b>0.26</b> (50)	8.34 <b>0.36</b> (10)	8.18 <b>0.40</b> (21)	8.37 <b>0.35</b> (3)
INORB	5.01 <b>0.36</b> (26)	4.97 <b>0.23</b> (50)	5.44 <b>0.22</b> (10)	5.05 <b>0.21</b> (21)	5.47 <b>0.32</b> (3)
IPVAC	3.51 <b>0.51</b> (26)	2.99 <b>0.33</b> (50)	3.44 <b>0.36</b> (8)	4.21 <b>0.32</b> (15)	4.40 <b>0.20</b> (3)
NASL	9.77 <b>0.82</b> (26)	9.20 <b>0.61</b> (50)	10.60 <b>0.70</b> (10)	9.38 <b>0.67</b> (21)	10.00 <b>0</b> (3)
CRANW	10.38 <b>0.57</b> (26)	9.96 <b>0.35</b> (50)	10.80 <b>0.63</b> (10)	10.86 <b>0.57</b> (21)	10.67 <b>0.58</b> (3)
DC-I <sub>1</sub>	19.17 <b>1.14</b> (26)	18.16 <b>0.76</b> (50)	20.23 <b>0.53</b> (9)	19.40 <b>0.86</b> (21)	20.33 <b>1.25</b> (3)
I <sub>1</sub> -M <sub>4</sub>	11.24 <b>0.49</b> (26)	10.73 <b>0.36</b> (50)	11.95 <b>0.33</b> (10)	11.75 <b>0.39</b> (21)	12.57 <b>0.61</b> (3)
M <sub>1</sub> -M <sub>4</sub>	5.64 <b>0.23</b> (26)	5.47 <b>0.14</b> (50)	5.97 <b>0.15</b> (10)	5.82 <b>0.16</b> (21)	6.23 <b>0.15</b> (3)
M <sub>1</sub> -M <sub>3</sub>	4.10 <b>0.21</b> (26)	4.00 <b>0.12</b> (50)	4.45 <b>0.13</b> (10)	4.30 <b>0.16</b> (21)	4.63 <b>0.21</b> (3)

## (a) Males (continued)

Character	<i>S. murina</i>	<i>S. dolichura</i>	<i>S. gilberti</i>	<i>S. griseoventer</i>	<i>S. aitkeni</i>
ANGCON	5.26 <b>0.33</b> (26)	5.14 <b>0.24</b> (50)	5.34 <b>0.23</b> (8)	5.42 <b>0.24</b> (20)	5.30 <b>0.40</b> (3)
CONRAM	4.33 <b>0.45</b> (26)	4.16 <b>0.31</b> (50)	4.43 <b>0.24</b> (9)	4.64 <b>0.33</b> (21)	4.43 <b>0.21</b> (3)
WT	19.54 <b>3.34</b> (8)	13.68 <b>3.07</b> (35)	21.75 <b>6.01</b> (2)	17.20 <b>4.34</b> (5)	30.5 <b>0</b> (1)
NV	81.22 <b>8.67</b> (25)	74.47 <b>6.75</b> (50)	89.73 <b>6.43</b> (10)	86.58 <b>8.39</b> (19)	88.37 <b>4.51</b> (3)
TV	78.88 <b>9.08</b> (25)	94.61 <b>7.22</b> (50)	83.25 <b>7.59</b> (10)	83.16 <b>5.14</b> (20)	98.20 <b>7.60</b> (3)
HF	17.11 <b>0.89</b> (25)	16.83 <b>0.68</b> (50)	18.13 <b>0.85</b> (10)	16.59 <b>1.18</b> (20)	17.50 <b>1.08</b> (3)
EAR	18.34 <b>1.09</b> (25)	19.66 <b>1.34</b> (48)	21.38 <b>1.05</b> (10)	18.06 <b>1.59</b> (20)	18.37 <b>0.45</b> (3)
TRAG	3.29 <b>0.40</b> (21)	3.34 <b>0.40</b> (47)	3.20 <b>0.21</b> (5)	3.22 <b>0.35</b> (9)	3.60 <b>0</b> (1)

## (b) Females

Character	<i>S. murina</i>	<i>S. dolichura</i>	<i>S. gilberti</i>	<i>S. griseoventer</i>	<i>S. aitkeni</i>
MAXL	24.76 <b>1.12</b> (17)	24.43 <b>0.96</b> (26)	26.56 <b>0.78</b> (8)	25.77 <b>0.92</b> (11)	26.35 <b>0.35</b> (2)
BASCRANL	22.29 <b>1.14</b> (18)	22.16 <b>0.94</b> (25)	24.00 <b>0.81</b> (8)	23.16 <b>1.13</b> (12)	23.70 <b>0.28</b> (2)
MSKH	6.86 <b>0.17</b> (18)	6.65 <b>0.27</b> (27)	7.21 <b>0.84</b> (8)	7.23 <b>0.18</b> (12)	7.60 <b>0.42</b> (2)
MSKW	13.02 <b>0.80</b> (16)	12.80 <b>0.75</b> (26)	13.97 <b>0.61</b> (7)	13.65 <b>0.62</b> (11)	13.80 <b>1.13</b> (2)
ZYHT	1.31 <b>0.15</b> (17)	1.20 <b>0.18</b> (28)	1.37 <b>0.17</b> (7)	1.33 <b>0.15</b> (12)	1.40 <b>0.28</b> (2)
BUL	4.83 <b>0.21</b> (18)	5.10 <b>0.17</b> (28)	5.16 <b>0.19</b> (5)	4.95 <b>0.16</b> (11)	4.90 <b>0</b> (2)
OBUL	9.02 <b>0.39</b> (18)	8.88 <b>0.34</b> (27)	9.55 <b>0.29</b> (4)	9.31 <b>0.28</b> (10)	9.55 <b>0.35</b> (2)
INBUL	3.28 <b>0.22</b> (17)	3.03 <b>0.21</b> (27)	3.30 <b>0.26</b> (3)	3.43 <b>0.27</b> (10)	3.70 <b>0.28</b> (2)

## (b) Females (continued)

Character	<i>S. murina</i>	<i>S. dolichura</i>	<i>S. gilberti</i>	<i>S. griseoventer</i>	<i>S. aitkeni</i>
C <sup>1</sup> -M <sup>1</sup>	9.41 <b>0.42</b> (18)	9.21 <b>0.32</b> (28)	10.08 <b>0.18</b> (8)	10.00 <b>0.34</b> (12)	10.45 <b>0.07</b> (2)
M <sup>1</sup> -M <sup>1</sup>	5.24 <b>0.21</b> (18)	5.16 <b>0.16</b> (28)	5.59 <b>0.08</b> (8)	5.43 <b>0.14</b> (12)	5.50 <b>0.28</b> (2)
M <sup>1</sup> -M <sup>3</sup>	4.61 <b>0.22</b> (18)	4.50 <b>0.15</b> (28)	4.93 <b>0.07</b> (8)	4.80 <b>0.14</b> (12)	4.85 <b>0.07</b> (2)
LM <sup>3</sup> -RM <sup>3</sup>	7.93 <b>0.42</b> (17)	7.61 <b>0.40</b> (28)	8.15 <b>0.20</b> (8)	8.12 <b>0.41</b> (12)	8.20 <b>0.57</b> (2)
INORB	4.62 <b>0.28</b> (18)	4.77 <b>0.25</b> (28)	5.23 <b>0.17</b> (8)	4.87 <b>0.20</b> (12)	5.25 <b>0.21</b> (2)
IPVAC	3.05 <b>0.38</b> (17)	2.96 <b>0.49</b> (28)	3.06 <b>0.35</b> (7)	3.77 <b>0.44</b> (10)	3.95 <b>0.50</b> (2)
NASL	8.89 <b>0.58</b> (18)	8.57 <b>0.50</b> (28)	10.00 <b>0.53</b> (8)	9.27 <b>0.47</b> (11)	9.50 <b>0.71</b> (2)
CRANW	9.78 <b>0.43</b> (18)	9.71 <b>0.53</b> (28)	10.50 <b>0.53</b> (8)	10.50 <b>0.52</b> (12)	10.50 <b>0.71</b> (2)
DC-I <sub>1</sub>	17.85 <b>0.97</b> (18)	17.53 <b>0.80</b> (28)	19.25 <b>0.73</b> (8)	18.41 <b>0.69</b> (11)	19.00 <b>0.42</b> (2)
I <sub>7</sub> -M <sub>1</sub>	10.73 <b>0.48</b> (18)	10.51 <b>0.39</b> (28)	11.65 <b>0.17</b> (8)	11.35 <b>0.41</b> (11)	11.85 <b>0.07</b> (2)
M <sub>1</sub> -M <sub>1</sub>	5.63 <b>0.25</b> (18)	5.45 <b>0.23</b> (28)	5.95 <b>0.09</b> (8)	5.87 <b>0.14</b> (12)	5.95 <b>0.07</b> (2)
M <sub>1</sub> -M <sub>3</sub>	4.06 <b>0.22</b> (18)	4.01 <b>0.13</b> (28)	4.39 <b>0.06</b> (8)	4.35 <b>0.13</b> (12)	4.45 <b>0.07</b> (2)
ANGCON	5.08 <b>0.30</b> (16)	5.09 <b>0.30</b> (27)	5.24 <b>0.21</b> (8)	5.21 <b>0.21</b> (12)	5.20 <b>0</b> (2)
CONRAM	3.98 <b>0.44</b> (18)	4.01 <b>0.32</b> (28)	4.14 <b>0.29</b> (8)	4.34 <b>0.30</b> (11)	4.25 <b>0.21</b> (2)
WT	14.33 <b>4.20</b> (7)	13.44 <b>3.38</b> (16)	13.75 <b>1.77</b> (2)	19.45 <b>2.76</b> (2)	0
NV	76.23 <b>9.49</b> (15)	73.67 <b>7.16</b> (27)	81.05 <b>5.75</b> (6)	77.67 <b>9.38</b> (9)	<b>84.75</b> <b>10.54</b> (2)
TV	75.65 <b>4.83</b> (15)	89.57 <b>7.31</b> (28)	75.23 <b>10.11</b> (6)	80.38 <b>4.47</b> (11)	92.65 <b>1.91</b> (2)
HF	15.97 <b>0.81</b> (15)	16.37 <b>0.99</b> (28)	17.53 <b>1.64</b> (6)	15.71 <b>0.79</b> (10)	17.55 <b>0.78</b> (2)
EAR	17.74 <b>1.68</b> (14)	18.63 <b>1.96</b> (26)	20.63 <b>0.89</b> (6)	17.12 <b>1.29</b> (10)	17.95 <b>0.50</b> (2)
TRAG	3.36 <b>0.24</b> (8)	3.30 <b>0.49</b> (24)	3.33 <b>0.21</b> (3)	3.13 <b>0.36</b> (7)	0

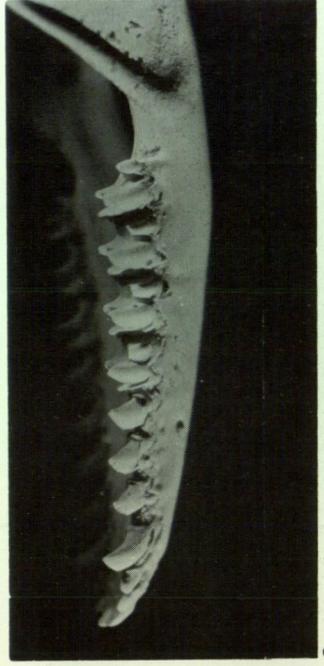
A Taxonomic Revision of the *Sminthopsis murina* Complex



a



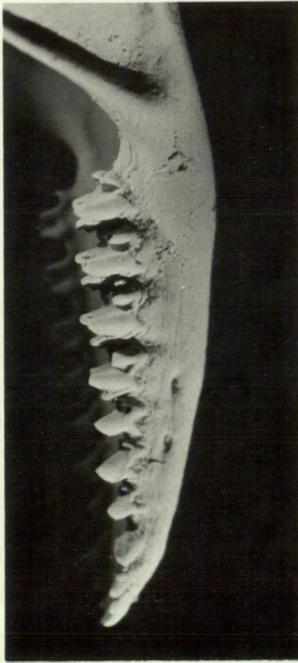
b



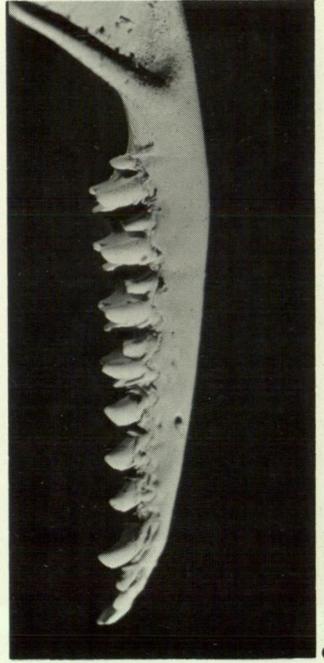
c



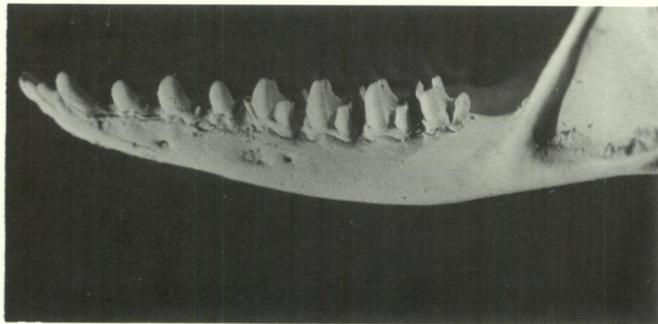
a



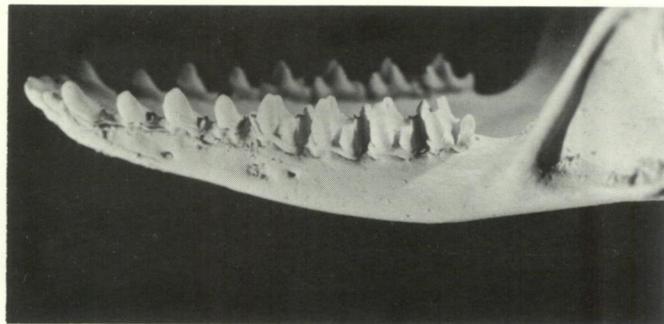
b



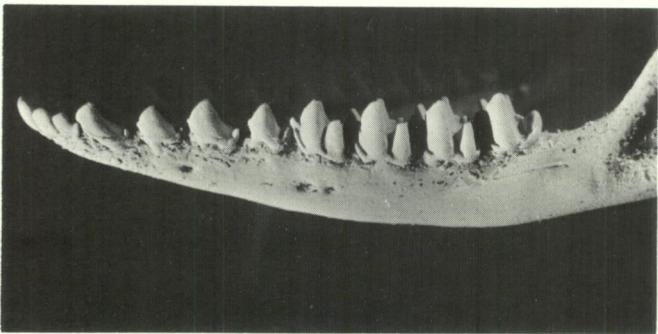
c



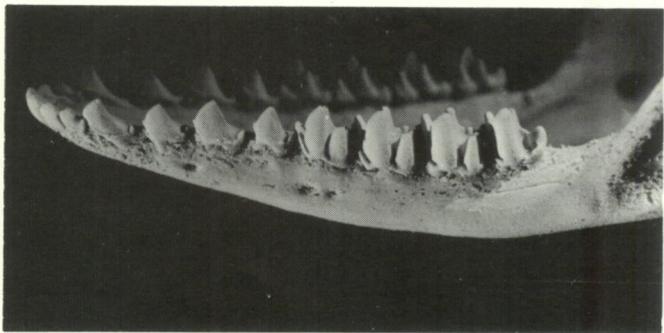
d



d



e



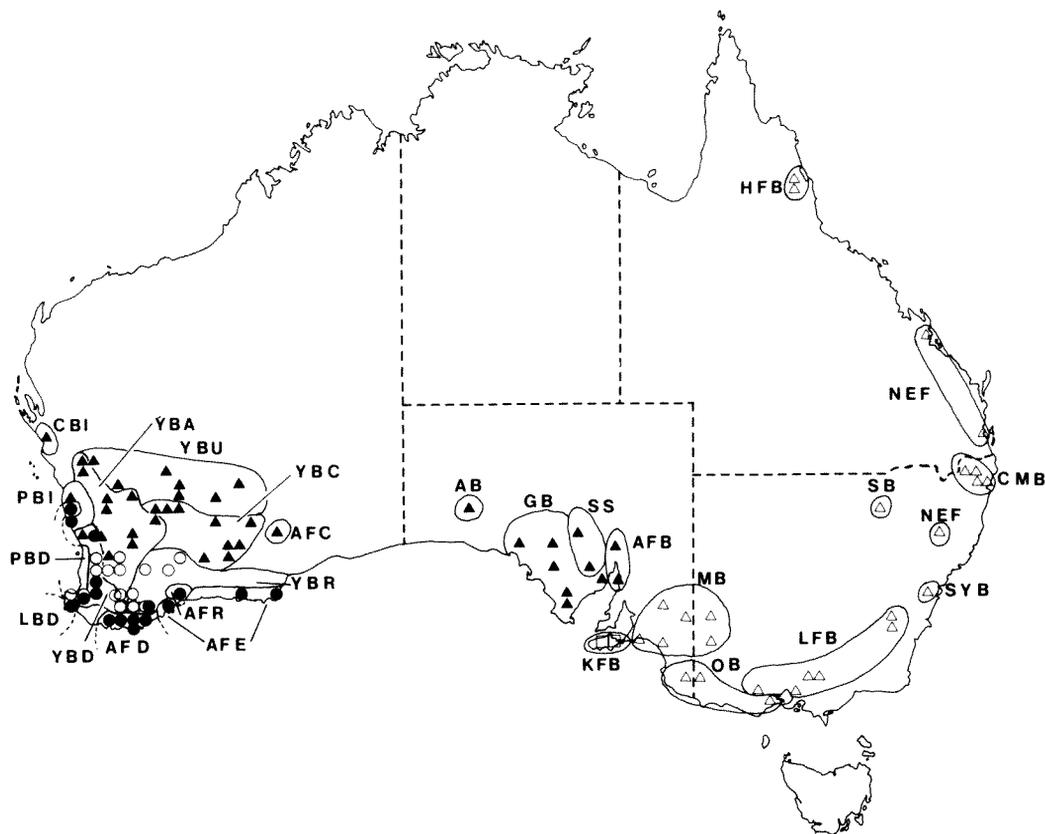
e

**Figure 2** Left dentary from buccal aspect, as stereopairs for:

- (a) *S. murina*, AM M6753
- (b) *S. dolichura*, holotype
- (c) *S. gilberti*, holotype
- (d) *S. griseoventer*, holotype
- (e) *S. aitkeni*, holotype.

Scale line, 5 mm.





**Figure 3** Allocation of *S. murina* ( $\Delta$ ), *S. dolichura* ( $\blacktriangle$ ), *S. gilberti* ( $\circ$ ), *S. griseoventer* ( $\bullet$ ), and *S. aitkeni* ( $\square$ ) specimens to geographic groups. HFB, Hodgkinson Fold Belt; NEF, New England Fold Belt; CMB, Clarence-Moreton basin; SB, Surat Basin; SYB, Sydney-Basin; LFB, Lachlan Fold Belt; OB, Otway Basin; MB, Murray Basin; KFB, Kanmantoo Fold Belt; AFB, Adelaide Fold Belt; SS, Stuart Shelf; GB, Gawler Block; AB, Arckaringa Basin; AFC, Albany-Fraser Province/Coolgardie; AFR, Albany-Fraser Province/Roe; AFE, Albany-Fraser Province/Eyre; AFD Albany-Fraser Province/Darling; YBD, Yilgarn Block/Darling; LBD, Leeuwin Block/Darling; PBD, Perth Basin/Darling; PBI, Perth Basin/Irwin; CBI, Carnarvon Basin/Irwin; YBA, Yilgarn Block/Avon; YBU, Yilgarn Block/Austin; YBC, Yilgarn Block/Coolgardie; YBR, Yilgarn Block/Roe.

*Sminthopsis dolichura* sp. nov.

(Figures 2b, 4a, 5, 6; Table 1)

**Holotype**

WAM M17985; adult male, skull and dentaries, carcass (liver removed for electrophoresis) in 70% ethyl alcohol. Pit-trapped by R.A. How *et al.* on 15 August 1980, 6 km SSE of Buningtonia Spring, Western Australia (31°28'10"S, 123°36'00"E), at 250 m above sea level. Type locality described under Distribution and Habitat.

**Paratypes**

10 females and 21 males; see Specimens Examined.

**Diagnosis**

*Sminthopsis dolichura* differs from *S. murina* as follows (measurements are means, in millimetres): longer tail (92.8 v. 77.7); a dorsal pelage that is a light fuliginous rather than a brownish colour; not more than eight teats; generally smaller skull, particularly maximum length (25.0 v. 25.7) and maximum width (13.1 v. 13.7); shorter DCI<sub>1</sub> (17.9 v. 18.6); narrower LM<sup>3</sup>-RM<sup>3</sup> (7.6 v. 8.1); and M<sup>3</sup> metacristid shorter or subequal to, rather than longer than its crown length. Differs from *S. gilberti* as follows: both shorter hind feet (16.7 v. 17.9) and ears (19.3 v. 21.1); longer tail (92.8 v. 80.2); smaller skull, particularly maximum length (25.0 v. 27.1) and maximum width (13.1 v. 14.4); shorter DC-I<sub>1</sub> (17.9 v. 19.8); shorter C<sup>1</sup>-M<sup>1</sup> (9.3 v. 10.2) and distance across LM<sup>3</sup>-RM<sup>3</sup> (5.5 v. 6.0) and higher CONRAM: I<sub>1</sub>-M<sub>1</sub> ratio (0.75 v. 0.72). Differs from *S. griseoventer* as follows: longer tail (v. 82.2); a white rather than a 'grizzled' grey ventral pelage; smaller skull, particularly maximum length (25.0 v. 26.4) and maximum width (13.1 v. 14.1); shorter C<sup>1</sup>-M<sup>1</sup> (v. 10.2); dP<sup>1</sup> has three major cusps rather than two; C<sub>1</sub> crown normally taller rather than subequal, or shorter than that of P<sub>3</sub>; entoconids on M<sub>2</sub> and M<sub>3</sub> absent or very small rather than moderate or large; shorter IPVAC (3.0 v. 4.0). Differs from *S. aitkeni* as follows: dorsal pelage has a lighter fuliginous colour and its ventral pelage whiter; smaller skull, particularly maximum length (v. 27.3), maximum width (v. 14.1) and maximum height (6.8 v. 7.7); shorter in all tooth dimensions, particularly C<sup>1</sup>-M<sup>1</sup> (v. 10.8); C<sub>1</sub> taller rather than subequal or shorter crowned than P<sub>3</sub>; entoconids on M<sub>2</sub> and M<sub>3</sub> absent or very small rather than moderate or large. If the above diagnosis fails to identify a specimen then it may be distinguished from *S. murina*, *S. gilberti*, *S. griseoventer* and *S. aitkeni* by the discriminant function analysis presented herein. Differs from other species of *Sminthopsis* in the way that *S. murina* (*sensu* Archer, 1981) differs from them. (See Archer [1981].)

**Description****Pelage**

Colour varies little over the range of the species. Dorsal fur, including that on forearms and hind feet, and sides of the body Fuscous Black at base, tipped with mixture of Greyish Olive and Black dorsally and occasionally with Light Pinkish Cinnamon laterally. Black tipped hairs more prominent mesially and extend from base of tail anteriorly to forehead. Overall the dorsal pelage is a light fuliginous colour. Apart from thin ring of Black around eye, face and cheeks Light Pinkish Cinnamon, as are small patches behind ears. Ventral fur similar in colour to *S. murina*. Dorsal and ventral surface of tail are the colour of their respective body pelage surfaces.

**Tail**

Average tail to vent length 92.8, i.e. 25.0% longer than average nose to vent length of 74.2. Tail invariably thin.

**Hind Foot**

As for *S. murina* except for the following: apical granule of fourth interdigital pad normally the largest and frequently fused with its posterior proximal granule. Small metatarsal granule present in WAM M6998 only. Post hallucal granule rarely present (WAM M17742), and fusion of several such granules to form a small elongate post hallucal pad is recorded only twice (WAM M6998, WAM M17995).



a

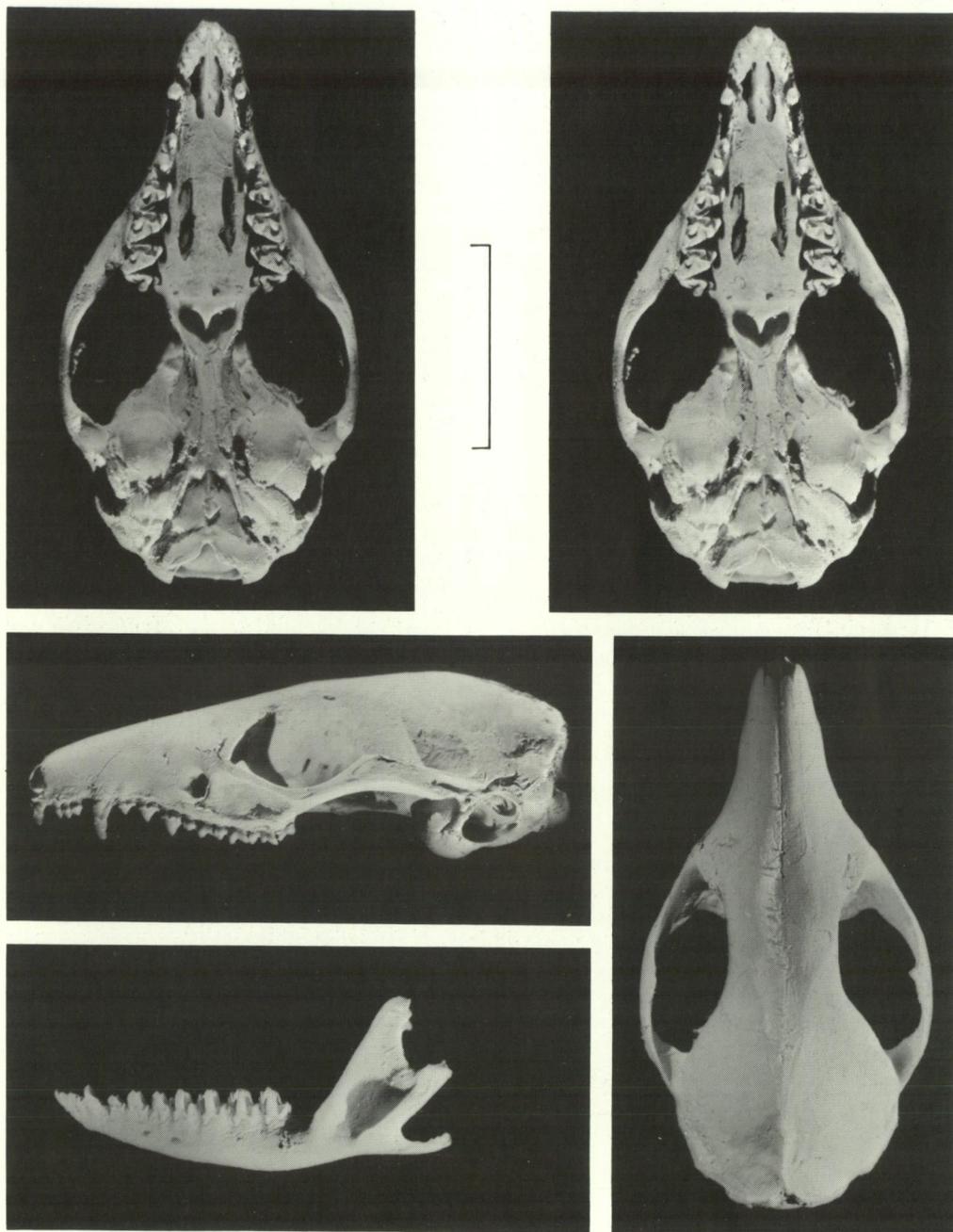


b



c

**Figure 4** (a) *S. dolichura* (animal still in captivity), note long tail and white underparts (photo. G. Barron).  
(b) *S. gilberti* holotype, note relatively short tail, long ears and white underparts (photo. G. Barron).  
(c) *S. griseoventer* holotype, note relatively short tail, short ears and greyish underparts.



**Figure 5** Skull and left dentary of the holotype of *S. dolichura*. The ventral aspects of the skull are stereopairs. Scale line, 10 mm.

### Nipple Number

Eight nipples only (N = 19).

### Dentition

As for *S. murina* except for the following points: C<sup>1</sup> usually slight to moderately premolariform, occasionally caniniform; C<sup>1</sup> short, frequently subequal and occasionally slightly taller crowned than P<sup>2</sup>. dP<sup>2</sup> StD slightly shorter than its paracone (e.g. WAM M2007, WAM M20119). dP<sub>4</sub> has no metaconid on posterior flank of protoconid. StC and StE absent M<sup>1</sup> to M<sup>2</sup>. M<sup>3</sup> metaacristid shorter or subequal to its crown length. P<sub>3</sub> always taller crowned than P<sub>1</sub> and P<sub>4</sub>; P<sub>4</sub> usually taller crowned than P<sub>1</sub>. Entoconids commonly absent but when present are tiny and restricted to M<sub>2</sub> and M<sub>3</sub>.

### Skull and Dentary

As for *S. murina*.

### Distribution and Habitat

*Sminthopsis dolichura* is widely distributed in the semi-arid savannah mallee country of Western Australia, and South Australia west of the Flinders Range (Figure 3).

It occurs in all major vegetation and landform types (Chapman and Kitchener [1978, 1981], Kitchener and Chapman, [1979], R.A. How [pers. comm.] and N. McKenzie [pers. comm.]) except samphire vegetation on salt flats and paleo drainage lines.

These vegetation formations range from:

- woodlands to open woodlands; these are usually dominated by *Eucalyptus* spp, but occasionally by *Acacia* spp. and *Casuarina* spp;
- tall to low and open to closed shrublands and heaths; these are usually dominated by a mixed assemblage of myrtaceous and proteaceous plants, but occasionally as a pure association of *Melaleuca* spp. (e.g. *M. uncinata*), or *Acacia* spp. (*A. resinomarginea*, *A. signata*) or *Casuarina* spp. (*C. campestris*);
- spinifex (*Triodia scariosa*) with mallee emergents.

The substrate of these formations comprise yellow, grey and red sands, and grey brown and red duplex soils involving clays and loams, occasionally the duplex soils have a pebble matrix.

The type locality of *S. dolichura* is a low woodlands of *Eucalyptus salubris* which is almost lacking in understory except for occasional low (< 1 m high) shrubs of *Cratystylis conocephala*, *Maireana sedifolia*, *Scaevola spinescens*, *Rhagodia spinescens* and *Atriplex vesicaria*. The soil A-horizon is a highly calcareous dark red loam with clay content increasing with depth (K. Newby, pers. comm.) (Figure 6).

### Origin of Name

From the Greek: *dolchos* (long) and *ura* (tail).

### Specimens Examined

#### Stuart Shelf group (SS)

Kootaberrra, 31°59'S, 137°30'E, 1♂, SAM M9624. Wirraminna, 31°21'S, 136°25'E, 1♂, SAM M7537 (S).

#### Adelaide Fold Belt group (AFB)

Weeroona Bay, 33°00'S, 137°46'E, 1♀, SAM M10999.



**Figure 6** Type locality of *S. dolichura*. The pit-trap from which the holotype was collected is in the foreground (photo: R.A. How).

*Gawler Block group (GB)*

Blesing (SW Eyre Penin.) 34°00'S, 135°00'E, 1♂, SAM M7535 (S). Paney Stn. 32°34'S, 135°27'E, 1♂, SAM M10834, Ceduna-Tarcoola, 31°33'S, 133°58'E, 1♀, SAM M9268. Lakes Giles Cons. Pk, 32°58'S, 136°45'E, 1♂, SAM M10344. Middle Back Range, 33°10'S, 137°07'E, 1♂, SAM M10995. Hincks Nat. Pk, 33°55'S, 135°55'E, 1♀, SAM M9408. Lake Everard HS, 31°44'S, 135°10'E, 1♀, WAM M18977.

*Arckaringa Basin group (AB)*

5 km N Ooldea, 30°24'S, 131°50'E, 1♂, SAM M9353.

*Albany-Fraser Province/Coolgardie group (AFC)*

Buningonia Spring area, 31°28'10"S, 123°36'00"E, 1♂, WAM M17985 (holotype) Buningonia Spring area, 31°27'S, 123°32'E, 2♂, 1♀, WAM M17994, WAM M17995, WAM M17986.

*Yilgarn Block/Darling group (YBD)*

Gingin, 31°19'S, 115°45'E, 1♂, WAM M16811.

*Perth Basin/Irwin group (PBI)*

Eneabba, 29°45'S, 115°24'E, 1♂, WAM M18066.

*Carnarvon Basin/Irwin group (CBI)*

34 km NW Murchison Hse, HS 27°21'S, 114°09'E, 1♀, WAM M7153.

*Yilgarn Block/Avon group (YBA)*

Buntine Nat. Res., 30°00'S, 116°37'E, 1♀, WAM M10284. Nth Bungalla Nat. Res., 31°32'S, 117°35'E, 1♀, WAM M13705. 13 km W Bolgart, 31°17'S, 116°23'E, 1♀, WAM M7149. Boyagin Nat. Res., 32°28'S, 116°52'E, 1♀, WAM M18941. Durokoppin Nat. Res., 31°25'S, 117°45'E, 1♀, WAM M13905. Wilroy Nat. Res., 28°38'S, 115°38'E, 1♀, WAM M15420. 1 km S Walyahmoning Rock, 30°39'S, 118°45'E, 1♀, WAM M8738. Tallering HS, 28°19'S, 115°51'E, 1♂, WAM M6386. Karroun Hill Nat. Res., 29°58'S, 117°43'E, 1♂, WAM M12608. E Yorkrakine Nat. Res., 31°24'S, 117°40'E, 1♂, WAM M13142. Nugadong Nat. Res., 30°14'S, 116°49'E, 1♂, WAM M13636. Sth Badjaling Nat. Res., 31°53'S, 117°53'S, 1♂, WAM M13704. Yorkrakine Rock Nat Res., 31°27'S, 117°30'S, 1♂, WAM M13709. Jibberding, 29°53'S, 116°49'E, 1♂, WAM M24549.

*Yilgarn Block/Austin group (YBU)*

Yundamindra area, 29°16'S, 122°24'E, 2♂, WAM M22074, WAM M2007 (J). Goongarrie area, 29°55'S, 121°08'N, 2♂, WAM M17546, WAM M20039. Goongarrie area, 29°55'S, 121°09'E, 1♂, WAM M20047. Goongarrie area, 29°54'S, 121°10'E, 1♂, WAM M20050. Yuinmery area, 28°32'S, 119°12'E, 1♀, WAM M17817. 6 km W Pinyalling Hill, 29°06'S, 117°15'E, 1♀, WAM M6998. 24 km S Pindar, 28°26'S, 116°02'E, 1♀, WAM M19056. Mt Elvire area, 29°33'S, 119°36'E, 2♂, 1♀, WAM M18313, WAM M18309, WAM M18312. Mt Elvire area, 29°19'S, 119°36'E, 2♂, WAM M18306, WAM M18310. Mt Elvire area, 29°27'S, 119°36'E, 1♂, WAM M18352. Mt Elvire area, 29°32'S, 119°39'E, 1♂, WAM M18307.

*Yilgarn Block/Coolgardie group (YBC)*

18 km NW Norseman, 32°03'S, 121°41'E, 1♀, WAM M11335. Bungalbin Hill area, 30°19'S, 119°43'E, 2♀, WAM M17943, WAM M17952. Bungalbin Hill area, 30°18'S, 119°44'E, 1♂, 1♀, WAM M20293, WAM M17759. Bungalbin Hill area, 30°18'S, 119°43'E, 1♂, WAM M20310. Mt Manning area, 30°00'S, 119°36'E, 2♂, 1♀, WAM M18303, WAM M18305, WAM M18301. McDermid Rock area, 32°01'S, 120°45'E, 4♂, 1♀, WAM M17675, WAM M17686, WAM M20119 (J), WAM M20120, WAM M17677. Mt Jackson area 30°25'S, 119°25'E, 1♂, WAM M17742. Mt Jackson area, 30°25'S, 119°15'E, 2♂, WAM M20258, WAM M20273. Mt Jackson area, 30°15'S, 119°15'E, 1♂, WAM M20274. Kalgoorlie area, 30°33'S, 121°14'E, 4♂, 1♀, WAM M20441-5. Kurnalpi area, 30°41'S, 122°35'E, 2♂, 3♀, WAM M20436-40. Higginsville, 31°45'S, 121°42'E, 2♂, WAM M5442, WAM M5463. Woodline area, 31°50'S, 122°19'E, 1♂, WAM 17969. Karroun Hill Nat Res., 30°12'S, 118°31'E, 1♂, WAM M14725.

*Smithopsis gilberti* sp. nov.

(Figure 2c, 4b, 7, 8; Table 1)

**Holotype**

WAM M18718; adult male, skull and dentaries, carcase (liver removed for electrophoresis) in 70% ethyl alcohol. Pit-trapped by G. Harold on 10 July 1980, 10 km and 260° from Mt Saddleback, Western Australia, (32°58'15"S, 116°20'20"E) at 240 m above sea level. Type locality described under Distribution and Habitat.

**Paratypes**

Eight females and 10 males; see *Specimens Examined*.

**Diagnosis**

*Sminthopsis gilberti* differs from *S. murina* as follows (measurements are means, in millimetres): both longer feet (17.9 v. 16.7) and ears (21.1 v. 18.1); dorsal pelage a light fuliginous rather than a brownish colour; not more than eight teats;  $C^1$ - $M^1$  longer (10.2 v. 9.7);  $M^3$  metacristid normally shorter than its crown length. Differs from *S. dolichura* as follows: shorter tail (80.2 v. 92.8) such that  $TV < HV$ ; both longer pes (v. 16.7) and ears (v. 19.3); generally larger skull, particularly maximum length (27.1 v. 25.0) and maximum width (14.4 v. 13.1), longer  $DCI_1$  (19.8 v. 17.9) and distance across  $LM^3$ - $RM^3$  (6.0 v. 5.5); lower CONRAM:  $M_1$ - $M_4$  ratio (0.72 v. 0.75). Differs from *S. griseoventer* as follows: both longer feet (17.9 v. 16.3) and ears (21.1 v. 17.7); whiter ventral pelage;  $dP^2$  has three rather than two major cusps;  $C_1$  taller crowned rather than shorter than or subequal to  $P_3$ ;  $P_3$  crown shorter than or subequal to, rather than longer than  $P_4$ ; entoconids on  $M_2$  and  $M_3$  absent or very small rather than moderate or large; longer nasal length (10.3 v. 9.3); larger minimum orbital width (5.3 v. 5.0) shorter IPVAC (3.3 v. 4.0); lower CONRAM:  $M_1$ - $M_4$  ratio (0.72 v. 0.78). Differs from *S. aitkeni* as follows: lower maximum skull height (7.3 v. 7.7); shorter  $C^1$ - $M^1$  (10.2 v. 10.8); shorter IPVAC (3.3 v. 4.2); longer nasal length (10.3 v. 9.8); dorsal pelage a lighter fuliginous colour and ventral pelage whiter; shorter tail length (80.2 v. 96.0); longer ear (21.1 v. 18.2);  $C_1$  crown taller rather than subequal to or shorter than  $P_3$ ; entoconids on  $M_2$  and  $M_3$  absent or very small rather than moderate to relatively large. If the above diagnosis fails to identify a specimen it may be distinguished from *S. murina*, *S. dolichura*, *S. griseoventer* and *S. aitkeni* by the discriminant function analysis presented herein. Differs from other species of *Sminthopsis* in the same way that *S. murina* (*sensu* Archer, 1981) differs from them (see Archer [1981]).

**Description**

**Pelage**

Colour similar to *S. dolichura*.

**Tail**

Average tail to vent length 80.2, i.e. slightly less than average nose to vent length of 86.5. Tail invariably thin.

**Hindfoot**

As for *S. murina*, except no specimens with metatarsal or post hallucal granules.

### Nipple Number

Eight nipples (N = 4).

### Dentition

As for *S. murina* except for the following: crown height of I<sup>2</sup>, I<sup>3</sup> and I<sup>4</sup> commonly subequal but I<sup>2</sup> frequently slightly shorter than I<sup>3</sup> and I<sup>4</sup> which are subequal. Crown width of I<sup>2</sup>, I<sup>3</sup> and I<sup>4</sup> normally subequal but occasionally I<sup>2</sup> < I<sup>3</sup> < I<sup>4</sup>. Posterolingual cingula infrequently enlarged on P<sup>3</sup>. dP<sup>2</sup> stylar cusp D slightly shorter than its paracone (e.g. WAM M20091). dP<sub>4</sub> lingual cingulum absent. StC slight to moderate, infrequently present on M<sup>1</sup> to M<sup>3</sup>. StE small to moderate, frequently present on M<sup>1</sup> to M<sup>3</sup>. M<sup>3</sup> metacristid usually shorter but occasionally subequal to its crown length. C<sub>7</sub> taller crown than P<sub>3</sub>. P<sub>7</sub> crown taller or subequal to P<sub>3</sub> which is taller than P<sub>5</sub>.

### Skull and Dentary

As for *S. murina*.

### Distribution and Habitat

*Sminthopsis gilberti* occurs in the near coastal ranges and parts of the wheatbelt of south-western Western Australia (Figure 3).

It appears to favour heathlands on generally 'heavy' soils, although it has also been captured in eucalypt woodlands and mallee, although these formations usually have a heath understrata.

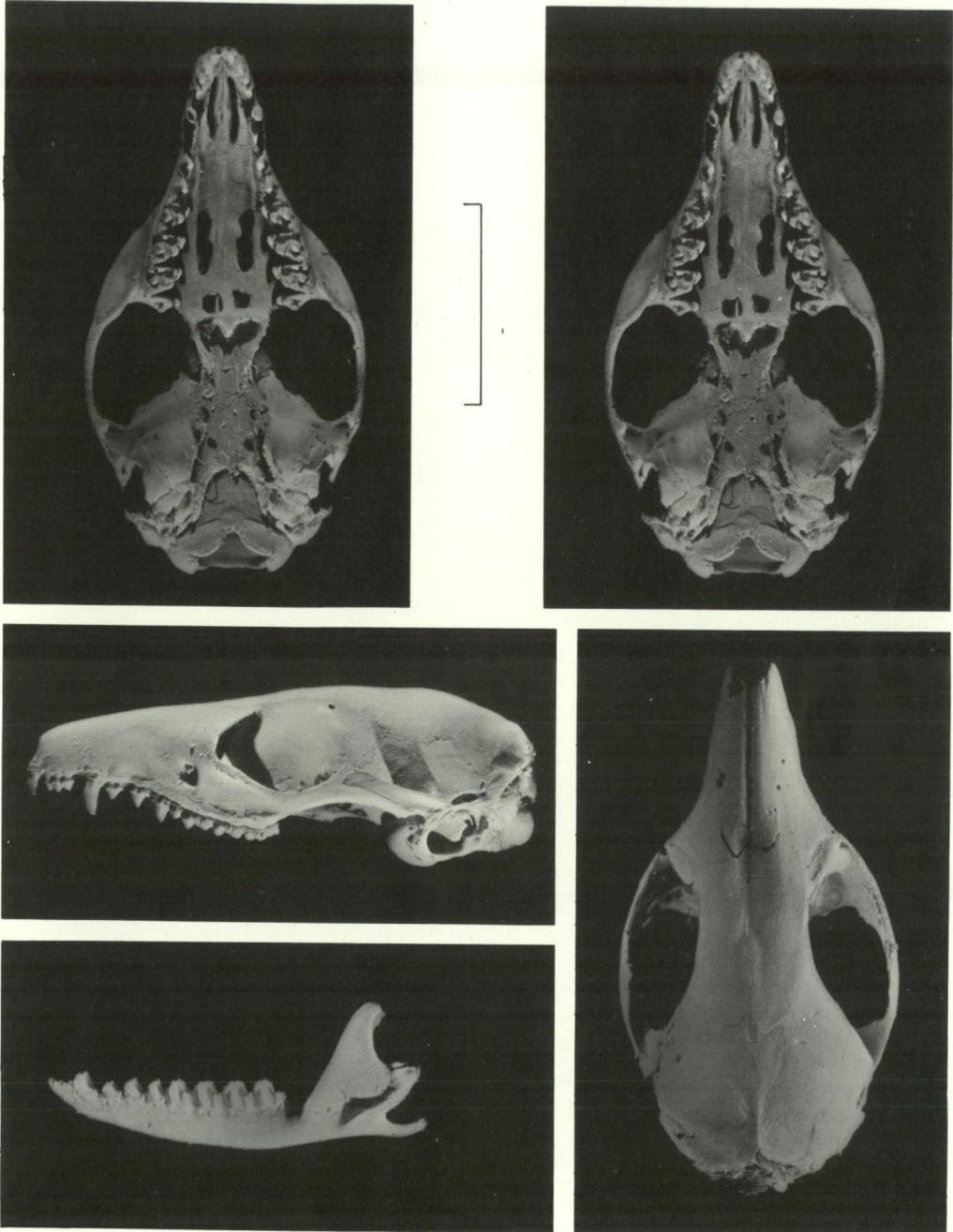
In the Darling Range it occurs 593 m above sea level in myrtaceous heaths, dominated by *Macrozamia reidleyi*, *Calothamnus quadrifidus* and *Xanthorrhoea preissii*, on shallow granitic soils with high clay content, and strewn with small angular granitic rocks. As well it is found on lower slopes incorporating also the dominant proteaceous heath elements: *Dryandra carduacea*, *Petrophile* spp. and *Leptospermum* sp., on granitic soils which have a surface scree of laterite pebbles. The type locality is at the base of the ranges (240 m above sea level) in a small gully with a seasonal creek. This is vegetated with an open woodland of *Eucalyptus wandoo* and *E. calophylla* with occasional *E. marginata*; there is a sparse, 2 m high, shrub layer of *Xanthorrhoea preissii* and *Acacia extensa* and a mixed, < 1 m high, shrub layer on light-brown sandy loam with some pisolitic gravel. The vegetation at this type locality (Figure 8) was extensively burnt during the summer of 1976/1977.

In the central and southern Wheat Belt *S. gilberti* occurs in open shrub mallee of *Eucalyptus eremophila* and occasional *E. foecunda* over a moderately dense heath to 2 m height of *Melaleuca uncinata*, *M. spathulata* and *Hakea lissocarpa* over low sedges on sandy loam. Also it is in open heaths dominated by *Casuarina campestris* on gravelly and coarse sandy soils.

At the eastern edge of the southern Wheat Belt, at Lake Cronin, it occurs in open woodlands of Salmon Gum, *Eucalyptus salmonophloia*, over sparse shrubs including *Exocarpus* spp. and *Acacia* spp., on heavy red-brown loam. It is also in moderately dense, 5 m high, regenerating mallee on heavy red-brown loam.

### Origin of Name

Named after John Gilbert who collected extensively in the south-west of Western Australia between 1843-44.



**Figure 7** Skull and left dentary of the holotype of *S. gilberti*. The ventral aspect of the skull are stereopairs. Scale line, 10 mm.



**Figure 8** Type locality of *S. gilberti* showing the dry watercourse in the foreground (photo: N.T. Allen).

### Specimens Examined

#### *Yilgarn Block/Darling group* (YBD)

Mt Saddleback, 32°58'15"S, 116°20'20"E, 1♂, WAM M18718 (holotype). Gracefield, 34°05'S, 117°20'E, 1♀, WAM M16005. Kojonup, 33°50'S, 117°09'E, 1♀, WAM M16014 (K). Lowden, 33°32'S, 115°58'E, 1♂, WAM M1874 (S). Churchman Brook Dam, 32°09'S, 116°05'E, 1♂, WAM M6878.

#### *Perth Basin/Darling group* (PBD)

Nr Wonnerup Siding, 33°48'S, 115°27'E, 1♂, WAM M12474.

#### *Yilgarn Block/Avon group* (YBA)

Tambellup, 34°02'S, 117°38'E, 1♂, 2♀, WAM M662 (S), WAM M709 (S), WAM M740 (S). Woodlands, 33°59'S, 117°39'E, 1♀, WAM M852 (S). Nr Congelin, 32°47'S, 116°58'E, 1♀, WAM M19523. Narrogin, 32°56'S, 117°11'E, 1♂, WAM M1564 (S). Brookton 32°22'S, 117°00'E, 1♂, WAM M18454.

#### *Yilgarn Block/Roe group* (YBR)

Lake Cronin area, 32°23'S, 119°45'E, 1♀, WAM M17642. Lake Cronin area, 32°24'S, 119°45'E, 1♂, 1♀, WAM M20091 (J), WAM M17643. Nr Kebaringup, 34°05'S, 118°08'E, 1♂, WAM M4 (S). Nth Tarin Rock, 32°59'S, 118°14'E, 1♂, WAM M8222 (S). Dragon Rocks Res., 32°49'S, 119°02'E, 1♂, WAM M9938.

*Sminthopsis griseoventer* sp. nov.

(Figures 2d, 4c, 9, 10; Table 1)

**Holotype**

WAM M24543. Adult male, skull and dentaries, carcase (liver removed for electrophoresis) in 70% ethyl alcohol. Pit-trapped by J.N. Dunlop on 15 August 1982 13.2 km and 68° from Bindoon, Western Australia (31°18'15"S, 116°01'00"E) at approximately 150 m above sea level. Type locality described under Distribution and Habitat.

**Paratypes**

13 females and 21 males; see Specimens Examined.

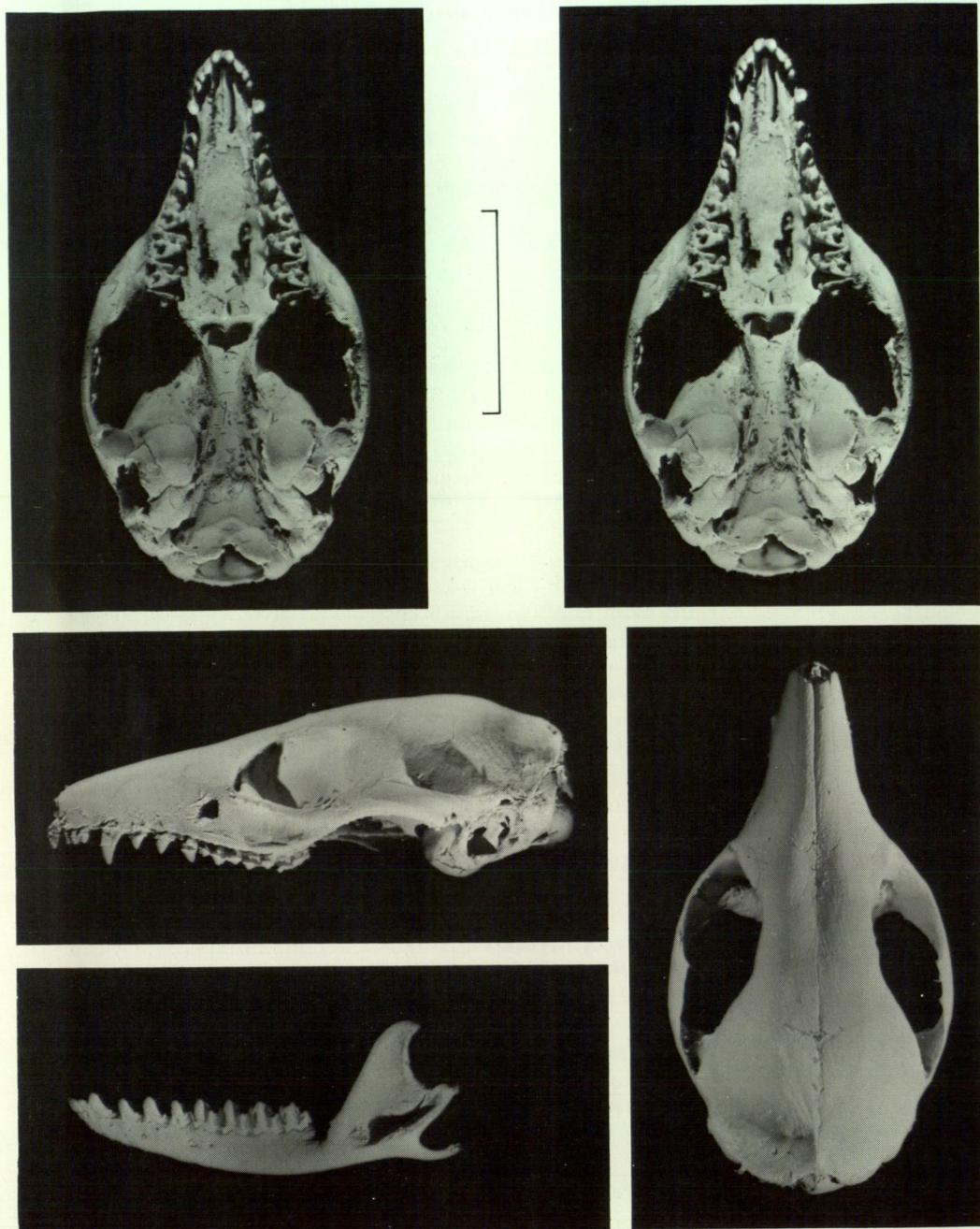
**Diagnosis**

*Sminthopsis griseoventer* differs from *S. murina* as follows (measurements are mean, in millimetres): dorsal pelage light fuliginous rather than brownish color and ventral pelage greyish rather than white; not more than eight nipples;  $C^1$ - $M^2$  longer (10.2 v. 9.7);  $dP^2$  with only two major cusps (StD absent);  $M^2$  metacristid shorter than or subequal to its crown length;  $C_1$  crown height normally less than or subequal to rather than greater than that of  $P_3$ ; entoconids on  $M_2$  and  $M_3$  medium to large rather than absent or small; generally longer IPVAC (4.0 v. 3.3); and higher CONRAM:  $M_1$ - $M_4$  ratio (0.78 v. 0.74). Differs from *S. dolichura* as follows: shorter tail (82.2 v. 92.8); grey rather than white ventral pelage; larger skull particularly maximum length (26.4 v. 25.0) and maximum width (14.1 v. 13.1); longer  $C^1$ - $M^2$  (10.2 v. 9.3);  $dP^2$  with only two major cusps (StD absent);  $C_1$  crown height usually lower rather than taller than that of  $P_3$ ; entoconids on  $M_2$  and  $M_3$  moderate to relatively large rather than absent or small; IPVAC frequently longer (4.0 v. 3.0). Differs from *S. gilberti* as follows: both shorter feet (16.3 v. 17.9) and ears (17.7 v. 21.1); grey, rather than white ventral pelage;  $dP^2$  with only two major cusps (StD absent);  $C_1$  subequal or shorter, rather than taller crowned than  $P_3$ ;  $P_3$  taller rather than shorter crowned than  $P_4$ ; entoconids on  $M_2$  and  $M_3$  moderate to large rather than absent or very small; shorter nasal length (9.3 v. 10.3); smaller minimum orbital width (5.0 v. 5.3); longer IPVAC (4.0 v. 3.3); higher CONRAM:  $M_1$ - $M_4$  ratio (0.78 v. 0.72). Differs from *S. aitkeni* as follows: shorter tail (82.2 v. 96.0) such that TV normally less than HV; shorter hind feet (16.3 v. 17.5); dorsal pelage light rather than a dark fuliginous colour; ventral pelage 'grizzled' grey rather than light grey; smaller maximum skull height (7.4 v. 7.7); shorter  $C^1$ - $M^2$  (10.2 v. 10.8);  $M^1$ - $M^2$  (5.4 v. 5.7) and  $M^1$ - $M^3$  (4.8 v. 5.0); shorter  $I_1$ - $M_4$  (11.6 v. 12.3); smaller minimum orbital width (5.0 v. 5.4); smaller nasal length (9.3 v. 9.8) and higher CONRAM:  $M_1$ - $M_4$  ratio (0.78 v. 0.71). If the above diagnosis fails to identify a specimen then it may be distinguished from *S. murina*, *S. dolichura*, *S. gilberti* and *S. aitkeni* by the discriminant function analysis presented herein. Differs from other species of *Sminthopsis* in the same way that *S. murina* (*sensu* Archer, 1981) differs from them (see Archer [1981]).

**Description**

**Pelage**

Dorsal fur, including that on forearms and feet, and sides of body, Fuscous Black at base, tipped with mixture of Light Greyish Olive and Chaetura Drab; the latter predominates providing a light fuliginous colour lower on the back. Apart from incomplete ring (broken posteriorly) of Chaetura Drab around eye, face and cheeks Light Greyish Olive. Hair of



**Figure 9** Skull and left dentary of the holotype of *S. griseoventer*. The ventral aspect of the skull are stereopairs. Scale line, 10mm.

ventral surface including fore and hind feet. Dark Greyish Olive base for four-fifths or more of its length, tipped with Light Gull Grey – producing a grizzled grey colour overall. Pes and manus white. Dorsal and ventral surfaces of tail the colour of their respective body pelage surfaces.

### **Tail**

Average tail to vent length 82.2; i.e. approximately equal to the average nose to vent length of 83.7. Tail invariably thin.

### **Hindfoot**

As for *S. murina* except apical granule of fourth interdigital pad subequal to that of other pads, and rarely fused with proximal granule. Small metatarsal granules infrequently present and usually associated with post hallucal granules (WAM M14584, WAM M24325, WAM M18296). The latter granules usually small but occasionally several fuse to form an elongate post hallucal pad.

### **Nipple Number**

Eight (N = 7) or six (N = 2) nipples.

### **Dentition**

As for *S. murina* except for the following:  $dP^2$  has three roots and two main cusps – a paracone and a taller metacone; protocone low and rudimentary; StD absent; small but obvious anterobuccal cusp may represent StA, metaacristid very slight (e.g. WAM M18854, WAM M11074).  $dP_4$  has no suggestion of metaconid on posterior flank of protoconid. StC tiny, occasionally present but on  $M^3$  only. StE tiny to small, occasionally present but on  $M^3$  only.  $M^3$  metaacristid shorter or subequal to its crown length.  $C_1$  crown height normally less than or subequal to that of  $P_3$  but occasionally slightly larger.  $P_3$  taller crowned than  $P_1$  and  $P_4$ ; relative height of  $P_1$  and  $P_4$  variable. Buccal and lingual cusps absent or very narrow on  $P_1$ ,  $P_3$ ,  $P_4$  and  $C_1$ . Parastylids present on  $M_1$  and  $M_4$ , rarely on  $M_2$ , absent  $M_3$ . Moderate to large entoconids normally present on  $M_2$  and  $M_3$ , small to moderate entoconids variable present on  $M_1$ , rarely on  $M_4$ .

### **Skull and Dentary**

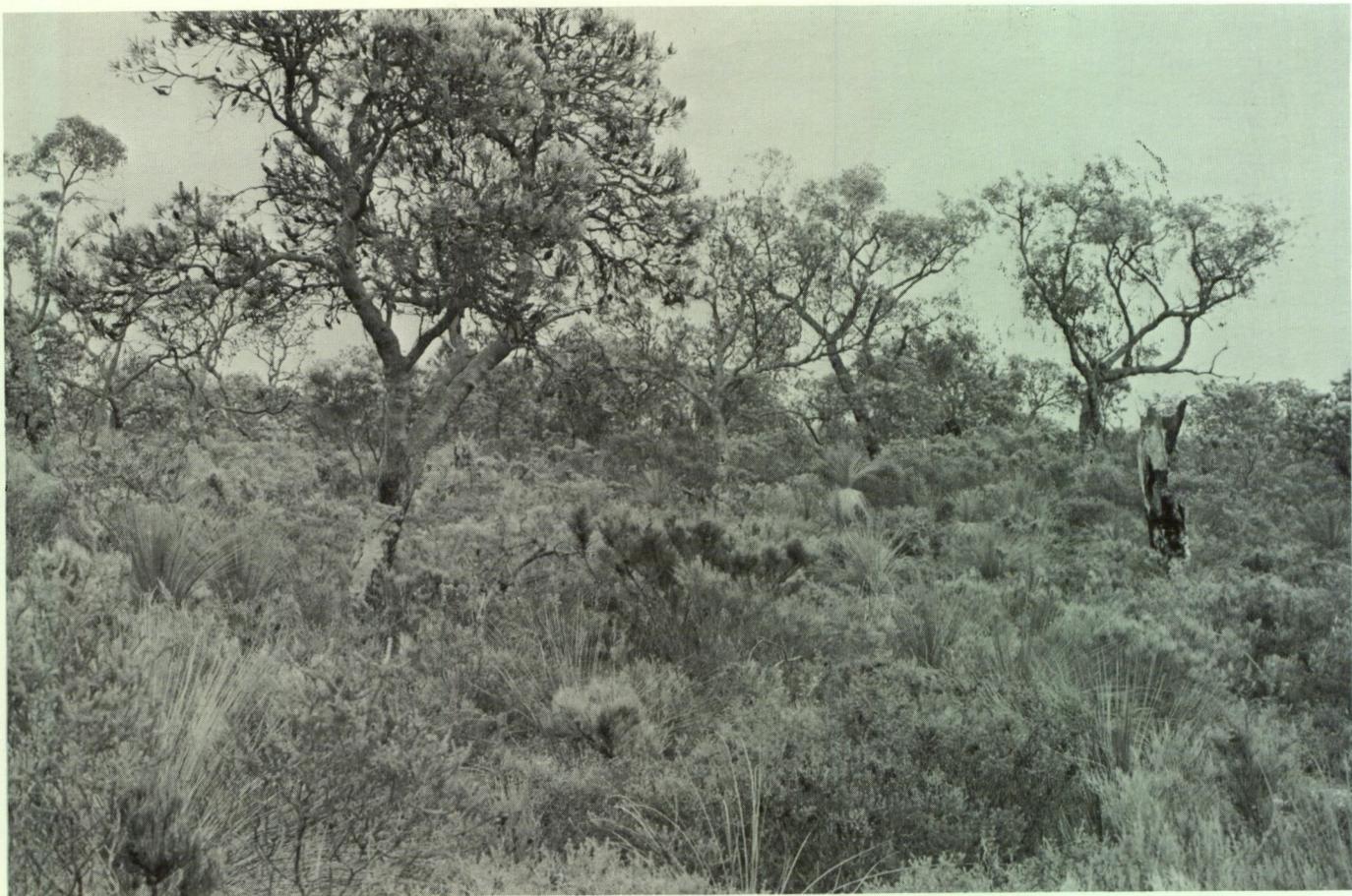
As for *S. murina* except for the following: rostral depression of frontals shallow, frequently absent. IPVAC tends to be longer; premaxillary vacuity normally extends posteriorly to a point in line with anterior edge of  $P^1$  but frequently, also to a point in line with cusp of  $P^1$ ; maxillary vacuity normally extends anteriorly to a point approximately in line with protocone of  $M^1$ , but frequently also with anterior edge of  $M^1$ .

### **Distribution and Habitat**

*Sminthopsis griseoventer* is restricted to the coastal plain and adjacent lateritic ranges of south-west Western Australia (Figure 3).

It occurs in a wide range of habitats including the major vegetation formations and soil types in the region:

- open eucalypt woodlands, 200 m above sea level; these are dominated by Jarrah, *E. marginata*, with occasional *E. calophylla*. The understorey is a very open low woodland of *Banksia grandis* and *Persoonia longifolia* over a low mixed shrub assemblage on laterite gravel with a high clay content;



**Figure 10** Type of locality of *S. griseoventer* (photo: N. Dunlop).

- moderate dense Jarrah woodlands over dense shrubland of *Melaleuca* spp., *Agonis parviceps* and *Euanora aristata* on grey sand;
- moderately dense low woodland of *Banksia attenuata* and *B. menziesii* over *Adenanthos cygnorum* on deep whitish silicious soil;
- seasonal swampland vegetated with 'Melaleuca and rushes';
- Eucalypt mallee over *Xanthorrhoea* sp. on stony substrate;
- 'Banksia coccinea scrub';
- *Banksia speciosa* shrubland 3 m high, over mixed heath 0.5 m high, on yellow gravelly sand;
- dense heath on lateritic breakaway country.

The type locality of *S. griseoventer* is described by N. Dunlop (pers. comm.) as follows: 'Banksia attenuata, B. menziesii and Eucalyptus tottiana open low woodland B over Casuarina humilis and Hakea sp. low scrub A over mixed low heath C dominated by Melaleuca scabra on deep, whitish-yellow sand. Stand not burnt for 12-15 years. Other plant species in low heath include Hibbertia spp., Petrophile linearis, Calothamnus quadrifidus, Gompholobium, Synaphea, Daviesia, Eremaea and Xanthorrhoea spp.' (Figure 10).

#### Origin of Name'

From the Latin – *griseus* (grey) and *venter* (abdomen).

#### Specimens Examined

##### Albany-Fraser Province/Roe group (AFR)

Nr Ravensthorpe, 33°35'S, 119°35'E, 1♂, WAM M10927.

##### Albany-Fraser Province/Eyre group (AFE)

Fitzgerald River Nat. Pk, 34°16'S, 119°25'E, 3♀, WAM M15170, WAM M15457, WAM M24325, Mt Bland, 34°11'S, 119°28'E, 1♀, WAM M8075. Nr Pt Dempster, 33°37'S, 123°49'E, 1♂, WAM M8652. Cape LeGrand Nat. Pk, 33°56'S, 122°09'E, 1♂, WAM M14584.

##### Albany-Fraser Province/Darling group (AFD)

Nr Walpole, 34°58'S, 116°32'E, 2♀, WAM M19039, WAM M19033. Nr Denmark, 34°53'S, 117°22'E, 1♀, WAM M3393. Denmark 34°58'S, 117°21'E, 2♂, WAM M1006 (S) WAM M1231 (S). King Creek, 34°51'S, 118°10'E, 1♀, WAM M7100 (K). Elleker, 35°00'S, 117°30'E, 1♀, WAM M1224 (S). Hay River, 34°48'S, 117°30'E, 1♀, WAM M1969 (S). Mt Manyeaks, 34°49'S, 118°16'E, 1♂, WAM M18296. Nr Torbay, 35°03'S, 117°32'E, 2♂, WAM M1841 (S), WAM M1126 (S). Chorkerup Siding, 34°50'S, 117°41'E, 3♂, WAM M1317 (S), WAM M1758 (S), WAM M1714 (S).

##### Yilgarn Block/Darling group (YBD)

68°, 13.2 km Gingin, 31°18'15"S, 116°01'00"E, 1♂, WAM M24543 (S) (holotype). Nr Gingin, 31°18'S, 116°01'E, 2♂, 1♀, WAM M24534-5, WAM M18854 (J). Worsley, 33°19'S, 116°00'E, 1♀, WAM M24555. Bridgetown, 33°50'S, 116°00'E, 1♂, WAM M8037.

##### Leeuwin Block/Darling group (LBD)

Forest Grove, 34°04'S, 115°06'E, 2♂, WAM M1642 (S), WAM M2059 (S). Augusta, 34°19'S, 115°09'E, 1♂, WAM M11074 (J).

##### Perth Basin/Darling group (PBD)

Newlands, 33°41'S, 115°53'E, 2♂, WAM M901 (S) WAM M1313 (S). Nr Mt Peron, 30°07'S, 115°09'E, 1♂, WAM M15987.

##### Perth Basin/Irwin group (PBI)

Badgingarra Nat. Pk, 30°30'S, 115°28'E.

##### Yilgarn Block/Roe group (YBR)

Nr Borden, 34°24'S, 118°05'E, 1♂, WAM M15196.

*Sminthopsis aitkeni* sp. nov.

(Figure 2e, 11; Table 1)

**Holotype**

SAM M7664. Adult male, skull and dentaries, carcase in 70% ethyl alcohol, collected by P. Tiggerman on 29 April 1969 from 'Section 146 Hundreds of Cassini, Kangaroo Island South Australia' (35°35'S, 137°19'E).

**Paratypes**

Two females and 2 males; see Specimens Examined.

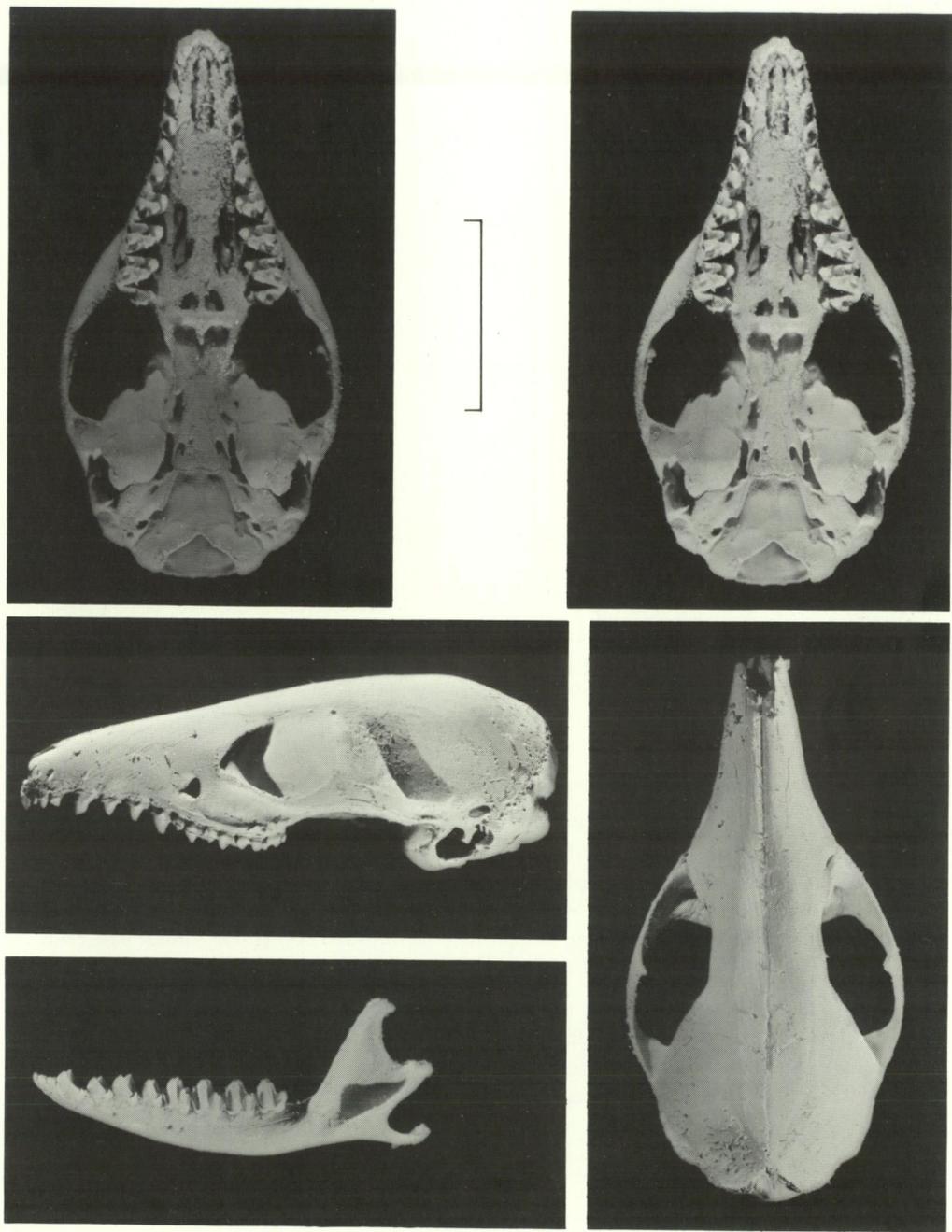
**Diagnosis**

*Sminthopsis aitkeni* differs from *S. murina* as follows (measurements are means, in millimetres): dorsal pelage dark fuliginous rather than a brownish colour; ventral pelage light grey rather than white; generally longer tail (96.0 v. 77.7); larger maximum skull height (7.7 v. 7.1); longer  $C^1-M^1$  (10.8 v. 9.7);  $M^2$  metacristid normally shorter than or subequal to rather than longer than its crown length;  $C_7$  crown height shorter or subequal to rather than taller than that of  $P_3$ ; entoconids on  $M_5$  and  $M_3$  medium to large rather than small to absent; and a generally longer IPVAC (4.2 v. 3.3). Differs from *S. dolichura* as follows: dorsal pelage darker fuliginous colour and ventral pelage light grey rather than white; larger skull, particularly maximum length (27.3 v. 25.0); maximum width (14.1 v. 13.1) and maximum height (7.7 v. 6.8); longer in all tooth dimensions particularly  $C^1-M^1$  (10.8 v. 9.3).  $C_7$  crown height subequal to or shorter than rather than longer than that of  $P_3$ ; entoconids on  $M_5$  and  $M_3$  moderate or large rather than absent or very small; lower CONRAM:  $M_1-M_4$  ratio (0.71 v. 0.75). Differs from *S. gilberti* as follows: dorsal pelage darker fuliginous colour and ventral pelage light grey rather than white; longer tail length (96.0 v. 80.2); shorter ear (18.2 v. 21.1); shorter nasal length (9.8 v. 10.3); longer IPVAC (4.2 v. 3.3); longer  $C^1-M^1$  (10.8 v. 10.2); larger maximum skull height (7.7 v. 7.3);  $C_7$  crown height subequal to or shorter rather than taller than that of  $P_3$ ; entoconids on  $M_5$  and  $M_3$  moderate or large rather than absent or very small. Differs from *S. griseoventer* as follows: longer tail (96.0 v. 82.2), such that TV normally longer than HV; longer hind feet (17.5 v. 16.3) dorsal pelage dark rather than a light fuliginous colour; ventral pelage light grey rather than 'grizzled' grey; larger maximum skull height (7.7 v. 7.4); longer  $C^1-M^1$  (10.8 v. 10.2),  $M^1-M^2$  (5.7 v. 5.4) and  $M^1-M^3$  (5.0 v. 4.8); longer  $I_7-M_4$  (12.3 v. 11.6); larger minimum orbital width (5.4 v. 5.0); larger nasal length (9.8 v. 9.3); shorter CONRAM:  $M_1-M_4$  (0.71 v. 0.78). If the above diagnosis fails to identify a specimen then it may be distinguished from *S. murina*, *S. dolichura*, *S. gilberti* and *S. griseoventer* by the discriminant function analysis presented herein. Differs from other species of *Sminthopsis* in the same way that *S. murina* (*sensu* Archer, 1981) differs from them (see Archer [1981]).

**Description**

**Pelage**

Dorsal fur, including that on forearms and hind feet, and lateral body fur, Fuscous Black at base tipped with a mixture of Greyish Olive and Black; the latter predominate, particularly mesially, producing a dark fuliginous colour which extends anteriorly to forehead. Apart from patches of black around eye, face, cheeks and throat Light Gull Grey. Ventral fur



**Figure 11** Skull and left dentary of the holotype of *S. aitkeni*. The ventral aspect of the skull are stereopairs. Scale line, 10 mm.

apart from chin, manus and pes, which are white, Deep Neutral Grey base for three-quarters of its length, tipped with white to Pale Gull Gray; overall this produces a light grey colour. Dorsal and ventral surfaces of tail the colour of respective body pelage surfaces.

#### **Tail**

Average tail to vent length 96.0, i.e. 10.5% longer than average nose to vent length of 86.9. Tail slightly incrassated in SAM M7664.

#### **Hindfoot**

As for *S. murina*, although apical granules of interdigital pads are a similar size; no obvious fusion of apical and proximal granules on fourth interdigital pad. No metatarsal or post hallucal granules.

#### **Nipple Number**

Six and probably two other nipples on damaged skin of SAM M8998.

#### **Dentition**

As for *S. murina* except for the following: crown width of  $I^2 < I^3 < I^4$  or  $I^2, I^3$  and  $I^4$  subequal. No posterolingual enlargement of  $P^3$  cingulum. Buccal and lingual cingula very slight to absent on  $P^1, P^2$  and  $P^4$ . StC moderate on  $M^2$  and  $M^3$  of one specimen only. StE very small on  $M^3$  of one specimen only.  $M^3$  metacrista less than or equal to its crown length.  $C_1$  crown height subequal to or shorter than that of  $P_3$ . Entoconids moderate to large on  $M_1$  to  $M_5$ , small and variable present on  $M_4$ .

Note: No juveniles available for description of deciduous premolars.

#### **Skull and Dentary**

As for *S. murina* except for the following: distance between premaxillary and maxillary vacuities tends to be larger; premaxillary vacuity extends posteriorly to a point in line with anterior edge or anterior root of  $P^1$ ; maxillary vacuity extends to a point in line with protocone or anterior edge of  $M^1$ .

#### **Distribution and Habitat**

Known only from Kangaroo Island, South Australia. The holotype and SAM M7936 were collected from the base of a Blackboy, *Xanthorrhoea tateana* in sclerophyll mallee (Aitken 1972).

#### **Origin of Name**

Named after the late Peter Aitken, Curator of Mammals, South Australian Museum.

#### **Specimens Examined**

##### *Kanmantoo Fold Belt group* (KFB)

Kingscote (K.I.) 35°39'S, 137°38'E, 1♀, SAM M10196 (S). Cassini (K.I.) 35°35'S, 137°19'E, 2♂, SAM M7664 (holotype), SAM M7926 (S). Kangaroo I. 35°35'S, 137°16'E, 1♂, 1♀, SAM M8997 (S), SAM M8998 (S).

#### **Unique Specimen**

Archer (1981:98) refers to WAM M7495 (actually M7945) as a unique specimen. This was collected by P. Bridge in 1967 from the doline of Easter Cave near Augusta, Western Australia. The carcass was decomposing but its standard external body measurements were recorded by J.L. Bannister. Unfortunately this adult specimen could not be sexed. This presents difficulty in placing it against the species clustered by discriminant function analysis

in Figure 12. If it is a female, then it does not cluster with any of the species distinguished in this study. If it is a male it clusters well with *S. dolichura*. WAM M7945 has no entoconids on  $M_1$ - $M_4$ , as is the case in *S. dolichura*. However, it differs from *S. dolichura* in that its tail length is less than its nose to vent length (90.9 v. 93.7 mm). Also its CONRAM:  $M_1$ - $M_4$  ratio is higher than that of *S. dolichura* (0.80). If it is *S. dolichura*, which is not certain on the above evidence, then it is the only south-western coastal record of that species. A more likely explanation is that it is representative of an undescribed taxon – perhaps *S. fuliginosa* (Gould, 1852 – see later Nomenclatural Note).

### Morphometric Analyses: Results and Discussion

The species show considerable difference in means and standard deviations for almost all variables (Table 1). While the majority of variables are strongly sexually dimorphic, the extent of this dimorphism is not significantly different between species (Table 2). Subsequent analyses separate data from the two sexes.

A previous study on dasyurids has suggested that skull variables can be coalesced into a few major factors (Kitchener *et al.* 1983). The potential for simplification of the current data set was assessed through principal component analysis.

#### Principal Component Analysis

Nearly all variables within the data set are highly intercorrelated. The 28 variables of the male data set are resolved into three major factors, with 24 of these variables having their highest loading on Factor I (Table 3). Factor I accounted for 54% of the total variation and almost certainly represented a measure of overall size. Neither Factor II nor Factor III reflect any obvious size or shape descriptions. Analysis of females produces an essentially similar solution (Table 3).

#### Discriminant Analysis

Discriminant analysis was used to select those combinations of morphological characters which best discriminate between the species of *Sminthopsis* examined here. For males, an analysis of skull, dentary and external body characters (weight and tragus not included as they are absent from many individuals), produces four functions (Table 4a) which assign individuals to species with varying degrees of accuracy. Applying all four functions to individuals with complete data sets, *S. dolichura* (N = 50), *S. gilberti* (N = 10) and *S. aitkeni* (N = 2) are classified with complete accuracy. Of the *S. murina* (N = 25), two are incorrectly classified: WAM M6753 as *S. gilberti* and J1742 as *S. dolichura*. Two *S. griseoventer* (N = 19) are also incorrectly classified: WAM M901 as *S. murina* and WAM M1758 as *S. aitkeni*. Function I, which is greatly influenced by overall skull and dentary dimensions (BASCRANL, MSKW, DCI<sub>7</sub>) and tail length, primarily distinguishes *S. dolichura* from the other species. Function II, which is largely based on  $C^1$ - $M^2$  and hind foot length (HF), distinguishes *S. griseoventer* and *S. aitkeni*. Function III, which is largely dependent on overall skull dimensions (BASCRANL, MSKW) and  $M_1$ - $M_3$  distinguishes *S. murina* from the other species and *S. griseoventer* from *S. aitkeni*. Function IV, which is influenced by characters describing the shape of the skull (MSKH, MINORB), overall size of dentary (DCI<sub>7</sub>), shape of the dentary (CONRAM) and tail length (TV), distinguishes maximally *S. griseoventer* and *S. aitkeni*. *S. gilberti* plots closest to *S. murina* on Functions I and II and is maximally distinguished from that species on Function III (Figure 12a).

**Table 2** Analysis of variance for the skull and body characters of *Sminthopsis murina*, *S. gilberti*, *S. griseoverter*, *S. dolichura* and *S. aitkeni* grouped by OTU and sex. For key to variables see p. 202. P-values of 0.001 denote 0.001 or less.

Variable	OTU		Sex		Interaction	
	F-ratio	P	F-ratio	P	F-ratio	P
MAXL	26.71	0.001	41.59	0.001	1.71	0.151
BASCRANL	17.28	0.001	42.13	0.001	1.76	0.140
MSKH	45.66	0.001	39.16	0.001	1.39	0.240
MSKW	18.37	0.001	30.03	0.001	1.50	0.205
ZYHT	9.95	0.001	1.443	0.231	0.65	0.627
BUL	12.98	0.001	30.55	0.001	0.96	0.434
OBUL	12.52	0.001	20.78	0.001	0.12	0.975
INBUL	21.75	0.001	1.50	0.223	0.99	0.410
C <sup>1</sup> -M <sup>2</sup>	41.13	0.001	24.68	0.001	0.62	0.651
M <sup>1</sup> -M <sup>2</sup>	21.84	0.001	0.62	0.431	0.68	0.608
M <sup>1</sup> -M <sup>3</sup>	35.79	0.001	0.00	0.951	1.40	0.235
LM <sup>3</sup> -RM <sup>3</sup>	23.79	0.001	2.07	0.152	1.09	0.363
INORB	15.93	0.001	33.63	0.001	1.03	0.394
IPVAC	40.33	0.001	12.33	0.001	2.07	0.087
NASL	19.25	0.001	36.06	0.001	1.21	0.310
CRANW	22.12	0.001	22.57	0.001	0.98	0.420
DCI <sub>1</sub>	25.74	0.001	47.64	0.001	1.19	0.317
I <sub>1</sub> -M <sub>1</sub>	62.52	0.001	31.19	0.001	1.16	0.332
M <sub>1</sub> -M <sub>1</sub>	46.39	0.001	0.42	0.519	0.73	0.572
M <sub>1</sub> -M <sub>3</sub>	48.73	0.001	0.26	0.614	0.80	0.529
ANGCON	1.88	0.124	2.16	0.147	0.60	0.615
CONRAM	2.21	0.078	15.05	0.001	1.96	0.128
WT	11.89	0.001	2.78	0.100	3.41	0.022
NV	7.05	0.001	0.31	0.582	1.76	0.163
TV	16.12	0.001	5.11	0.027	1.10	0.356
HF	10.17	0.001	13.44	0.001	2.51	0.062
EAR	9.92	0.001	6.14	0.015	0.46	0.710
TRAG	0.50	0.738	0.01	0.936	0.21	0.888

Comparable analysis for females (Table 4b) shows that they can be separated by the first two functions (Figure 12b). *S. gilberti* (N = 8), *S. griseoverter* (N = 8), *S. murina* (N = 15) and *S. aitkeni* (N = 2) are classified with complete accuracy. Of the *S. dolichura* (N = 26) one, SAM M9408 from Eyre Peninsula, is classified as *S. aitkeni*. Function I which is largely based on a range of characters related to skull shape, both tooth row length (C<sup>1</sup>-M<sup>2</sup>, M<sub>1</sub>-M<sub>3</sub>), shape of the dentary (DCI<sub>1</sub>, CONRAM) and external body measurements (HV, TV and EAR)

**Table 4** Standardised discriminant functions for the variables selected by the discriminant analysis from the five species of *Sminthopsis* (*murina*, *dolichura*, *gilberti*, *griseoventer* and *aitkeni*) for (a) male skull, dentary and external body characters and (b) comparable female characters. Selection was based on minimisation of Wilk's Lambda (Klecka 1975) and variables are in descending order of discriminatory power based on this statistic.

Discriminant function scores are calculated as the summation of the products of the unstandardised discriminant function coefficients (in brackets) and the respective constant.

(4a)

Character	Discriminant Function			
	I	II	III	IV
BASCRANL	0.885 (0.85)	-0.567 (-0.54)	1.331 (1.27)	0.326 (0.31)
MSKH	-0.509 (-2.07)	0.301 (1.22)	-0.154 (-0.63)	1.230 (5.00)
MSKW	0.820 (1.00)	-0.268 (-0.33)	-1.180 (-1.44)	0.338 (0.41)
BUL	0.312 (1.63)	-0.040 (-0.21)	-0.301 (-1.57)	0.343 (1.79)
C <sup>1</sup> -M <sup>1</sup>	-0.298 (-0.86)	1.124 (3.24)	-0.580 (-1.68)	-0.608 (-1.75)
LM <sup>1</sup> -RM <sup>1</sup>	-0.537 (-1.42)	-0.393 (-1.04)	0.779 (2.06)	0.663 (1.75)
INORB	0.286 (1.09)	-0.087 (-0.33)	-0.355 (-1.35)	-0.856 (-3.25)
IPVAC	-0.700 (-1.96)	0.316 (0.88)	0.239 (0.67)	0.398 (1.11)
NASLEN	0.264 (0.39)	-0.310 (-0.46)	0.010 (0.01)	0.462 (0.68)
DC-I <sub>1</sub>	-1.763 (-2.11)	-0.648 (-0.78)	-0.197 (-0.24)	-1.200 (-1.44)
M <sub>1</sub> -M <sub>4</sub>	-0.483 (-2.83)	-0.571 (-3.34)	0.280 (1.64)	0.085 (0.50)
M <sub>1</sub> -M <sub>3</sub>	0.408 (2.70)	0.427 (2.83)	-0.995 (-6.58)	0.245 (1.62)
ANGCON	0.231 (0.84)	0.526 (1.93)	0.508 (1.86)	-0.298 (-1.09)
CONRAM	0.041 (0.12)	0.750 (2.22)	0.351 (1.04)	-1.128 (-3.34)
TV	1.148 (0.15)	0.583 (0.08)	-0.234 (-0.03)	0.830 (0.11)
HF	-0.270 (-0.34)	-0.887 (-1.11)	-0.080 (-0.10)	0.230 (0.29)
EAR	-0.160 (-0.13)	-0.293 (-0.23)	-0.334 (-0.26)	-0.298 (-0.24)
CONSTANT	24.04	8.07	24.43	-20.64

(4b)

Character	Discriminant Function		
	I	II	III
MSKH	-0.470 (-1.82)	0.584 (2.27)	0.205 (0.79)
ZYHT	0.936 (5.77)	-0.073 (-0.45)	0.212 (1.31)
BUL	-0.393 (-2.14)	0.169 (0.92)	-0.056 (-0.30)
INBUL	0.326 (1.40)	0.445 (1.90)	0.094 (0.40)
C <sup>1</sup> -M <sup>1</sup>	0.833 (2.49)	1.412 (4.21)	-0.792 (-2.36)
M <sup>1</sup> -M <sup>3</sup>	-0.478 (-2.97)	-0.740 (-4.60)	-0.038 (-0.24)

(4b) continued

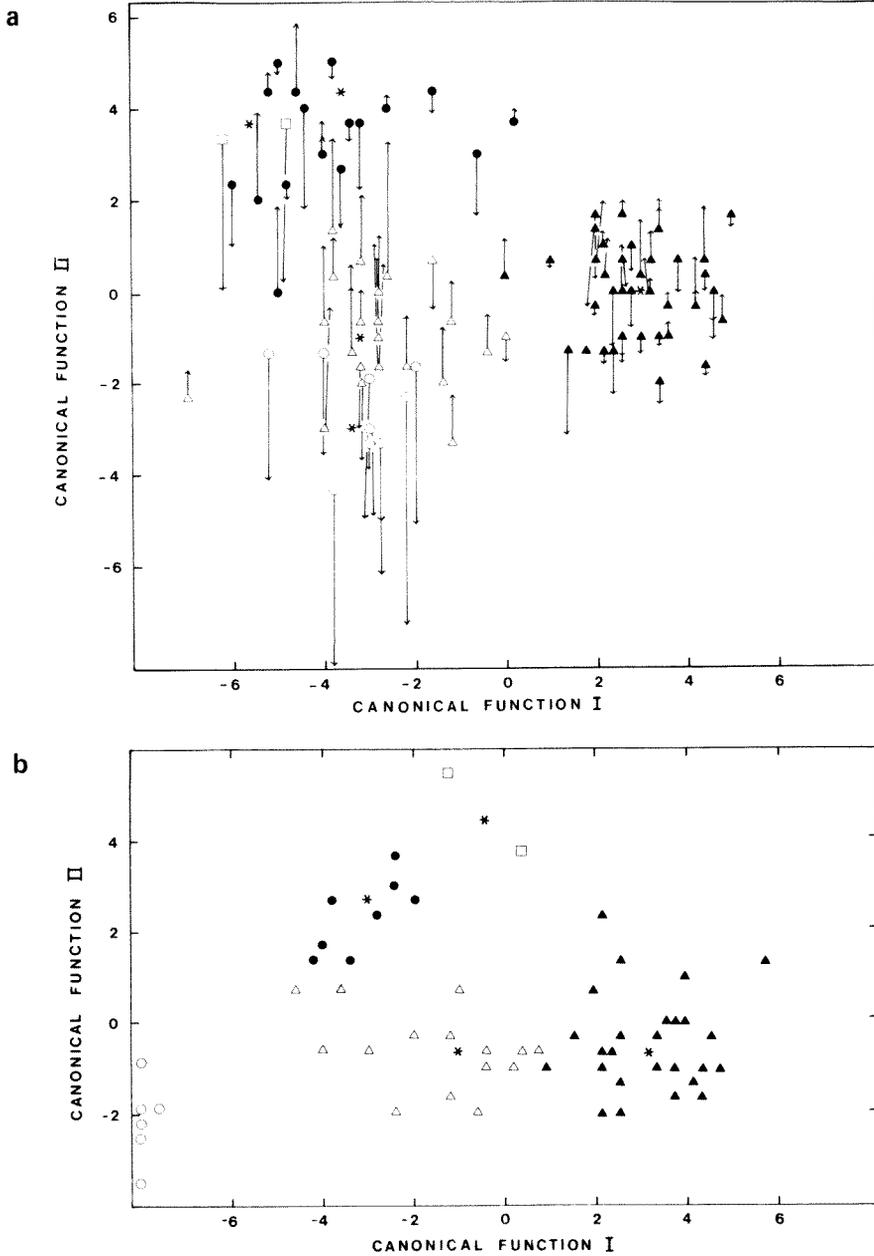
Character	Discriminant Function		
	I	II	III
LM <sup>2</sup> -RM <sup>3</sup>	-0.638 (-1.63)	-0.092 (-0.23)	1.023 (2.61)
INORB	-0.655 (-2.48)	-0.303 (-1.15)	-0.960 (-3.64)
IPVAC	0.203 (0.43)	0.264 (0.56)	0.267 (0.57)
NASLEN	-0.646 (-1.31)	0.005 (0.01)	-0.164 (-0.33)
DC-I <sub>1</sub>	-1.887 (-2.31)	-1.819 (-2.23)	0.520 (0.64)
M <sub>1</sub> -M <sub>3</sub>	-1.015 (-7.13)	0.224 (1.57)	-0.155 (-1.09)
CONRAM	1.222 (3.66)	0.642 (1.92)	0.028 (0.08)
NV	0.946 (0.12)	0.286 (0.04)	-0.435 (-0.06)
TV	2.191 (0.34)	0.444 (0.07)	-0.411 (-0.06)
HF	-0.343 (-0.36)	-0.252 (-0.27)	-0.484 (-0.51)
EAR	-1.107 (-0.64)	-0.605 (-0.35)	-0.125 (-0.07)
CONSTANT	71.96	-11.21	26.98

### Phenetic and Phylogenetic Analysis

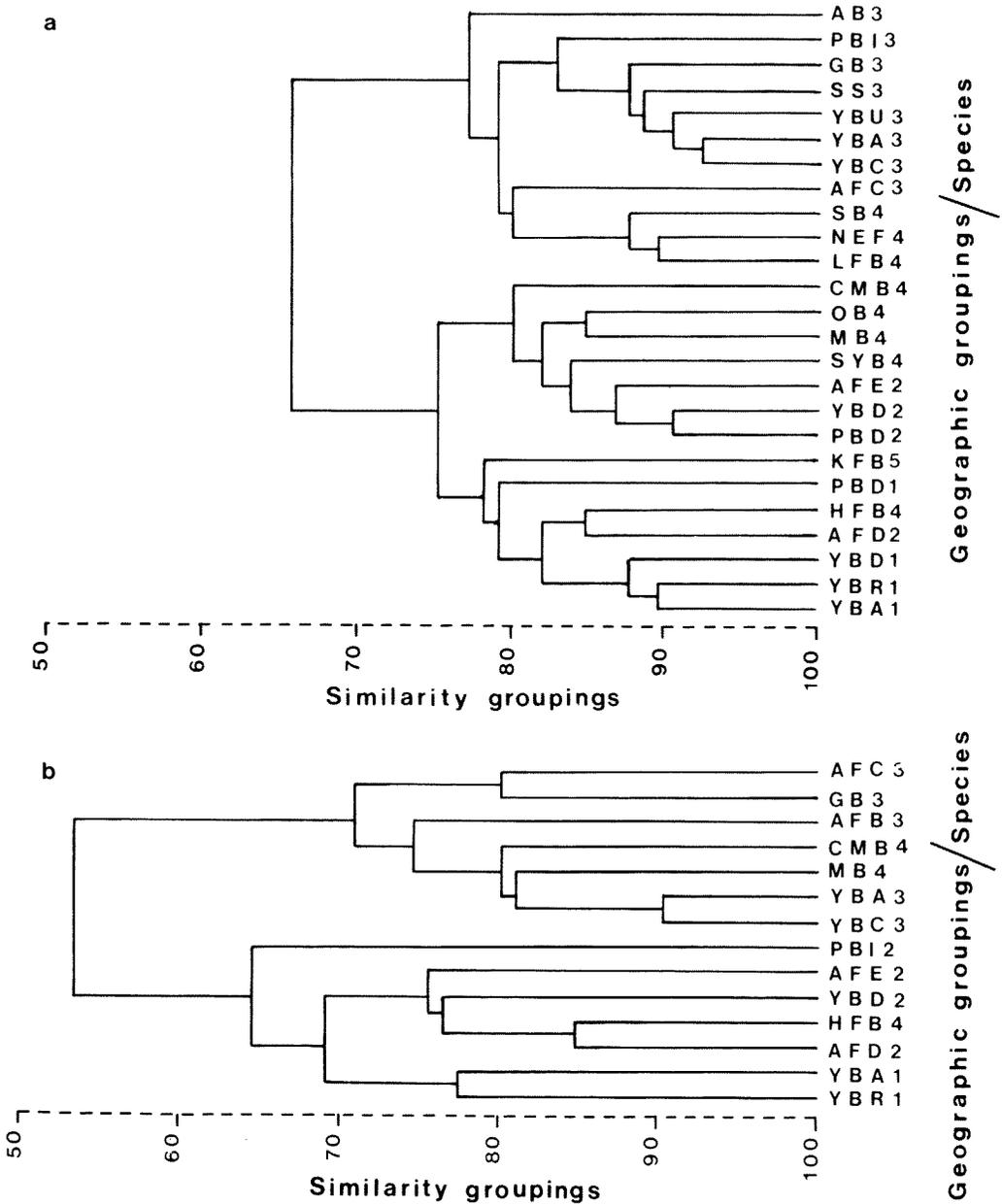
The generalised patterns of most classifications whether male, female, phenetic or phylogenetic are essentially similar but minor details vary (Figures 13, 14). Similarities are (a) groupings of *S. dolichura* OTUs usually with a monophyletic origin, (b) groupings of most *S. gilberti* OTUs, (c) splitting of *S. murina* into two groups, one always containing the NEF and LFB OTUs with the other always containing the HFB OTU and arising close to *S. aitkeni* and (d) widely dispersed placement of *S. griseoventer* OTUs often intergrading with *S. murina*.

The most important differences between the Wagner trees arise from the shifting placement of MB, OB and CMB OTUs between the two *S. murina* groups and the disparity of the direction of the Wagner trees for the male and female groups. In addition to the latter, Wagner trees for males and females are highly discordant, whether these trees are produced from the raw (Figure 14), gap-coded or 'size free' data. Groupings on both of the latter two are similar to those of the former.

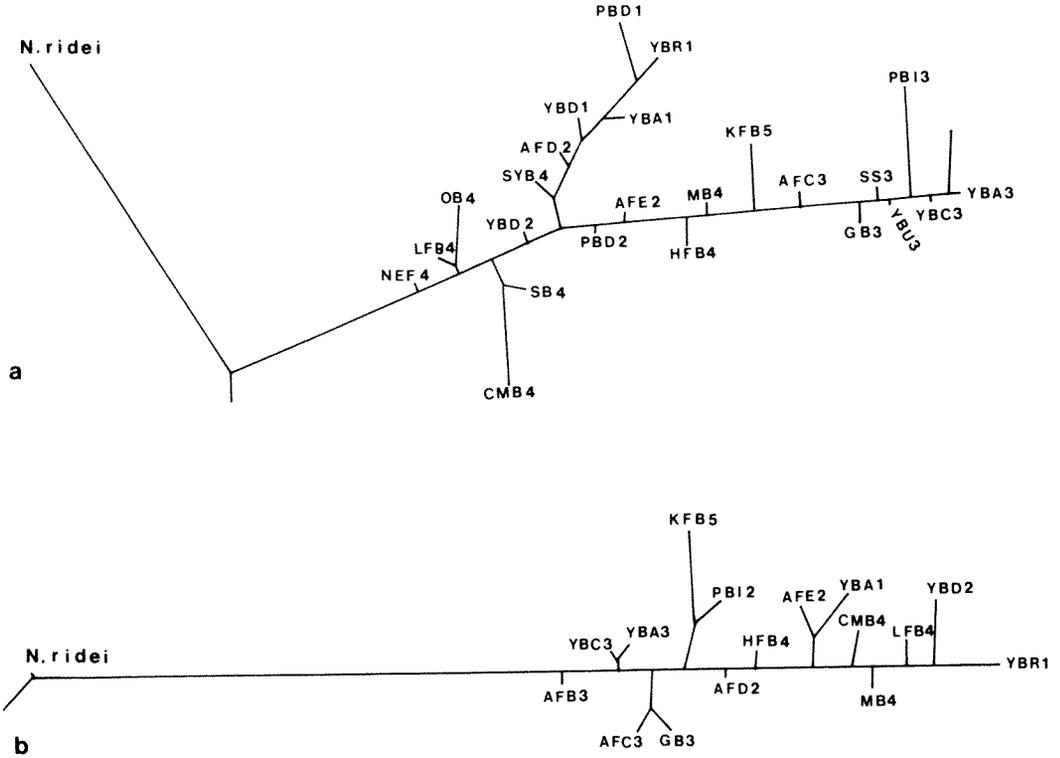
Wagner trees are rooted using a population of *Ningauti ridei* as an outgroup, but the direction and branching patterns of these trees are concordant with those rooted with *Sminthopsis granulipes* and *S. crassicaudata* and *S. macroura* or those rooted through the branch connecting the two most divergent OTUs without outgroups. Neither did the inclusion of the tragus measurements, causing a decrease in the number of populations (as not all had tragus data), cause any alteration in the Wagner trees. Thus although patterns differ, individual Wagner trees are quite robust.



**Figure 12** Discriminant function clusters of skull characters of *S. murina* ( $\triangle$ ), *S. dolichura* ( $\blacktriangle$ ), *S. gilberti* ( $\circ$ ), *S. griseoverter* ( $\bullet$ ), and *S. aitkeni* ( $\square$ ): (a) males, (b) females. \*, group means. In males, increased separation is achieved with canonical function III (arrows) which are drawn to the same scale as function I & II.



**Figure 13** Dendrogram of phenetic relationships of the five species of *Sminthopsis* according to their geographic groupings (a) males; (b) females. For explanation of geographic group alpha codes see Figure 3; the suffixed species numeric code is as follows: 1, *S. gilberti*; 2, *S. griseoventer*; 3, *S. dolichura*; 4, *S. murina*; and 5, *S. aitkeni*.



**Figure 14** Wagner tree of the five species of *Sminthopsis* according to their allocation into geographic groups, constructed from raw means of all variables except tragus and weight, (a) males, (b) females. Branch lengths are proportional to patristic distances. For explanation of geographic group alpha codes see Figure 3; the suffixed species numeric code is as follows: 1, *S. gilberti*; 2, *S. griseoventer*; 3, *S. dolichura*; 4, *S. murina*; and 5, *S. aitkeni*.

**General Discussion**

In agreement with our previous study of dasyurid morphometrics (Kitchener *et al.* 1983) the extensive data set covering 22 craniometric and five external morphological characters resolves into a few components able to account for most variation. Foremost amongst these is a size factor accounting for approximately half the total variance, being highly correlated with most characters, particularly the craniometrics. Overall size is often considered an unsuitable character for use in systematics, due to the confounding effects of nongenetic factors such as environment and age. However, in this case the contribution of overall size to morphological discrimination of species, grouped primarily by the traditional approach, is substantial, as judged by the discriminant analysis. Accurate placement of animals into five putative species is effected in the majority of cases using the identification criteria of Table 4.

A purely morphometric appraisal of the systematics of the *Sminthopsis* OTUs provides good support for a monophyletic origin of only two of the five putative species. These two are *S. gilberti* and *S. dolichura*. However, due to the dependence of this classification on size characteristics and the problems of morphometric characters in general (Kitchener *et al.* 1983), it is not certain whether this monophyly represents a true monophyletic origin or merely a distinctiveness of derived characters resulting from occupying a unique environment. A general lack of monophyly for the other species groups precludes the use of these Wagner trees in testing hypotheses concerning vicariance biogeography following the methods of Platnick and Nelson (1978).

Further similarity to the *Ningau* situation (Kitchener *et al.* 1983) arises from the discordant systematic predictions of male and female character sets. In an attempt to resolve some of the contradictions between male and female classification and also between the traditional and numerical classifications, the continuous morphometric variables were gap-coded to produce additive binary characters. In some instances these characters represent a better estimate of the underlying genetic structure (Sneath and Sokal 1973). This was unsuccessful and in both male and female cases the new classifications are still widely variant and are more similar to Wagner trees constructed from raw data than to each other. We can only surmise that there may be substantially different selective pressures on the morphology of male and female dasyurids, which may account in part for the extensive sexual dimorphism.

One facet of nearly all Wagner trees, and somewhat less so of the phenograms, is the division of *S. murina* into two groups. A group generally to the east and south of the Great Dividing Range, composed of the NEF, LFB, OB, SB and CMB OTUs which is close to the hypothesised ancestor of the *S. murina* (*sensu* Archer 1981) group, and a group comprising individuals from the Murray Darling Basin OTU (MB) and Mount Molloy, north-eastern Queensland OTU (HFB); this group is situated on the branch of the Wagner tree giving rise immediately to *S. aitkeni* and later to *S. dolichura*. On this basis there may be cause for a taxonomic subdivision of *S. murina* (*sensu stricto*), although further study of morphometrics and other characters, such as biochemical genetic characters, are needed before the validity or taxonomic level of this split can be assessed.

The HFB OTU is very similar to individuals from Tolga, approximately 64 km to the south, which have previously been accorded subspecific status (*S. murina tatei*). Generally individuals in the HFB and MB OTUs are distinguishable from other *S. murina* populations by their generally longer tails (80.6 and 79.9 mm, respectively) which are normally longer than their nose to vent lengths. Also they frequently have a short inter-palatal distance (3.2 and 3.1 mm, respectively). The HFB individuals also have short bullae (4.8 mm).

*Sminthopsis aitkeni* by virtue of having only one population is unable to be tested for monophyly; but its substantial separation, reflected by patristic distance, from other *Sminthopsis* OTUs agrees with our proposed placement of this form as a distinct species.

Probably the most fragmented group on the Wagner tree is *S. griseoventer*. Although the OTUs assigned to *S. griseoventer* are not greatly separated when assessed through patristic difference, they do arise from three distinct branches of the male and female Wagner tree.

These numerous instances of disagreement between the traditional and numerical classifications must result from either, differences in their data inputs or, differences in interpretation of these data, or perhaps both. The various attributes of classificatory techniques, with respect to the way their underlying concepts interpret systematic data, are

copiously documented in journals such as *Systematic Zoology*. A reiteration of these phenomena is unnecessary here as their characteristics are independent of the animal group for which they are employed.

While the results of different classificatory schemes using similar data sets have been shown to produce disparate results both in the general case (see for example Rohlf and Sokal 1981) and specifically for carnivorous marsupials (Kirsch and Archer 1982), innate characteristics of data sets may, in some cases, swamp distinctions in classificatory technique. The degree of congruence between the phenetic and phylogenetic classifications of both males and females for raw, gap-coded and 'size free' data most probably reflects the properties of our morphometric data set. This data set of 27 variables for each OTU may be flawed for use in numerical taxonomy in a number of ways: (a) morphometric variables may be substantially altered by non-genetic factors, such as environment; (b) these variables may also be subject to intense natural selection (for instance Morton and Alexander [1982] suggest that tail length of *S. crassicaudata* is selected on the basis of the adaptiveness of food storage in various environments); (c) the coding of morphometric variables to reflect genetic characters is notoriously difficult; (d) our 27 variables respond to a much smaller number of underlying factors (as seen in the principal components analysis) and a single change in one factor will be weighted by the number of times that factor is replicated (thus size differences play major roles in determining the placement of OTUs on trees); (e) as *Sminthopsis* is rarely abundant, many values of character for OTUs are based on a few, often one or two, individuals.

As numerical taxonomic studies require numerous independent characters to be effective, the iteration of a few underlying factors (d) is probably the most serious flaw. Future studies of small mammals should expand their character sets to include more non-craniometric characters.

That cladistic analyses commonly have trouble with data sets such as used here is emphasised by Kirsch and Archer's (1982) inability to find monothetic groupings for any carnivorous marsupial taxa and is probably also responsible for the large amounts of homoplasy apparent in their Wagner trees. One assumption in applying Wagner analysis to phylogeny reconstruction is that the characters used must be conservative with respect to change (Felsenstein 1978). It may be that, as a result of selective forces and non-genetic influences, many morphometric characters used here violate this assumption.

Traditional taxonomic approaches must also rely on morphological characters; however these approaches, often by virtue of their subjectivity, make less rigorous demands on their data; for instance their dependence on fewer characters allows them to ignore much of the iteration of single factors. In addition, they are also able to employ some characters, such as colour, which are exceedingly awkward to include in numerical approaches.

In no way can these findings be construed to suggest that the *principles* of traditional mammalian taxonomy are superior to those of more recent taxonomic theories; rather we would suggest the converse to be true. Instead, this should be seen as a difference in operationality, given the current constraints of collection and coding of morphometric data from the rare small marsupials. Neither should it be taken to suggest that morphometric criteria be abandoned, for they may contain information on reproductive isolation, thus speciation, not available through other characters: in this case the tentative division of *S. murina* (*sensu* Waterhouse). This study emphasises that morphometric characters should

continue to be used in marsupial taxonomy. However, they should first be subjected to extensive univariate and covariate analyses, and research into mechanisms to transform them into parameters which more accurately characterise gene pools should be a primary consideration.

#### Nomenclatural Note

Because *S. fuliginosa* is a possible available name for one of the species of *Sminthopsis* recognised in this study, we have found it necessary to detail our findings regarding aspects of the 'holotype' of *S. fuliginosa*, particularly doubts concerning the provenance of its type locality and the material selected to represent the type.

Previous authors (Thomas 1888, Tate 1947, Troughton 1965, Archer 1981) have referred to BM 44.2.15.20 as the holotype of *S. fuliginosa* (Gould, 1852). However, Gould specified no example in his type description apart from providing several body measurements and an illustration of the externals. BM 44.2.15.20 is more correctly termed a lectotype, which was designated as such by Thomas (1888).

The name *Sminthopsis fuliginosa* (Gould, 1852) cannot be assigned to any of the three new species described herein from Western Australia for the following reasons:

*Lectotype skull.* Much of the posterior part of the skull of lectotype of *A. fuliginosus* BM 44.2.15.20, a young adult male, is missing (see stereopair photograph in Archer [1981: 96]). Measurements presented by Archer (1981: 88) of the remains of this lectotype skull and the dentaries, particularly  $C_1^1-M_1^4$ ,  $M_1^1-M_1^4$ ,  $M_1^1-M_3^3$ , length from posterior edge of articular condyle to anterior edge of  $I_7$  alveolus ( $DCI_7$ ) and distance from ascending ramus to articular condyle ( $CONRAM$ ) would exclude *S. gilberti* and *S. griseoverter*, but fall within the range of measurements for *S. dolichura*. The absence of developed entoconids on  $M_7-7$  in the holotype (Archer 1981, Figure 16 and Archer pers. comm.) and confirmed by Hill (pers. comm.) also excludes *S. griseoverter*.

*Lectotype skin.* Gould's (1852, letterpress P1.41) type description of *S. fuliginosa* states that 'the whole of the upper surface dark greyish brown interspersed with numerous longer black hairs, giving it a fuliginous or sooty hue... the sides of the chest sooty grey, separated down the centre by a narrow line of buffy grey extending from the chin to the insertion of the forelegs; undersurface pale greyish white.'

Of the three species under consideration, only *S. griseoverter* could be described as having the chest 'sooty grey' but neither *S. griseoverter*, *S. gilberti* or *S. dolichura* have a 'narrow line of buffy grey extending from the chin to the insertion of the forelegs.' Gould's description of 'undersurface pale greyish white' would better match *S. gilberti* and *S. dolichura* than *S. griseoverter* which is a grizzled grey colour.

J.E. Hill (pers. comm.) describes the colour of the underparts of the lectotype of *S. fuliginosa* as follows: 'Overall this is best described as greyish white, with the white element predominating. The underside of the chin to the lower lip and posteriorly to the base of the throat has a moderate covering of whitish hairs, only faintly tinged with grey. Under the microscope this covering is insufficiently dense to wholly conceal the underlying skin: the hairs are rather short and woolly. Pelage of this nature extends just to the sides of the throat where the hairs become longer, denser, to have a dark, slaty base extending for nearly half their length, with a whitish tip, and to be interspersed with occasional longer, brownish guard hairs. The chest has a relatively dense cover of similarly dark based, white tipped hairs. The pelage over the belly from a line just anterior to the last ribs to and including the inguinal region is longer, almost lank: the hairs have dark, slaty grey bases, the dark colour extending for about one third to one half of their length, and are generously and liberally tipped with greyish, almost creamy white. Pelage of this nature extends to and just on to the flanks. The greyish undercolour is not completely obscured by the white tipping but shows through on the anterior part of the belly and on the chest to give a more or less "mottled" effect: posteriorly the grey is more totally obliterated and the

pelage appears on the surface to be more clearly greyish white.' This description would fit *S. gilberti* and *S. dolichura* but not *S. griseoventer* in which the dark base of the hair of the underparts is more than three-quarters of its length and tipped with a light grey colour.

Gould's (1852) type description of *S. fuliginosa* states that both the length of the tail and length of the nose to root of the tail (measures approximating nose to vent and tail to vent) are  $3\frac{1}{4}$  inches (= 83 mm). Measurements of the holotype (Hill pers. comm.) record the length of the tail to vent and snout to vent as 86.2 and 94.0 mm, respectively. However, Hill considered that in recent times 'skull measurements may have been distorted during the extraction of the skull.' The measurements match those of *S. griseoventer* and *S. gilberti* but not that of *S. dolichura*. The length of the tarsi and toes in the type description of *S. fuliginosa* is  $\frac{3}{8}$  inches (= 15.9 mm) which falls within the range of measurements of *S. griseoventer* and *S. dolichura* but not *S. gilberti*.

*Type locality.* Gould (1852, letterpress to P1.41) does not state the type locality of *S. fuliginosa* but notes that the species is very abundant in King George Sound and vicinity of Perth. Thomas (1888: 305), 'R. Avon, W.A.' Tate (1947: 121), 'River Avon, King George's Sound, Western Australia.' Troughton (1965) considers that J. Gilbert's actual collection locality was 'Toodyay on the Avon River, 15 miles from Northam.' He attributes this error in location by Tate (1947) to result from Gould (1852) 'giving the local name "Twoor-dong-aborigines of King George's Sound" at the heading of his description of the "Sooty Antechinus".' Archer (1981) reports that the label on the 'holotype' is not the original and gives the locality as 'R. Avon, W.A.' Hill (pers. comm.) 'according to the register, the specimen came from "hill sides on the banks of the Avon".'

Gould's (1852) type description of *S. fuliginosa* clearly relates to, and closely paraphrases, Gilbert's (in Whittell 1954) notes on the 'Twoor-dong' accompanying his specimen No. 37 collected from King George Sound. Gilbert stated that the 'Twoor-dong' 'so much resembles that (species) found at Perth that I first considered them to be identical... (however) it not only differs in its mode of making a nest and other habits, but is very much darker, having the cheeks paler, while the underside is not so pure a white.' Gilbert referred to the Perth species as 'Dtam-in' and states that 'I only know of two habitats for this species (Dtam-in); viz. the grass lands of Toodyay Valley and in the groves of *Xanthorrhoea* surrounding the swamps and lakes around Perth. Gould (1852, letterpress to P1. 42) described the "Otam-in" [*sic*] as *Sminthopsis albipes* (Waterhouse). Gilbert (in Whittell 1954) stated that the "Dtam-in" is rarely seen or met with in small families as is the nearly allied species "Twoor-dong" from King George's Sound.'

This last statement by Gilbert implies that the 'Twoor-dong' as recognised by him was restricted to King George Sound. Gilbert provided Gould with much of his natural history information and is paraphrased by Gould on the distribution of the 'Twoor-dong' and 'Dtam-in.' It is, then, possible that Gilbert's King George Sound specimen no. 37 is the basis of the type description of *S. fuliginosa* and that this, not Toodyay, is the type locality. Interestingly, Archer (pers. comm.) when examining specimens in the British Museum for his revision of *Sminthopsis*, recorded measurements of three *Antechinus fuliginosus* Gould, 1852, 'syntypes' from King George Sound, Western Australia which were glued to a board. Hill (pers. comm.) states 'that this board is BM(NH)46.4.4.59-61 with 1 skull, 2 rostra, 2 mandibles and labelled "King George's Sound *Antechinus fuliginosus* Gould 1852." Further, this board is marked on the back by Gray "306 c.d.e.", "Antechinus. W. Australia," "46.4.4.59-61," "No. 37 of my list Gould," in another hand "probably fuliginosa," in another hand "Phascogale crassicaudata" and in yet a fourth, modern hand "37 of Gilbert's List is "Twoor-dong" of King George Sound see Whittell (1954) W. Aust. Nat. 4: 108-9." On the front of the board this same hand has written "*Antechinus fuliginosus* Gould, 1852," "King George Sound," "SYNTYPES," "46.4.4.59-61" while Gray has also written "W. Australia." Our old Register (i.e. Gray's temporary Register) makes it quite clear that no skins were ever received: in the main Register the specimens are each annotated "No. 37." Another specimen, BM(NH)53.10.22.25 comes from Toodyay and was also presented by Gould. However, Thomas (1888) lists only three specimens of *S. murina* (*sensu lato*) collected by J. Gilbert from Western Australia, including the holotype of *S. fuliginosa*; none of these listed specimens is from King George Sound.

*Lectotype history.* Hill (pers. comm.) suggests that at one time during the last century the skin had its skull inside it and have been a 'mounted animal'. He states that 'existence of the rostrum only tends to support this opinion since at the time that it was collected many collectors cut off the skulls in this way and left them in the skin.' Thomas (1888) lists the lectotype as 'Ad. sk.' with no mention of the skull which tends to confirm Hill's suggestion that at that time the skull or what was left of it was still in the skin. Hill considers it possible, then, that in its early days this specimen was exposed to light and also that its measurements may have been distorted during the extraction of the rostral fragment. Further, the lectotype has neither Gilbert's collecting number nor its original label attached. However, the label attached to the skin of the lectotype of *S. fuliginosa* states 'Fig'd as *Ant. albipes* in Voy. Ereb. Terr. E.G. (from photo of type skin provided by J.E. Hill and fide' M. Archer).

In conclusion, while the rostral part of the skull of the lectotype of *S. fuliginosa* is very similar to *S. dolichura*, the dimensions and colour of the pelage, on which the type description is based, is not *S. dolichura* and cannot confidently be ascribed to either *S. griseoventer* or *S. gilberti*. It is, then, possible that we have not examined specimens of *S. fuliginosa* in this revision, and that more extensive collecting in the region of King George Sound will provide examples of this taxon. In this regard the unique specimen referred to earlier, WAM M7945, is coastal in the south-west, has no entoconids, and has body measurements similar to those in the type description of *S. fuliginosa*, as well as skull and dentary proportions similar to the lectotype of *S. fuliginosa*. However the skin of WAM M7945 could not be preserved to compare with the type description of *S. fuliginosa*. Nevertheless, of the specimens examined WAM M7945 best represents *S. fuliginosa*.

Another possibility is that the lectotype BM (NH) 44.2.15.20 selected by Thomas (1888) is not a syntype, for it differs from the type description as follows: the pelage of the chest has no medium buffy stripe or hairs that are noticeably 'sooty grey'; the nose to root of tail length is much longer than that of the type description – although this may be due to stretching of the skin as a result of the later removal of the skull; and it was apparently collected near the Avon River, Toodyay and not from King George Sound or in the vicinity of Perth.

It is possible, but by no means certain, that Gould's type description was based on the skins associated with the skulls and dentaries collected by J. Gilbert from King George Sound (his No. 37). However, it is not possible to distinguish Gilbert's No. 37 from other parts comprising BM(NH) 46.4.4.59-60. Also the skins associated with these parts are lost and apparently were never presented to the British Museum (Natural History). Although many of the diagnostic characters of these skulls and dentaries are absent through damage, and the sex of the parts is not known, the comprehensive measurements of them, kindly provided by M. Archer, indicate a real possibility that the dentaries and skulls comprise different taxa. For example, interpalatal vacuities are long (4.0 to 4.5 mm), indicating *S. griseoventer* – while the single CONRAM to  $M_{1-4}$  ratio (0.70) is very low, indicating *S. gilberti*. The  $M_{1-4}^2 : M_{1-4}$  ratio for all combinations available (on the assumption that the dentaries may not be correctly matched with the skulls) of 0.867, 0.881, 0.883, 0.897, 0.898 and 0.914, are outside the minimum values of *S. griseoventer* or *S. gilberti* (see Table 1). They are, however, similar to the values expected from the ratio of average  $M_{1-4}^2$  lengths of *S. griseoventer* to average  $M_{1-4}$  lengths of *S. gilberti* (0.909). Also, small to moderate entoconids are present on  $M_{2-3}$  of one set of dentaries but are absent from the other.

#### Acknowledgements

Mr G. Barron and Mr D. Elford, Western Australian Museum, produced the photographs. Mr N.T. Allen, Worsley Alumina Pty Ltd and Mr N. Dunlop, Murdoch University, kindly photographed and described type localities of two of the new species. Mr J.E. Hill, British Museum of Natural History, was of great assistance to us with nomenclatural problems – as was Dr G.M. Storr, Western Australian Museum and Dr W.D.L. Ride, Canberra College of Advanced Education. Dr P. Baverstock and Mr M. Adams, Department of Agriculture, South Australia, assisted greatly in our understanding of the taxa described herein through

their electrophoretic studies; the former kindly read the MS. Dr J. Calaby, Messrs P. Aitken, and S. Van Dyck and Ms J. Dixon, CSIRO Wildlife Collections, South Australian Museum, Queensland Museum, Victorian Museum, kindly arranged loan of specimens.

#### References

- Aitken, P.F. (1972). *Sminthopsis murina* (Waterhouse) 1838. A new record from Kangaroo Island, South Australia. *South Aust. Nat.* **46**: 36-37.
- Archer, M. (1981). Results of the Archbold expeditions. No. 104. Systematic revision of the marsupial dasyurid genus *Sminthopsis* Thomas. *Bull. Am. Mus. Nat. Hist.* **168**: 63-223.
- Baverstock, P.R., Adams, M; and Archer, M (1984). Electrophoretic resolution of species boundaries in the *Sminthopsis murina* complex (Dasyuridae). *Aust. J. Zool.* (in press).
- Beard, J.S. (1980). A new phytogeographic map of Western Australia. *West. Aust. Herb. Res. Notes* **3**: 37-58.
- Chapman, A. and Kitchener, D.J. (1978). Mammals of Durokoppin and Kodjokodjin Nature Reserves. *Rec. West. Aust. Mus. Suppl. No. 7*: 49-54.
- Chapman, A. and Kitchener, D.J. (1981). Mammals of Billyacatting Hill Nature Reserve. *Rec. West. Aust. Mus. Suppl. No. 13*: 31-34.
- Felsenstein, J. (1978). Cases in which parsimony or compatibility methods will be positively misleading. *Syst. Zool.* **27**: 401-410.
- Gould, J. (1852). *The Mammals of Australia* Taylor and Francis. Vol. 1, p1. 41-42 and text.
- Humphries, J.M., Bookstein, F.L., Chernoff, B; Smith, G.R., Elder, R.L. and Pass, S.G. (1981). Multivariate discrimination by shape in relation to size. *Syst. Zool.* **30**: 291-308.
- Iredale, T. and Troughton, E. Le G. (1934). A check-list of the mammals recorded from Australia. *Mem. Aust. Mus.* **6**: 1-122.
- Kirsch, J.A.W. and Archer, M. (1982). Polythetic cladistics, or, when parsimony's not enough: the relationship of carnivorous marsupials. In: *Carnivorous Marsupials* (Ed. M. Archer): 595-619. (Royal Zoological Society of New South Wales: Sydney.)
- Kitchener, D.J. and Chapman, A. (1979). Mammals of Buntine and Nugadong Reserves. *Rec. West. Aust. Mus. Suppl. No. 9*: 85-94.
- Kitchener, D.J., Stoddart, J. and Henry, J. (1983). A taxonomic appraisal of the genus *Ningui* Archer (Marsupialia: Dasyuridae), including description of a new species. *Aust. J. Zool.* **31**: 361-79.
- Krefft, G. (1867). On the classification of the small Dasyuridae of Australia, with descriptions of two new genera and one new species. *Proc. Zool. Soc. Lond.* **1886**: 431-435.
- Mayr, E. (1963). *Animal Species and Evolution* 797 pp. (The Belknap Press: Harvard University Press, Cambridge, Mass.)
- Morton, S.R. and Alexander, F. (1982). Geographic variation in the external morphology of *Sminthopsis crassicaudata* (Dasyuridae, Marsupialia). In: *Carnivorous Marsupials* (Ed. M. Archer): 694-698. (Royal Zoological Society of New South Wales: Sydney.)
- Nie, N.H., Hull, C., Jenkins, J.G., Steinbrenner, K., and Brand, H.D. (1975). *Statistical Package for the Social Sciences* (McGraw-Hill Book Co.: New York.)
- Platnick, N.I. and Nelson, G.J. (1978). A method of analysis for historical biogeography *Syst. Zool.* **17**: 1-16.
- Ridgway, R. (1912). *Colour Standards and Colour Nomenclature* (Published by the author: Washington.)
- Rohlf, F.J. and Sokal, R.R. (1981). Comparing numerical taxonomic studies. *Syst. Zool.* **30**: 459-490.
- Sneath, P.H.A. and Sokal, R.R. (1973). *Numerical Taxonomy* (W.H. Freeman and Co.: San Francisco.)

- Tate, G.H.H. (1947). On the anatomy and classification of the Dasyuridae (Marsupialia). *Bull. Am. Mus. Nat. Hist.* **88**: 97-156.
- Thomas, O. (1888). Catalogue of the Marsupialia and Monotremata in the collection of the British Museum (Nat. Hist.), London, *Brit. Mus. (Nat. Hist.)* **11**: 401 pp.
- Troughton, E. Le G. (1965). A review of the marsupial genus *Sminthopsis* (Phascogalinae) and diagnoses of new forms. *Proc. Linn. Soc. N.S.W.* **89**: 309-321.
- Waterhouse, G.R. (1842). On two new species of marsupial animals from South Australia. *Proc. Zool. Soc. Lond.* **10**: 47-48.
- Whittell, H.M. (1954). John Gilbert's notebook on marsupials. *West. Aust. Nat.* **4**: 104-114.