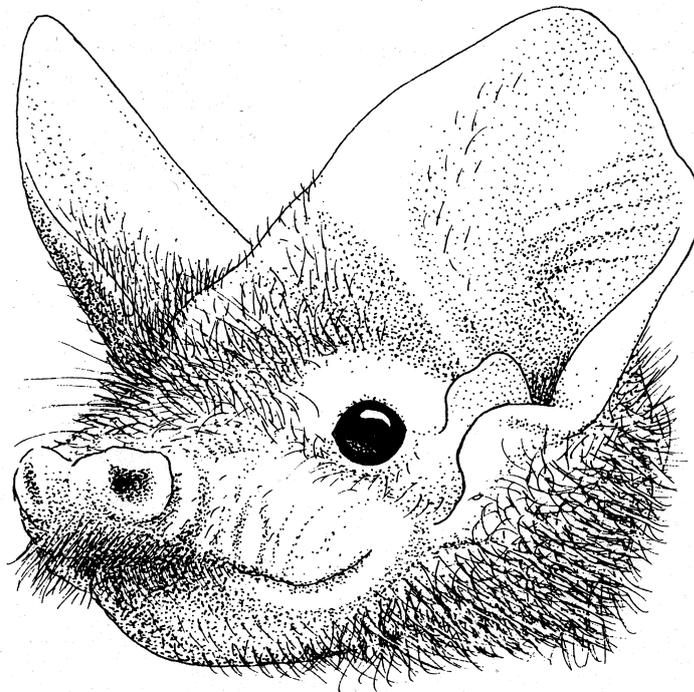


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An Interim Guide to Identification of Insectivorous Bats of South-eastern Australia

Harry Parnaby



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An Interim Guide to Identification of Insectivorous Bats of South-eastern Australia

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ABSTRACT. Species keys using external characters are given for the 33 microchiropteran bat species recorded from south-eastern Australia, except for the five species of the taxonomically chaotic genus *Mormopterus*, and female *Eptesicus*. The key is designed for use by non-specialists. Identification criteria, synonyms and broad distributional limits are summarised in individual species accounts. Substantial taxonomic uncertainty affects two thirds of the species in south-eastern Australia. Field identification of a significant proportion of species remains problematical because reliable external, diagnostic characters are not known. Consequently, easy or accurate field identification is not possible for many species. The need to retain voucher specimens to confirm identifications is emphasised.

PARNABY, H., 1992. An interim guide to identification of insectivorous bats of south-eastern Australia. Technical Reports of the Australian Museum 8: 1-33.

This manual is designed to assist field identification of live bats by people with no prior experience of our bat fauna. Technical terms have been avoided where possible. It is an interim document due to the limitations in our current knowledge of the taxonomy of this group.

The main aim is to assist species identification in the following ways: a) summarise current knowledge of species identification for the 33 insectivorous bat species recorded from south-eastern Australia (see Appendix); b) alert field workers to the fact that although many species can be recognised with experience by their 'overall appearance', actually defining what these differences are is often difficult and reliable field characters have yet to be discovered for such species; c) indicate that species identification of some genera is not possible at present due to taxonomic confusion and/or because species are defined using skull, dental or

biochemical characters; d) encourage a minimum standard of notes to be routinely recorded for each bat during field studies.

The five distinctive megachiropteran bat species known from the region (three species of Fruit Bat *Pteropus* spp, the Tube-nosed Bat, *Nyctimene robinsoni* and the Blossom Bat *Syconycteris australis*) are not covered in this guide. The latter species are discussed by Hall & Richards (1979) and Strahan (1983).

As further versions of this document are planned, difficulties encountered in using the key and suggestions for improvement will be welcome.

Scope

The species key is based on one developed for use

in north-eastern New South Wales and tested in the field in 1992 during the New South Wales National Parks and Wildlife Service North East Biodiversity Study. North-eastern New South Wales contains one of the highest diversities of bat species in Australia. Extending the geographic coverage to include south-eastern Australia involved inclusion of only three additional species not found in north-eastern New South Wales. Extending the coverage diminishes the usefulness of diagnostic features because it encompasses a greater diversity of environments which result in much greater variation between bat populations. Much of this variation has not been documented, although many species are much smaller and have paler fur colour in inland areas compared to populations of the same species from the Dividing Range or coastal areas.

The key is designed for use primarily in far south-eastern Queensland, New South Wales, and Victoria (Fig.1). Many bat species display considerable geographic variation in size and appearance. This complicates species identification and it is suggested that other keys be consulted for adjoining regions of south-eastern Australia which are not covered by this guide. Reardon & Flavel (1987) provide a good coverage of the South Australian bat fauna including detailed distributional data, while Taylor *et al.* (1987) should be consulted for Tasmania.

Provision of detailed distribution maps and ranges of forearm lengths and weights are beyond the scope of this guide, the primary objective of which is to assist species identification. Consequently this document is not intended to replace Hall & Richards (1979) which has remained the most comprehensive guide to identification and distribution of eastern Australian bats. Although dated by extensive changes in species taxonomy and additional distributional data since 1979, it remains a valuable reference for many species, which is indicated by citation in the Species Accounts.



Fig.1. Area of south-eastern Australia covered by the key.

Current State of Knowledge

The taxonomy and distribution of the bat fauna of south-eastern Australia is still poorly known and new species undoubtedly remain to be named. The extent of morphological variation shown by many species is not yet properly documented, either because few individuals have been captured or because of confusion resulting from the similarity of many species, both morphologically and electrophoretically.

About two thirds of the 38 bat species recorded from south-eastern Australia are known to require taxonomic clarification! (Parnaby 1991). *It is simply not possible at present to easily or accurately identify many bat species.* Thus you will have difficulty in attempting to identify many of the common and widely distributed genera. Species in genera which are likely to be particularly troublesome are female Little Brown Bats (*Eptesicus* spp), Broad-nosed Bats (*Scotorepens* spp), Mastiff-bats (*Mormopterus* spp) and possibly Long-eared Bats (*Nyctophilus* spp). This is unfortunate, because the latter four genera comprise 19 of the 33 insectivorous bat species known from south-eastern Australia and include nearly all of the species which are commonly captured in bat traps or mist nets! Collecting voucher specimens to confirm identifications is therefore an essential procedure in most field studies.

The two most useful references which provide individual species accounts for eastern Australia (Hall & Richards 1979; Strahan 1983) are about ten years out of date, during which time many species diagnoses have altered radically. Taxonomic revisions of the past decade have resulted in dramatic changes to the diagnoses and identification criteria of many species and consequently some statements in this manual will be at variance with the less recent literature. This fact must be recognised when consulting the literature because many species names used during the past 20 years are now applied to quite different species.

Limitations of the Key

In using this key, it must be recognised that knowledge of bat species taxonomy of some genera is quite inadequate. Useful identification criteria have not been discovered and this will inevitably lead to some frustration when attempting identification of problematical species. Although this document will provide a guide to recognising the number of species in an area, it is necessary for the user to gain direct experience of the range of species in their area and with some persistence, it will be possible to learn to recognise difficult species. Although with experience, some difficult species could be recognised in the field, regional variation exists in most characters and few definitive criteria can be given which are useful for recognising such species over a larger geographic area.

The distribution map accompanying each species

account is provided to enable an immediate assessment of the broad distributional limits of each species and is not meant to provide a detailed summary of distribution. Large extensions in the known geographic range are likely for many species as they become better known. Therefore it is important that species identification is not unduly influenced by the options implied by these distribution maps.

Using the Key

For all but the most distinctive species it is important to consult several species accounts in conjunction with the species key before arriving at an identification. Table 1 provides a guide to species which are likely to be confused with one another. A graph of variation in forearm lengths of species of the family Vespertilionidae will assist in early elimination of some species (Fig.24).

In a number of instances the key contains comparative statements for species discrimination. While such statements are exasperating for the user, they are included either because appropriate data which would enable quantitative statements are not available, or because species overlap in quantitative characters and no other diagnostic external criteria are known. In a restricted geographic area, it will frequently be easy, with experience, to distinguish living examples of many

species for which few criteria are given in this key, by their overall appearance and behaviour.

Several steps in the key rely on forearm lengths which are based on adults (i.e., wing joints fully fused) and are likely to result in spurious results if juvenile or subadult individuals are used.

Figure 2 illustrates anatomical features used in the key.

Capture Techniques

The two techniques usually used for capturing bats are mist nets, and bat traps which are also called harp traps or 'constantine traps'. Capture techniques are reviewed in detail by Hellman & Churchill (1985), and Kuntz & Kurta (1988). Bat traps are discussed by Tidemann & Woodside (1978) and Francis (1989). The following provides a brief review of nets and traps.

Each method is optimal under different situations and for different species. For example, the Golden-tipped Bat has only been captured in bat traps and is evidently skilled at avoiding nets whereas nets are most effective for capture of Blossom Bats. Mist nets, which are the same nets used to capture birds, have the advantage of greater catching area than a bat trap. Nets can be set in such places as next to and across water holes or creeks or along tracks or clearings. A permit is necessary to

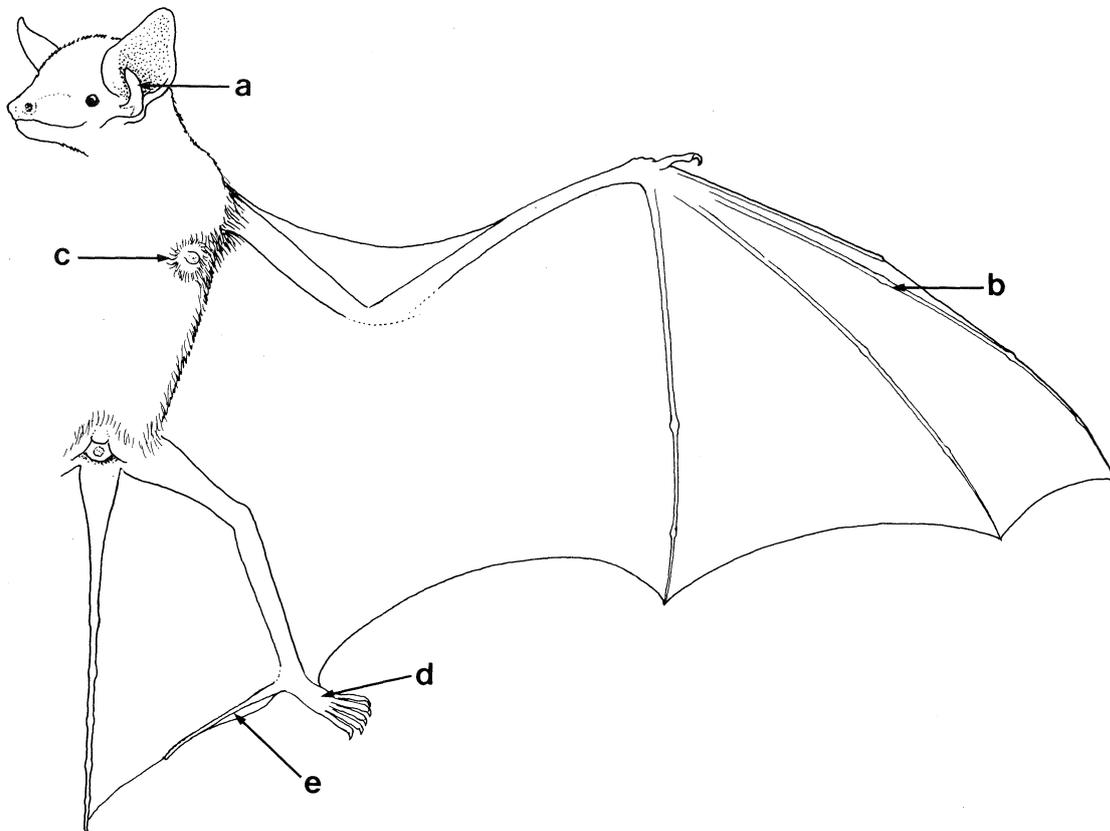


Fig.2. Terms used in the key: a, tragus; b, third digit; c, teat; d, pes; e, calcar.

Table 1. Guide to species which are likely to be confused during identification.

	<i>Eptesicus pumilus</i>	<i>Eptesicus darlingtoni</i>	<i>Eptesicus regulus</i>	<i>Eptesicus vulturinus</i>	<i>Eptesicus baverstocki</i>	<i>Eptesicus troughtoni</i>	<i>Chalinolobus gouldii</i>	<i>Chalinolobus morio</i>	<i>Chalinolobus dwyeri</i>	<i>Chalinolobus nigrogriseus</i>	<i>Chalinolobus picatus</i>	<i>Scotorepens greyii</i>	<i>Scotorepens balstoni</i>	<i>Scotorepens orion</i>	<i>Scotorepens sp</i>	<i>Scoteanax rueppellii</i>	<i>Falsistrellus tasmaniensis</i>	<i>Kerivoula papuensis</i>	<i>Myotis adversus</i>	<i>Miniopterus australis</i>	<i>Miniopterus schreibersii</i>	<i>Nyctophilus geoffroyi</i>	<i>Nyctophilus gouldi</i>	<i>Nyctophilus bifax</i>	<i>Nyctophilus timoriensis</i>
<i>Eptesicus pumilus</i>		●	●	●																					
<i>Eptesicus darlingtoni</i>	●		●			●		●				●								●					
<i>Eptesicus regulus</i>	●	●		●	●	●						●													
<i>Eptesicus vulturinus</i>	●		●		●																				
<i>Eptesicus baverstocki</i>			●	●																					
<i>Eptesicus troughtoni</i>		●	●					●				●								●					
<i>Chalinolobus gouldii</i>							●	●													●				
<i>Chalinolobus morio</i>		●				●	●													●					
<i>Chalinolobus dwyeri</i>						●		●	●	●															
<i>Chalinolobus nigrogriseus</i>								●		●															
<i>Chalinolobus picatus</i>								●	●																
<i>Scotorepens greyii</i>		●	●			●						●	●	●											
<i>Scotorepens balstoni</i>												●		●	●										
<i>Scotorepens orion</i>												●	●		●										
<i>Scotorepens sp</i>												●	●	●											
<i>Scoteanax rueppellii</i>																	●								
<i>Falsistrellus tasmaniensis</i>																●									
<i>Kerivoula papuensis</i>																			●						
<i>Myotis adversus</i>																			●						
<i>Miniopterus australis</i>		●				●		●													●				
<i>Miniopterus schreibersii</i>						●														●					
<i>Nyctophilus geoffroyi</i>																						●			
<i>Nyctophilus gouldi</i>																						●		●	●
<i>Nyctophilus bifax</i>																							●		
<i>Nyctophilus timoriensis</i>																						●			

purchase and use such nets. Mist nets require frequent inspection, perhaps every 5 to 10 minutes, to prevent bats chewing their way out of the mesh. Bat traps have gained preference to nets during general fauna survey work as they do not require regular inspection and can be left unattended all night.

Handling Bats

A successful way to hold bats involves anchoring the bat with the thumb gently pressed between the shoulder blades, with the wings folded. Bats are usually agitated until able to secure a good toe hold with both feet. Do not attempt to hold bats by the wing tips as this could result in the wing bones being broken. If handled correctly, many species will not attempt to bite. Few species in south-eastern Australia are capable of a really painful bite.

Live bats can be held in cloth bags but care is required both to ensure that bags are stored in a cool place away from direct sun light; that the cloth is porous enough to allow air circulation; and that too many are not placed in one bag as this could result in some individuals being suffocated.

Particular care is required when storing Horseshoe bats which are highly prone to desiccation of the wing and tail membranes in low humidity: the wing membranes can become completely inflexible, like a dried leaf. This must be avoided but can be alleviated by moistening the wing membranes.

Measurements

It is useful to record the following information for each individual captured: forearm length, weight, sex,

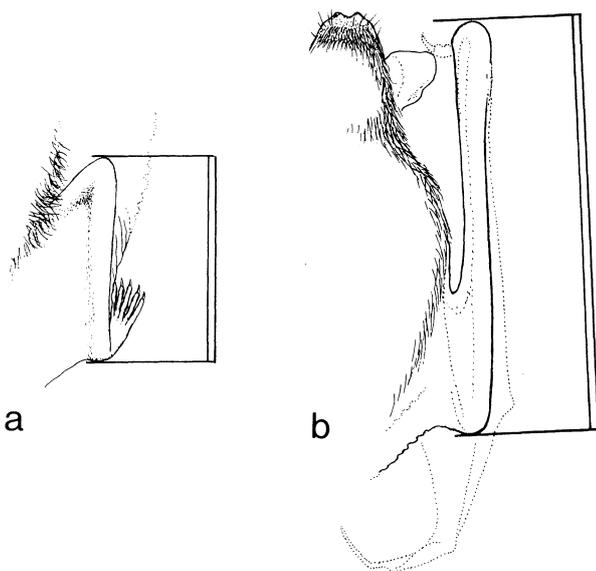


Fig.3. Position for measuring a, hindleg length; and b, forearm length.

and note whether the wing joints are fused or not, indicating subadult or adult. Two additional measurements must be taken when using this key: for Broad-nosed Bats (*Scotorepens*), it is important to measure hindleg length (see Fig.3a) and for Long-eared Bats (*Nyctophilus*), outer breadth across the upper canines, at the gum line. Such measurements need to be quite accurate and are best taken using a pair of vernier callipers rather than a rule. Forearm length is best measured as the maximum distance from the wrist to the elbow, with the wing folded (Fig.3b).

Ageing

Bats grow to near adult size very early in life, often within five or six months. Adults can be distinguished from young bats by the degree of fusion of the wing joints. In very young individuals the transparent cartilaginous bands in the wing joint are quite obvious but become progressively more difficult to recognise with increasing ossification. Subadult bats can also be recognised by differences in fur colour and texture: usually being generally darker with softer fur and with more supple and less scared wings. Inspection of wing joints is best done by shining a torch behind the wing joint.

Three age categories are frequently recognised, which form a continuum:

Juvenile – still weaning, wing joints with large and obvious cartilaginous bands (Fig.4a).

Subadult – wing joint has smooth outline; cartilaginous band and blood vessels very distinct (Fig.4b);

Adult – wing joints knobby, cartilaginous gap not visible (Fig.4c).

The latter two categories are most relevant to this guide as they refer to volant individuals, i.e., individuals which are most likely to be captured in mist nets and bat traps. Nursing females infrequently fly carrying their young.

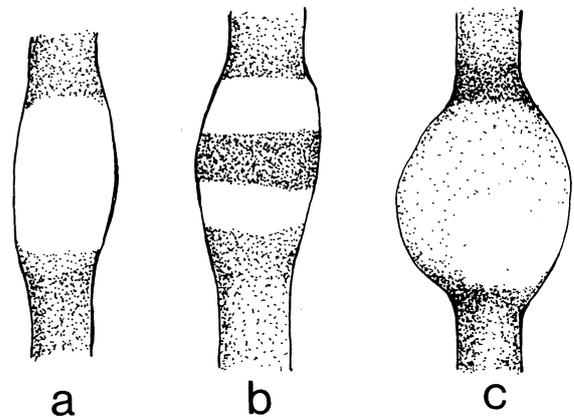


Fig.4. Stages in fusion of wing joints of; a, juvenile; b, subadult and c, adult.

Determining Sex

Male bats of most species have quite a conspicuous penis (Fig.5) and if you are confused as to a bat's gender, it is likely that you have a female. Where the penis is small and slender in species such as Bent-wing Bats (*Miniopterus spp.*) and the Eastern Horseshoe Bat (*Rhinolophus megaphyllus*) it can be easily overlooked, particularly if the penis is adhering to wet fur.

Reproductive Condition

Identifying the reproductive condition is not easy and requires familiarity with the various conditions of teat size and shape and the relative size of the testes and

epididymides for each species. The following notes are an introductory guide only.

Females. The condition of the teats, located one under each armpit (Fig.2), can provide an approximate guide to reproductive condition. Four categories are often used:

Nulliparous – (females which have never given birth) the nipple is very small and dome like, often surrounded by dense fur (Fig.6a). The surrounding skin is neither pigmented, raised or wrinkled.

Pregnant – determined by gentle abdominal palpation; it might be useful to examine males as experience is necessary to distinguish a full stomach from a pregnancy;

Lactating – nipple large and pendulous, surrounding skin raised by conspicuous, distended, subcutaneous white milk glands (Fig.6b). Milk can often be expressed by gently squeezing the nipple.

Post-lactating – nipple pendulous and surrounded by a circular patch of naked wrinkled skin.

Regressed – nipples small, often subtriangular rather than a small dome; surrounding skin often darker pigmentation (Fig.6c).

Males. Note testes size, and the size of the dark epididymal sac which is attached to, and extends from, the ventral surface of the testes along the tail membrane. The epididymal sac, used for sperm storage, increases with size as the testes (used for sperm production) decrease in size.

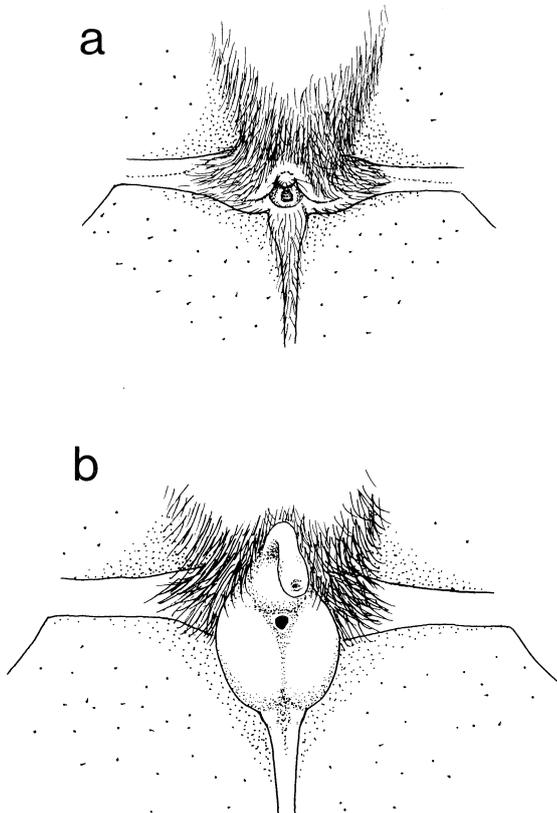


Fig.5. Bat genitals: a, female; b, male.

Voucher Specimens

In view of the extent of taxonomic confusion of bat species, it is particularly important to many studies to retain voucher specimens of each species, both to confirm identification, and to increase our general knowledge of species, most of which are poorly known. Measurements or photographs are not useful alternatives to voucher specimens for establishing species identity. It is not known which measurements will be useful for distinguishing the many species which belong to taxonomically confused genera, or which features to photograph. In any case, once the bat is released there is no way of checking measurements if errors were made. Many species are poorly represented in research collections. This is a major obstacle to assessing morphological variation within species and thus to evaluating the diagnostic value of characters.

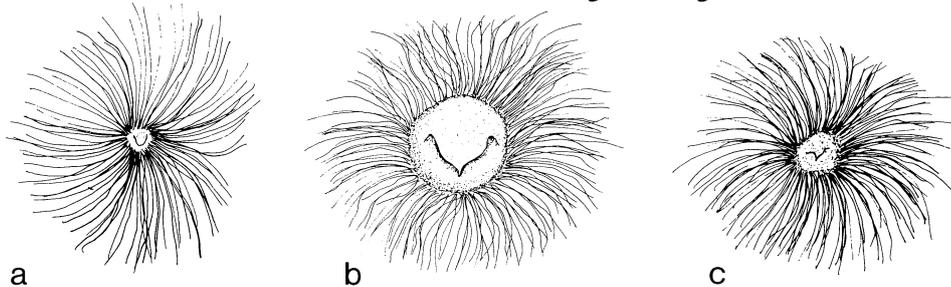


Fig.6. Mammary area at different stages of reproductive cycle: a, nulliparous female; b, lactation; and c, teats regressed.

It is strongly recommended that any doubtful or aberrant individuals be taken as voucher specimens, provided permits are obtained from the relevant State authority. If voucher specimens are routinely taken, such as to confirm identification during a fauna survey, and only one specimen is taken per species, it is suggested that males are taken, as they are more useful for identification purposes. It is recommended that no more than four specimens (preferably two of each sex) per area be routinely taken of each species although this will depend on the intensity of any previous bat research at that locality.

The value of voucher specimens is greatly diminished unless the following data is recorded for each: date of collection, locality (as detailed as possible to enable identification of the site in future decades), and collectors name. It is also desirable to record weight and method of capture.

A tag must be attached to associate this data with each specimen. Cardboard price tags are too soft and are liable to either disintegrate when wet, or the surface will rub off, obliterating the writing. Each individual can be assigned a field number using dymo tape attached with a short length of strong cotton thread; fishing line is less desirable as it is difficult to tie.

Specimen Preservation

Specimens should be fixed in 10% formalin overnight, then transferred to 75% ethanol. If left in formalin for

longer, or if the formalin is too strong, specimens become very brittle and decalcification can occur which damages the specimen. The formalin should be buffered to reduce the risk of decalcification, by adding about 2 gm of sodium carbonate per litre. It is very important to make a median longitudinal incision of at least 1 cm in the abdominal wall to open the abdominal cavity for preservation. It is also important to puncture the diaphragm to allow fixatives into the chest. Make sure that there is at least twice as much fluid as specimens in the jar – do not jam the container full of bodies. A few drops of detergent concentrate should be placed in the formalin solution to act as a wetting agent. This will assist fluid penetration of the fur.

A significant amount of water loss occurs from the body following death which dilutes the fixative solution. For some reason, the very convenient method of injecting formalin into the abdominal and chest cavities results in a high percentage of rotten specimens in which all the fur falls off, and this method is not recommended.

If ethanol is not available, methylated spirits will adequately preserve specimens but must be diluted with one part water to three parts methylated spirits. However, it is preferable to use ethanol, as methylated spirits tends to dehydrate specimens more than ethanol.

NB: The fixative recommended is 10% formalin, i.e., 1 part of formalin to 9 of water, NOT 10% formaldehyde solution. Formalin is the name given to a 35-40% formaldehyde solution. 10% formalin solution is a 4% formaldehyde solution.

Key to Families of Insectivorous Bats

1. Claw present on second wing digit; tragus absent from ear **and** no noseleaf Pteropodidae (fruit bats)
- Claw absent on second wing digit; tragus present, or if absent, complex noseleaf present 2
2. Tail enclosed in tail membrane (Fig.7a) 3
- Substantial portion of tail protrudes from tail membrane Fig.(7b-c) 4

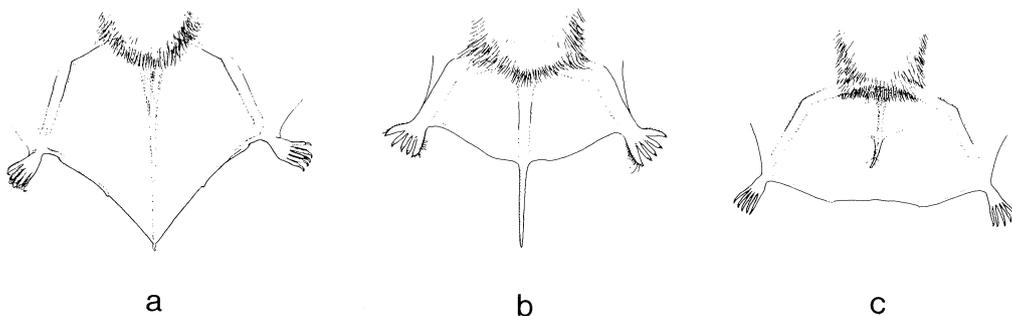
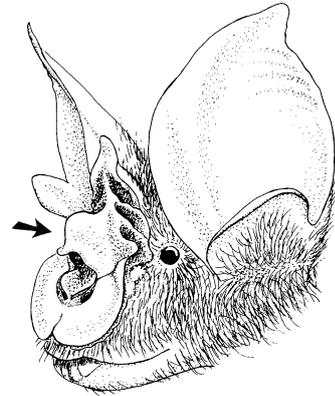


Fig.7. Dorsal view of the tail illustrating differences between families in the projection of the tail from the tail membrane: a, Vespertilionidae and Rhinolophidae; b, Molossidae; and c, Emballonuridae.

- 3. Complex skin projections (noseleaf) surround nostrils (Fig.8), tragus absent family Rhinolophidae: *Rhinolophus megaphyllus*
- Highly complex noseleaf (as in Fig.8) absent but simple noseleaf may be present (Fig.9a); tragus present family Vespertilionidae

Fig.8. *Rhinolophus megaphyllus*, showing complex noseleaf.



- 4. Terminal section of tail protrudes from edge of tail membrane; tail membrane slides up and down tail (Fig.7b) family Molossidae
- Terminal section of tail projects freely through dorsal surface of tail membrane (Fig.7c).....family Emballonuridae *Saccolaimus flaviventris*

Species Key to Family Vespertilionidae

NB. This key must be used in conjunction with accompanying species accounts and is only valid for adult individuals.

- 1. Ears joined above the head; simple noseleaf (skin exfoliations) present around nostrils as in Figure 9a (genus *Nyctophilus*) 16
- Ears short, not joined above the head; noseleaf absent (Fig.9b) 2

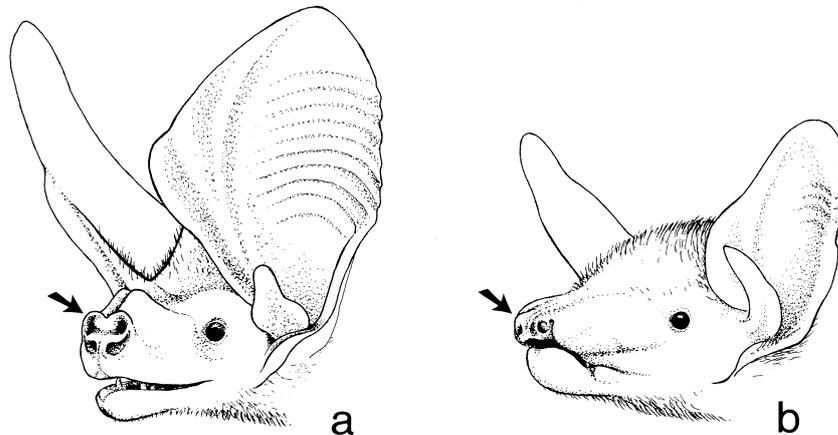


Fig.9. Head of a, *Nyctophilus gouldi*, showing simple noseleaf and membrane joining ears; and b, *Falsistrellus tasmaniensis* showing separate ears and absence of noseleaf.

- 2.(1) Terminal bone of third wing digit relatively long, more than half the length of remaining digit, see Figure 10a (examine with the wing folded); wing membrane attached to ankle (Fig.11a) (genus *Miniopterus*)..... 19
- Terminal bone of third wing digit relatively short, less than half the length of the rest of the digit (Fig.10b); wing membrane attached to base of toe (Fig.11b) 3

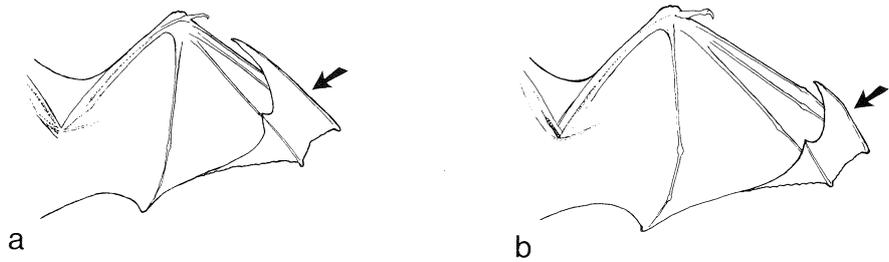


Fig.10. Differences in the length of the terminal joint of the third wing digit of; a, *Miniopterus schreibersii*; and b, *Chalinolobus gouldii*.

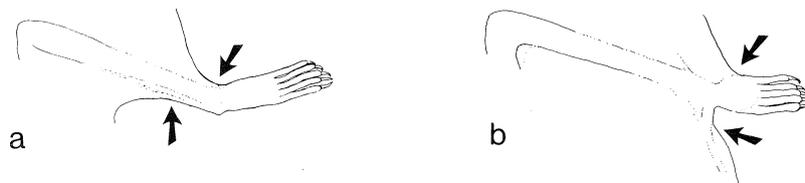


Fig.11. Attachment of the wing membrane in: a, *Miniopterus* spp, attached to ankle; b, *Chalinolobus* spp, attached to base of toe.

- 3.(2) Bright golden hairs on forearms and hindlegs; dorsal and ventral fur black with golden tips*Kerivoula papuensis*
- Fur colour not as above 4
- 4.(3) Calcar extends from the ankle to about three quarters of the way to the tail tip (Fig.12a); tragus long and very slender (Fig.13a)*Myotis adversus*
- Calcar extends much less than three quarters of distance to tail tip (Fig.12b); tragus shape not extremely elongate (Fig.13b-d)..... 5

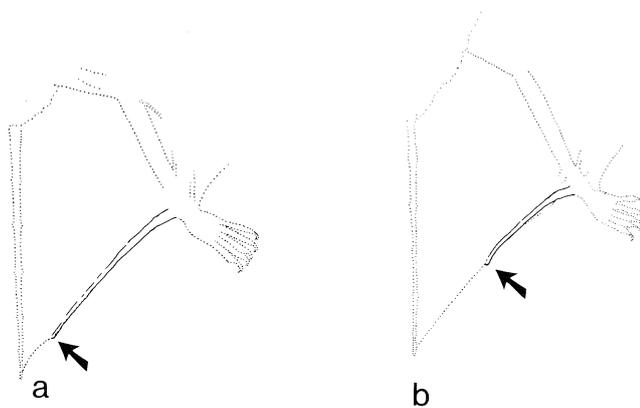


Fig.12. Relative length of the calcar: a, *Myotis adversus*; b, *Chalinolobus gouldii*.

5.(4) Ear broadly rounded; ear breadth approximates ear length (Fig.14a-b); small horizontal lobe of skin (indistinct in some species) project from lower lip from near corner of mouth (Fig.15) (genus *Chalinolobus*) 11

— Ear slightly more pointed; ear length somewhat greater than ear breadth (Fig.14c-d); skin lobes absent from lower jaw 6

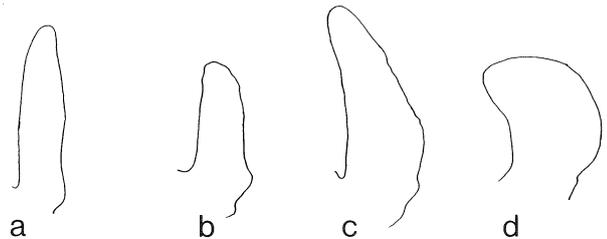


Fig.13. Contrast between the elongate tragus of *Myotis adversus* (a), compared to other species: b, *Eptesicus regulus*; c, *Falsistrellus tasmaniensis*; and d, *Chalinolobus gouldii*.

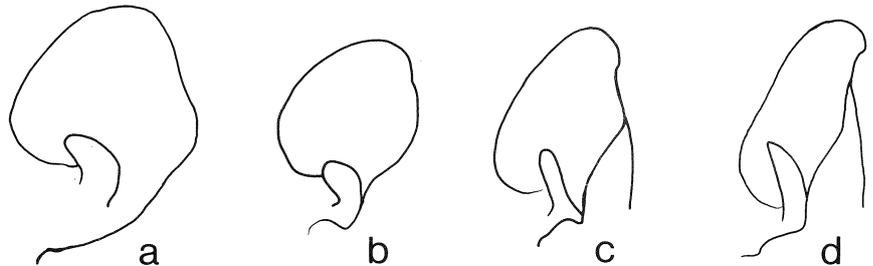


Fig.14. Left ear outline, contrasting the relatively broad ears and more rounded tips of a, *Chalinolobus gouldii* and b, *Chalinolobus morio*; with the more elongate ears of c, *Eptesicus regulus* and d, *Falsistrellus tasmaniensis*.

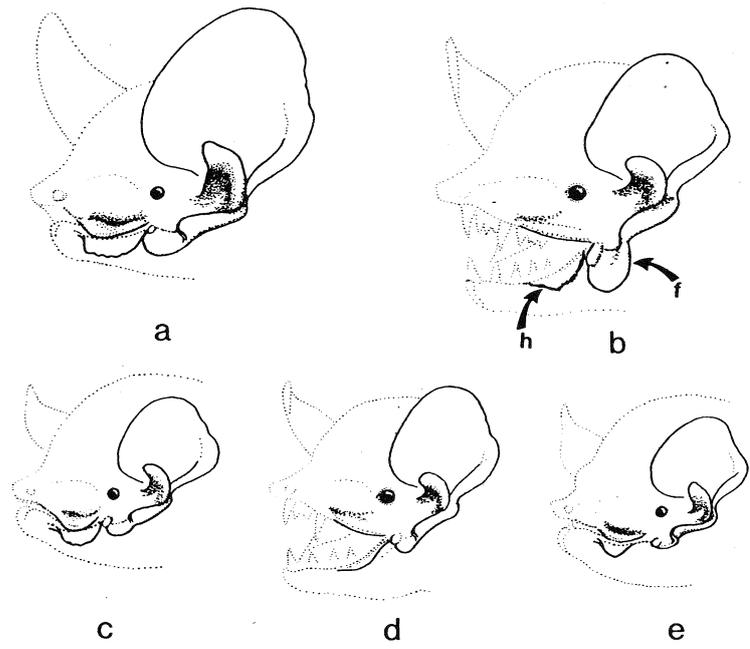


Fig.15. Details of the ear of *Chalinolobus*, showing projection of ear above the fur; development of the horizontal lobe (h) and downward projecting ear margin (f); a, *C. dwyeri*; b, *C. gouldii*; c, *C. picatus*; d, *C. nigrogriseus*; e, *C. morio*.

- 6.(5) Forearm length greater than 42 mm 15
- Forearm less than 42 mm 7
- 7.(6) Two upper incisors on each side; first incisor larger and notched, (notch might be obliterated in very worn teeth), second incisor small and abuts first (Fig.16a) genus *Eptesicus* (see notes and male species key below)
- Clearly only one upper incisor on each side, incisor not notched (Fig.16c) (genus *Scotorepens*)..... 8

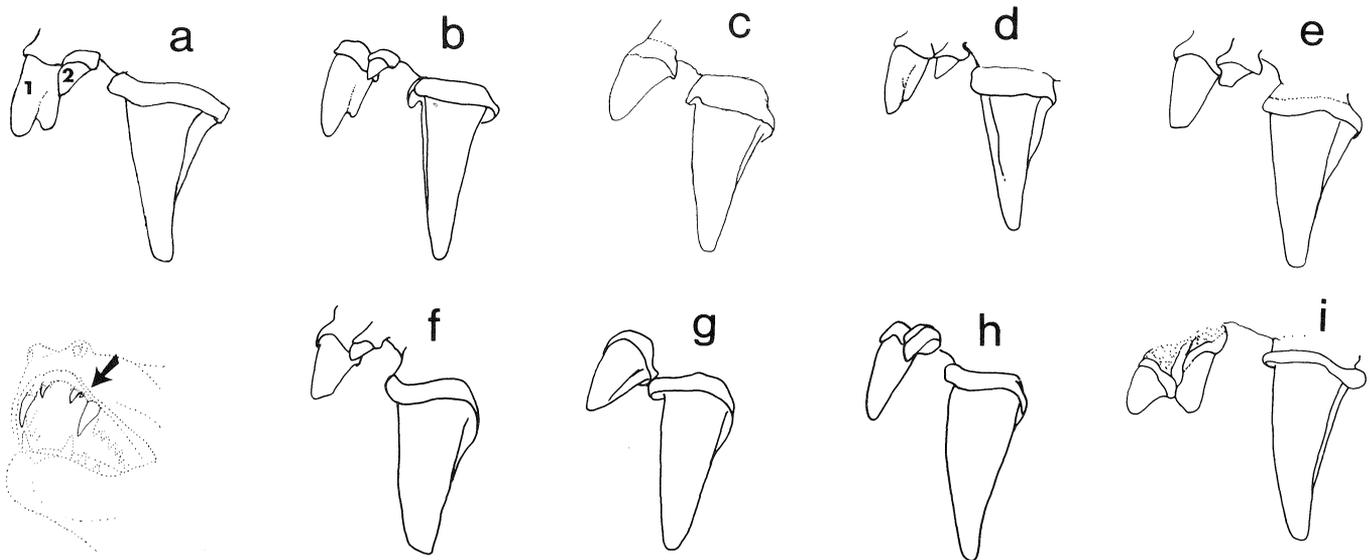


Fig.16. Upper left incisors and canine of: a, *Eptesicus darlingtoni*; b, *Chalinolobus morio*; c, *Scotorepens greyii*; d, *Chalinolobus picatus*; e, *Chalinolobus nigrogriseus*; f, *Falsistrellus tasmaniensis*; g, *Scoteanax rueppellii*; h, *Chalinolobus gouldii*; and i, *Miniopterus schreibersii*. 1, first upper incisor, and 2, second upper incisor. (not to scale)

- 8.(7) Size smaller, forearm less than about 32.5 mm, not recorded east of the Dividing Range *S. greyii*
- Larger, forearm greater than about 32.5 mm 9
- 9.(8) Forearm greater than about 34 mm, or if less than 34 mm, hindleg relatively short, less than 41% of forearm length (Fig.17)..... 10
- Forearm less than about 34 mm; tibia relatively longer, more than 41% of forearm length (Fig.17); east of Dividing Range..... *Scotorepens* sp.
- 10.(9) Hindleg relatively shorter, less than 41% of forearm length (Fig.17); glans penis with few spines surrounding tip (Fig.18a); not recorded inland of Dividing Range *S. orion*
- Hindleg relatively longer, more than 41% of forearm length (Fig.17); glans penis with numerous spines surrounding tip (Fig.18b); found inland of Dividing Range *S. balstoni*

11.(5) Ears either too short to touch when pressed together over the head, or only just touch and overlap (Fig.15b) 12

— Ears easily touch when pressed together over the head, and overlap by some 5 mm or more (Fig.15a) *Chalinolobus dwyeri*

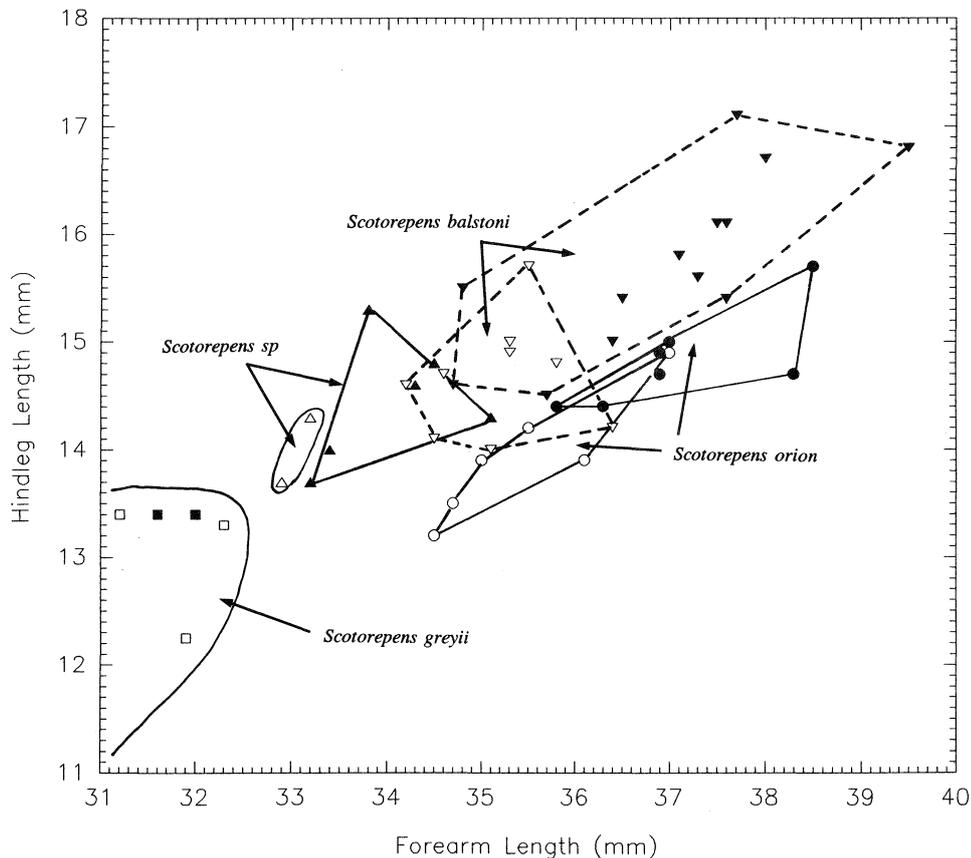


Fig.17. Plot of hindleg length against forearm length (mm) for adults of four species of *Scotorepens*. Solid symbols depict females, open symbols, males.

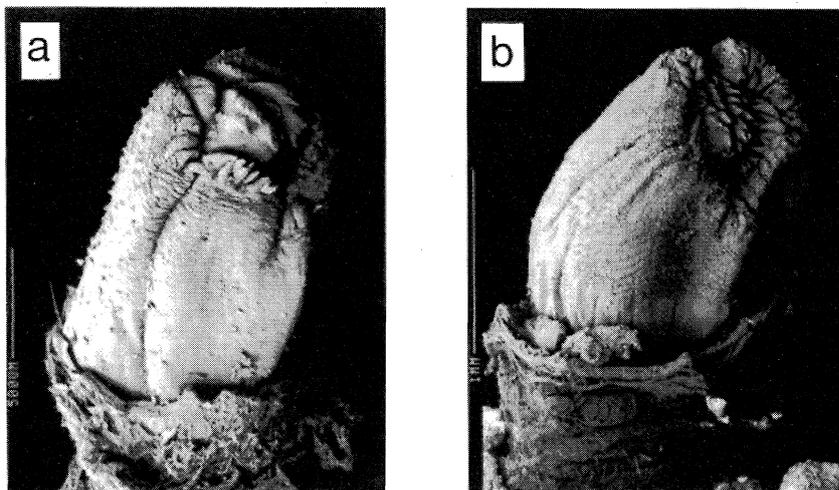
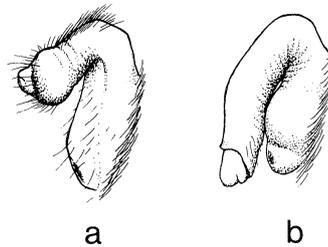


Fig.18. Scanning electron micrograph of frontolateral view of glans penis of: a, *S. orion* (AM M27452); and b, *S. balstoni* (AM M16612).

- 12.(11) Ear margin attached to side of chin ends in a conspicuous downward projecting skin flap (Fig.15b); forearm usually greater than 41 mm [40-50 mm] *Chalinolobus gouldii*
- Ear margin attachment not enlarged into a conspicuous downward projecting flap (Fig.15c-e); forearm usually less than 41 mm 13
- 13.(12) General fur colour black or grey black 14
- General fur colour variably brown, or greyish brown *Chalinolobus morio*
- 14.(13) First upper incisor notched (Fig.16d); pronounced white fringe of fur down either side of ventral side of body; horizontal skin flap on lower lip is relatively large (Fig.15c) *Chalinolobus picatus*
- First upper incisor not notched (Fig.16e); white fringe of ventral fur not always present; horizontal skin flap on lower lip is relatively small (Fig.15d) *Chalinolobus nigrogriseus*
- 15.(6) Two upper incisors on each side, the second being extremely minute and easily overlooked, usually a gap between incisors and canine (Fig.16f); ears easily meet when pressed together over the head, and overlap by some 5 mm or more; penis hairy (Fig.19a) *Falsistrellus tasmaniensis*
- One upper incisor on each side, which abuts the canine (Fig.16g); ears barely touch when pressed together above the head, or if so, only slightly overlap for a few mm; penis less hairy, tip of penis flattened and projects from foreskin (Fig.19b) *Scoteanax rueppellii*

Fig.19. Lateral view of the penis of: a, *Falsistrellus tasmaniensis*, and b, *Scoteanax rueppellii* showing the longer, more naked penis of the latter (not to scale).



- 16.(1) Bump on snout behind noseleaf high compared with height of noseleaf and composed of 2 lobes joined by a prominent elastic membrane (Fig.20a); tip of penis tapers to a distinct 'beak' (Fig.21a) *Nyctophilus geoffroyi*
- Snout bump lacks prominent median membrane, nasal bump either low and rounded or high with rudimentary median membrane (Fig.20b-c); tip of penis rounded, does not form a beak (Fig.21b-c) 17
- 17.(16) Snout bump low and rounded (Fig.20b); general colour of fur and skin pigmentation of face and wings tan or light brown; penis has rudimentary urethral lappets (Fig.21b); lower elevations of far northern NSW and south-eastern Qld *Nyctophilus bifax*
- Snout bump relatively high (Fig.20c); penis with enlarged urethral lappets (Fig.21c); general colour of fur and skin pigmentation tends to be dark grey or greyish brown 18

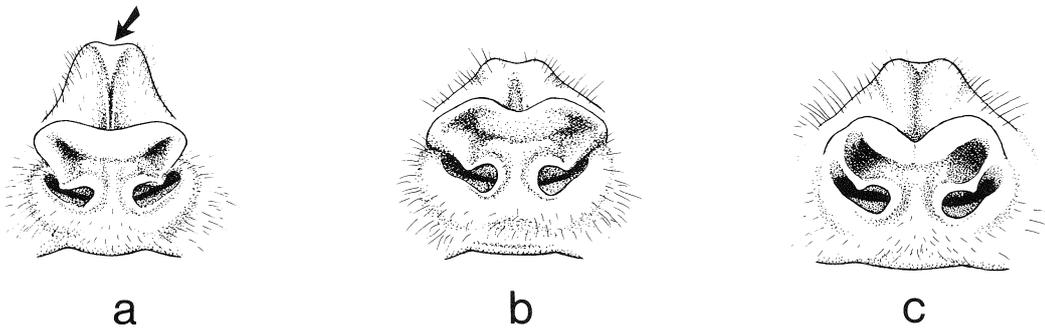


Fig.20. Development of the postnasal bump in *Nyctophilus*; a, *N. geoffroyi*; b, *N. bifax* and c, *N. gouldi*. Arrow indicates diagnostic elastic membrane.

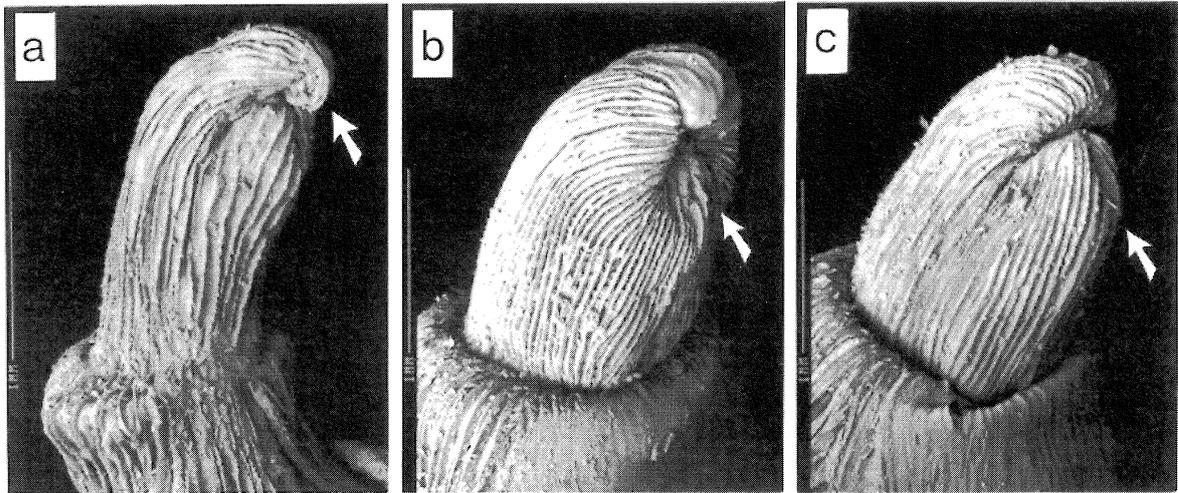


Fig.21. Scanning electron micrographs of frontolateral views of the glans penis (foreskin removed) of *Nyctophilus* spp with arrows indicating diagnostic characters: a, *N. geoffroyi* (AM M27433), showing diagnostic 'beak' formed by tip; b, *N. bifax* (AM M13249) with small urethral lappets; and c, *N. gouldi* (AM M27235) with large urethral lappets.

- 18.(17) General body size smaller, outer width of upper canines at gum line, less than 5.6 mm; widely distributed, inland and coastal areas*Nyctophilus gouldi*
- General size larger, outer width of upper canines at gum line greater than 5.6 mm; drier habitats, inland of the Dividing Range *N. timoriensis*
- 19.(2) Size larger, forearm length greater than 44 mm *M. schreibersii*
- Size smaller, forearm length less than 44 mm *M. australis*

Species Key to Male *Eptesicus* using Penile Characters

(Identification of females problematic: see species accounts)

- 1. End of penis not distinctly swollen (Fig.22a), penis very short relative to body size, with or without distinctive angularity (Fig.22) 2
- End of penis clearly swollen (Fig.22b); penis pendulous, never with distinctive angularity (Fig.22b) 4

- 2.(1) Penis with distinct angularity (Fig.22a); head of penis, with foreskin removed, dorsoventrally compressed (Fig.23a-b) 3
- Penis lacks distinct angularity; head of penis, with foreskin removed, cylindrical, not dorsoventrally compressed (Fig.23g) *E. finlaysoni* [not recorded from south-eastern Australia]

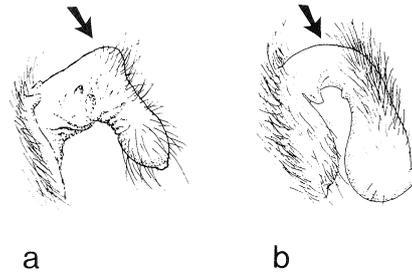


Fig.22. Lateral view of the penis of: a, *Eptesicus darlingtoni*; and b, *Eptesicus regulus*, illustrating the more angular dorsal surface and less enlarged tip of *E. darlingtoni*. (not to scale)

- 3.(2) Forearm less than 33 mm *E. pumilus*
- Forearm greater than 33 mm *E. darlingtoni*
- 4.(1) Glans penis with very strong furrow on lower surface (e.g., Fig.23c)..... 5
- Glans penis lacks strong furrow on lower surface (e.g., Fig.23e)..... 6
- 5.(4) Glans penis with distinct lateral flap (Fig.23c); head of penis relatively short and stocky *E. regulus*
- Glans penis lacks distinct lateral flap, head of penis laterally compressed and relatively elongate (Fig.23d) *E. troughtoni*
- 6.(4) Glans penis has abruptly truncated end (Fig.23e) *E. vulturinus*
- Glans penis terminates in a funnel shape (Fig.23f) *E. baverstocki*

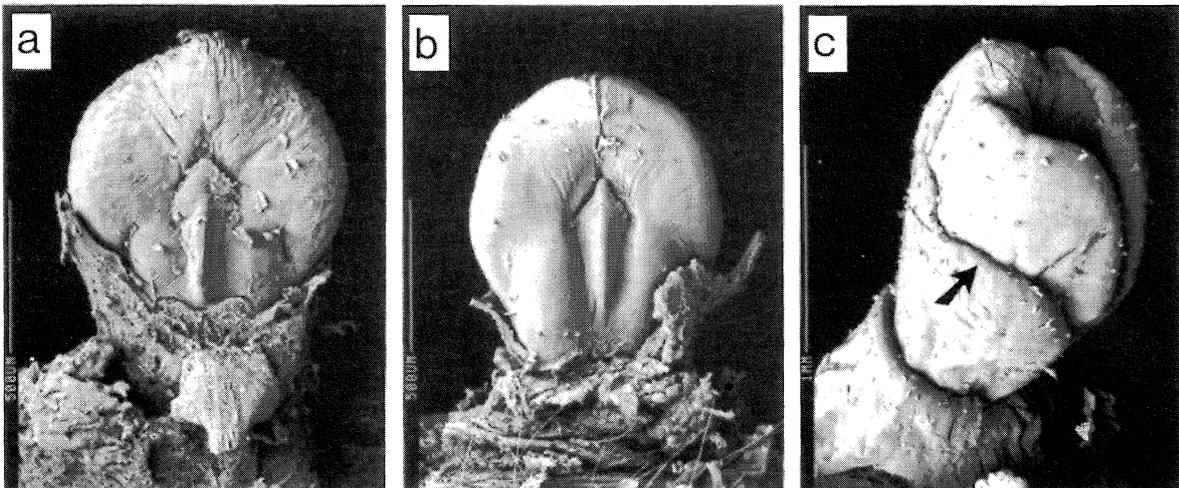


Fig.23 (part 1). Scanning electron micrographs of frontolateral views of the glans penis of *Eptesicus* spp: a, *E. pumilus* (AM M27380); b, *E. darlingtoni* (AM M27571); c, *E. regulus* (AM M27549), arrow indicates lateral fold.

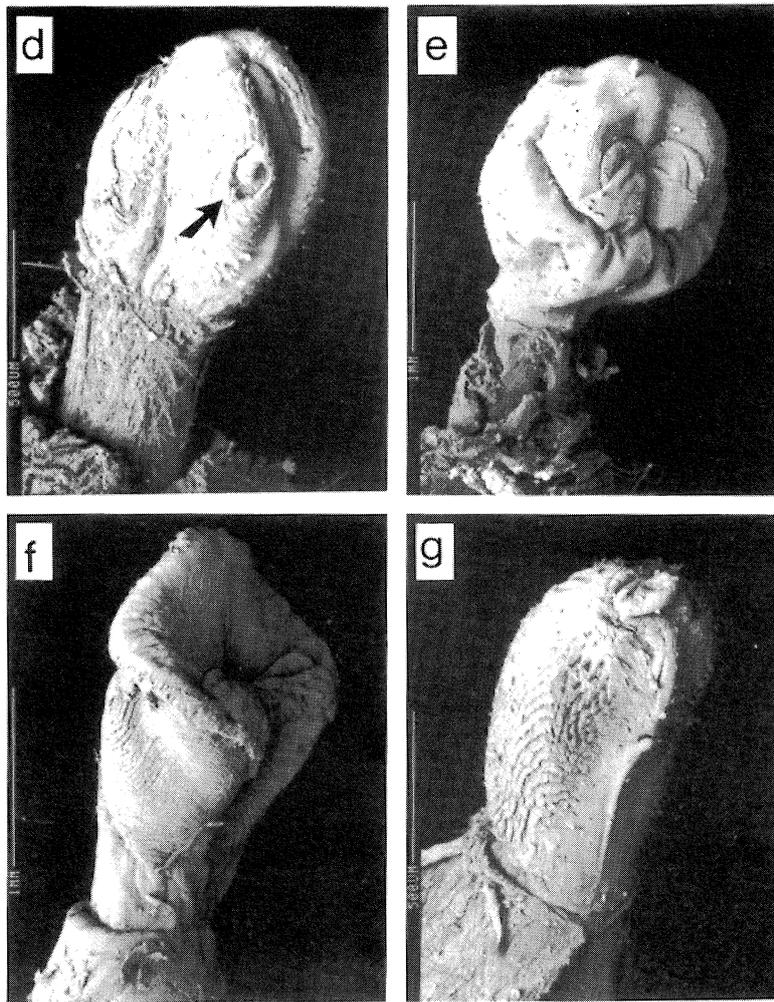


Fig.23 (part 2). Scanning electron micrographs of frontolateral views of the glans penis of *Eptesicus* spp: d, *E. trougtoni* (CSIRO CM453), arrow indicates damage during preparation; e, *E. vulturinus* (AM M27362); f, *E. baverstocki* (AM M12171); and g, *E. finlaysoni* (AM M5709).

Species Accounts

Many bat species do not have well established common names and many of the names previously proposed are now inappropriate due to taxonomic revisions. I have generally followed Strahan (1992) but for some species have coined new names, pending the adoption of suitable common names.

Each species is discussed using the following headings.

Synonyms – lists changes to scientific names since 1965 which are relevant to the south-eastern Australian populations of a species. It is not intended to provide a detailed synonymy using the conventions of scientific nomenclature.

Similar species – species with which confusion is likely are listed including characters useful for recognition.

Notes – miscellaneous notes on the general biology of the species.

References – lists references which discuss the

species taxonomy, identification or distribution. References dealing solely with the biology of the species are indicated with an asterisk. This section provides a lead into the literature and is not a comprehensive bibliography.

Finally, a distribution map is provided, showing the approximate distribution for each species. It must be emphasised that this is likely to change substantially for many species as more information becomes available.

Family Vespertilionidae – Simple-nosed Bats

Eptesicus

Little Brown Bats

Reliable field identification criteria have yet to be determined for some *Eptesicus* species in this region thus frustration is inevitable and species identification is

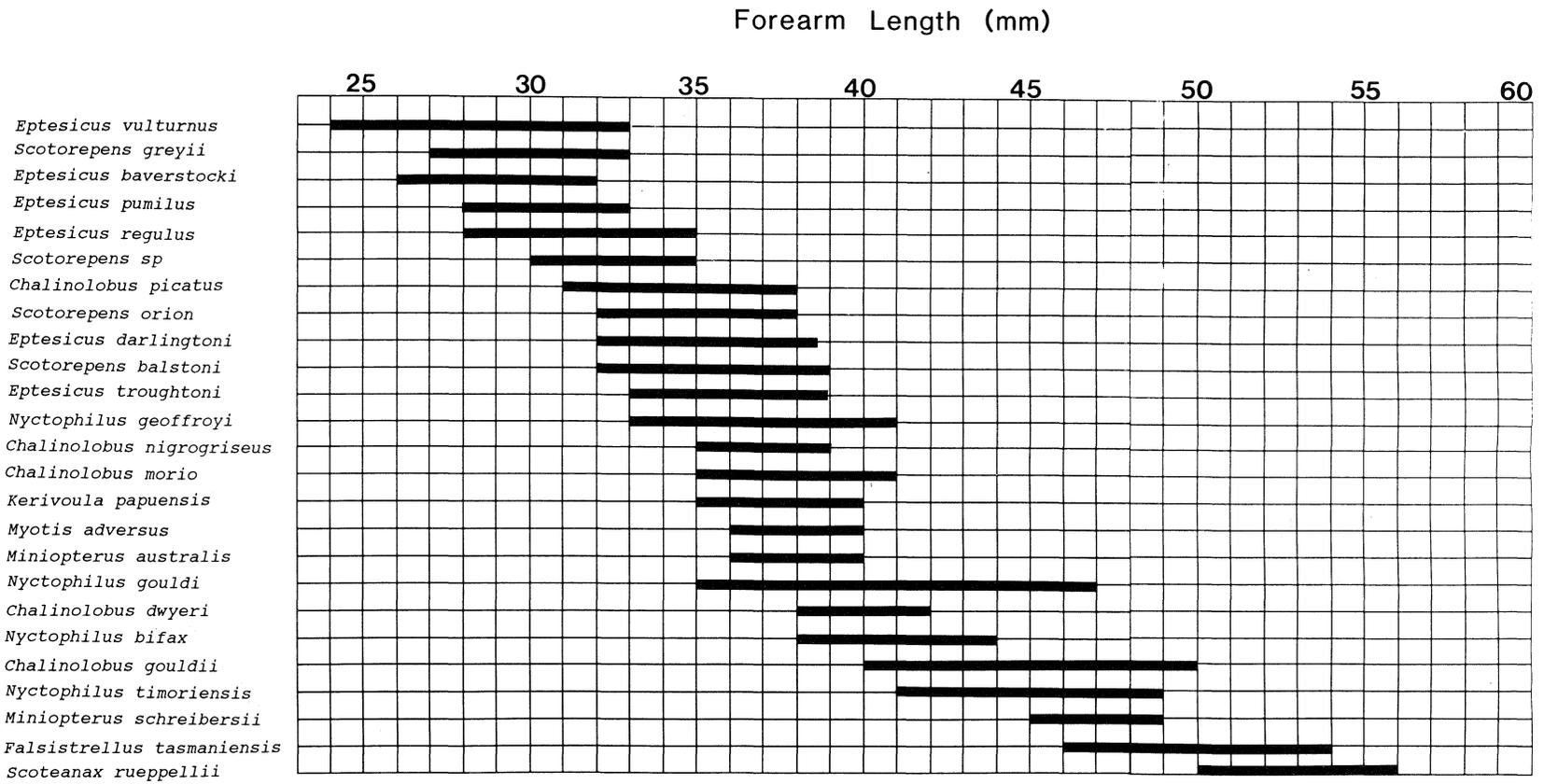


Fig. 24. Ranges of forearm length for species of the family Vespertilionidae from south-eastern Australia.

likely to be difficult. Males of most species can be recognised from the morphology of the head of the penis (with the foreskin rolled back), but females are likely to be difficult to identify. Consequently it is suggested that all species accounts be consulted.

Of the six species recorded from south-eastern Australia, the highest number of sympatric species occurs in north-eastern New South Wales, where five species are likely to be encountered.

Identification of adults is often possible using a combination of fur colour and forearm length of each sex separately as females average larger than males for all species. As both of the latter characters vary considerably in different areas, familiarity with this genus is best attempted by restricting work initially to one area to eliminate the confusion arising from geographic variation. Familiarity with differences in fur colour, relative length of the fur on the head, and overall appearance can be gained by examination of adult males using morphology of the penis from whence it will be possible with experience to recognise females. A minority of females (perhaps 5-10%) are likely to be difficult to identify with confidence from external appearance, even by experienced bat workers.

Larger species of *Eptesicus* might be confused with the smaller species of Broad-nosed Bats (*Scotorepens*) as they bear a general resemblance. In *Eptesicus* the snout is broad and bare but is much more so in *Scotorepens*. The upper incisor teeth are different, being a single un-notched tooth on each side in *Scotorepens* spp compared with two upper incisors on each side in *Eptesicus* (Fig.16). The Chocolate Wattled Bat (*Chalinolobus morio*) is often confused with larger species such as *E. darlingtoni*.

The recently named species, *E. finlaysoni*, is included in the key to male *Eptesicus*. Although it has not been reported from south-eastern Australia, its distribution could extend into southern Queensland or western New South Wales.

Although Australian species have long been regarded as belonging to the genus *Eptesicus*, it is likely that they do not belong with true *Eptesicus* (Kitchener *et al.*, 1987; Volleth & Tidemann, 1989; Hill & Harrison, 1987). Volleth & Tidemann (1991) propose that Australian species be placed in a separate genus, *Vespadelus*, and it is likely that this name will be adopted increasingly in the literature. I support the use of *Vespadelus* but have retained *Eptesicus* in this interim document solely to reduce confusion.

Eptesicus darlingtoni Allen, 1933

Large Forest Eptesicus

Synonyms. *Eptesicus sagittula* McKean, Richards & Price, 1978 (in part). *Eptesicus pumilus*, before 1978.

Similar species. *Eptesicus darlingtoni* can be confused with the following species. *Eptesicus troughtoni*

males differ by having a much larger penis and the glans penis is strikingly different (Fig.23).

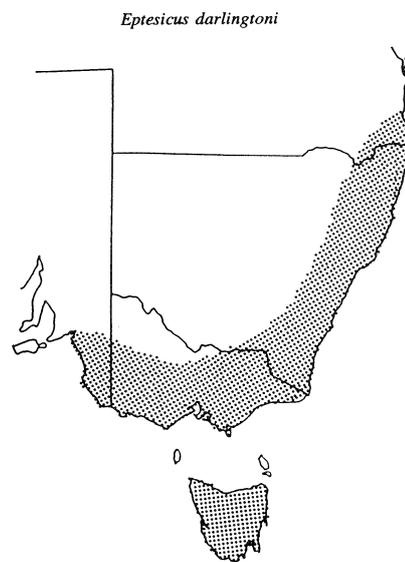
Eptesicus regulus males are easily distinguished by penis shape. The short bent penis of *E. darlingtoni* contrasts with the pendulous penis of *E. regulus* (Fig.22). Females of these two species can be very difficult to distinguish. *Eptesicus regulus* is smaller, forearm mostly less than 34 mm. Females with forearms larger than 36 mm, and males larger than 35 mm are probably not *E. regulus*. While most male *E. darlingtoni* have forearms larger than 34 mm, but occasionally are as small as 33.5 mm, most male *E. regulus* are less than about 33 mm. The head often appears flatter in *E. regulus*. Fur colour of *E. darlingtoni* is often dark grey compared to the lighter brown colour of *E. regulus*.

Eptesicus pumilus is similar to a small version of *E. darlingtoni* but can be distinguished by forearm length. If the forearm of either sex is longer than 33.5 mm then the specimens are almost certainly *E. darlingtoni*. The fur colour of *E. pumilus* is usually darker than *E. darlingtoni*.

For similarities to *Chalinolobus morio* see comments under that species.

Notes. Common throughout its range. Roosts in tree hollows.

References. Kitchener *et al.*, 1987.



Eptesicus pumilus (Gray, 1841)

The Pumilus

Synonyms. *Eptesicus sagittula*. *Eptesicus pumilus* has been confused with *E. sagittula* (= *E. darlingtoni*) since the late 1970's. Literature references to *E. pumilus* prior to the revision of Kitchener *et al.* 1987, have nothing to do with *E. pumilus* as currently defined. In eastern Australia these references refer to species now known as *E. troughtoni* and *E. finlaysoni*.

Similar species. *Eptesicus pumilus* most resembles

small individuals of *E. darlingtoni*, but is distinguished by smaller forearm length. The penis of both species is similar (Fig.23).

Eptesicus pumilus differs from *E. vulturnus* in having darker fur and more pigmented skin of face and wings and in larger average size. Male *E. pumilus* have a short, angled penis (Fig.22) rather than the relatively large penis with a markedly bulbous tip of *E. vulturnus*. There are obvious differences in the shape of the glans penis (Fig.23). *Eptesicus pumilus* differs from *E. regulus* in having darker fur and skin pigmentation, a smaller and angular penis (Fig.22), and a more rounded head. A small proportion of female *E. pumilus* can be difficult to distinguish from *E. regulus* on fur colour, head profile and forearm length.

Notes. Common. The roost preferences of this species are unknown. There appears to be no evidence that it roosts in caves. Forearm length and weights of *E. pumilus* from north-eastern New South Wales are: females, 30.1-32.7 mm (n=42); males, 29.0-31.5 mm (n=30); weight, females (excludes heavy pregnancy) 3.5-6.0 gm (n=40), males, 3.5-4.5 gm (n=25).

References. Kitchener *et al.*, 1987.

Eptesicus pumilus



Eptesicus regulus (Thomas, 1906)

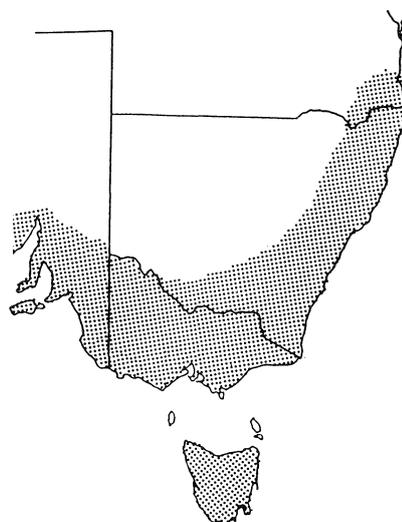
The Regal Eptesicus

Synonyms. *Eptesicus pumilus*, before 1978.

Similar species. Females can be difficult to distinguish from *E. darlingtoni* although in some areas *E. regulus* has a lighter brown fur colour.

Confusion with the little known *E. trouhntoni* is possible; the general shape of the penis is similar in both species but the glans penis of *E. regulus* is less compressed laterally and has a lateral fold (Fig.23). Confusion is also likely with *E. vulturnus* and *E. darlingtoni* (see relative species accounts). Females

Eptesicus regulus



might be difficult to distinguish from *E. pumilus*, but the latter has a more dome-shaped head and usually darker fur colour and pigmentation of skin and wings.

Notes. Common.

References. Kitchener *et al.*, 1987.

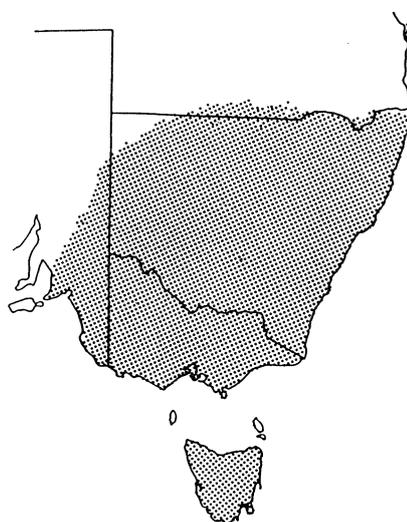
Eptesicus vulturnus Thomas, 1914

Pale Eptesicus

Synonyms. *Eptesicus pumilus*, before 1978.

Similar species. *Eptesicus vulturnus* is most likely to be confused with the following species. *Eptesicus pumilus* has much darker fur colour than *E. vulturnus*; averages larger in size; has an angled penis (Fig.22); the glans penis is very compressed dorsoventrally and does not have an enlarged tip (Fig.23).

Eptesicus vulturnus



Eptesicus regulus is of larger average size; has darker fur; the tip of the penis is less enlarged; the glans penis has an obvious ventral furrow, is not truncated and has lateral folds (Fig.23).

Eptesicus baverstocki probably has paler fur than *E. vulturnus*; the forearm length averages several millimetres greater than *E. vulturnus* from the same locality and the tip of the penis is tapered, not abruptly truncated (Fig.23).

Notes. Common. Some inland specimens referred to as *E. vulturnus* prior to Kitchener *et al.* (1987) are likely to be *E. baverstocki*. This species probably roosts in tree hollows.

References. Kitchener *et al.*, 1987; Tidemann 1982*.

Eptesicus baverstocki Kitchener, Jones & Caputi, 1987

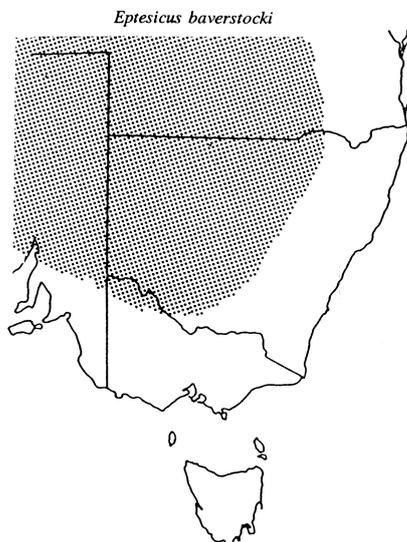
Baverstocks Bat

Synonyms. None.

Similar species. *Eptesicus baverstocki* is most likely to be confused with *E. vulturnus*, but can be readily separated by the funnel-shaped tip of the glans penis (Fig.23). *Eptesicus baverstocki* is generally larger than *E. vulturnus* from the same area and might have lighter coloured fur.

Notes. *Eptesicus baverstocki* is an inland species about which little is known.

References. Kitchener *et al.*, 1987.



Eptesicus troughtoni Kitchener, Jones & Caputi 1987

Troughtons Eptesicus

Synonyms. None. Confused with *E. pumilus pumilus*

prior to 1987.

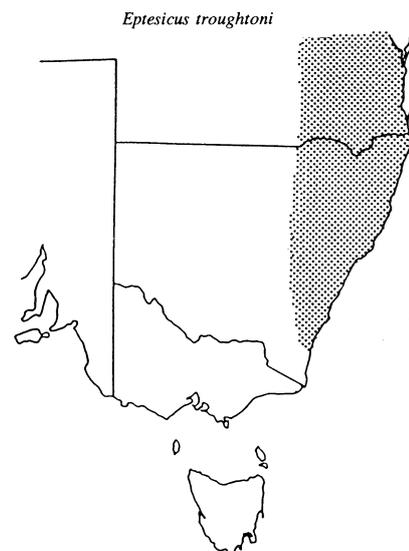
Similar species. Likely to be confused with *E. darlingtoni*, which is of similar size but has a much smaller, angled penis and the glans penis is of a radically different shape (Fig.23). Forearm length for 14 females from Bonalbo, New South Wales, 34.4-36.6 mm, one male, 34.7 mm (this extensively overlaps the forearm range of *E. darlingtoni*). *Eptesicus regulus* is generally smaller and has a similar sized penis but with laterally compressed glans penis which lacks lateral folds (Fig.23). Fur colour of *E. troughtoni* is probably much darker than *E. regulus*.

Eptesicus vulturnus is much smaller, forearm length usually less than 33 mm; probably has lighter fur colour; and the penis has a more bulbous tip on the penis (Fig.23).

Notes. *Eptesicus troughtoni* is a poorly known species which is evidently a cave dweller. This species was not captured during an extensive bat trapping program during the North East Biodiversity Study.

A specimen from Wadbilliga Swamp, south coastal New South Wales (Australian National Wildlife Collection number CM6568) considerably extends the known distribution of this species to south-eastern New South Wales.

References. Kitchener *et al.*, 1987.



Chalinolobus

Wattled Bats

Chalinolobus morio (Gray, 1841)

Chocolate Wattled Bat

Synonyms. None.

Similar species. *Eptesicus darlingtoni* has more rounded ears which protrude further from the fur than those of *C. morio*; the general fur colour is a paler

brown; the penis is much shorter than in *C. morio*; the notch in the first upper incisor is much more pronounced, and skin lobes on the lower lip are absent in *E. darlingtoni*.

Miniopterus australis has a proportionately longer terminal joint of the third wing digit than *C. morio*, and lacks skin lobes on the lower lip.

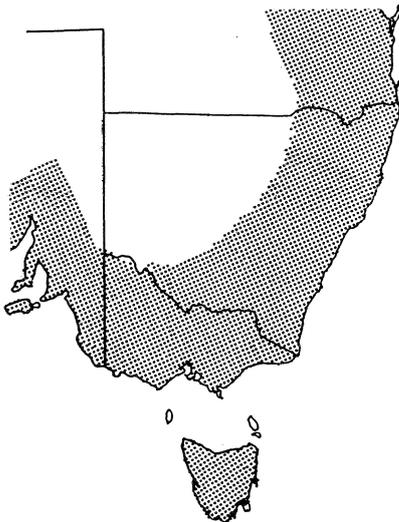
Chalinolobus gouldii is larger than *C. morio*, the forearm is usually greater than 41 mm; the dorsal fur colour is usually not uniform with black shoulders contrasting with lighter, brown rump; base of ear margin near chin ending in a very conspicuous downward skin flap, and no notch on first upper incisor of *C. gouldii* (Fig.16).

Chalinolobus morio is readily distinguished from *C. picatus* and *C. nigrogriseus* (see respective species accounts).

Notes. Common, but few records from inland localities.

References. Young, 1979*; Hall & Richards, 1979; Lunney *et al.*, 1985*.

Chalinolobus morio



***Chalinolobus gouldii* (Gray, 1841)**

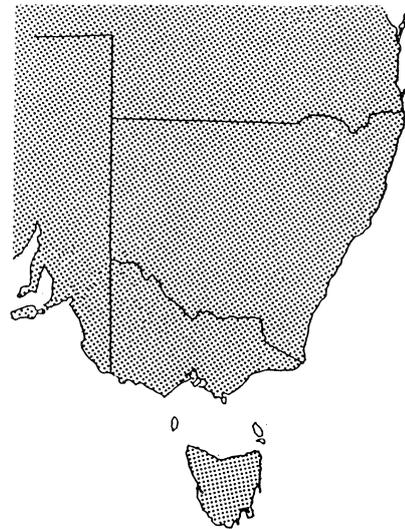
Goulds Wattled Bat

Synonyms. None.

Similar species. In *Miniopterus schreibersii* the terminal joint of the third wing digit is much longer than in *C. gouldii* (Fig.10); the pes is more conspicuous than *C. gouldii* because the wing membrane attaches to the ankle rather than the base of the toe; and the second upper incisors are relatively larger in *M. schreibersii* (Fig.16). *Chalinolobus gouldii* often has a contrast in the dorsal fur colour between the dark shoulders and the paler rump, but some individuals are uniformly dark.

Chalinolobus gouldii is easily distinguished from *C. dwyeri* and *C. nigrogriseus* (see respective species accounts). *Chalinolobus gouldii* is unlikely to be confused

Chalinolobus gouldii



with *C. picatus* which is much smaller.

Notes. Common.

References. Hall & Richards, 1979; Tidemann, 1984; Dixon & Huxley, 1989*.

***Chalinolobus dwyeri* Ryan, 1966**

Large Pied Bat

Synonyms. None.

Similar species. *Chalinolobus dwyeri* is most similar to *C. gouldii* (Goulds Wattled Bat), but is easily distinguished because: *C. dwyeri* has much larger ears with more pointed tragus; bands of white fur down either side of underbody; dorsal fur which is uniform black; notched first upper incisor; and attachment of ear margin on chin not enlarged into such a conspicuous flap as in *C. gouldii* (Fig.15). The ears, relative to body

Chalinolobus dwyeri



size, are dramatically larger than those of *C. gouldii*, project well above the fur, and easily overlap when pressed together over the head. In *C. gouldii* they only just reach or overlap.

Chalinolobus dwyeri has dramatically larger ears and a distinctly more elongate tragus than *C. nigrogriseus*; the horizontal skin flap on each side of the lower lip and the downward termination of the ear margin at jaw, are both more enlarged; and the first upper incisor is notched in *C. dwyeri*.

Chalinolobus picatus is readily distinguished from *C. dwyeri* by its smaller size, relatively shorter, smaller ears, and a less developed downward flap at the termination of the ear margin where it attaches to the chin (Fig.15).

Notes. Uncommon. It is a little known species which generally occurs in drier habitats and roosts in caves.

References. Ryan, 1966a; Dwyer, 1966*; Hall & Richards, 1979.

Chalinolobus nigrogriseus (Gould, 1856)

Hoary Bat

Synonyms. None.

Similar species. *Chalinolobus nigrogriseus* is most likely to be confused with *C. picatus* (see respective species account). It is easily distinguished from *C. gouldii*, which is much larger; has a forearm of more than 40 mm compared to about 34-38 mm for *C. nigrogriseus*; generally has dark or black fur colour, sometimes with indistinct frosting, not just black on shoulders as in most *C. gouldii*; and the ear attachment near chin is not enlarged into a prominent flap as in *C. gouldii* (Fig.15).

Chalinolobus nigrogriseus could be confused with *C. dwyeri* which also has very dark fur, but has much larger ears which easily met when pressed together

above the head; the tragus is more elongate (Fig.15); usually has obvious pure white flank stripes; and has a notched first upper incisor.

Chalinolobus nigrogriseus is clearly distinguishable from *C. morio*, which has a uniform rich brown or grey, rather than blackish fur colour; has a notched first upper incisor, and has a more pronounced horizontal skin flap on the lower lip than *C. nigrogriseus* (Fig.15).

Notes. *Chalinolobus nigrogriseus* was confused with *C. picatus* prior to 1966. It is widespread in south-eastern Queensland, but known from only two localities in New South Wales. The presence of a white fringe of fur on either side of the flank of *C. picatus* is often used to distinguish that species from *C. nigrogriseus*. However, some specimens of *C. nigrogriseus* from New South Wales also have a white fringe on each flank although perhaps not as pronounced as in *C. picatus*.

References. Ryan, 1966a; Van Deusen & Koopman, 1971; Hall & Richards, 1979; Milledge *et al.*, in press.

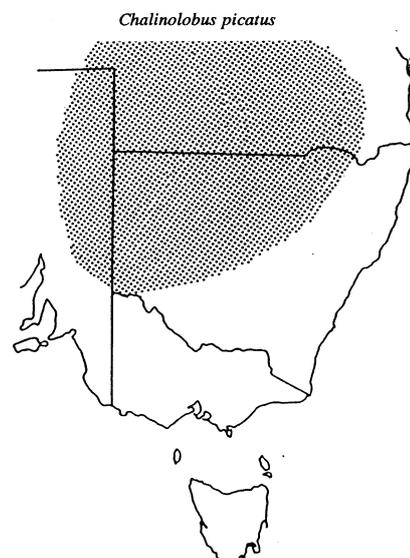
Chalinolobus picatus (Gould, 1852)

Little Pied Bat

Synonyms. None.

Similar species. This species is most likely to be confused with *C. nigrogriseus* but differs by having a notched first upper incisor (Fig.16); the white fringe of fur down each flank is always present; is generally smaller; and the horizontal skin flap on each lower lip is more pronounced (Fig.15).

This species is easily distinguished from *C. morio*, which has a uniform ventral fur colour and never has a fringe of distinct white fur down each flank on the ventral surface, has brown or grey brown rather than



black fur, and is larger.

Chalinolobus dwyeri (see respective species account).

Notes. *Chalinolobus picatus* was confused with *C. nigrogriseus* prior to 1966. It is widely distributed throughout inland New South Wales and Queensland. This species has been reported roosting in caves, but in some areas it primarily roosts in tree hollows (C.R. Tidemann, personal communication).

References. Ryan, 1966a; Van Deusen & Koopman, 1971; Hall & Richards, 1979; Tidemann, 1988.

Nyctophilus

Long-eared Bats

Nyctophilus geoffroyi Leach, 1821

Lesser Long-eared Bat

Synonyms. None.

Similar species. *Nyctophilus geoffroyi* is most easily confused with *N. gouldi*, but from the same area it is usually smaller. The two lobes which form the bump behind the nose leaf are connected by a more extensive elastic membrane which gives the impression of a more pronounced "Y" shape (Fig.20). The ventral fur is often a uniform off-white colour rather than the slightly darker and more mottled fur of *N. gouldi*, but the ventral fur colour alone is often not a reliable way of distinguishing these species. The tip of the penis in *N. geoffroyi* is more pointed than in *N. gouldi*, forming a more distinct 'beak' (Fig.21).

Notes. Common.

References. Hall & Richards, 1979; Ellis *et al.*, 1991*; Grant, 1991*.

Nyctophilus geoffroyi



Nyctophilus gouldi Tomes, 1858

Gould's Long-eared Bat

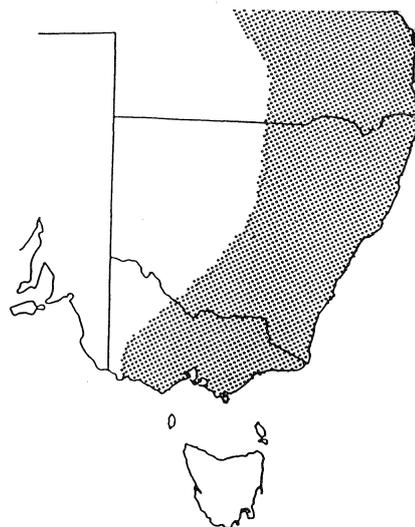
Synonyms. *Nyctophilus timoriensis gouldi*, prior to 1979.

Similar species. Smaller individuals of *Nyctophilus gouldi* might be confused with *N. geoffroyi*. The Y-shaped groove, diagnostic of *N. geoffroyi*, might cause confusion because in some instances a distinct but weaker groove is also present in *N. gouldi*. In *N. geoffroyi* the elastic membrane joining each lateral lobe of the bump is more extensive (Fig.20) than in *N. gouldi*. *Nyctophilus bifax* could be confused with *N. gouldi* (see species account).

Notes. Common. Individuals from the inland, where the species is sympatric with *N. timoriensis*, are much smaller and have paler fur colour than those from the Dividing Range and coastal areas.

References. Parnaby, 1987; Ellis *et al.*, 1989; Phillips & Inwards, 1985a*; Lunney *et al.*, 1988*; Grant, 1991*.

Nyctophilus gouldi



Nyctophilus bifax Thomas, 1915

Northern Long-eared Bat

Synonyms. Temporarily confused as *Nyctophilus gouldi bifax* in Koopman (1984) and Mahoney & Walton (1988).

Similar species. *Nyctophilus bifax* is most likely to be confused with *N. gouldi* but *N. bifax* has light tan or brown rather than grey or grey-brown fur colour. The ears often appear to be relatively shorter in *N. bifax*, but ear length alone overlaps between these two species, as does forearm length. The bump behind the noseleaf is lower than in *N. gouldi* (Fig.20) and distinct differences in the shape of the tip of the glans penis is visible with the eye (Fig.21).

Nyctophilus bifax

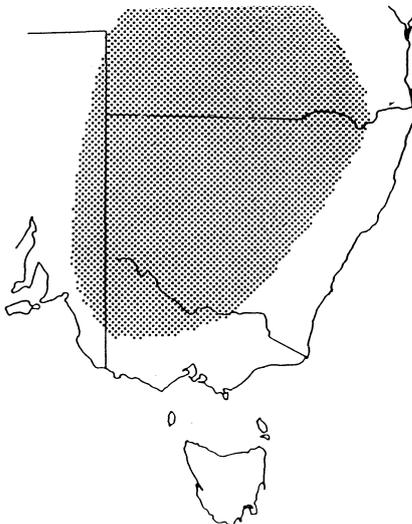
Notes. Common, but localised.
References. Parnaby, 1987.

Nyctophilus timoriensis (Geoffroy, 1806)

Greater Long-eared Bat

Synonyms. *Nyctophilus major* Gray, 1844.

Similar species. *Nyctophilus timoriensis* is most similar to *N. gouldi* from montane areas. Despite extensive overlap in the range of forearm lengths *N. timoriensis* has a larger, more thick set body than *N. gouldi*, with a broader snout. Where the two species occur in the same area *N. timoriensis* is easily distinguished from *N. gouldi* by its much larger size (e.g., forearm greater than 41 mm). Montane populations of *N. gouldi* are similar in forearm length to *N. timoriensis* (which does not occur in montane areas), but

Nyctophilus timoriensis

N. timoriensis can be distinguished by the greater outer breadth across upper canines.

Notes. Uncommon and poorly known.

References. Hall & Richards, 1979.

Scotorepens

Broad-nosed Bats

Although this genus was recently revised, it is evident that further taxonomic clarification of species is needed in south-eastern Australia. One problem is the very small number of specimens available for some species, which limits the following comments on species discrimination and variation.

In their taxonomic revision of *Scotorepens*, Kitchener & Caputi (1985) stated that *S. orion* and *S. balstoni* could be distinguished by the ratio hindleg/forearm length, *S. orion* being less than 41%. This does not always hold, as is apparent from the overlap of measurements between species in Figure 17, but it still provides a useful guide in many cases.

Due to the above difficulties, the species key and identification criteria given for this genus are unsatisfactory, but with the possible exception of south-eastern Queensland, usually only two species are sympatric in any area.

Scotorepens orion (Troughton, 1937)

Eastern Broad-nosed Bat

Synonyms. *Nycticeius orion*.

Similar species. *Scotorepens orion* is clearly a larger bat than *Scotorepens* sp. with a forearm greater than about 34 mm and a heavier weight of more than about

Scotorepens orion

8 gm. It differs from *S. balstoni* in the relatively shorter hindleg; in the overall fur colour which is probably much darker (needs confirmation) and has a more pug appearance; and the tip of penis which has relatively few spines compared with *S. balstoni* (Fig.18).

Notes. Common, but not known to overlap in distribution with *S. balstoni*

References. Kitchener & Caputi, 1985.

Scotorepens sp.

Broad-nosed Bat

Synonyms. None.

Similar species. *Scotorepens* sp. is smaller than *S. orion*; weight about 6-8 gm compared to about 8-12 gm in *S. orion*; forearm less than about 34 mm; ratio hindleg/forearm is above 41% compared to below 41% in *S. orion* (see Fig.17). Fur colour is paler than *S. orion*, and the muzzle is less pug-like. Although ranges of measurements and weights are likely to overlap between *Scotorepens* sp. and *S. orion*, live animals from the same area are recognisably distinct.

Notes. The taxonomic status of this species is unclear. It is possibly part of the *S. greyii*/*S. sanborni* species complex, but does not fit readily with either species. All records are east of the Great Divide. There are few records from New South Wales, but it is possibly common in south-eastern Queensland.

References. None.

Scotorepens sp



Scotorepens greyii (Gray, 1843)

Little Broad-nosed Bat

Synonyms. *Nyctieius greyii*, *Scoteinus greyii*.

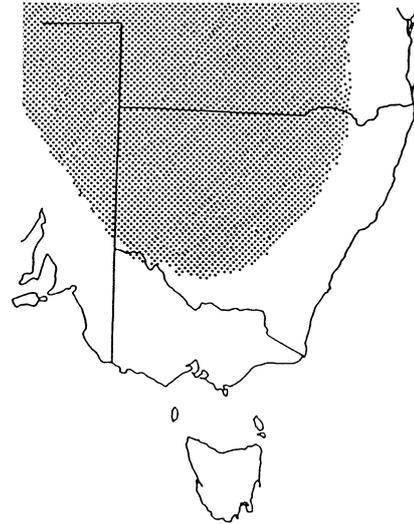
Similar species. *Scotorepens greyii* is the smallest species of Broad-nosed Bat; forearm length is less than

about 33 mm and the weight is less than about 7 gm. It is most likely to be confused with *S. balstoni* but is distinctly smaller than that species from the same locality.

Notes. Common, roosts in tree hollows.

References. Kitchener & Caputi, 1985.

Scotorepens greyii



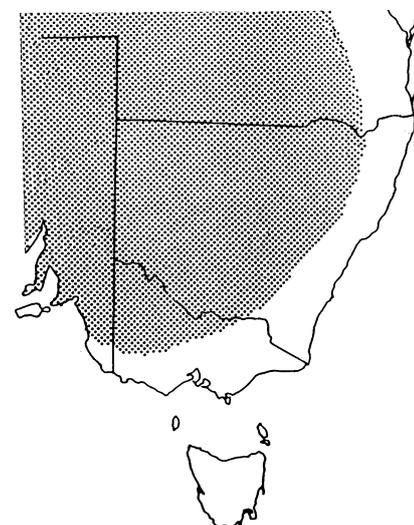
Scotorepens balstoni (Thomas, 1906)

Western Broad-nosed Bat

Synonyms. *Nyctieius balstoni*, *Scoteinus balstoni*. The large *Nyctieius influatus* Thomas, 1924 has been synonymised by Kitchener & Caputi (1985).

Similar species. *Scotorepens balstoni* can be difficult to distinguish from *S. orion* which has a richer brown and more bicoloured fur; and has a more thick set appearance. *Scotorepens orion* has fewer barbs

Scotorepens balstoni



surrounding the tip of the glans penis (Fig.18). *Scotorepens balstoni* is larger in size than *S. greyii*, e.g. forearm length larger than about 32 mm.

Notes. Often captured in lower numbers than *S. greyii*, with which it is sympatric over much of its range.

References. Kitchener & Caputi, 1985; Ryan, 1966b*.

Scoteanax rueppellii (Peters, 1866)

Greater Broad-nosed Bat

Synonyms. *Nycticeius rueppellii*, prior to 1985.

Similar species. *Scoteanax rueppellii* is easily confused with *F. tasmaniensis*, but *S. rueppellii* lacks a minute second upper incisor; its fur tends to be less dense; the colour of the base of the fur is lighter resulting in less contrast with the terminal fur colour than in *F. tasmaniensis*; and the ear tips just touch or overlap by only a few millimetres compared to substantial overlap in *F. tasmaniensis*.

Notes. Sparse.

References. Hall & Richards, 1979; Kitchener & Caputi, 1985; Woodside & Long, 1984*.

Scoteanax rueppellii



Falsistrellus tasmaniensis (Gould, 1858)

Great Pipistrelle

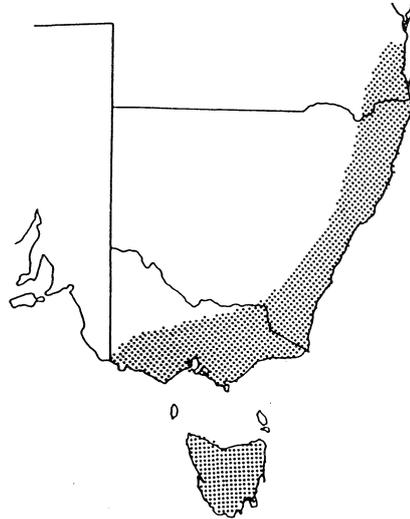
Synonyms. *Pipistrellus tasmaniensis*, prior to 1986.

Similar species. *Pipistrellus tasmaniensis* is easily confused with *S. rueppellii*, but can be separated using the same characters discussed above. Great care is required to locate the minute second upper incisor, which appears as a small splint scarcely protruding from the gum.

Notes. Uncommon, localised.

References. Hall & Richards, 1979; Kitchener *et al.*, 1986; Phillips *et al.*, 1985b*.

Falsistrellus tasmaniensis



Myotis adversus (Horsfield, 1824)

Large-footed Myotis

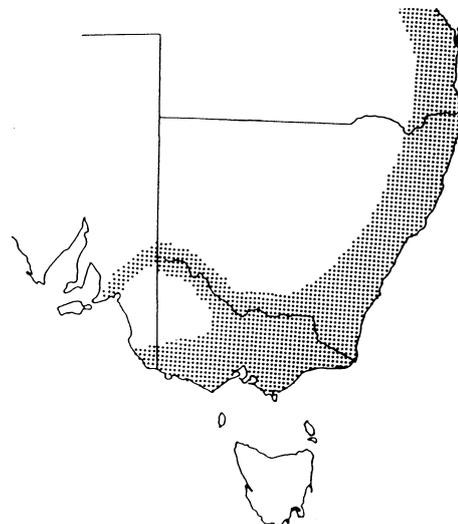
Synonyms. None.

Similar species. This distinctive species is sometimes confused with *Miniopterus schreibersii*, but is readily distinguished by more elongate ear and tragus; much shorter terminal joint in third wing digit; and relatively larger pes. This species has relatively large feet compared to any other species of the family in south-eastern Australia.

Notes. Captured near bodies of water, including brackish water. Diet includes small fish.

References. Dwyer, 1970*; Robson, 1984*.

Myotis adversus



Kerivoula papuensis Dobson, 1878

Golden-tipped Bat

Synonyms. *Phoniscus papuensis*.

Similar species. *Kerivoula papuensis* is easily recognised in life from all other species by the obvious golden tips on an otherwise dark fur and by the golden hairs of the forearm and dorsal surface of hindleg. The ear margin forms a characteristic funnel shape and the tragus is extremely slender.

Notes. Uncommon, localised. Captured in rainforest and adjoining sclerophyll forest.

References. Lunney & Barker, 1986.

*Miniopterus*

Bent-wing Bats

Both species which occur in this area are similar but separable by size. *Miniopterus schreibersii* has a forearm length greater than about 44 mm. Species in *Miniopterus* are easily recognised from all other genera by the very long last bone in the third wing digit. Winged bat fly parasites are often conspicuous. The hind foot protrudes from the tail membrane in a prominent way due to the attachment of the tail membrane to the ankle rather than the toe as in other genera, and by the calcar which is held up against the hindleg resulting in the wing membrane being drawn against the leg.

Miniopterus schreibersii (Kuhl, 1817)

Large Bent-wing Bat

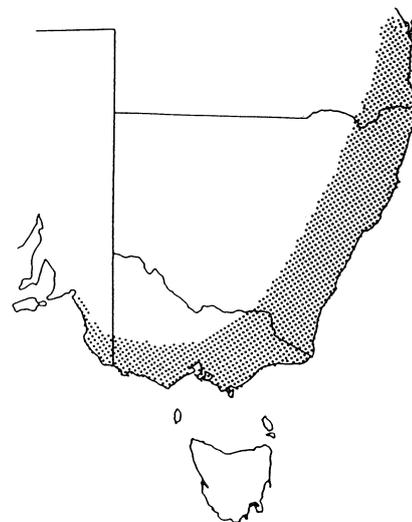
Synonyms. *Miniopterus oceanensis* Maeda, 1982.

Similar species. *Miniopterus schreibersii* is often

confused with *Chalinolobus gouldii*, but differs as described under that species account. It closely resembles *M. australis* but is consistently larger.

Notes. A common cave dwelling species which has been extensively studied during the 1960's. The species taxonomy of this genus is very complex and it is unlikely that Australian populations are the same species as *M. schreibersii*, which extends from the Australasian region to Europe (P. Wilson, personal communication).

References. Dwyer 1963, 1969; Hall & Richards, 1979; Wilson, 1985.

Miniopterus schreibersii*Miniopterus australis* (Tomes, 1858)

Little Bent-wing Bat

Synonyms. None.

Miniopterus australis

Similar species. *Miniopterus australis* is often confused with *Chalinobus morio* or *Eptesicus darlingtoni* (see respective species accounts) but is easily recognised by the very long terminal joint in the third wing digit. This species resembles a small version of *M. schreibersii*.

Notes. Localised and common, a cave dweller.

References. Dwyer 1968; Hall & Richards, 1979.

Family Rhinolophidae – Horseshoe Bats

Rhinolophus megaphyllus Gray, 1834

Eastern Horseshoe Bat

Synonyms. None.

Similar species. *Rhinolophus megaphyllus* cannot be confused with any other species in south-eastern Australia due to its highly distinctive, complex noseleaf (Fig.8).

Notes. Common, roosts in caves.

References. Young, 1975*; Kirle, 1979; Hall & Richards, 1979.

Rhinolophus megaphyllus



Family Molossidae – Mastiff-bats (no key provided)

Species definitions of eastern Australian forms other than *Tadarida australis* are so muddled that an informative species key is not possible.

Tadarida australis (Gray, 1838)

White-striped Mastiff-bat

Synonyms. *Nyctinomus australis*. Although Mahoney

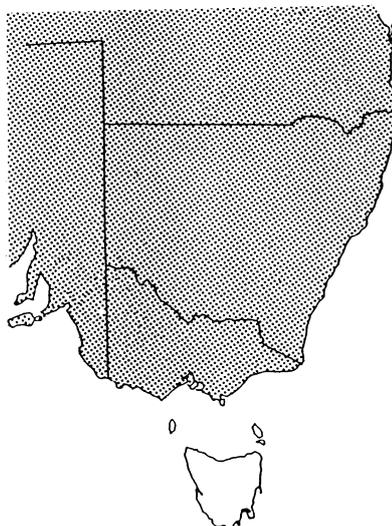
& Walton (1988b) use *Nyctinomus*, it should evidently be replaced with *Tadarida* (F.R. Allison, personal communication).

Similar species. *Tadarida australis* is easily distinguished from all other molossids in south-eastern Australia by its large size, (forearm length greater than about 56 mm) and white stripes of fur down each side of the underbody.

Notes. Sparse but conspicuous. *Tadarida australis* is an above canopy forager which is unlikely to be captured in harp traps, but might be mist netted over water holes. This species and the Yellow-bellied Sheathtail-bat are among the few which emit audible echolocation calls, which are quite loud.

References. Hall & Richards, 1979; Kitchener & Hudson, 1982*.

Tadarida australis



Mormopterus

Little Mastiff-bats

The taxonomy of this genus has remained chaotic and field criteria have yet to be established for many of the species in south-eastern Australia. Consequently, the following notes provide no more than a guide to the number of species likely to occur in any area. Further work is required to find useful field identification criteria.

The following account is based largely on the unpublished taxonomic research of Norm McKenzie (personal communication), who recognises five species in this region. According to McKenzie: a) it is not possible to identify these species from the literature due to the extent of previous confusion about species diagnoses; b) while some species are likely to be distinguished in the field by forearm length and penile morphology, field criteria have yet to be determined for a number of species, which are currently recognised with certainty from discriminant function scores based on a combination of external, cranial and

dental dimensions; c) appropriate species nomenclature (including common names) remains unresolved due to difficulties in obtaining type specimens, most of which are held in European museums.

Mormopterus planiceps (Peters, 1866)
species complex

Little Mastiff-bat – large penis species

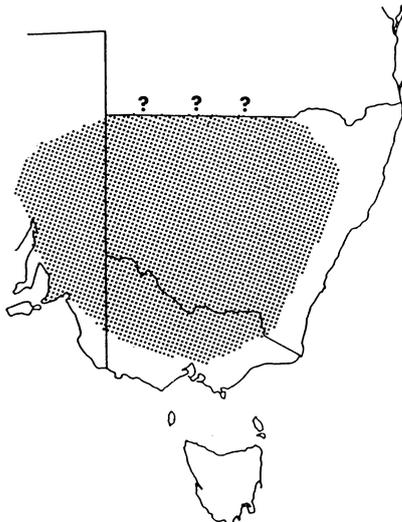
Synonyms. *Tadarida planiceps*.

Similar species. In the large penis species of *Mormopterus planiceps* the length of the penis is greater than about 8 mm, compared to less than about 5 mm for the small penis species of *Mormopterus planiceps* complex. It is unclear whether females can be distinguished using external criteria.

Notes. Common.

References. Adams *et al.*, 1988; Krutzsch & Crichton, 1987*; Crichton & Krutzsch, 1987*.

Mormopterus planiceps complex [large penis species]



Mormopterus planiceps (Peters, 1866)
species complex

Little Mastiff-bat – small penis species

Synonyms. *Tadarida planiceps*.

Similar species. This species resembles the large penis species of *Mormopterus planiceps* (see above) but males can easily be distinguished by the size of the penis.

Notes. Common.

References. Reardon & Flavel, 1987.

Mormopterus norfolkensis (Gray, 1839)

Eastern Little Mastiff-bat

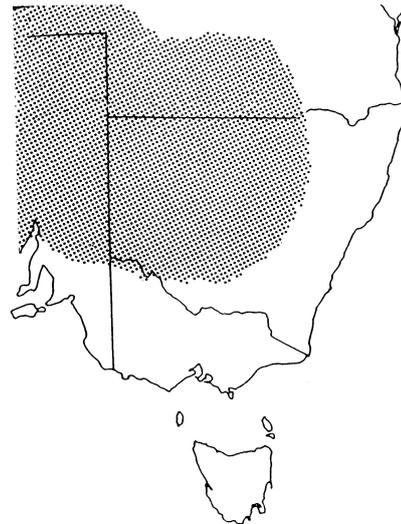
Synonyms. *Tadarida norfolkensis*.

Similar species. Distinctly different from *Mormopterus* sp. 1 and both species of the *M. planiceps* complex in: more upright ears, more slender forearm relative to body size, and generally less robust head and body.

Notes. Little is known about this species which is known from very few localities. Reliable records exist from the Brisbane area and around Sydney.

References. Allison, 1989.

Mormopterus planiceps complex [small penis species]



Mormopterus norfolkensis



Mormopterus beccarii Peters, 1881

Beccaris Mastiff-bat

Synonyms. *Tadarida beccarii*.

Similar species. *Mormopterus beccarii* is similar to *M. planiceps*, but larger forearm length greater than 35

mm and weight greater than 14 gms.

Notes. This species occurs across southern Queensland, but the only New South Wales record, from a house in Alstonville near Lismore, requires confirmation.

References. Allison, 1989.

Mormopterus beccarii



Mormopterus sp. 1

Mastiff-bat [no common name]

Synonyms. Unclarified.

Similar species. The species differs from *M. norfolkensis* by having less erect ears and a less slender forearm. It possibly differs from species of the *M. planiceps* complex by its richer brown fur colour.

Notes. Widely distributed.

References. None.

Mormopterus sp. 1.



Family Emballonuridae – Sheath-tail-bats

Saccolaimus flaviventris (Peters, 1867)

Yellow-bellied Sheath-tail-bat

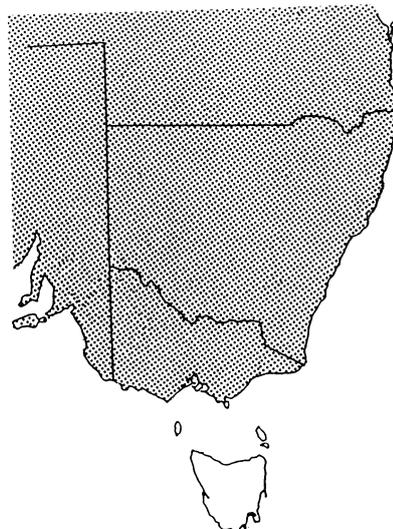
Synonyms. *Taphozous flaviventris*.

Similar species. *Saccolaimus flaviventris* is a large and highly distinctive species. It is the only species of this family in south-eastern Australia and cannot be confused with any other by its characteristic tail, which protrudes from the dorsal surface of the tail membrane.

Notes. Few records. This species is probably an above canopy or woodland forager and is very rarely captured in bat traps or mist nets in forest areas. Nearly all records from New South Wales, Victoria and South Australia are from January to May, giving rise to speculation that this species is migratory, although an investigation of seasonal fat deposition (Chimimba & Kitchener, 1987) found no evidence consistent with migration.

References. Hall & Richards, 1979; Chimimba & Kitchener, 1987*, 1991.

Saccolaimus flaviventris



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APPENDIX

The 38 bat species recorded from south-eastern Australia

VESPERTILIONIDAE

Simple-nosed Bats

<i>Eptesicus darlingtoni</i>	Large Forest Eptesicus
<i>Eptesicus pumilus</i>	The Pumilus
<i>Eptesicus regulus</i>	The Regal Eptesicus
<i>Eptesicus vulturinus</i>	Pale Eptesicus
<i>Eptesicus baverstocki</i>	Baverstocks Bat
<i>Eptesicus troughtoni</i>	Troughtons Eptesicus
<i>Chalinolobus morio</i>	Chocolate Wattled Bat
<i>Chalinolobus gouldii</i>	Goulds Wattled Bat
<i>Chalinolobus dwyeri</i>	Large Pied Bat
<i>Chalinolobus nigrogriseus</i>	Hoary Bat
<i>Chalinolobus picatus</i>	Little Pied Bat
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat
<i>Nyctophilus gouldi</i>	Goulds Long-eared Bat
<i>Nyctophilus bifax</i>	Northern Long-eared Bat
<i>Nyctophilus timoriensis</i>	Greater Long-eared Bat
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat
<i>Scotorepens</i> sp.	Broad-nosed Bat
<i>Scotorepens greyii</i>	Little Broad-nosed Bat
<i>Scotorepens balstoni</i>	Western Broad-nosed Bat
<i>Scoteanax rueppellii</i>	Greater Broad-nosed bat
<i>Falsistrellus tasmaniensis</i>	Great Pipistrelle
<i>Myotis adversus</i>	Large-footed Myotis
<i>Kerivoula papuensis</i>	Golden-tipped bat
<i>Miniopterus schreibersii</i>	Large Bent-wing bat
<i>Miniopterus australis</i>	Little Bent-wing bat

RHINOLOPHIDAE

Horseshoe Bats

<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe bat
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MOLOSSIDAE

Mastiff-bats

<i>Tadarida australis</i>	White-striped Mastiff-bat
<i>Mormopterus planiceps</i> sp. 1	Little Mastiff-bat
<i>Mormopterus planiceps</i> sp. 2	Little Mastiff-bat
<i>Mormopterus norfolkensis</i>	Eastern Little Mastiff-bat
<i>Mormopterus beccarii</i>	Beccaris Mastiff-bat
<i>Mormopterus</i> sp.1	No common name

EMBALLONURIDAE

Sheath-tail-bats

<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat
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PTEROPODIDAE

Fruit Bats

<i>Pteropus alecto</i>	Black Flying Fox
<i>Pteropus scapulatus</i>	Little Red Flying Fox
<i>Pteropus poliocephalus</i>	Grey-headed Flying Fox
<i>Nyctimene robinsoni</i>	Tube-nosed Bat
<i>Syconycteris australis</i>	Blossom Bat