

ISSN 0035-922X

JOURNAL OF

THE ROYAL SOCIETY

OF

WESTERN AUSTRALIA

VOLUME 64

PART 4

JANUARY, 1982

PRICE THREE DOLLARS

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REGISTERED BY AUSTRALIA POST-PUBLICATION No. WBG 0351

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WESTERN AUSTRALIA

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## Hair structure of some Western Australian mammals

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(communicated by B. K. Bowen)

Manuscript received 19 February 1980; accepted 17 February 1981

### Abstract

The technique of identification of hair in predator scats has been used in an attempt to locate areas in which the Dibbler, *Antechinus apicalis*, lives. A photographic reference system of the diagnostic features of the structure of the hair of 15 species of mammals indigenous to the south of Western Australia has been compiled. This has been used in conjunction with the photographs in Brunner and Coman (1974) of the hair structure of other species found in the 3 regions where the scats were collected. No Dibbler remains were found.

### Introduction

The method of identification of mammalian hair developed by Brunner and Coman (1974) has been found useful in mammal surveys. Uncommon or inconspicuous species which are not often registered by conventional techniques may be detected by analysis of hair remains in predator scats (Brunner and Bertuch 1976, Friend 1978). It was considered that this technique might be useful in the search for the Dibbler, *Antechinus apicalis*, which is now considered to be extremely rare. The Dibbler has been found in recent times in only two localities, Cheyne Beach and Jerdacuttup, in the south of Western Australia. Morcombe (1967) trapped the first two specimens seen for 83 years at Cheyne Beach and his discovery, together with the finding of two Dibblers on farms near Jerdacuttup, led to further searches being made (Woolley 1977, 1980). Trapping has been carried out in a number of localities in the vicinity of Cheyne Beach and Jerdacuttup, and also in the Fitzgerald River National Park which lies within the present known range of the Dibbler. However, the only area in which Dibblers have been trapped is the one in which they were found by Morcombe and only 9 individuals have been captured (Woolley 1980). Because attempts to locate other populations of the Dibbler by conventional trapping methods have been unsuccessful predator scats have been collected from the three regions in the south of Western Australia in which trapping for the Dibbler has been carried out.

In order to identify the hair found in the predator scats it was necessary to prepare a reference set of photographs of the most diagnostic features of the

hair of mammals which might be found in the regions in which the scats were collected. This paper reports on the structure of the hair of some mammals from the south of Western Australia; the mammalian prey items, identified by reference to the structure of hair and skeletal remains, found in the scats collected will be reported elsewhere.

### Reference photographs of hair structure

The 3 localities (Cheyne Beach, Jerdacuttup and Fitzgerald River National Park) in which trapping for the Dibbler has been carried out are shown in Figure 1. A list of the indigenous and introduced mammals which might be found in the degree squares encompassing the trapping areas was compiled from the following sources: Ride (1970); records of the Western Australian Museum (computer printout of mammalian species recorded by one degree squares dated 12 June 1978); information provided by Dr. A. N. Start, National Parks Board of Western Australia. The 38 mammals listed comprised the following 28 indigenous and 10 introduced species:—*Antechinus apicalis*\*, *A. flavipes leucogaster*\*, *Antechinomys laniger*\*, *Smiithopsis crassicaudata*, *S. graulipes*\*, *S. hirtipes*\*, *Phascogale calura*\*, *Dasyurus geoffroyi*\*, *Myruccobius fasciatus*\*, *Isoodon obesulus*, *Tarsipes spencerae*\*, *Cercatus concinnus*, *Trichosurus vulpecula*, *Bettongia penicillata*\*, *Macropus eugenii*\*, *M. fuliginosus*, *M. irma*\*, *Potorous platyops*\*, *P. tridactylus*, *Setonix brachyurus*\*, *Tachyglossus aculeatus*, *Hydromys chrysogaster*, *Notomys mitchelli*, *Pseudomys albocinctus*, *P. occidentalis*\*, *P. shortridgei*, *Rattus fuscipes*, *R. rattus*, *Mus musculus*, *Oryctolagus cuniculus*, *Felis catus*, *Canis familiaris*, *Vulpes vulpes*, *Sus scrofa*, *Ovis aries*, *Bos taurus* and *Equus caballus*.

The structure of the hair of 13 of the indigenous species and of the 10 introduced species is illustrated in Brunner and Coman (1974). Samples of hair of the 15 indigenous species not illustrated (asterisked in the above list) were obtained from either museum specimens (Western Australian Museum, WAM; Macleay Museum New South Wales, MM) or live animals (Murdoch University Colony MU) and a set of photographs of the structure of the hairs of each prepared (Figs 2-16). Hair profiles were drawn to scale. Whole mounts, cross sections and cuticular scale casts were prepared as described in Brunner and Coman (1974) and photographed using a Zeiss photomicroscope. Prints were all made to one standard magnification (x308).

The hairs found in the scats were identified using a photographic reference system as described in Brunner and Coman (1974). To make identification easier the 38 species listed above were grouped according to various characteristics of the primary guard

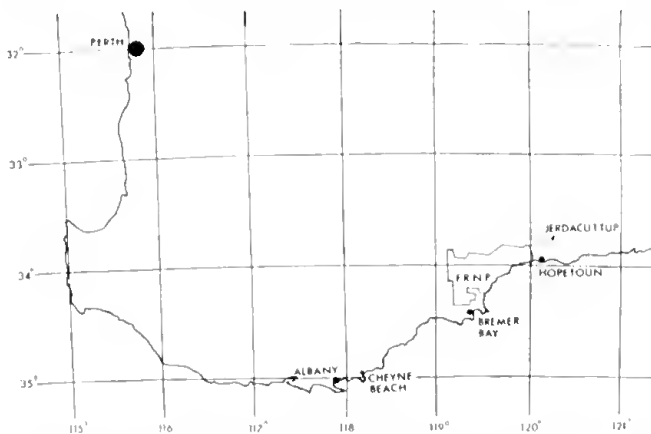
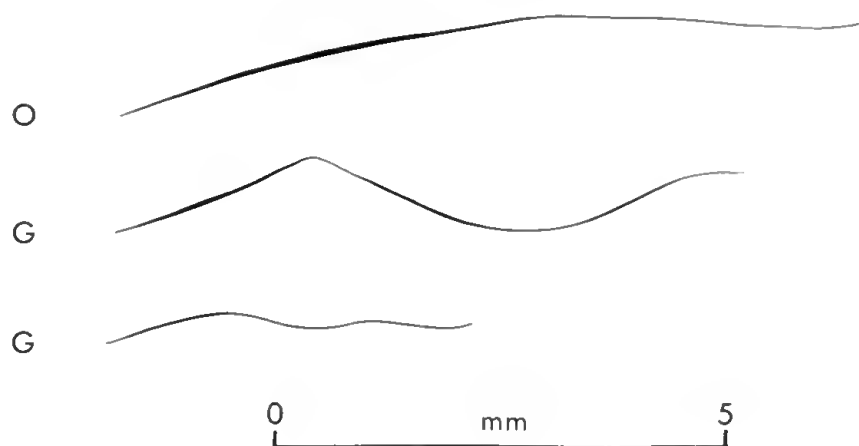
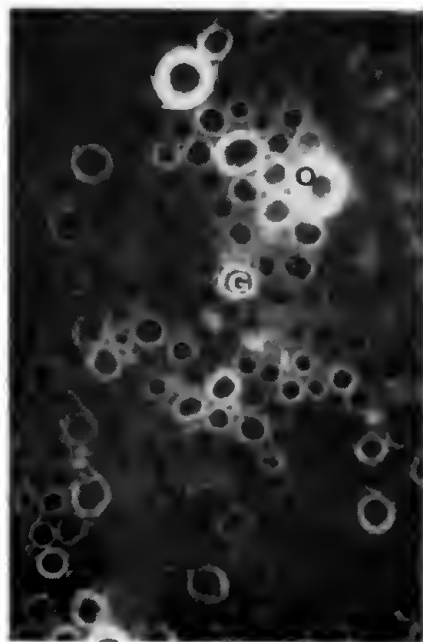


Figure 1.—Map showing the three regions (Cheyne Beach, Fitzgerald River National Park = F.R.N.P. and Jerdacuttup) in which scats were collected. Drawn from map R201, sheet 111, Australia S.W. sheet 2nd ed. Division of National Mapping, Canberra, A.C.T.

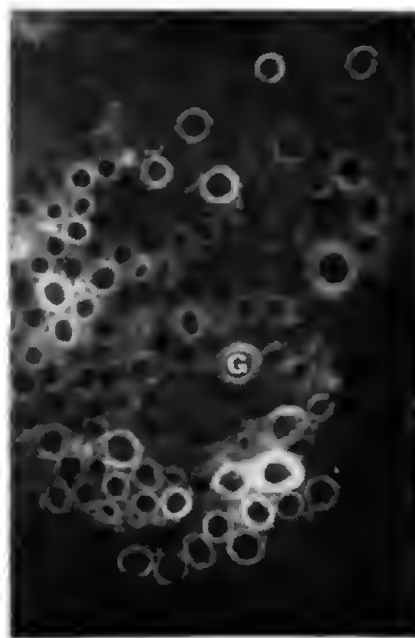
Hair profiles:- O = over hair, G = guard hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs 30  $\mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair in mid-shaft region; E, primary guard hair near base; F, smaller guard hair in shield region; G, smaller guard hair in mid-shaft region.
- II-J Scale patterns of guard hairs.  
H, shield; I, transition between shield and shaft region; J, lower-shaft.



A



B

Figure 2.—*Antechinomys laniger* WAM M1546.



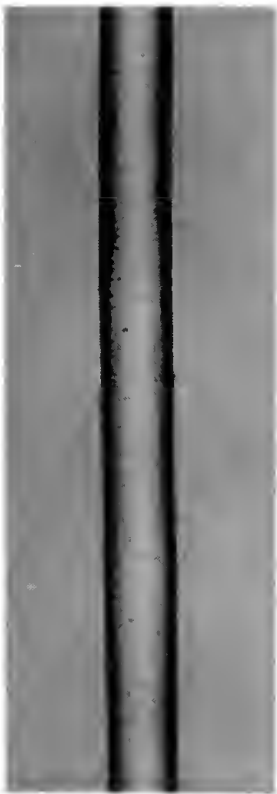
C

D

E

F

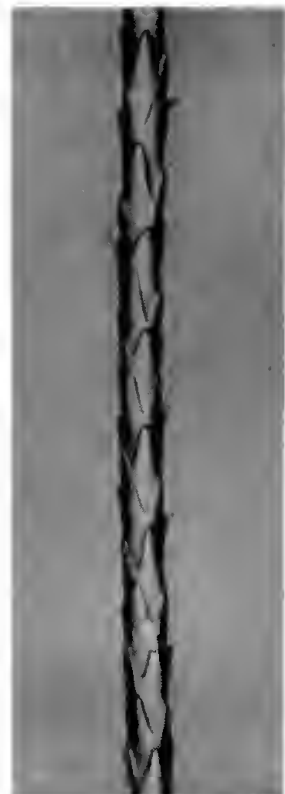
G



H

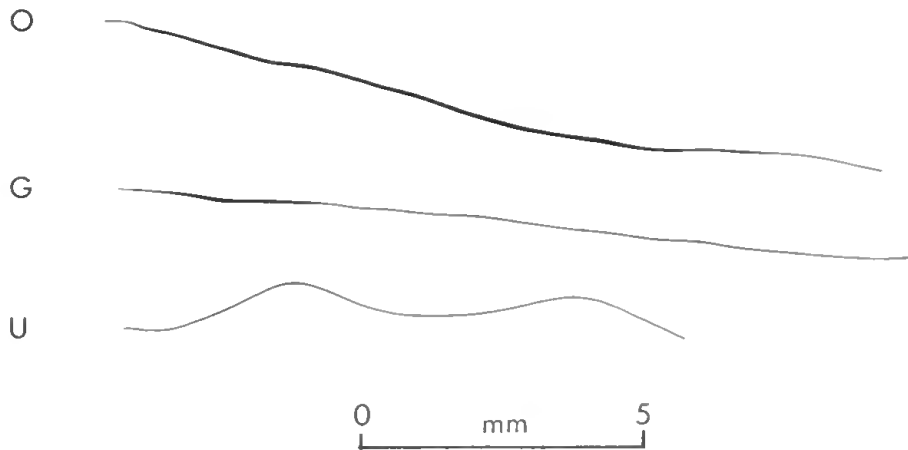


I



J

Hair profiles:- O = over hair, G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $40\ \mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in mid-shield region; D, primary guard hair in proximal shield region; E, primary guard hair in mid-shaft region; F, primary guard hair near base; G, under hair in proximal 1/3.
- H-K Scale patterns of guard hairs.  
H, shield; I, transition between shield and shaft regions; J, shaft; K, near base.

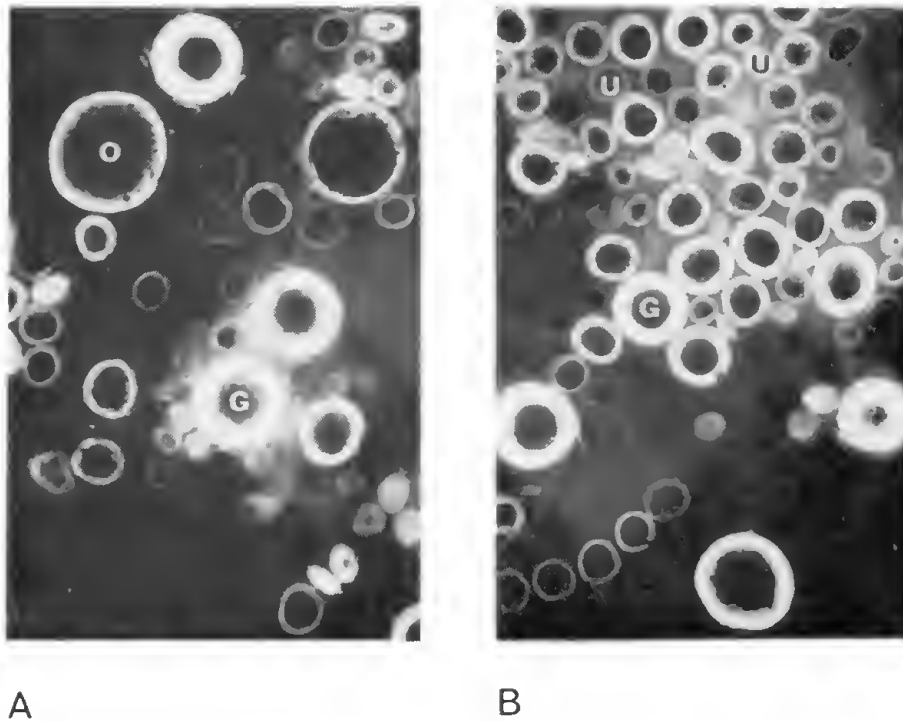


Figure 3.—*Sminthopsis granulipes* WAM M2333.



C



D



E



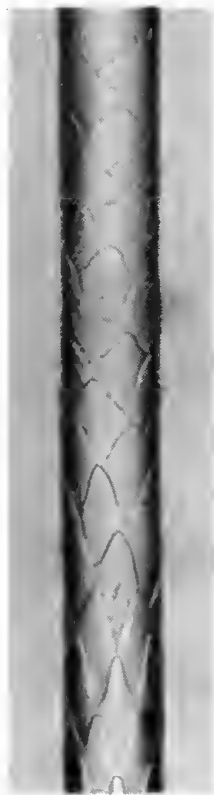
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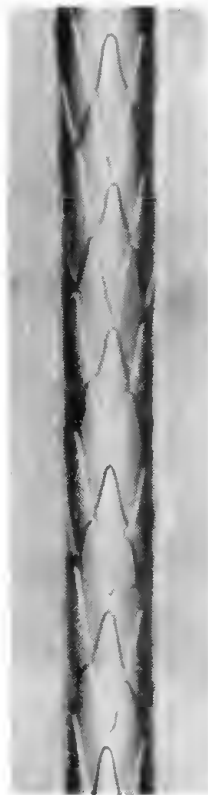
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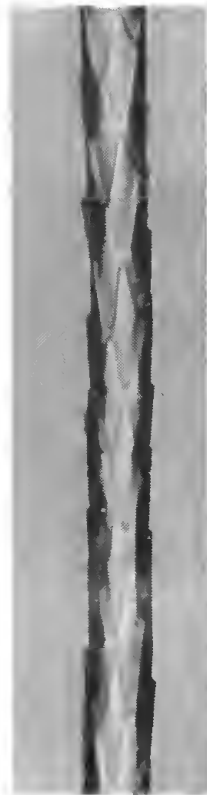
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I

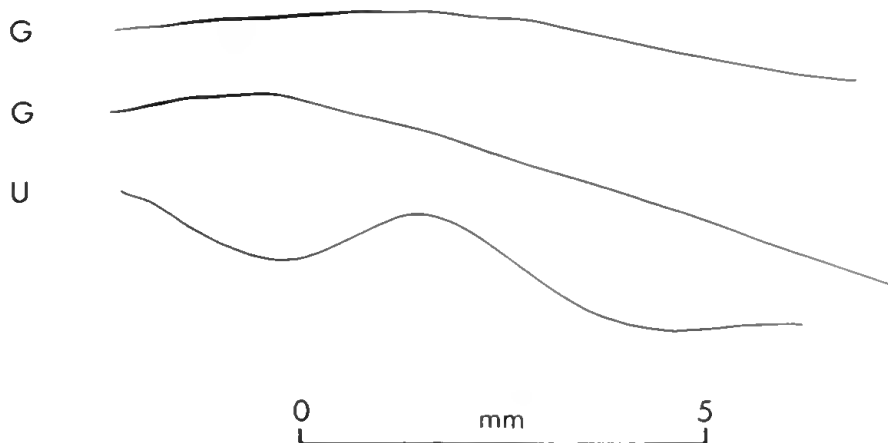


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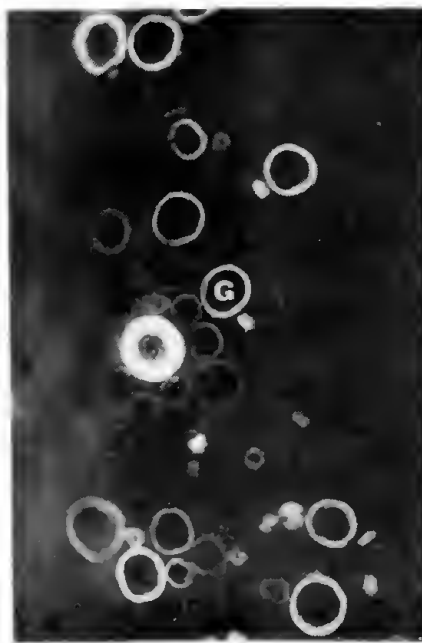
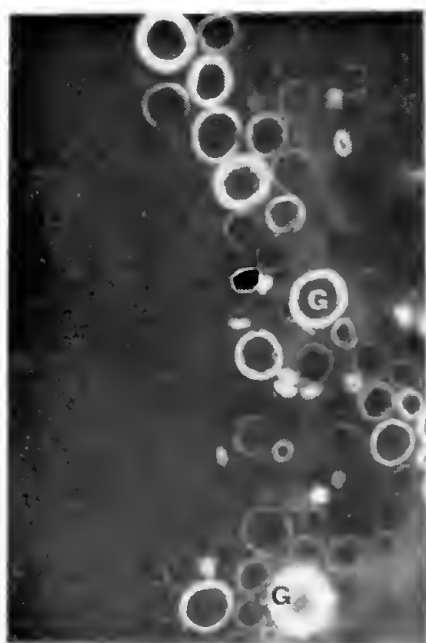


K

Hair profiles:- G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $40\ \mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair showing transition between shield and shaft; E, primary guard hair in shaft region; F, smaller guard hair in shield region; G, under hair in proximal 1/2.
- H-J Scale patterns of guard hairs.  
H, shield; I, transition between shield and shaft regions;  
J, shaft.

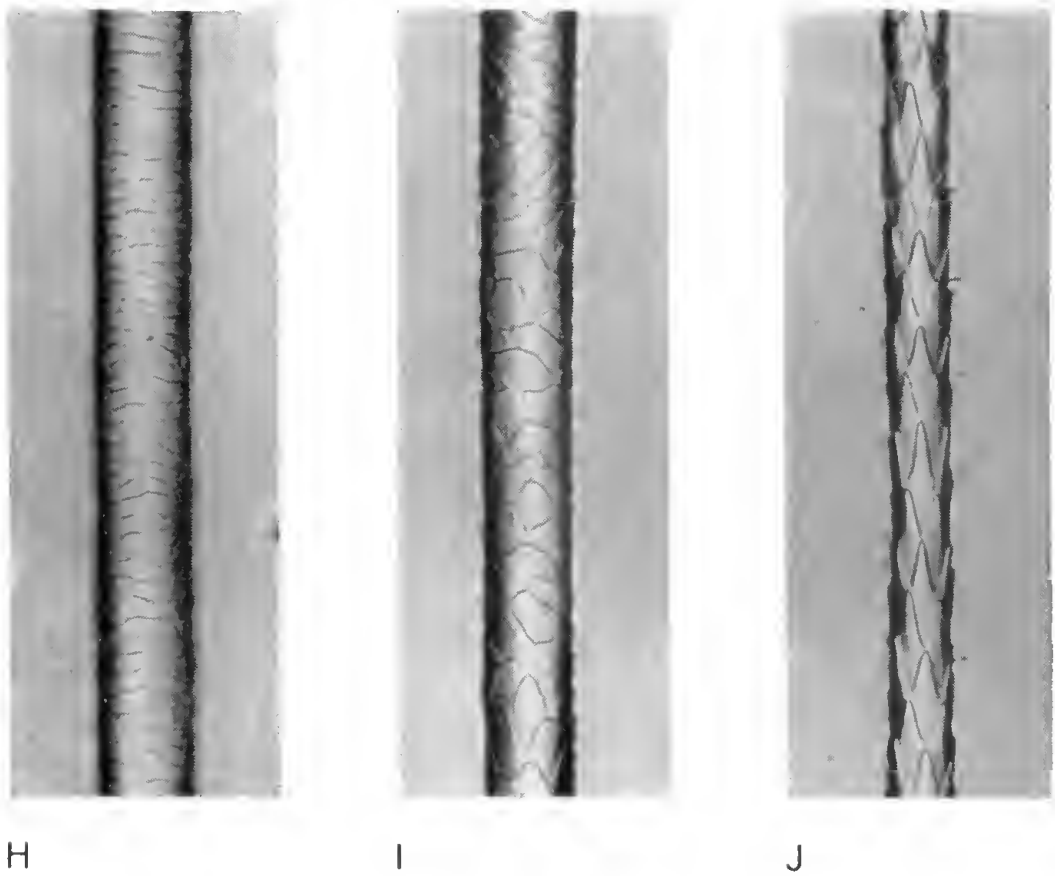
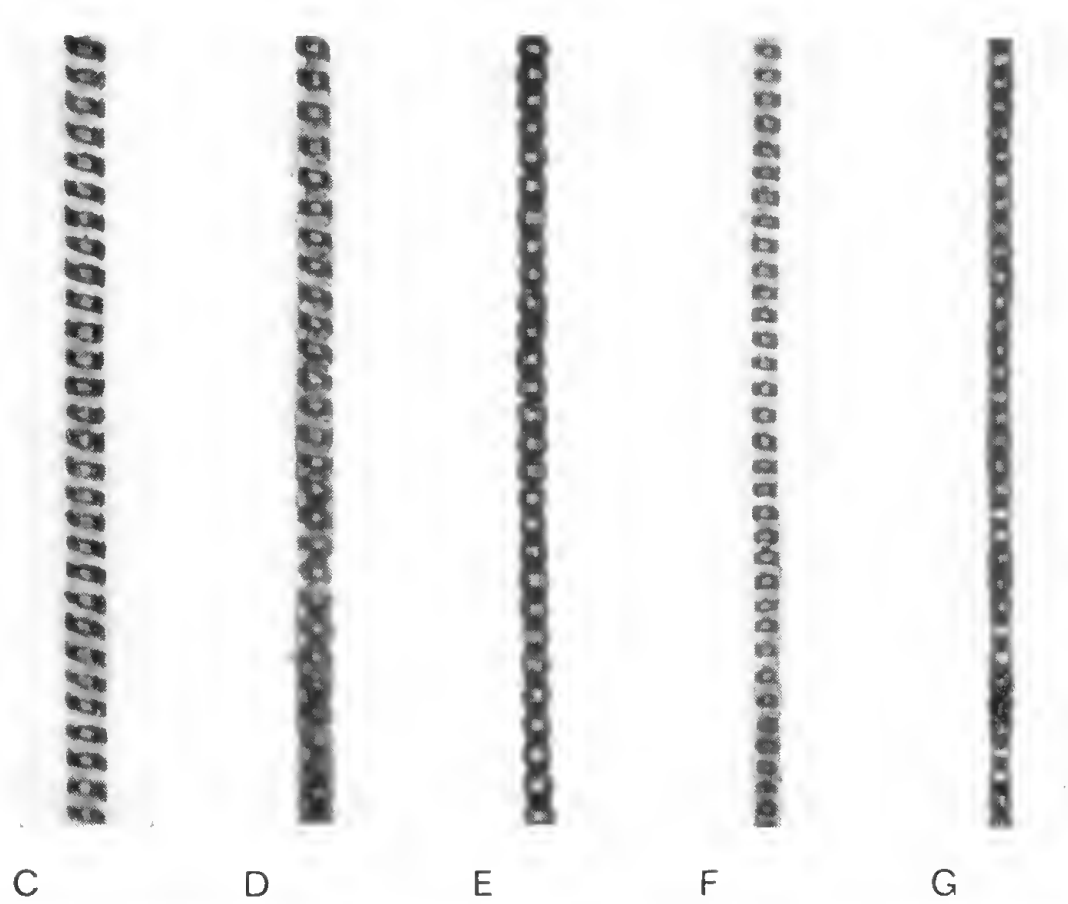


A

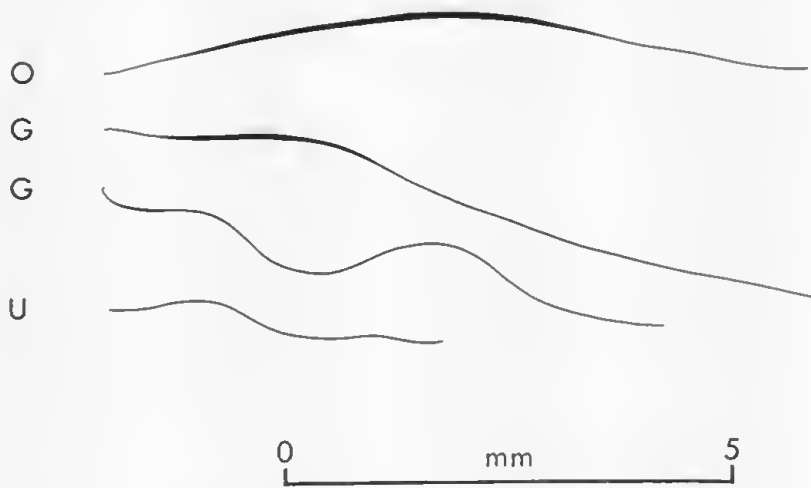
B

Figure 4. —*Sminthopsis hirtipes* WAM M1577.

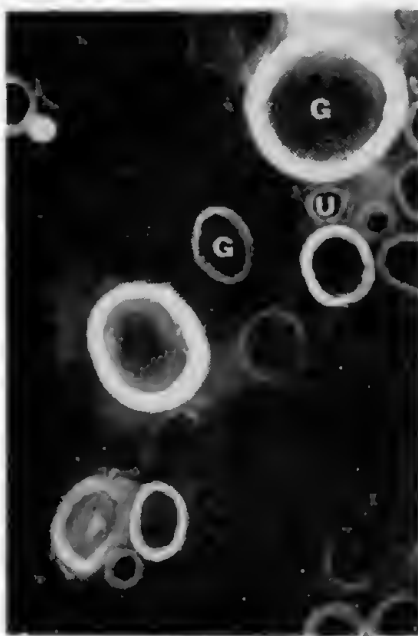




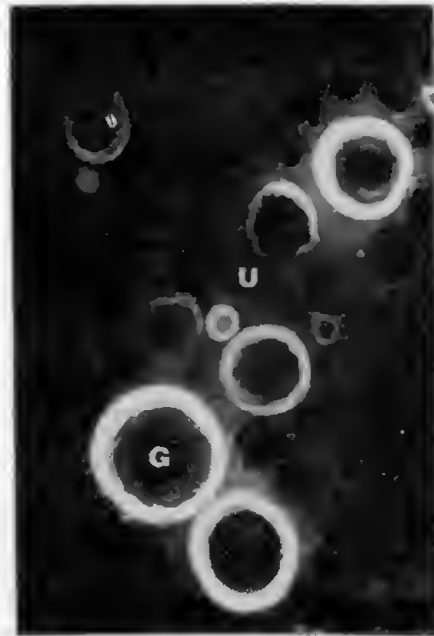
Hair profiles:- O = over hair, G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs 80  $\mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair in mid-shaft region; E, F, smaller guard hairs in shield region; G, under hair in proximal 1/2.
- H-K Scale patterns of guard hairs.  
H, shield; I, transition between shield and shaft regions; J, shaft; K, near base.



A

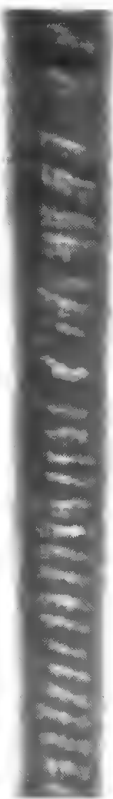


B

Figure 5.—*Tarsipes spencerae* WAM M15460.



C



D



E



F



G



H



I

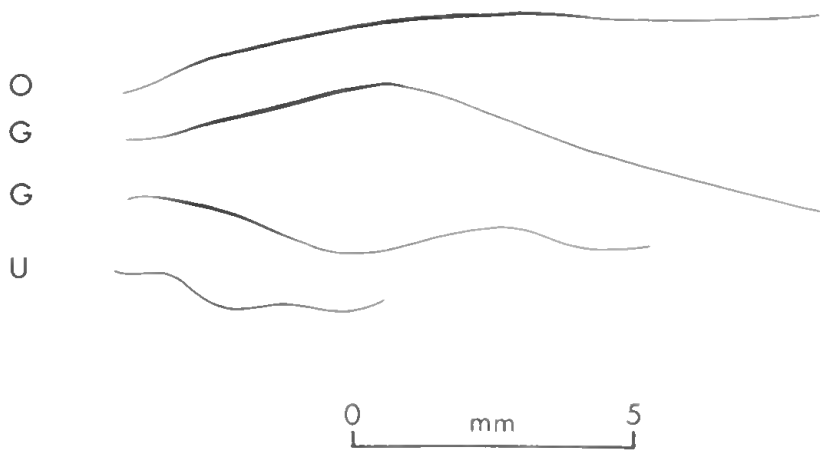


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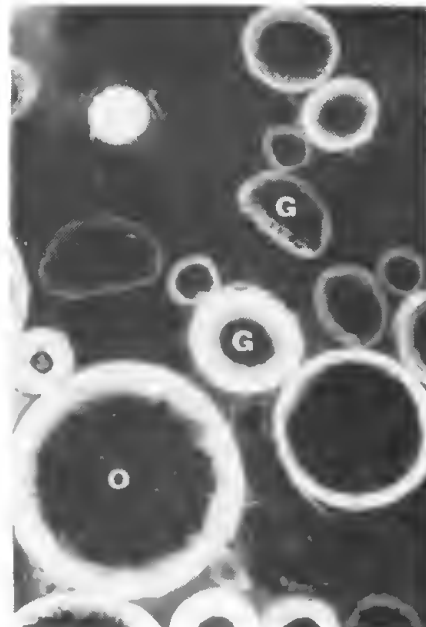
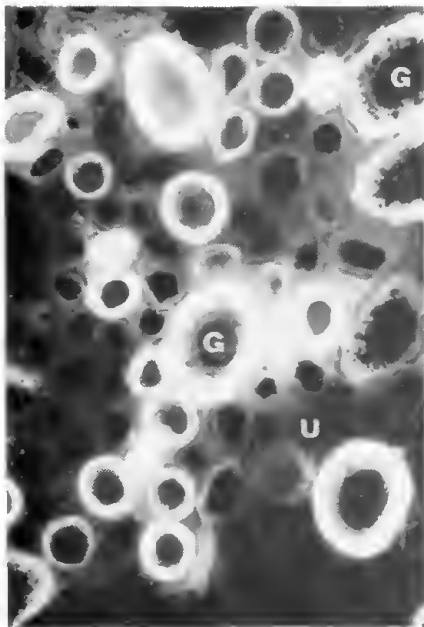


K

Hair profiles:- O = over hair, G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs 45  $\mu\text{m}$ .  
C-G Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair in mid-shaft region; E, F, smaller guard hairs in shield region; G, under hair in proximal 1/2.  
H-L Scale patterns of guard hairs.  
H, I, shield; J, transition between shield and shaft regions; K, mid-shaft; L, near base.



A

B

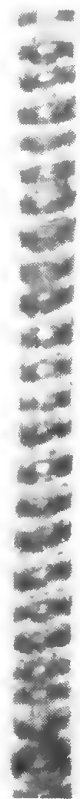
Figure 6.—*Antechinus flavipes leucogaster* WAM M5559.



C



D



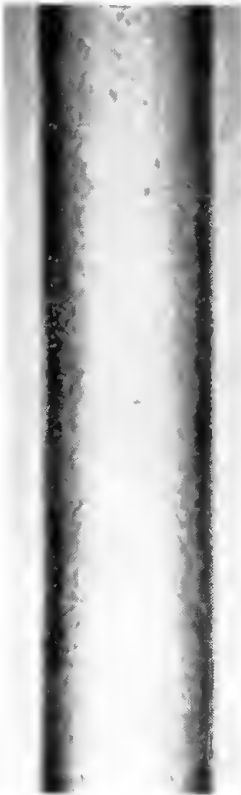
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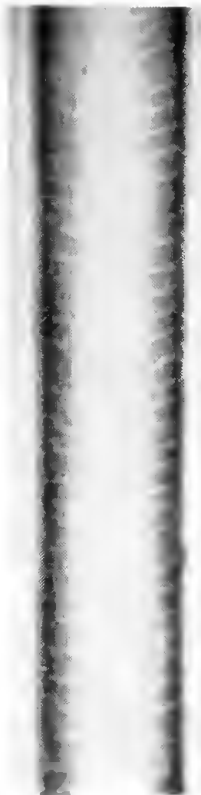
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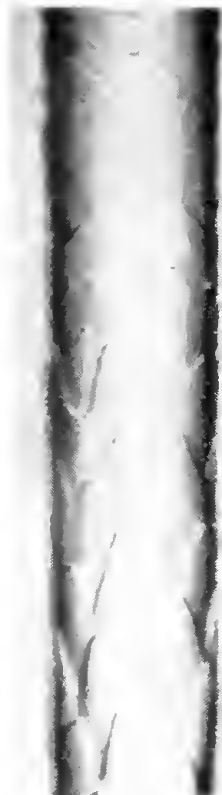
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J

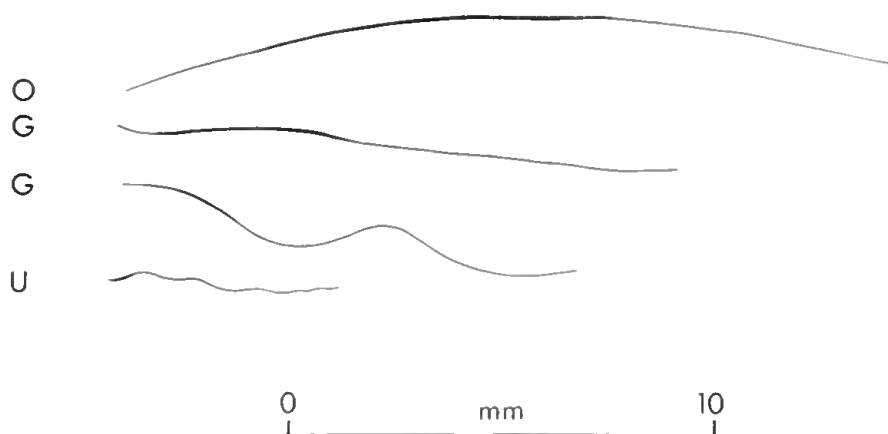


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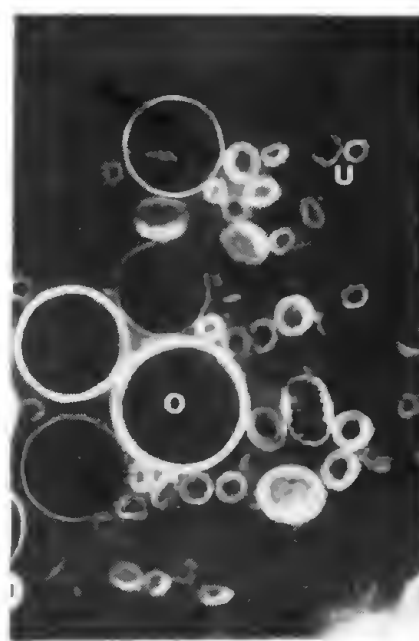
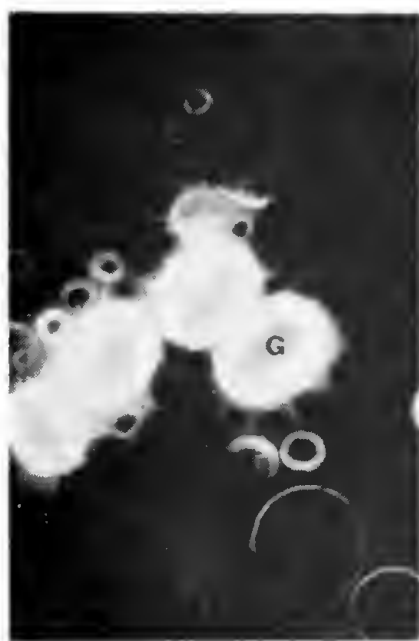


L

Hair profiles:- O = over hair, G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $65 \mu\text{m}$ .
- C-H Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair in mid-shaft region; E, F, smaller guard hairs in shield region; G, smaller guard hair in mid-shaft region; H, under hair in proximal  $1/2$ .
- I-L Scale patterns of guard hairs.  
I, mid-shield; J, lower shield; K, transition between shield and shaft regions; L, shaft.



A

B

Figure 7.—*Antechinus apicalis* WAM M15471-2.



C



D



E



F



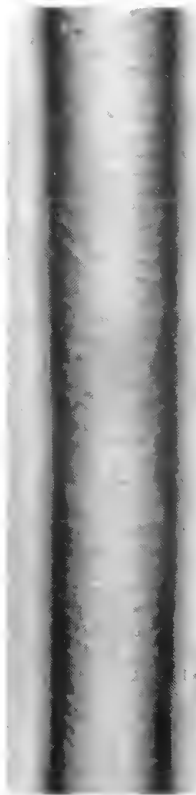
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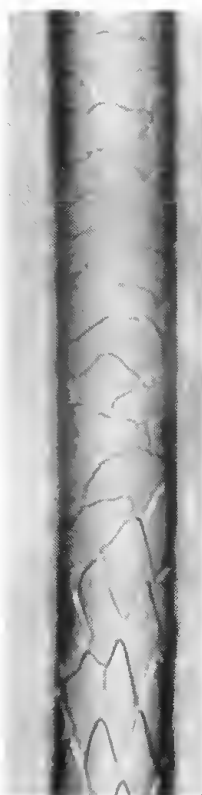
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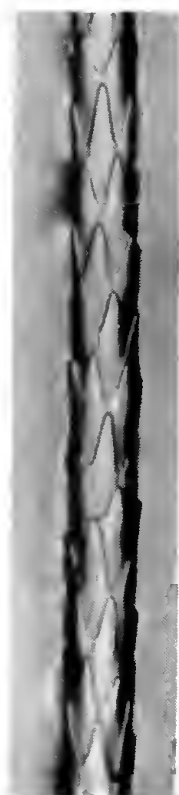
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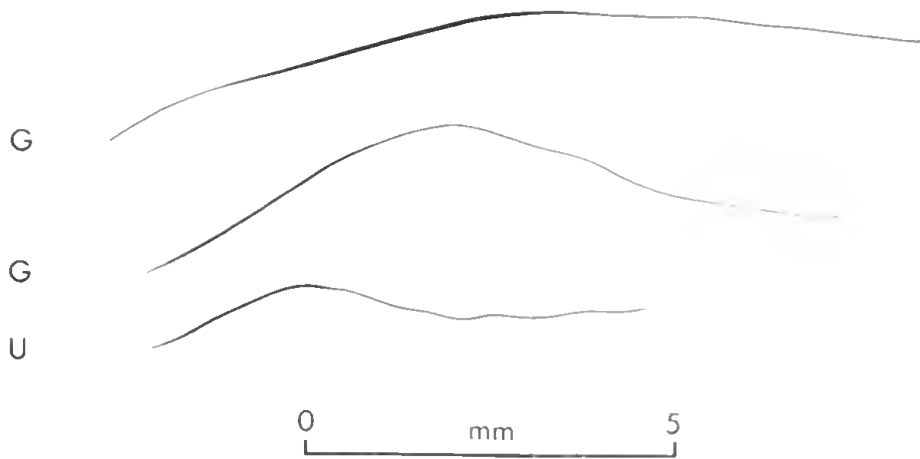


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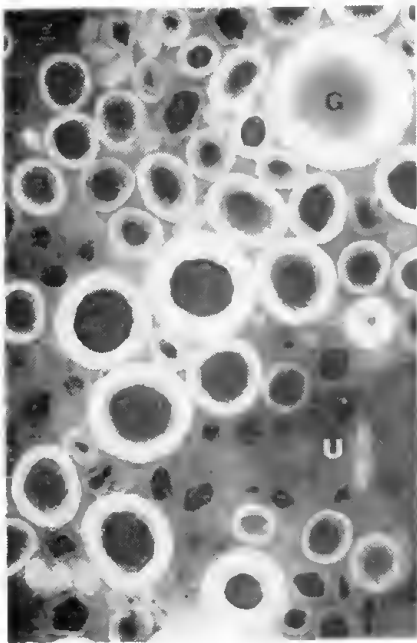


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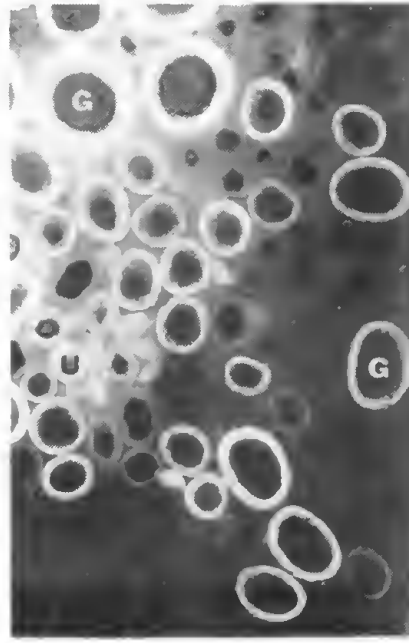
Hair profiles:- G = guard hair, U under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $50\ \mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair in mid-shaft region; E, smaller guard hair in shield region; F, smaller guard hair in mid-shaft region;  
G, under hair in proximal 1/3.
- H-K Scale patterns of guard hairs.  
H, shield; I, transition between shield and shaft regions;  
J, mid-shaft; K, near base.



A



B

Figure 8.—*Phascogale calura* WAM M5311.

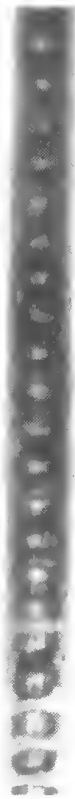




C



D



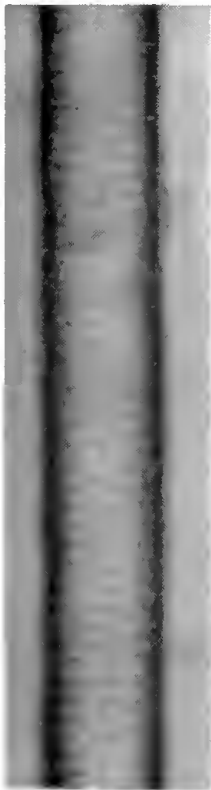
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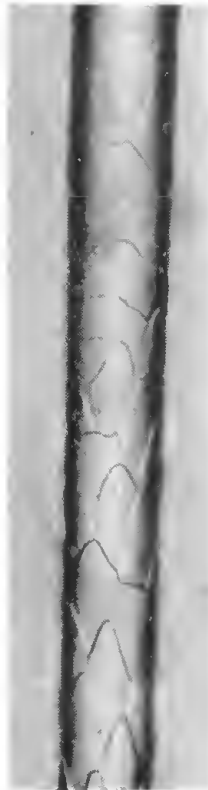
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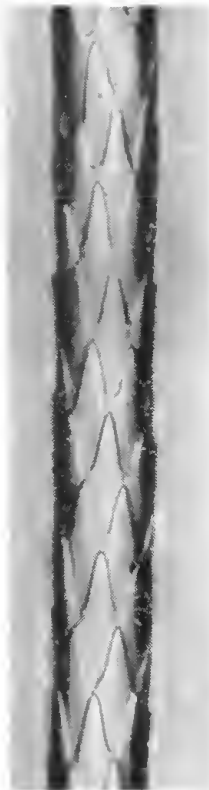
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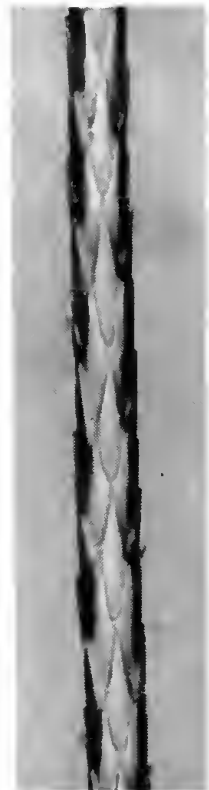
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I

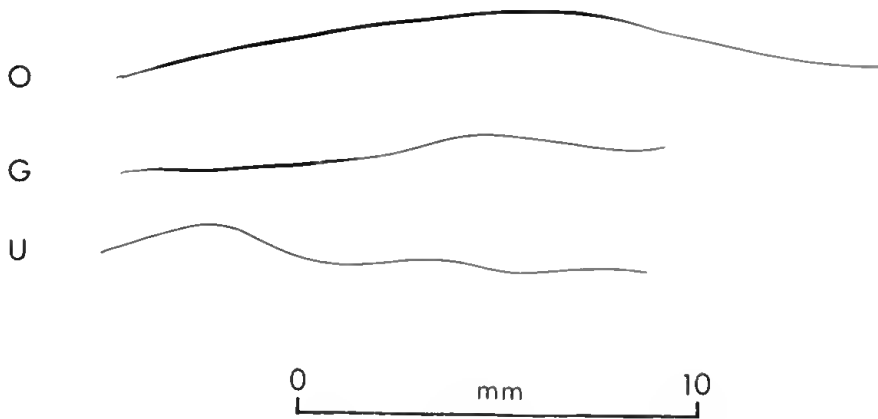


J



K

Hair profiles: - O = over hair, G = guard hair, U = under hair



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $80\ \mu\text{m}$ .
- C-H Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in mid-shaft region; E, smaller guard hair in widest region; F, smaller guard hair in mid-shaft region; G, smaller guard hair near base; H, under hair in proximal 1/3.
- I-L Scale patterns of guard hairs.  
I, J, distal 1/3; K, transition between distal and proximal regions; L, proximal 1/3.

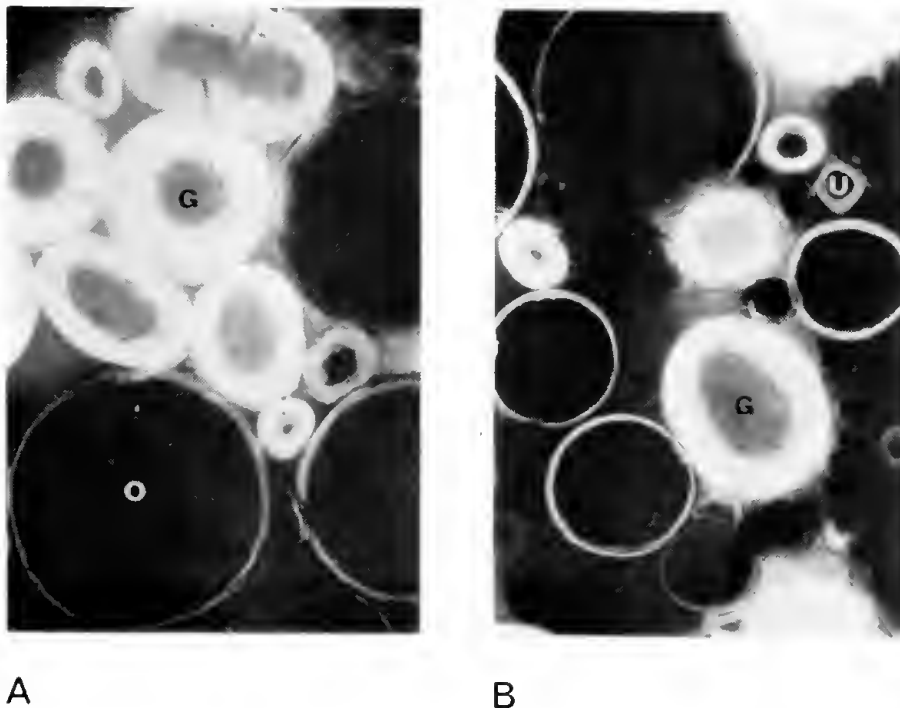
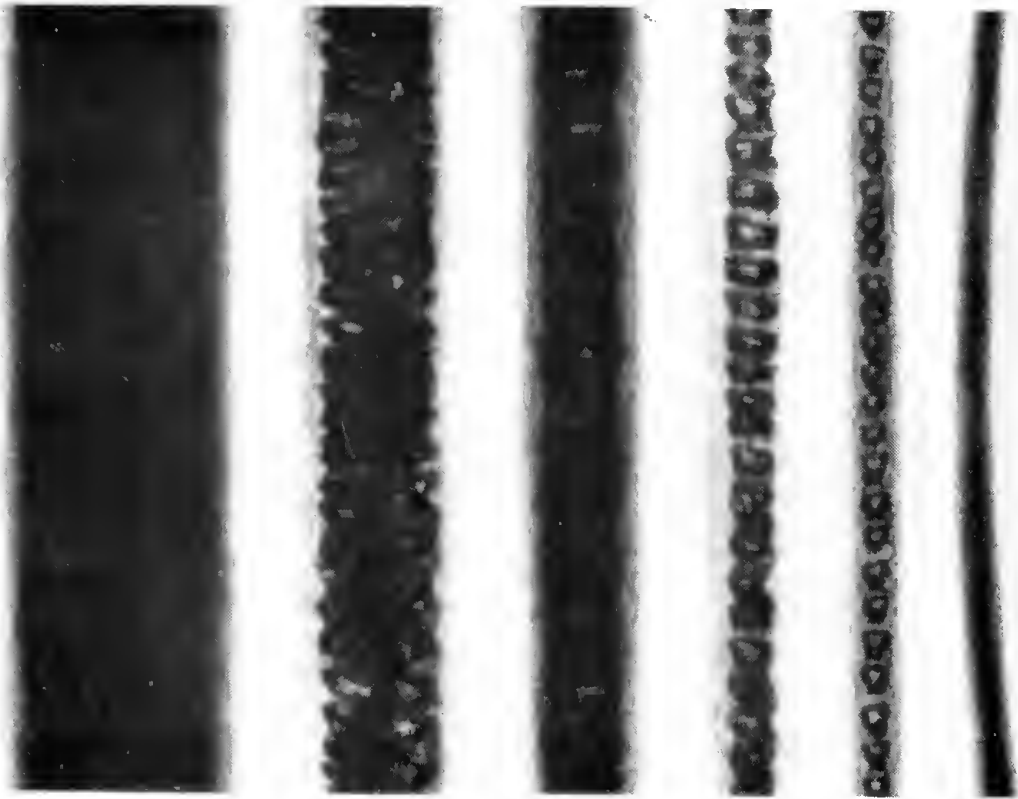


Figure 9.—*Dasyurus geoffroii* WAM M1106.



C

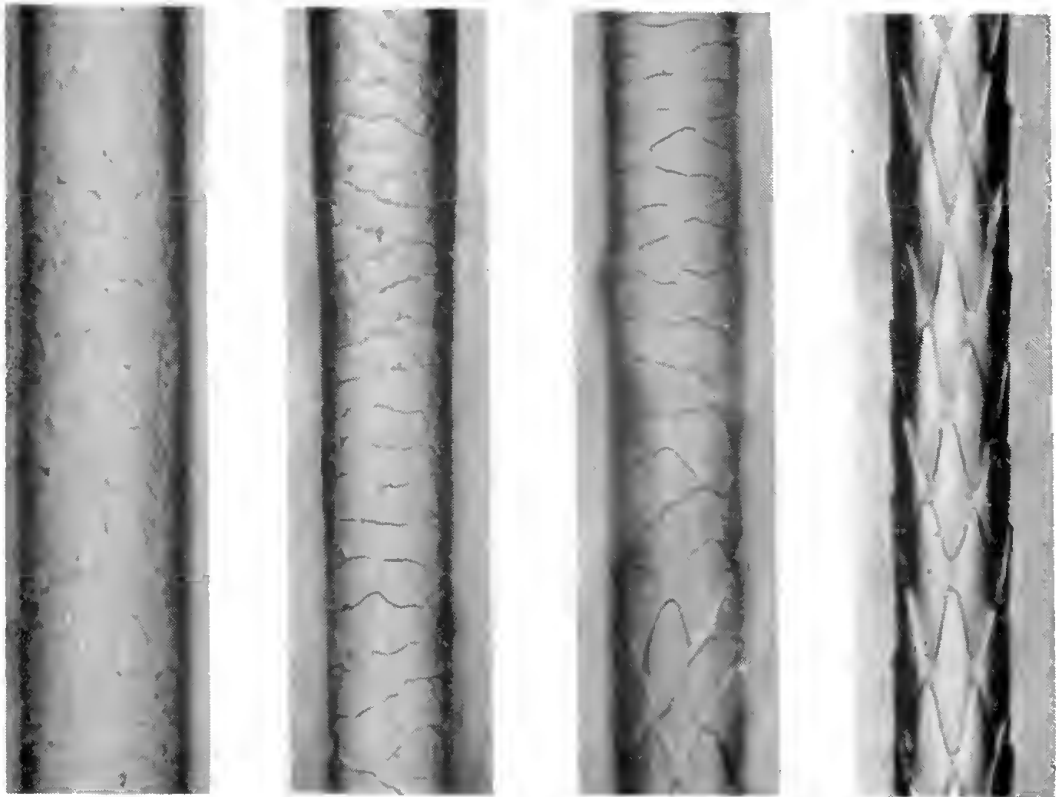
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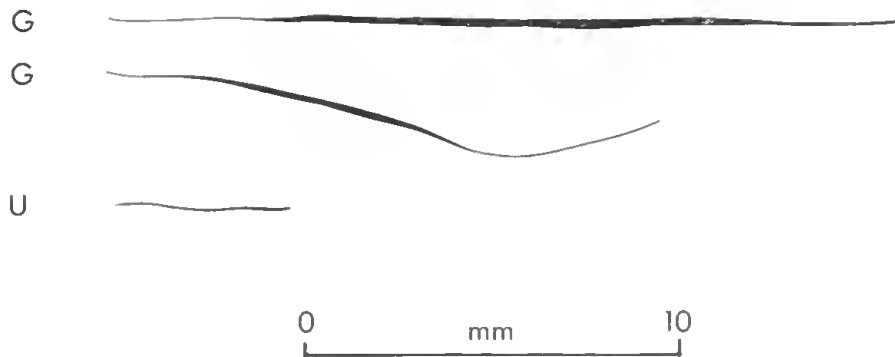
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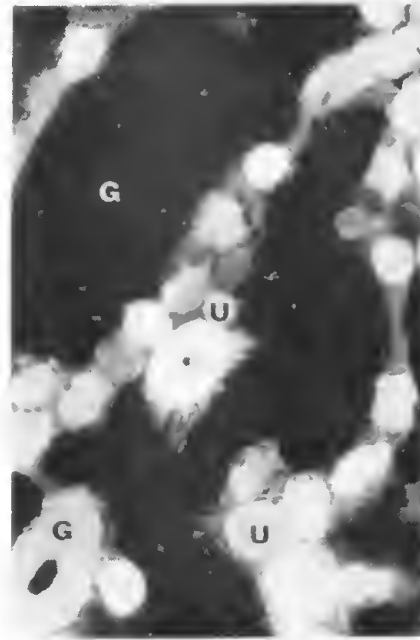
Hair profile:- G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $165\ \mu\text{m}$ .  
C-F Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in proximal 1/3; E, primary guard hair near base;  
F, under hair in proximal 1/2.  
G-I Scale patterns of guard hairs.  
G, distal 1/3; H, proximal 1/3; I, near base.



A



B

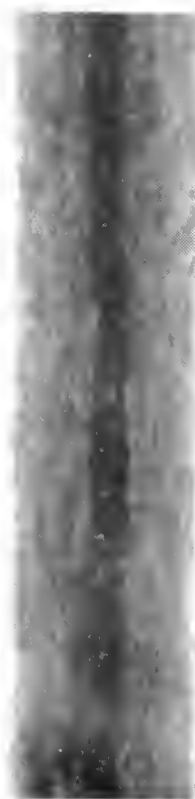
Figure 10.—*Myrmecobius fasciatus* WAM M918.



C



D



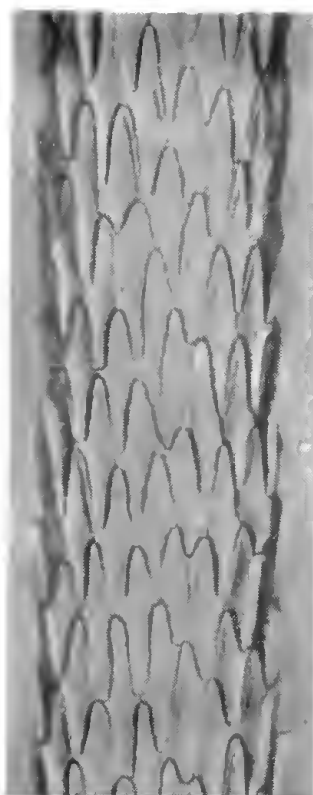
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F



G

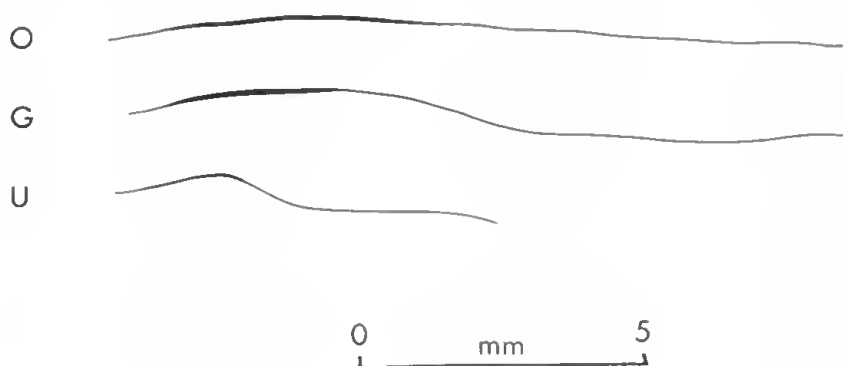


H

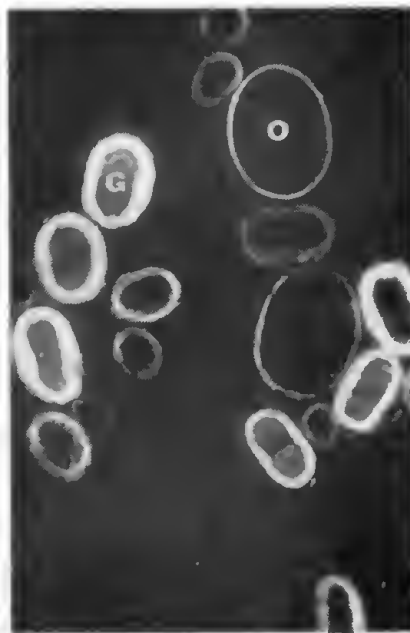
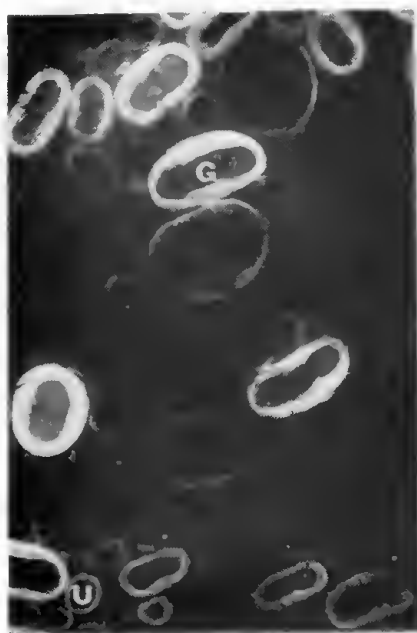


I

Hair profiles:- O = over hair, G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $40\ \mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in shield region; D, primary guard hair in mid-shaft region; E, smaller guard hair in shield region; F, smaller guard hair in mid-shaft region, G, under hair in proximal 1/2.
- H-K Scale patterns of guard hairs.  
H, shield; I, transition between shield and shaft regions; J, mid-shaft; K, near base.



A

B

Figure 11.—*Pseudomys occidentalis* WAM M10093.



C



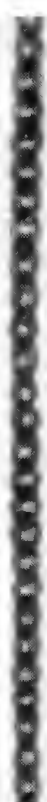
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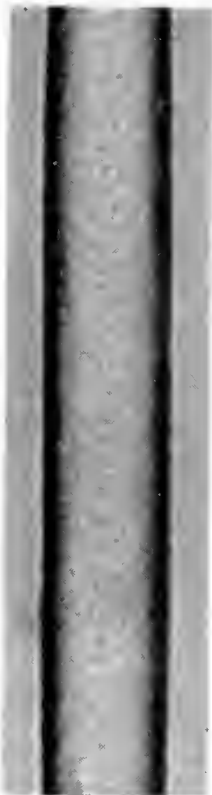
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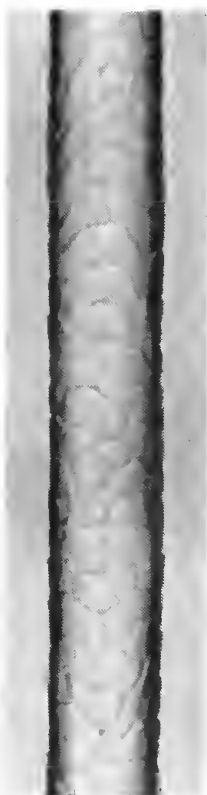
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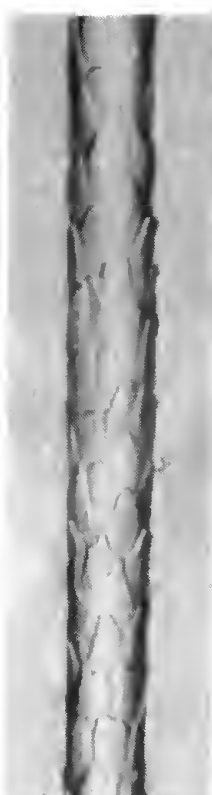
G



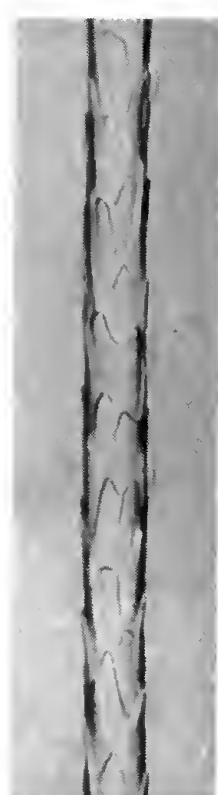
H



I

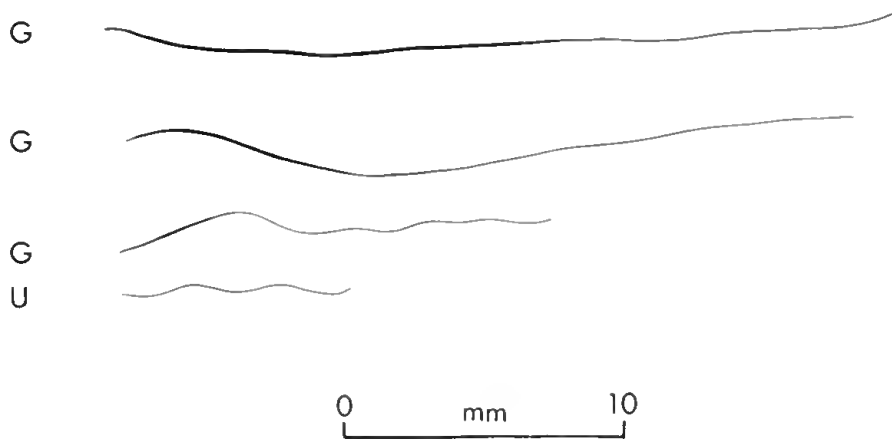


J

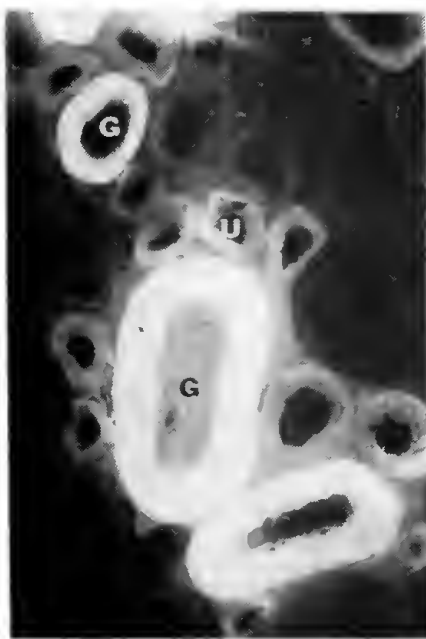


K

Hair profiles:- G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $120\ \mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in mid-shaft region; E, smaller guard hair in widest region; F, smaller guard hair in mid-shaft region; G, under hair in proximal 1/2.
- H-K Scale patterns of guard hairs.  
H, distal 1/3; I, transition between distal and proximal regions; J, mid-shaft; K, near base.



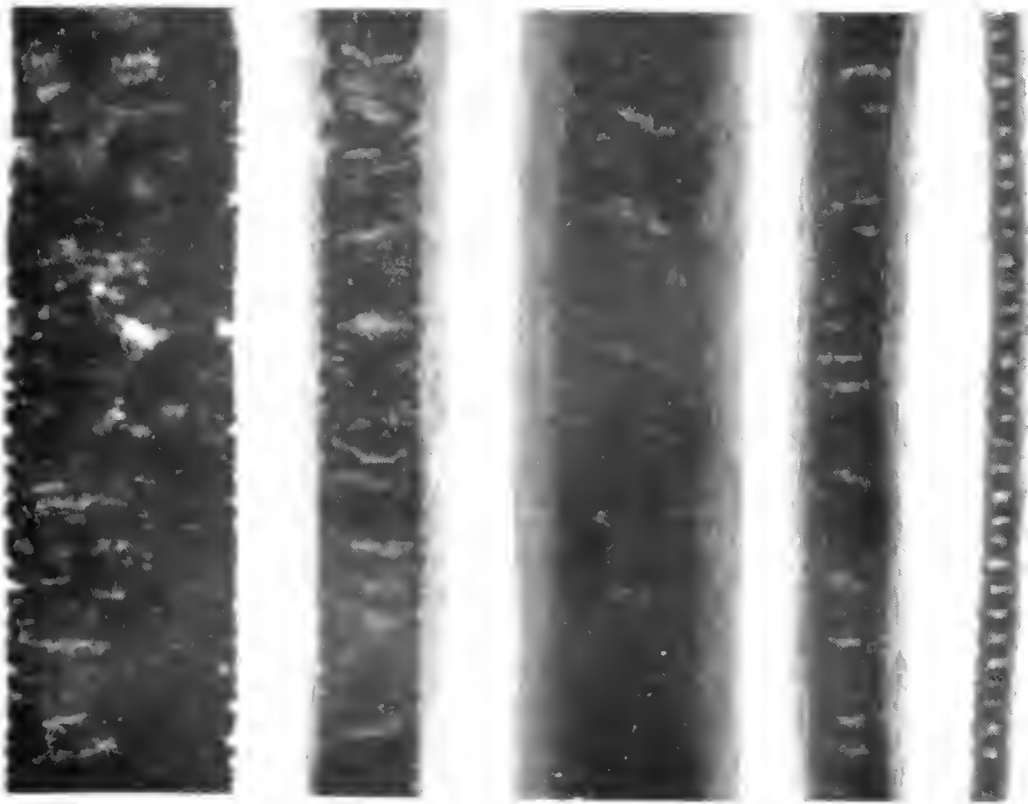
A



B

Figure 12.—*Bettongia penicillata* WAM 1366.





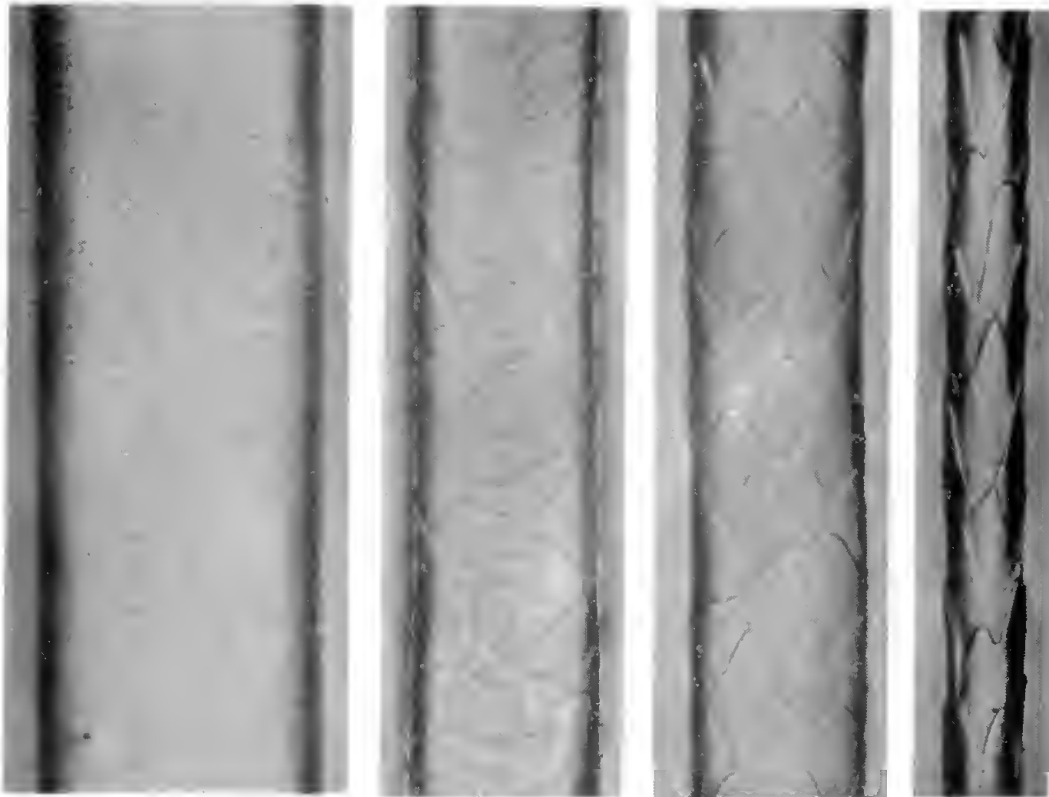
C

D

E

F

G



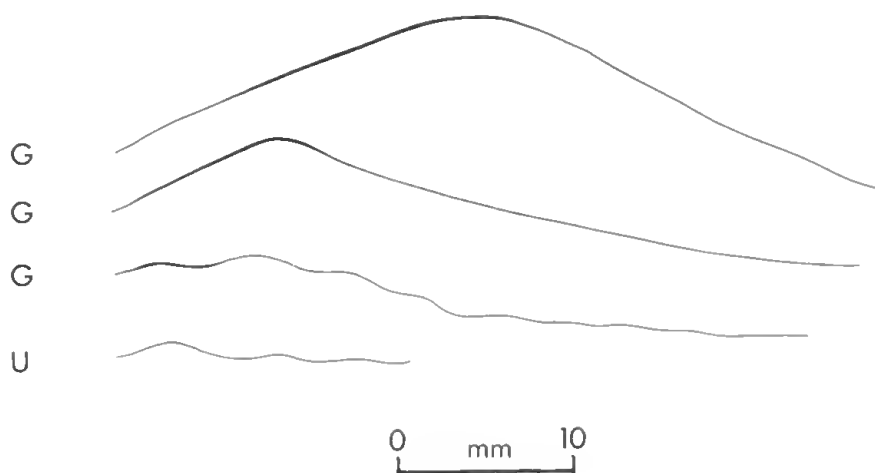
H

I

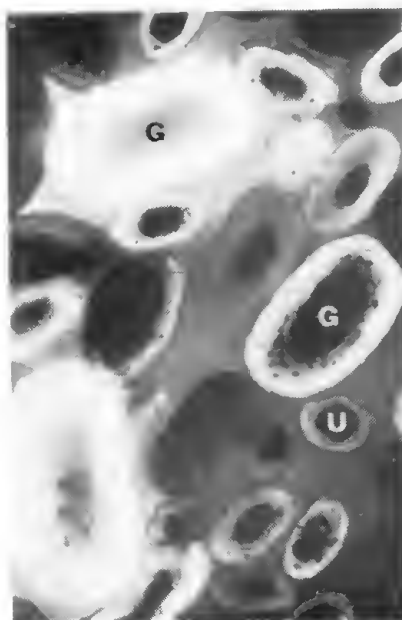
J

K

Hair profiles:- G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs 95  $\mu$ m.
- C-G Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in mid-shaft region; E, smaller guard hair in widest region; F, smaller guard hair in mid-shaft region; G, under hair in proximal 1/2.
- H-J Scale patterns of guard hairs.  
H, distal 1/3; I, mid-shaft; J, proximal 1/3.



A

B

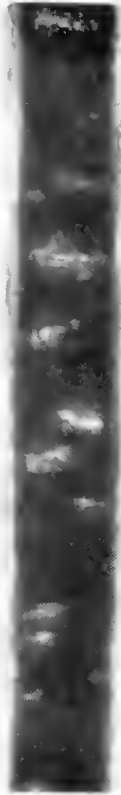
Figure 13.—*Macropus eugenii* MU.



C



D



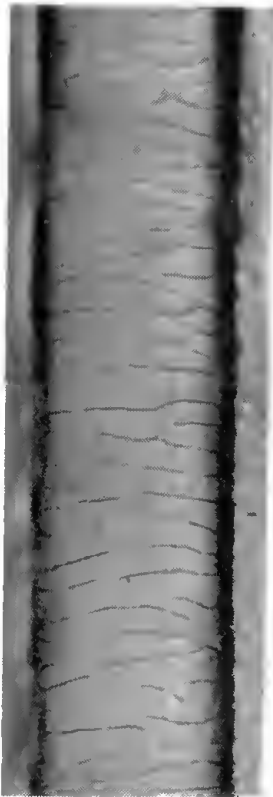
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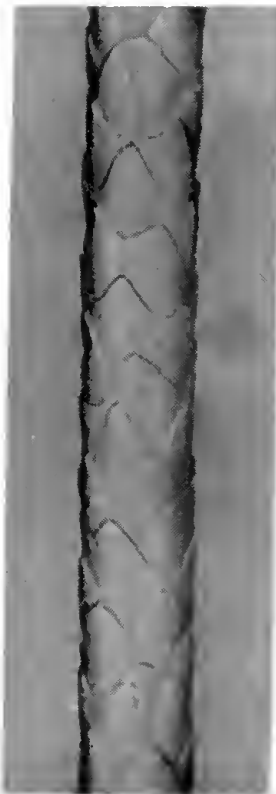
F



G



H

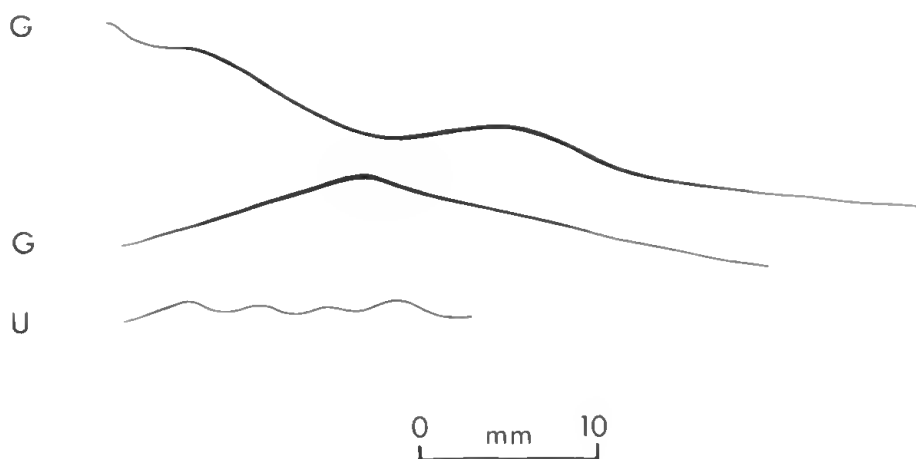


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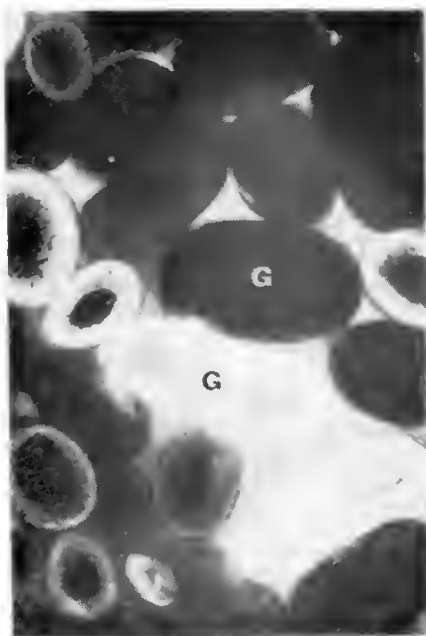


J

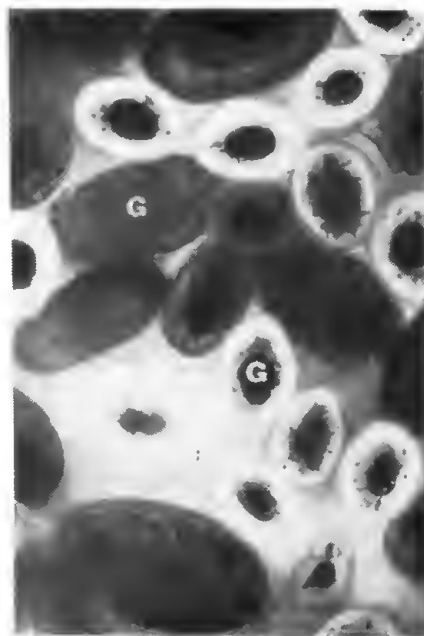
Hair profiles:- G = guard hair, U = under hair.



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $105\ \mu\text{m}$ .
- C-G Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in mid-shaft region; E, smaller guard hair in widest region; F, smaller guard hair in mid-shaft region; G, under hair in proximal  $1/2$ .
- H-J Scale patterns of guard hairs.  
H, distal  $1/3$ ; I, mid-shaft; J, near base.



A



B

Figure 14.—*Macropus irma* MU.



C



D



E



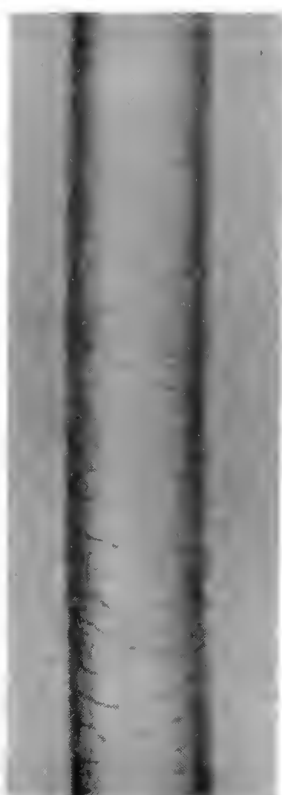
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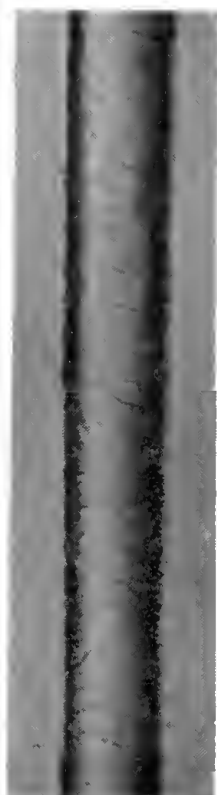
G



H

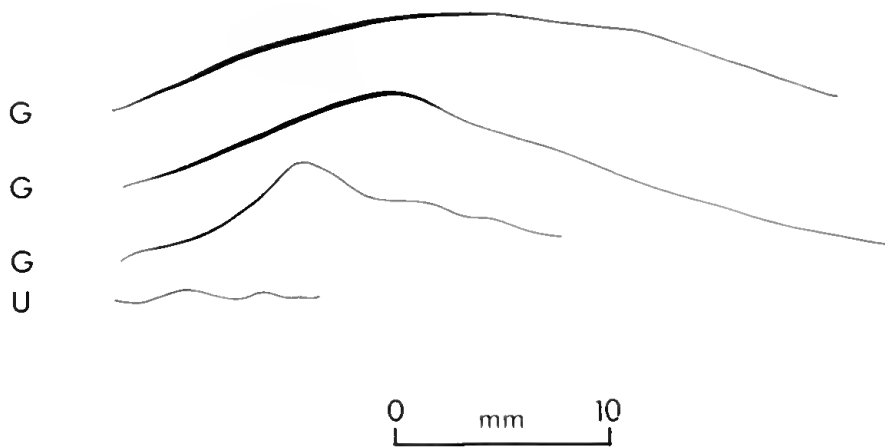


I

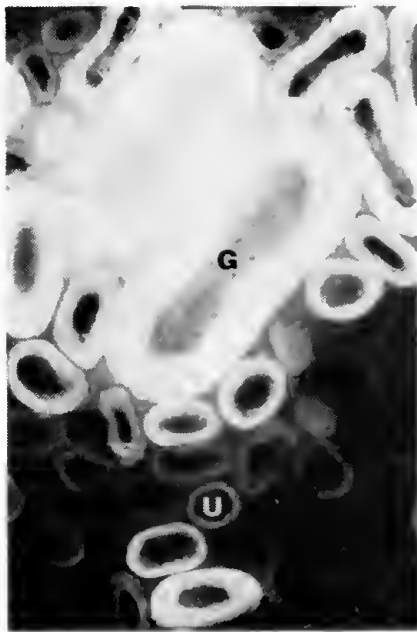


J

Hair profiles:- G = guard hair, U = under hair.



- A, B. Cross sections of hairs.  
Maximum diameter of primary guard hairs  $120\ \mu\text{m}$ .
- C-F. Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in mid-shaft region; E, primary guard hair near base;  
F, under hair in distal 1/3.
- G-I. Scale patterns of guard hairs.  
G, distal 1/3; H, mid-shaft; I, proximal 1/3.



A

B

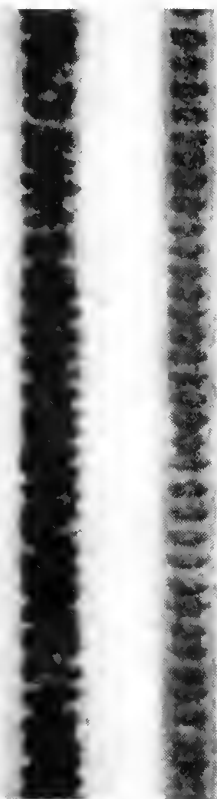
Figure 15.—*Potorous platyops* MM ♀.



C

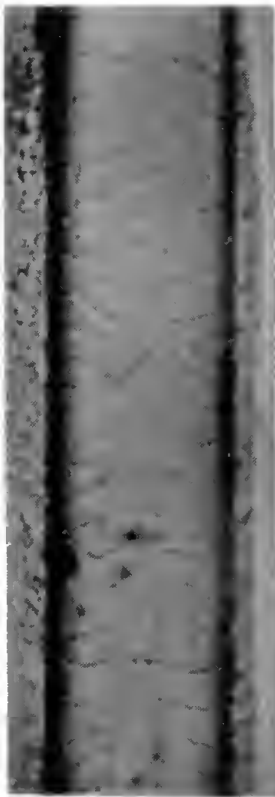


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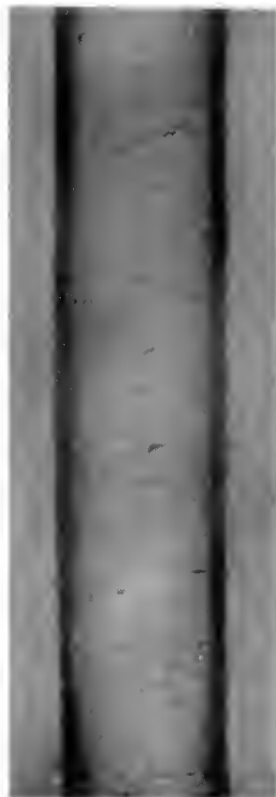


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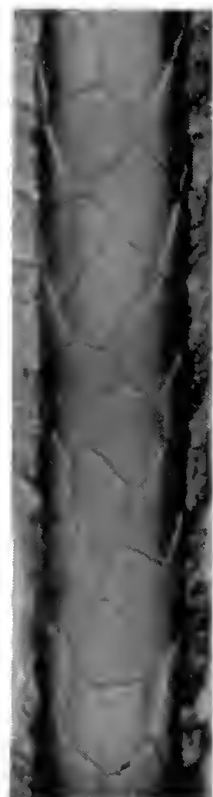
F



G

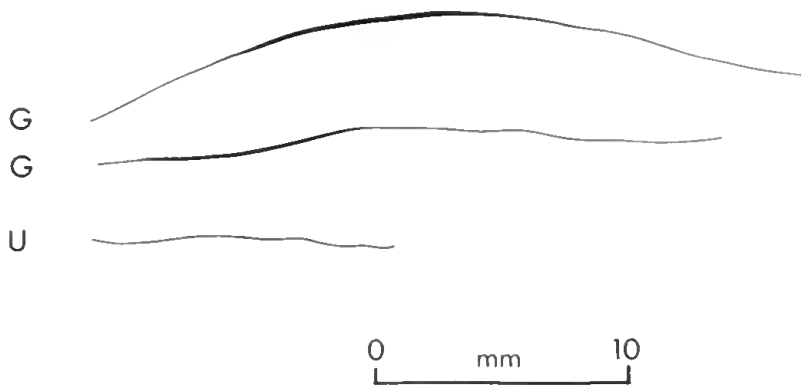


H

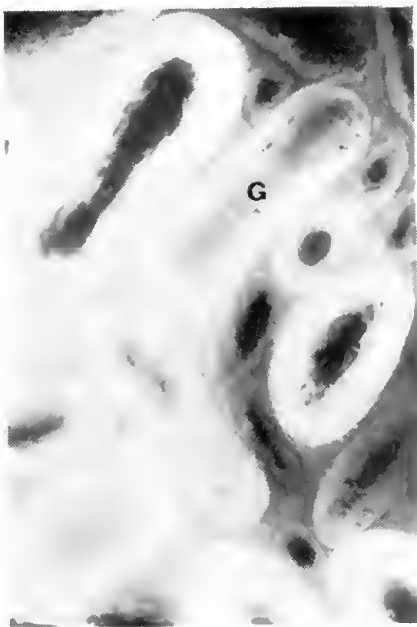


I

Hair profiles: - G = guard hair, U = under hair



- A, B Cross sections of hairs.  
Maximum diameter of primary guard hairs  $145\ \mu\text{m}$ .
- C-F Whole mounts of hairs.  
C, primary guard hair in widest region; D, primary guard hair in mid-shaft region; E, smaller guard hair in mid-shaft region; F, under hair in proximal  $1/2$ .
- G-J Scale patterns of guard hairs.  
G, H, distal  $1/3$ ; I, mid-shaft; J, near base.



A



B

Figure 16.—*Setonix brachyurus* MU.





C



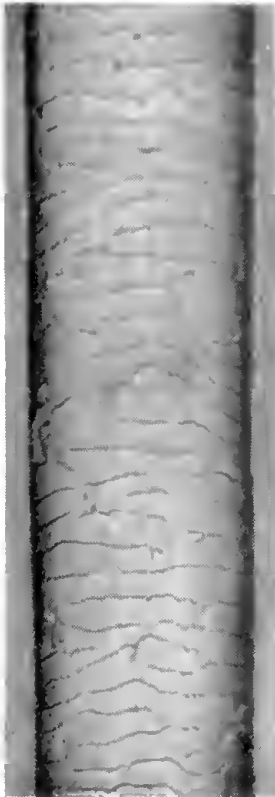
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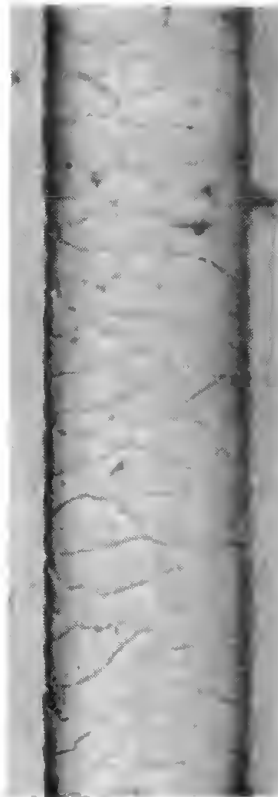
E



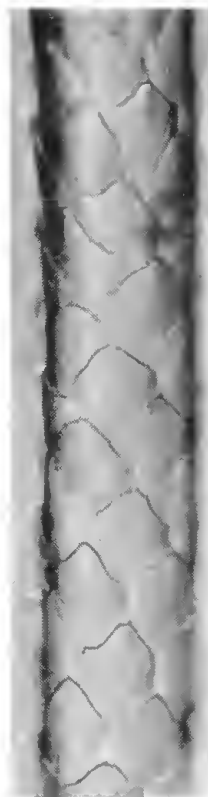
F



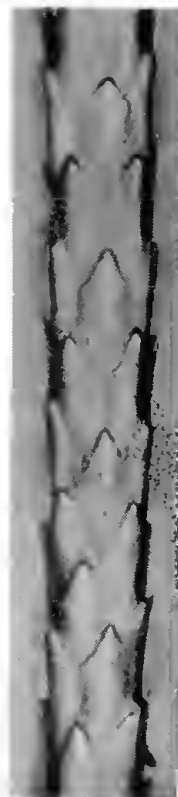
G



H



I



J

hairs (Table 1). In addition to the photographs hair samples from most of the species were available so that direct comparisons could be made if necessary.

### Discussion

The species to which a sample of unknown hair belongs can be identified by comparison with the photographs of the structure of hairs in a reference collection. Some species are very easily identified because the hairs have very obvious distinguishing characters while others lack such obvious characters and may show only small differences from related forms.

Among the species illustrated examples with obvious distinguishing characters include *Antechinus apicalis*, *Myrmecobius fasciatus*, *Tarsipes spencerae*,

**Table 1**

*A grouping of terrestrial mammals from the south of Western Australia based on the structure of the primary guard hairs*

Group	Hairs predominantly circular in cross section.	
Group 1	Dasyuridae	* <i>Antechinomys laniger</i> * <i>Sminthopsis granulipes</i> * <i>Sminthopsis hirtipes</i>
	Tarsipedidae	* <i>Tarsipes spencerae</i>
	Burramyidae	<i>Cercartetus concinnus</i>
Group 2	Hairs predominantly oval in cross section.	
Sub-group (a)	Hairs with medulla much reduced or absent.	
	Bovidae	<i>Ovis aries</i>
	Suidae	<i>Sus scrofa</i>
Sub-group (b)	Maximum diameter of guard hairs 45µm, with a distinct constriction before shield.	
	Dasyuridae	* <i>Antechinus flavipes leucogaster</i> <i>Sminthopsis crassicaudata</i> <i>Sminthopsis murina</i>
Sub-group (c)	Maximum diameter of guard hairs greater than 45µm, with a distinct constriction before shield.	
	Dasyuridae	* <i>Antechinus apicalis</i> * <i>Phascogale calura</i> * <i>Dasyurus geoffroyi</i> * <i>Myrmecobius fasciatus</i>
Sub-group (d)	Maximum diameter of guard hairs greater than 45µm, no constriction before shield.	
	Bovidae	<i>Bos taurus</i>
	Canidae	<i>Canis familiaris</i> <i>Vulpes vulpes</i>
	Equidae	<i>Equus caballus</i>
	Felidae	<i>Felis catus</i>
Group 3	Hairs lenticular (double convex) in cross section.	
	Phalangeridae	<i>Trichosurus vulpecula</i>
Group 4	Hairs predominantly oblong in cross section.	
Sub-group (a)	Medulla absent.	
	Tachyglossidae	<i>Tachyglossus aculeatus</i>
Sub-group (b)	Maximum diameter of guard hairs 45µm, with a distinct constriction before shield.	
	Muridae	<i>Notomys mitchellii</i> <i>Pseudomys albocinereus</i> * <i>Pseudomys occidentalis</i>
Sub-group (c)	Maximum diameter of guard hairs greater than 45µm, with a distinct constriction before shield.	
	Muridae	<i>Hydromys chrysogaster</i>
Sub-group (d)	Maximum diameter of guard hairs greater than 45µm, with no constriction before shield.	
	Macropodidae	* <i>Bettongia penicillata</i> * <i>Macropus eugeni</i> <i>Macropus fuliginosus</i> * <i>Macropus irma</i> * <i>Potorous platyops</i> <i>Potorous tridactylus</i> * <i>Setonix brachyurus</i>
Group 5	Hairs predominantly reniform (concave-convex) in cross section.	
Sub-group (a)	Hairs with divided medulla.	
	Peramelidae	<i>Isodon obesulus</i>
Sub-group (b)	Hairs with bilobed or large medulla.	
	Muridae	<i>Mus musculus</i> <i>Pseudomys shortridgei</i> <i>Rattus fuscipes</i> <i>Rattus rattus</i>
Group 6	Hairs predominantly dumb-bell shaped in cross section.	
	Leporidae	<i>Oryctolagus cuniculus</i>

\* Species illustrated in Figures 2-16, remainder illustrated in Brunner and Coman (1974).

*Setonix brachyurus* and *Antechinomys laniger*. *A. apicalis* displays a globular arrangement of the medulla which is very distinctive in cross section. The hairs of both *M. fasciatus* and *T. spencerae* can be easily recognised by the appearance of the medulla in whole mounts and cross sections. *S. brachyurus* has thick, long hair which displays a very distinctive scale pattern along the proximal half of the hair. Many of the guard hairs of *A. laniger* show an uncommon profile, with constrictions at several points along the length of the hair.

Some of the marsupials illustrated are difficult to distinguish from closely related forms illustrated in Brunner and Coman (1974). These include:—*Antechinus flavipes leucogaster*, the western form of *A. flavipes*; *Sminthopsis hirtipes*, which appears to differ from *S. crassicaudata* only in the width of the primary guard hairs and *Potorous platyops* and *P. tridactylus*, in which there are only subtle differences in the appearance of the medulla, best appreciated by examining hairs rather than photographs. Among the murids, hair from *Pseudomys occidentalis* differs little from other species of *Pseudomys* illustrated in Brunner and Coman (1974), *P. shortridgei* being the exception.

The grouping of species in Table 1 shows some discrepancies with the grouping in Brunner and Coman (1974). We have placed *Sminthopsis crassicaudata* in Group 2 (hairs predominantly oval in cross section) and not in Group 1 (hairs predominantly circular in cross section) on the basis of the illustration in Brunner and Coman which shows mainly oval hairs, and on the examination of reference hairs. *Macropus fuliginosus* and *Potorous tridactylus* have been placed in Group 4 (hairs predominantly oblong in cross section) whereas Brunner and Coman place them in Group 2 (hairs predominantly oval in cross section). The difficulty in this case appears to lie in the rather subjective interpretation of the difference between oval and oblong sections.

The primary aim in preparing this reference collection of photographs was to provide a method for identifying the hair of the Dibbler, *Antechinus apicalis*. The distinctive character of the hair of this species makes it unlikely that any samples of it would be misidentified, and none was found in any of the predator seats examined.

*Acknowledgements.*—We wish to thank Mr. H. Brunner (Keith Turnbull Research Institute) for instruction in the techniques involved in the identification of hair and Dr. D. J. Kitcbener (Western Australian Museum), Dr. P. Stanbury (Macleay Museum) and Dr. M. B. Renfree (Murdoch University) for hair samples.

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**Journal  
of the  
Royal Society of Western Australia**

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1982

Part 4

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Editor: A. E. Cockbain

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