RECORDS
OF THE
SOUTH AUSTRALIAN MUSEUM

VOLUME 19

Published by the Museum Board

Adelaide 1985–1986

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Nos. 1-5. Published May 1985.

Nos. 6-10. Published June 1986.

Nos. 11-14. Published May 1986.

No. 15. Published August 1986.

Nos. 16-19. Published November 1986.

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A BIBLIOGRAPHY OF ABORIGINAL ARCHAEOLOGY IN SOUTH AUSTRALIA

BY PHILIP G. JONES

Summary

A bibliography of South Australian Aboriginal archaeology, indexed accordingly to subject and region, and citing 600 references, including published and unpublished material is presented.

A BIBLIOGRAPHY OF ABORIGINAL ARCHAEOLOGY IN SOUTH AUSTRALIA

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(Manuscript accepted 30 August 1984)

ABSTRACT

JONES, P. G. 1985. A Bibliography of Aboriginal archaeology in South Australia. *Rec. S. Aust. Mus.* **19**(1): 1-14.

A bibliography of South Australian Aboriginal archaeology, indexed according to subject and region, and citing 600 references, including published and unpublished material is presented.

CONTENTS

INTRODUCTION

Archaeological knowledge is constructed from the available evidence; this bibliography represents an attempt to document this evidence as it relates to South Australia and to make it accessible to researchers.

The bibliography contains a full listing of references relating to the theory and practice of Aboriginal archaeology in South Australia. It cites published and unpublished material extracted from a wide range of sources. Unpublished material has been chosen selectively; only notes or documents of direct significance have been included. Recent newspaper and magazine articles about archaeology are numerous and vary in quality. Only significant examples have been included.

The bibliography falls into three main sections:

A. General

Section A is an introductory section covering relevant legislation and general texts relating to theory, method and developments in South Australian Aboriginal archaeology.

B. Subject Listing

Section B contains subject-related references ("Rock Engravings and Paintings", "Shell Middens" etc.) organized under ten subject headings. Individual entries are cross-referenced to the regional divisions dealt with in Section C by means of alphabetical key letters which follow each entry.

C. Regional Listing (see Fig. 1)

Section C includes references which relate to particular areas in South Australia rather than to specific archaeological subjects as dealt with in Section B. These references have been arranged under a general heading, relating to the State as a whole, and under eight regional headings (a-h). These broad regional divisions reflect a convenient organization of the reference material. They do not represent precise geographic or topographic boundaries or cultural areas.

The subject and regional listings have been used as the most effective means of arranging the quantity and diversity of reference material. The two listings are not mutually exclusive; regional listings in Section C should be supported by relevant material from Section B.

For those conducting archaeological research in specific localities there are two additional sources which may be consulted. Both contain restricted information:

(1) The annual Bibliography of Consulting Reports prepared by the Australian Association of Consulting Archaeologists Incorporated. This can be obtained through the Association, P.O. Box 214, Holme Building, University of Sydney, N.S.W. 2006.

(2) South Australian Archaeological Site Reports. Two different files of these Reports are maintained, one in the South Australian Museum (Anthropology and Archaeology Section) and the other in the South Australian Department of Environment and Planning (Heritage Conservation Branch).

The writer wishes to thank Mrs Joan Murphy for her cooperation and patience in typing this manuscript.

SERIES ABBREVIATIONS USED

A.H.R.	Aboriginal and Historic Relics Unit relocated from South Australian Museum in 1979. Currently operates as part of the Heritage Conservation Branch, Department of Environment and Planning, South Australia
A.I.A.S.	Australian Institute of Aboriginal Studies, Canberra
Am. Antiquity	American Antiquity
American Philosoph. Soc. Mem.	American Philosophical Society Memoir
Annals Aust. Coll. of Dental Surgeons	Annals of the Australian College of Dental Surgeons
Ann. Rev. Anthrop.	Annual Review of Anthropology
Archaeol. in Oceania	Archaeology in Oceania
Arch. Phys. Anthrop. in Oceania	Archaeology and Physical Anthropology in Oceania
Artefact	The Artefact
Asian Persp.	Asian Perspectives
Aust. Ab. Stud	Australian Aboriginal Studies
Aust. Archaeol.	Australian Archaeology
Aust. Archaeol. Assoc. Newsletter	Australian Archeological Society Newsletter
Aust. J. of Botany	Australian Journal of Botany
Aust. J. Sci.	Australian Journal of Science
Aust. Mus. Mag.	Australian Museum Magazine
Aust. Mus. Mem.	Australian Museum Memoirs
Aust. Nat. Hist.	Australian Natural History
Aust. N.Z. Ass. Adv. Sci.	Australian and New Zealand Association for the Advancement of Science
Aust. Quat. Newsl.	Australian Quaternary Newsletter
Cam. U. Press	Cambridge University Press
Curr. Anthrop.	Current Anthropology
E.I.S.	Environmental Impact Statement
F.O.S.A.M.	Friends of the South Australian Museum Newsletter
J. Arch. Science	Journal of Archaeological Science
J. Anthrop. Soc. S. Aust.	Journal of the Anthropological Society of South Australia
J. Biogeogr.	Journal of Biogeography
J. Roy. Anthrop. Inst.	Journal of the Royal Anthropological Institute
J. Roy. Soc. W. Aust.	Journal of the Royal Society of Western Australia
J. Soc. Oceanist.	Journal de la Societe Oceanistes
Nat. Hist.	Natural History
Nat. Mus. Vic. Mem.	National Museum of Victoria Memoirs
New Quart. Cave	New Quarterly Cave Research
O.U.P.	Oxford University Press
Proc. Prehistoric Society	Proceedings of the Prehistoric Society
Proc. Roy. Geog. Soc. Aust., S. Aust. Branch	Proceedings of the Royal Geographical Society of Australia, South Australian Branch
Proc. Roy. Soc. Tas.	Proceedings of the Royal Society of Tasmania
Proc. Roy. Soc. Vic.	Proceedings of the Royal Society of Victoria
Rec. Aust. Mus.	Records of the Australian Museum
Rec. S. Aust. Mus.	Records of the South Australian Museum
Report Aust. Assoc. Adv. Sci.	Report of the Australian Association for the Advancement of Science
Rep. Wash. Geol. Cong.	Report of the Washington Geological Congress
Revue Ethnogr. Tradit. Pop.	Revue D'Ethnographie et des Traditions Populairs
Site Rec. Newsletter	Site Recording Newsletter, Heritage Conservation Branch, Department of Environment and Planning, South Australia
S.A. Mus. A. D.	South Australian Museum Archival Documentation
S. Aust. Nat.	South Australian Naturalist
S. Aust Ornithologist	South Australian Ornithologist
Syd. Univ. Spel. Soc. J.	Sydney University Speleological Society Journal
Trans. Br. Cave. Res. Ass.	Transactions of the British Cave Research Association
Trans. Roy. Soc. S. Aust.	Transactions of the Royal Society of South Australia
Vic. Nat.	Victorian Naturalist

A. GENERAL

(1) *Legislation*

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B. SUBJECT LISTING

(1) *Incised Stones, Cylcons*

AISTON, G. 1929. Magic stones of the tribes east and north-east of Lake Eyre. *Proc. Roy. Soc. Tas.* 47-50. **h**
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* Bold face letters a-h refer to regions listed in Section C.
Bold face letter x refers to several regions or the entire State.

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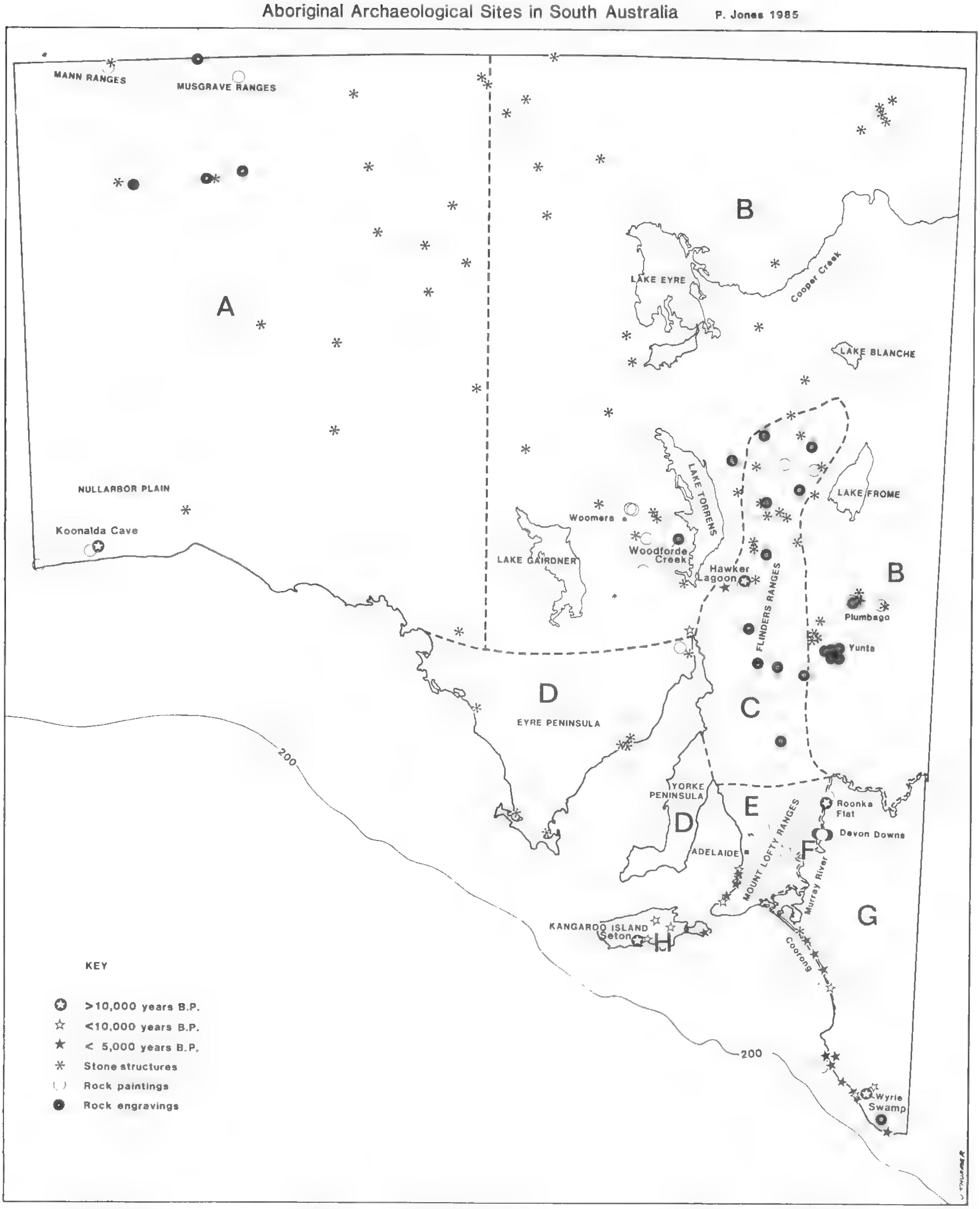

FIG. 1. Map of South Australia showing the regions referred to in the text. Symbols denote localities of different subjects listed (see key for explanation).

A NEW AND INTERESTING SPECIES OF CETHEGUS THORELL (ISCHNOTHELINAE, DIPLURIDAE) FROM SOUTH AUSTRALIA

BY ROBERT J. RAVEN

Summary

A new species, Cethegus ischnotheloides, is described from South Australia. Males possess spine-like bristles on the palpal tarsi that are attenuate as in Ischnothelini.

A NEW AND INTERESTING SPECIES OF *CETHEGUS* THORELL (ISCHNOTHELINAE, DIPLURIDAE) FROM SOUTH AUSTRALIA

by

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(Manuscript accepted 22 March 1983)

ABSTRACT

RAVEN, R. J. 1985. A new and interesting species of *Cethegus* Thorell (Ischnothelinae: Dipluridae) from South Australia. *Rec. S. Aust. Mus.* 19(2): 15-17.

A new species, *Cethegus ischnotheloides,* is described from South Australia. Males possess spine-like bristles on the palpal tarsi that are attenuate as in Ischnothelini.

INTRODUCTION

Until recently, only three species of *Cethegus* were known from Australia (Main 1960). In a revision of Australian Ischnothelinae, Raven (1984) clarified the diagnostic characters of *Cethegus* and *C. fugax* (Simon) and described eight new species. Main (1960) included specimens from eastern South Australia in *C. fugax.* However, Raven (1984) included only specimens from southwestern Australia in that species. When Raven's study was completed, Mr David Lee, Senior Curator of Arachnids and Helminths at the South Australian Museum, presented me with two interesting males of *Cethegus* from central South Australia. One character of these males is unlike that of any other Australian ischnothelinid and requires amendation of the diagnosis of the Euagrini.

Abbreviations are standard for the Araneae and with methods used may be found in Raven (1984). All measurements are in millimetres except eye measurements that are in graticule units, each being 0.025 mm.

SYSTEMATICS

Tribe Euagrini Raven, 1979

Diagnosis

Diplurid spiders with long posterior lateral spinnerets with long apical segment; a hirsute pigmented cuticular crescent surrounds the base of the posterior median spinnerets. No cuspules on labium or maxillae. Spines present or absent on normal or attenuate male palpal tarsi. Cheliceral furrow with one row of teeth on promargin. Trichobothria with corrugiform collar around bases. Tarsal organ low.

Remarks

Previously, the presence of spines on male palpal tarsi was known only for the western European genus *Phyxioschaema* in the Euagrini (Raven, 1981). However, only Ischnothelini (in the Dipluridae) have the characteristic extension of the male palpal tarsi (see Raven, 1983). In most Euagrini, palpal tarsi of males are short and truncate; in *Cethegus ischnotheloides,* the male palpal tarsi are 'spinose' and are slightly elongate apically (unlike other known *Cethegus*).

Tribe Euagrini Raven

Cethegus ischnotheloides n. sp.

(Figs 1-4) (Table 1)

Diagnosis

Males with elongate embolus reaching proximal palpal patella; spine-like bristles present on attenuated palpal tarsi. Sternum with blunt hairs. Females unknown.

Holotype male SAM N1981 394

Carapace 6.56 long, 5.69 wide. Abdomen 5.38 long, 4.13 wide.

Description:

Colour in alcohol: Carapace and legs reddish brown, chelicerae maroon. Abdomen entirely brown.

Carapace: Fovea short, semicircular, deep. Lateral margins with few weak lateral bristles. About 3 pairs of foveal bristles. Striae deep, glabrous. Clypeus 0.18 wide. Black hairs on interstrial ridges.

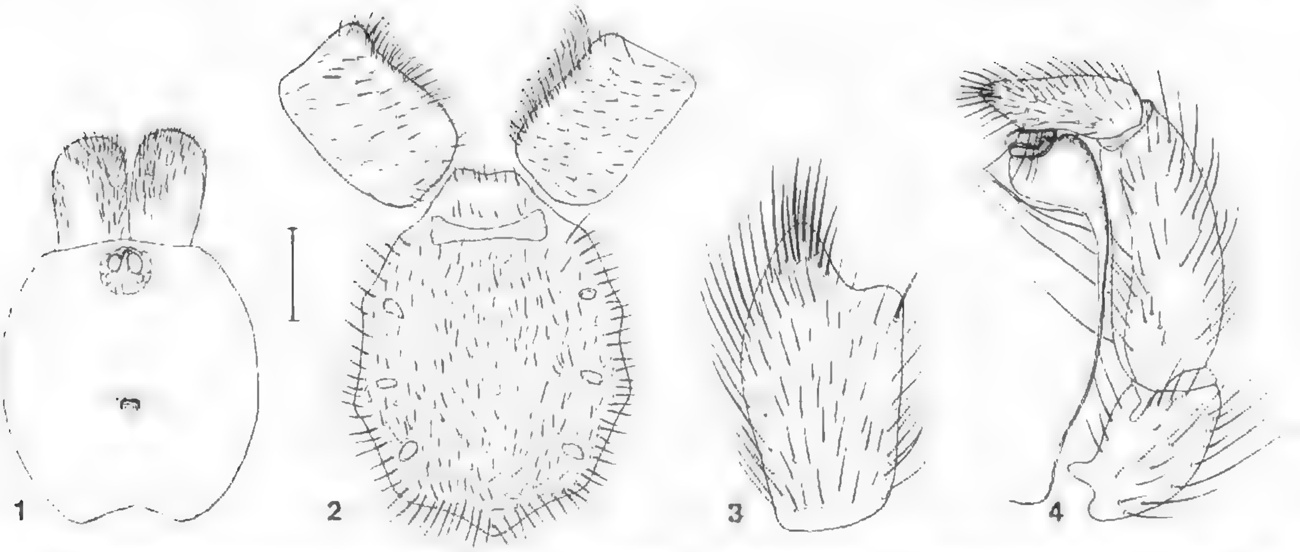
Eyes: On strongly raised tubercle; group is 0.27 times head-width, and is 1.59 times wider than long. Front row centres form strongly procurved line; back row centres form slightly procurved or straight line. Ratio of AME:ALE:PME:PLE, 18:14:11:13. Ratio of MOQ front width:back width:length, 30:33:28. Eye interspaces as AME diameters: AME-AME = ALE-PLE, 0.3; AME-ALE = PME-PLE, 0.05.

Chelicerae: With fine transverse dorsal ridges. Promargin with 4 large and 8 small teeth; basally with 2 fine teeth.

Maxillae: 1.80 long, 1.25 wide; with some short pointed setae; serrula ridge-like.

Labium: 0.63 long, 1.13 wide; groove broad and continuous.

Sternum: 3.52 long, 2.92 wide; all sigilla oval; posterior and middle sigilla 0.18 long and away from



FIGS. 1-4. *Cethegus ischnotheloides* n.sp. male holotype. 1. carapace and chelicerae. 2. sternum, maxillae and labium. 3. dorsal palpal tarsus showing attenuation and spine-like bristles. 4. retrolateral palpal patella, tibia and tarsus. Scale line = 2 mm for fig. 1; 1 mm for figs 2, 4; 0.5 mm for fig. 3.

margin; anterior sigilla 0.20 long and 0.25 away from margin. Setae long erect or short blunt.

Palp: Bulb pyriform; embolus long, tapering, extending to proximal patellae; tibia with slight ventral groove; tarsus slightly pointed with cluster of slender spine-like bristles.

Legs: Leg formula, 4321. Leg I smooth, cylindrical. Tarsi III and IV erect hairs forming weak scopula divided by setae. *Spines.* No true spines on femora or patellae. Leg 1: tibia, p1 v2; metatarsus, p2 v2; tarsus, v4. Leg 2: tibia, p2 v3; metatarsus, p3 v5; tarsus, v5. Leg 3: tibia, p3 di r3 v6; metatarsus, p11 r5 v8; tarsus d3 v7. Leg 4: tibia, p4 r4 v7; metatarsus, p9 d3 r5 v6; tarsus d4 v9. Palp: 0. *Claws:* 12 fine teeth on paired claws; 3 fine teeth on unpaired claw. *Trichobothria:* Two rows, each of 10, on tibiae; about 10, in a line on metatarsi; 8, of different length on tarsi in irregular row.

Spinnerets: Posterior medians 1.20 long, 0.36 in diameter and 0.68 apart; crescent of cuticle present as darkened area forming an anterior fold. Basal, middle, apical and total articles of posterior laterals, 1.92, 1.64, 2.04, 5.60 long respectively.

Material examined: Holotype male (N1981394), paratype male (N1981395), sand dunes, Commonwealth Hill Station, 29°57'S., 134°10'E., South Australia, April, 1981, P. Bird, R. Sinclair, deposited S.A.M.

Distribution: Central South Australia.

TABLE 1. LEG MEASUREMENTS OF *CETHEGUS ISCHNOTHELOIDES*.
VALUES ARE FOR MALE HOLOTYPE.

	Leg I	Leg II	Leg III	Leg IV	Palp
Femur	5.13	5.06	5.00	6.25	3.44
Patella	2.94	2.81	2.81	3.19	1.94
Tibia	3.19	3.19	3.31	3.56	2.81
Metatarsus	4.69	5.06	5.94	6.44	—
Tarsus	2.25	2.69	3.19	3.75	1.69
Total	18.20	18.81	20.25	23.19	9.88

Remarks: Males of *Cethegus ischnotheloides* differ from those of *C. fugax* in the 'spinose' pointed palpal tarsi.

PHYLOGENETIC AND BIOGEOGRAPHIC SIGNIFICANCE

Inasmuch as males of *C. ischnotheloides* possess 'spinose' pointed palpal tarsi, they differ from males of all other Australian Euagrini and bear some resemblance to male Ischnothelini. However, because spinose male palpal tarsi are also found in genera of Masteriinae and Diplurinae, the presence of spines may be regarded either as a symplesiomorphy or a parallelism—a hypothesis involving their synapomorphy is falsified by the absence of cuspules and the presence of corrugiform trichobothrial base collars in Euagrini. I here regard the presence of spinose palpal tarsi in Ischnothelinae as a plesiomorphic retention. However, parsimoniously, the attenuated palpal tarsus of males of *C. ischnotheloides* is presumably a parallelism otherwise *Cethegus* and *Ischnothele* are paraphyletic.

That a Western Australian euagrine should retain characters otherwise present only in Indian and Neotropical (*Ischnothele*) and Ethiopian (*Lathrothele* and *Thelechoris*) genera is probably predictable. Some geologists (e.g. Powell et al., 1981) propose that pre-drift India was in close contact with Western Australia. If that were so, some sharing of taxa dating to that period is to be expected. Spiders of the genus *Cethegus*, as defined by Raven (1984), are predominantly xerophilic although a number of species occur in northeastern Queensland. Throughout its range, to my knowledge, *Cethegus* is allopatric with other euagrine genera. I suggest that *Cethegus* represents a group that was first isolated in Australia as the most plesiomorphic genus (that proposition will be discussed more completely elsewhere) and as such has retained characters of the presumed sister group of the Euagrini, the Ischnothelini. Therefore, *Cethegus ischnotheloides* may be the most plesiomorphic *Cethegus* species.

ACKNOWLEDGMENTS

I am grateful to Mrs V. E. Davies and R. Molnar for commenting upon this manuscript, to Mr David Lee for bringing the spiders to my attention and to Ms R. Owens for carefully typing the manuscript.

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MILLIPEDES FROM AUSTRALIA, 5: AUSTRALIOSOMATINI FROM SOUTH AUSTRALIA, WITH A NOTE ON THE STATUS OF POLYDESMUS INNOTATUS KARSCH, AND FIRST RECORD OF A SECOND MEDITERRANEAN JULID IN AUSTRALIA (DIPLOPODA: POLYDESMIDA, PARADOXOSOMATIDAE & JULEDA, JULIDAE)

BY C. A. W. JEEKEL

Summary

Two new species of the genus Heterocladosoma Jeekel, H. zebratus and H. galaxias, and one of the genus Somethus Chamberlin, S. grossi, are described. Australiosoma castaneum Attems is redescribed and made the type-species of a new genus Oncocladosoma, which is probably related to Somethus, Dicladosomella Jeekel and Phyllocladosoma Jeekel. A new subspecies, O. castaneum ingens, and two new species, O. conigerum and O. clavigerum, are added to the new genus. The holotype of Polydesmus innotatus Karsch, a subadult female, has been re-examined; it may be referable to a genus close to Otoplacosoma Verhoeff (tribe Antichiropodini). A list of the known South Australian Paradoxosomatidae is given, and some distributional patterns are briefly discussed. Brachyiulus lusitanus Verhoeff, a west Mediterranean julid, is recorded from a number of South Australian localities.

MILLIPEDES FROM AUSTRALIA, 5: AUSTRALIOSOMATINI FROM SOUTH AUSTRALIA, WITH A NOTE ON THE STATUS OF *POLYDESMUS INNOTATUS* KARSCH, AND FIRST RECORD OF A SECOND MEDITERRANEAN JULID IN AUSTRALIA (DIPLOPODA: POLYDESMIDA, PARADOXOSOMATIDAE & JULIDA, JULIDAE)

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(*Manuscript accepted 22 September 1983*)

ABSTRACT

JEEKEL, C. A. W. 1985. Millipedes from Australia, 5: Australiosomatini from South Australia, with a note on the status of *Polydesmus innotatus* Karsch and first record of a second Mediterranean julid in Australia (Diplopoda: Polydesmida, Paradoxosomatidae & Julida, Julidae). *Rec. S. Aust. Mus* 19(3): 19-37.

Two new species of the genus *Heterocladosoma* Jeekel, *H. zebratus* and *H. galaxias*, and one of the genus *Somethus* Chamberlin, *S. grossi*, are described. *Australiosoma castaneum* Attems is redescribed and made the type-species of a new genus *Oncocladosoma*, which is probably related to *Somethus*, *Dicladosomella* Jeekel and *Phyllocladosoma* Jeekel. A new subspecies, *O. castaneum ingens*, and two new species, *O. conigerum* and *O. clavigerum*, are added to the new genus. The holotype of *Polydesmus innotatus* Karsch, a subadult female, has been re-examined; it may be referable to a genus close to *Otoplacosoma* Verhoeff (tribe Antichiropodini). A list of the known South Australian Paradoxosomatidae is given, and some distributional patterns are briefly discussed. *Brachyiulus lusitanus* Verhoeff, a west Mediterranean julid, is recorded from a number of South Australian localities.

INTRODUCTION

This is the second of two papers treating the Paradoxosomatidae of South Australia. The first paper dealt with the Antichiropodini (Jeekel 1982a) and the present contribution treats the Australiosomatini of the State. As pointed out already, our knowledge of the millipedes of South Australia is extremely scanty. In the family Paradoxosomatidae only two species had been described: *Polydesmus (Strongylosoma) innotatus* Karsch, 1881, an unrecognizable species of uncertain taxonomic status, and *Australiosoma castaneum* Attems, 1944, a reasonably well characterized but as yet not correctly classified species (cf. Jeekel 1968: 26).

The material reported upon was received on loan from the South Australian Museum, Adelaide. It had been collected mostly in the surroundings of Adelaide, and only few samples from elsewhere were available. Nevertheless, it gives a fair first impression of the composition of the fauna, and indicates that South Australia has a relatively rich representation of Paradoxosomatidae (together with the suborder Cambalidea of the order Spirostreptida the family appears to be the dominant millipede group) with still many new species to be expected.

The type-specimen of *Polydesmus innotatus* Karsch has been re-examined, but it is a subadult female, which cannot be associated with any of the other South Australian paradoxosomatids at hand. Neither can it be referred with certainty to either of the two relevant Australian paradoxosomatid tribes.

It has been pointed out earlier (Jeekel 1981: 20) that records of millipedes introduced into Australia from elsewhere are few. The material in the South Australian Museum contains, besides some specimens of *Ommatoiulus moreleti* (Lucas), a species now known to have become widespread in a large part of South Australia, also a number of samples of *Brachyiulus lusitanus* Verhoeff, a Mediterranean julid known to have synanthrope tendencies, but as yet recorded only a few times from outside the palearctic region.

The bulk of the material treated, including the types of the new species, is preserved in the South Australian Museum, some paratypes and voucher specimens have been retained by the author for the Zoological Museum at Amsterdam.

SOUTH AUSTRALIAN AUSTRALIOSOMATINI

Heterocladosoma Jeekel

Heterocladosoma Jeekel, 1968: 144.

Type-species: Eustrongylosoma bifalcatum Silvestri, 1898.

Remarks

This genus was proposed for three species occurring in the coastal region of Queensland. The quite unexpected discovery of two new species in South Australia extends the range of the genus considerably and establishes an important faunistic link between the fauna of South Australia and that of the Australian east coast.

Heterocladosoma is well characterized by two tibiotarsal branches arising from the base of the acropodite of the gonopod, one narrow lanceolate, the other more voluminous, broadly laminate and apically more or less recurved. The femoral process is coalesced with the solenomerite over most of its length, its free part arising from the distal part of the channel-bearing branch of the gonopod as in *Somethus* Chamberlin. But contrary to *Somethus*, which has only one tibiotarsal branch, the spermal channel does not make a loop, but runs straight towards the apex of the solenomerite.

Heterocladosoma zebratum n. sp.

Material

Coralbignie to Buckleboo, South Australia, 15-16.III.1950, leg. G. F. Gross, ♂ holotype, 3 ♀ paratypes.

North of Kokotha, South Australia, 11.VI.1956, burnt out of spinifex, leg. G. F. Gross, 1 ♂ paratype.

Nonning, Gawler Ranges, South Australia, 17. VI. 1956, burnt out of spinifex (*Triodia* sp.), leg. G. F. Gross, 1 ♂ paratype.

Description

Colour: Probably somewhat faded. Head with clypeus, frons and anterior part of vertex brown; remainder, including lateral sclerites brownish yellow. Antennae light brown, infuscate towards apex of 6th antennomere; 7th antennomere black, its tip whitish. Intersegmental membranes of antennae brownish yellow. Collum with a broad zone along anterior and lateral margins brown, remaining part brownish yellow. Subsequent somites with a rather narrow zone of the prosomites adjacent to waist, the waist itself, and the part of metatergites adjacent to waist, about halfway towards the transverse furrow, brown, fading below the level of paranota to brownish yellow. Remaining parts of pro- and metasomites brownish yellow. Venter and sternites brownish yellow. Legs brown, with pale intersegmental membranes and a pale tarsal tip. Anal somite dorsally brownish yellow, sides brown; margins yellowish. Paraprocts brown, with brownish yellow margins. Hypoproct yellowish.

Width: ♂: 2.5-3.5 mm, ♀: 3.2-3.5 mm.

Head and antennae: Labrum widely and rather weakly emarginate. Clypeus rather strongly impressed towards labrum and with an impression on each side below antennal sockets. Lateral border widely convex, weakly emarginate near labrum. Surface uneven due to the presence of setiferous pits. Pubescence moderate, setae of moderate length. Lateral parts of head almost hairless. Frons not demarcated from clypeus or vertex, sparsely setiferous. Antennal sockets separated by 1.5 times diameter of a socket or by 0.7 times the length of 2nd antennomere. Postantennal groove rather deep and wide, the wall in front moderately prominent. Postantennal bean-shaped area indistinct, weakly demarcated and not inflated. Vertex longitudinally widely convex, more strongly so near collum; transversely faintly concave, and laterally rather strongly convex, but without inflated lateral edges. Vertigial sulcus moderately impressed, running downward to upper level of sockets. Vertex hairless. Antennae rather long and slender, weakly clavate, with 5th and 6th antennomeres thickest. Antennomeres subcylindrical, but 5th and 6th a little more obconical; 6th antennomere not inflated. Pubescence moderate in proximal antennomeres, becoming rather dense in the distal ones. Relative length of antennomeres 2 to 6: 0.95, 1.00, 0.95, 0.95, 0.90.

Collum: About as wide as head, subtrapezoidal in dorsal outline. Anterior border straight in middle, widely rounded more laterally and straight again towards lateral sides. Posterior border widely and weakly concave, laterally rather weakly convex. Lateral sides almost evenly and rather narrowly rounded. Marginal rim laterally a little incrassate, not brimlike. Premarginal furrow distinct, vanishing towards middle of anterior border. Surface smooth, hairless, transversely widely and evenly convex in middle to become somewhat more strongly convex laterally; longitudinally widely convex, a little more strongly so near anterior border.

Somites: Rather weakly constricted. Prosomites dulled by a fine cellular structure. Waist narrow, rather sharply demarcated from pro- and metasomite, dorsally distinctly beaded down to level of paranota, weakly striolate along sides. Metatergites smooth, shiny, hairless. Transverse furrow present from 5th to 17th somite, weakly indicated on 4th and 18th somites. Furrow rather well impressed, with a vague sculpture, disappearing laterally at a distance from dorsal furrow of paranota about equal to dorsoventral diameter of a poriferous paranotum. Sides smooth in general, but up to 4th somite somewhat granulose. Pleural keels up to 3rd somite represented by rather distinct curved crenulate ridges, concavity upwards, without posterior lappet. Pleural keels in 4th somite vestigial, in 5th absent. Sixth somite with a weak posterior swelling and 7th with a low conical swelling near posterior margin of somite.

Paranota: 2nd somite a little wider than collum. In dorsal aspect anterior border rounded and slightly shouldered at base; latero-anterior edge narrowly rounded, without distinct lateral tooth. Lateral border widely and almost evenly rounded. Latero-posterior edge subangular, narrowly rounded, a little produced caudad and projecting weakly behind margin of somite. Posterior margin very short and a little concave. In lateral aspect upper side straight, sloping a little in anterior direction. Marginal rim rather thick, a little callous; upper furrow distinct, also along anterior and posterior margins. Third somite a little wider than 2nd and as wide as 4th. Paranota of 3rd somite in dorsal aspect widely and evenly rounded, a little more narrowly rounded anteriorly. Latero-posterior edge angular and a little produced caudad, but not projecting behind margin of somite. Posterior border short, straight. In lateral aspect upper margin straight, curving abruptly dorsad anteriorly. Dorso-ventral width not much larger than that of paranota of 2nd somite; ventral demarcation by a distinct impression, reaching forward to about three-fifths length of metasomite. Paranota of 4th somite rather similar to 3rd. In dorsal aspect more widely curved than in 3rd somite, with posterior edge subangular, not produced caudad, and posterior border straight. In lateral aspect upper margin curved dorsad more widely. Dorso-ventral width as in 3rd somite, but ventral demarcation reaching cephalad to about halfway. Paranota of 5th somite rather weakly developed and rather weakly prominent. Margin in dorsal aspect widely convex. Posterior edge subangular in poreless somites, narrowly rounded in poriferous somites. In posterior somites posterior edges become minutely angular and produced a little caudad from 14th somite onwards, projecting only a little behind caudal margin of somite in 17th and 18th somites. In lateral aspect dorsal demarcation of paranota weakly concave anteriorly, weakly convex posteriorly in poriferous somites, about straight in poreless somites. Dorsal furrow anteriorly rather abruptly curving upwards, but not reaching waist. Paranota dorsoventrally not wide, rather narrow, especially in poreless somites. Ventral demarcation by a depression reaching cephalad to about halfway or two-fifths length of metasomite. Posterior edges in lateral aspect acutely angular, especially in poreless somites. In poreless somites ventral demarcation a little concave.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.3:1.0). Cross impressions well developed; longitudinal impression rather wide; transverse impression also rather wide, but narrow between coxae. No sternal cones. Pubescence rather dense, especially near bases of coxae; hairs of moderate length. Sternite of 4th somite rather broad, rather densely setiferous, and transversely rather widely concave. Sternite of 5th somite with a broad process arising between and slightly in front of anterior coxae; at base the process is a little wider than distance between coxae. Process short, projecting downward, widely rounded. Anterior side a little concave with dense brush of short setae. Posterior side faintly convex with some long hairs. Transverse impression deep. Posterior part of sternite excavate, but not down to level of metasomal ring; not raised at base of coxae. A group of long setae in the middle. Sternite of 6th somite deeply excavate; posteriorly level with metasomal ring but anteriorly a little raised above level as in posterior part of sternite of 5th somite. Coxal bases not raised, but coxae of legs distinctly elongate. Transverse impression wide and shallow. Four areas with long setae arranged in a square. Sternite of 7th somite with a low and rather narrow, finely granular ridge laterocephalad of gonopod aperture. Sternite of 8th somite excavate, particularly in anterior half, and raised only a little above ventral level of metasomal ring. Transverse impression weakly developed. Legs rather long and slender, prefemora rather convex dorsally. Pubescence on ventral side rather dense in all podomeres. Hairs moderately long. Tarsi pubescent on all sides. Femora almost straight. Tibial and tarsal scopulae present on anterior legs but soon thinning out and absent from legs of 7th somite onwards. First leg strongly incrassate. Coxa of 2nd leg with a short medial rounded cone. Relative length of podomeres 2 to 6 in middle somites: 0.65, 1.00, 0.60, 0.55, 0.75.

Anal somite: Dorsal profile straight or faintly convex. Sides of epiproct concavely converging, before apex a slight indication of an abrupt stepwise narrowing, quite near apex. Apex of epiproct with lateral edges narrowly rounded and posterior margin weakly concave. Epiproct broad at base, distally still rather broad. Dorsoventral width moderate, length moderate. Setae not on tubercles. Paraprocts with narrow, moderately high rims. Setae not on tubercles. Hypoproct large triangular, parabolically rounded with sides convex and apex more narrowly rounded. Setae not on tubercles.

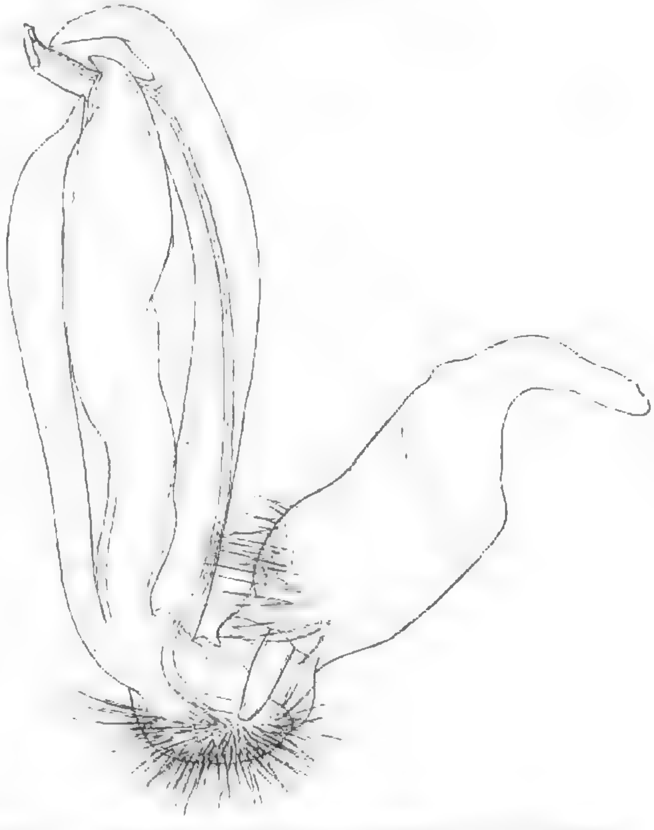


FIG. 1. *Heterocladosoma zebratum* n. sp., holotype♂, right gonopod, medial aspect.

Gonopods: (Fig. 1) Coxa somewhat elongate, rather stout at base, but narrowing distad. Setiferous area rather large. Prefemur short, ovoid; its distal demarcation transverse on axis of acropodite. Tibiotarsal branches both well developed; caudal one lanceolate, widening a little distad; anterior one stouter, more irregular in shape, and ending in an acuminate somewhat uncate apex. Solenomerite well developed, with permal channel running along medial side, widely curved and apically narrowing to solenomerite proper, which curves a little mesad. Femoral process arising quite near apex of solenomerite, curving caudad, about as long as solenomerite proper, apex acuminate.

Female: Sternites as long as wide. Pubescence of legs and sterna less conspicuous than in male. Legs shorter, prefemora not incrassate. Relative length of podomeres 2 to 6 in middle somites: 0.80, 1.00, 0.50, 0.50, 0.85. Head with vertex transversely more evenly convex, not particularly flattened in middle and without lateral swellings. Collum with anterior border much more evenly convex and only a little more strongly rounded laterally. Pleural keels of 2nd somite produced into a long process; of 3rd somite in a long posterior cone; in 4th somite only a minor cone near caudal margin. Coxa of 2nd leg with a dagger-like process arising from ecto-caudal side of apex, pointing latero-ventrad. Epigynal structure consisting of two paramedian wide emarginations separated medially by a low conical process pointing cephalad.

Remarks

The three previously described species of *Heterocladosoma*, viz *H. bifalcatum* (Silvestri, 1898), *H. transversetaeniatum* (L. Koch, 1867), and *H. hamuligerum* (Verhoeff, 1924), are all from the coastal region of Queensland between Cairns and Brisbane. Compared to *H. zebratum* and *H. galaxias* these three species are different in that the largest tibiotarsal branch projects a little distad of the seminiferous branch. *H. hamuligerum* is distinct in having the seminiferous branch apically divided into three processes, a solenomerite and two, or possibly one, deeply split femoral branches. In *H. transversetaeniatum* and *H. bifalcatum* the bifurcation of the seminiferous branch into solenomerite and femoral process is situated closer to the base of the branch, resulting in a relatively greater length of the two distal processes. *H. transversetaeniatum* is particularly distinct in its voluminous gonopod telopodite and in the apex of the larger tibiotarsal branch which is strongly recurved forming an elongate spinelike production. As yet it is not clear to which of the three Queensland species *H. zebratum* and *H. galaxias* are most closely related, but on account of the total configuration of the gonopods these new species seem to approach *H. bifalcatum* more than the others.

Heterocladosoma galaxias n. sp.

Material

Gammon Plateau, South Australia, 19.IX.1956, leg. G. F. Gross, ♂ holotype.

Description

Colour: Head dark brown, with labral area, an area around antennal sockets and sutures of lateral sclerites yellowish brown. Antennae dark brown, with 6th and 7th antennomeres darkest; intersegmental membranes yellowish, tip whitish. Collum blackish brown, with a pair of semilunate yellowish white spots at caudal margin, almost touching medially and continued laterally in a yellowish streak along caudal margin, disappearing near lateral rounding. Somites blackish brown, ventrally paler. Sternites and legs rather dark brown. Dorsum marked by two series of paramedian oval yellowish white spots, occupying the metatergites from halfway between waist and transverse furrow, and prosomites of the next somite to about halfway to its waist. Lateral sides a shade paler brown in their posterior third. Anal somite dark, but ventral side including hypoproct paler brownish; epiproct entirely yellowish white.

Width: 3.3 mm.

Head and antennae: As in the preceding species, but differing in antennal sockets being a little closer to each other, and separated by 1.35 times diameter of a socket, or by 0.6 times length of 2nd antennomere. Antennae with distal antennomeres a little shorter; relative length of antennomeres 2 to 6: 0.95, 1.00, 0.95, 0.85, 0.75.

Collum: Differing only in being a little wider than head.

Somites: Waist rather narrow, distinctly demarcated from both pro- and metasomites, dorsally not beaded, but faintly longitudinally striate down to level of stigmata. Pleural keels in 4th somite weakly developed.

Paranota: Posterior edge of paranota of 2nd somite, not caudally produced, posterior border obsolete. In lateral aspect the upper margin curves a little upward caudally. Posterior edge of paranota of 3rd somite produced a little and projecting slightly caudad of margin. Posterior edges of paranota of 5th and subsequent somites narrowly rounded in dorsal aspect, becoming subangular in 14th somite only, not produced caudad. Ventral demarcation of paranota reaching cephalad to about three fifths of length of metasomite. Posterior edges in lateral aspect rather narrowly truncate in poreless somites, more widely and more obliquely truncate in poriferous somites.

Sternites and legs: Similar to those of the preceding species. Sternal cones are weakly indicated in sternites of middle part of body. Sternite of 5th somite with process directed downward and a little cephalad, projecting scarcely in front of the sternite. Process rather short, its apex quite widely triangular, medially rounded. In lateral aspect posterior side of process straight, with a transverse concavity at its base. Legs rather long and moderately stout. Relative length of podomeres 2 to 6 in middle somites: 0.50, 1.00, 0.55, 0.55, 0.70.

Anal somite: Epiproct almost parabolically rounded; apex rather narrowly rounded, medially straight and not emarginate.

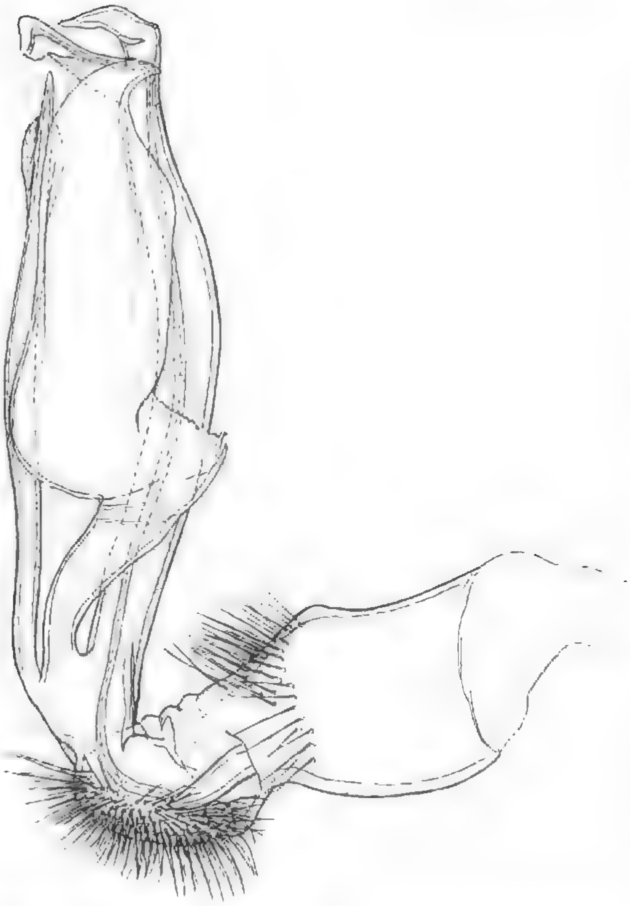


FIG. 2. *Heterocladosoma galaxius* n. sp., holotype ♂, right gonopod, medial aspect.

Gonopods: (Fig. 2) Largely similar to those of the preceding species, but anterior tibiotarsal branch quite different: narrow at base, gradually widening distad, sharply crooked, and curving rather abruptly distad again; terminal part rather voluminous and tapering towards apex and somewhat uncate. Posterior tibiotarsal process distally widening, then rather abruptly narrowing and ending in a narrow spinelike process (strongly reminiscent of a similar structure in *Streptocladosoma dissimile* Jeekel (1980: 8, Figs 8-9.)

Female: Unknown.

Remarks

Although this species is obviously closely related to *H. zebratum,* it is easily distinguished by its very distinctive colour pattern, by differences in the structure of the gonopods, and some other features like the different sculpture of the waist, the slightly stronger development of the pleural keels, the less prominent paranota, and the presence of weak sternal cones.

Somethus Chamberlin

Somethus Chamberlin, 1920: 651; Jeekel, 1968: 27; Jeekel, 1979: 651.

Type-species: Somethus fuscipes Chamberlin, 1920.

Remarks

This genus was erected by Chamberlin for the reception of a single species from an unknown Australian locality. Unfortunately, the original description was not accompanied by a drawing of the gonopod of the type-species. On that account the placement in the tribe Australiosomatini was somewhat arbitrary (Jeekel 1968). A re-examination of the type material (Jeekel 1979) confirmed the placement. However, with regard to the gonopod structure, doubt still exists on the true identity of the species.

The discovery of some species of the genus in northern Tasmania and Victoria, to be published elsewhere, and the new species described hereunder has proved that *Somethus* is a well-defined genus characterized in particular by having a single tibiotarsal branch, arising from near the base of the acropodite of the gonopod, a small femoral process emanating from the channel-bearing branch of the gonopod more or less near its apex, and a short solenomerite proper, having a triangular additional process, in which the spermal channel makes a loop before running towards the apex of the solenomerite.

The record of *Somethus grossi* n. sp. from South Australia extends the distribution westward into the moister parts of that State. It seems likely that the type-species may be found sooner or later somewhere in southeastern Australia also.

Somethus appears to be closely related on the one hand to *Phyllocladosoma* Jeekel, 1968, and *Dicladosomella* Jeekel, 1982, in which the femoral process is completely lost and the tibiotarsal branch more broadly expanded, and on the other hand to *Oncocladosoma* n. gen., in which the femoral process is vestigial or absent and the tibiotarsus is also more voluminous and more or less clubshaped. The four mentioned genera are furthermore each characterised by a particular size and curvature of the solenomerite proper.

Somethus grossi n. sp.

Material

Rankin Creek, near Melrose, South Australia, 13.VI.1954, leg. G. F. Gross (E.S.I. 1355), ♂ holotype, 1 ♀ paratype.

Same locality, date and collector (E.S.I. 1335), 3 ♂ paratypes.

Description

Colour: Head brown, with labral area, an area around the antennal sockets, and lateral sclerites of head yellowish. Antennae yellowish to brown, with 6th and basal part of 7th antennomere darkest. Collum brown, with traces of a rather narrow, medially widest, transverse band along posterior margin. Somites also brownish, with most of area behind the transverse furrow, including posterior half of paranota, yellowish.

Venter, sternites and legs yellowish. Anal somite brown, but most of epiproct, and margins of paraprocts, and hypoproct yellowish. The material appears to have lost much of its original colour and the brown colour may have been blackish brown in living specimens.

Width: ♂: 3.2-3.4 mm, ♀: 3.7 mm.

Head and antennae: Labral emargination of moderate width and depth. Clypeus very strongly impressed towards the labrum, the impression crescentic in shape, and surface above it a little inflated. Clypeus with setiferous pits, moderately densely pubescent; on each side below antennal sockets a rather weak impression. Setae rather short. Lateral border of clypeus widely and weakly convex, a notch near the labrum. Lateral sclerites of head hairless. Frons not demarcated from clypeus or vertex, smooth, hairless. Antennal sockets separated by 1.6 times diameter of a socket or by 0.7 times length of the 2nd antennomere. Postantennal groove rather deep and moderately wide, wall in front rather prominent. Bean-shaped area at posterior margin of antennal sockets rather distinctly demarcated, slightly inflated. Vertex almost evenly convex longitudinally, slightly more convex near collum; almost flat or even a little concave transversely; lateral edges rounded and somewhat inflated. Vertex smooth, shiny, hairless; vertigial sulcus rather deeply impressed, not reaching upper level of the antennal sockets. Antennae rather long, slender, hardly clavate. Antenomeres subcylindrical; 6th slightly more obconical but not inflated. Pubescence moderate in proximal antennomeres becoming dense in distal ones. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.90, 0.80, 0.70.

Collum: A little wider than head, subtrapezoidal in dorsal outline. Anterior border straight or very faintly concave, widely rounded more laterally and straight again towards lateral sides. Posterior border widely emarginate in middle, widely rounded towards lateral sides. Lateral border moderately widely and symmetrically rounded. Surface transversely weakly convex, laterally more strongly so, and even slightly incurved at sides. Longitudinally surface evenly widely convex. Lateral margin with a narrow and low rim; premarginal furrow distinct, disappearing at level of the lateral edge of the vertex. Surface smooth, shiny and hairless.

Somites: Rather weakly constricted. Prosomites dulled by a fine cellular structure and with fine striae. Waist narrow, rather distinctly demarcated from pro- and metasomites, dorsally finely but distinctly longitudinally ribbed down to the level of the paranota, faintly striolate below that level. Metatergites smooth or with some fine wrinkles, shiny and hairless. Transverse furrow present on 5th to 16th somites, vaguely also on 17th somite. Furrow moderately impressed and with some vague sculpturing, running laterad to a distance from upper margin of paranota equal to the dorso-ventral diameter of a poriferous paranotum. Sides smooth, or somewhat irregularly and finely wrinkled, shiny. Anterior somites up to 4th with sides a little subgranularly uneven. No pleural keels.

Paranota: 2nd somite a little wider than the collum. Lateral border in dorsal outline straight anteriorly and a little diverging in caudal direction, and widely convex posteriorly. Latero-posterior edge narrowly rounded, incurved so as to be slightly produced and projecting a little behind margin of somite. Posterior border almost obsolete. Anterior border moderately widely rounded, latero-anterior edge narrowly rounded, with a small, almost obsolete lateral tooth. In lateral aspect upper margin widely and weakly concave dorsally, situated on a low level, and therefore scarcely visible from above; upper margin slightly sloping in anterior direction. Paranotum dorsoventrally rather narrow. The upper furrow distinct along all margins including the anterior and posterior. Third somite a little narrower than 2nd and a little wider than 4th. Paranota in dorsal aspect evenly rounded, anteriorly and posteriorly more narrowly. Posterior edges particularly in 3rd somite angular, in 3rd somite slightly produced caudad, but not projecting behind margin of the somite; in 4th narrowly rounded and not produced. Posterior border in 3rd somite very short, almost obsolete, in 4th obsolete. In lateral aspect paranota of 3rd and 4th somites with a widely concave upper margin, rather abruptly curving dorsad anteriorly, posteriorly curving upwards and shortly paralleling posterior margin of somite. Dorso-ventral width rather narrow to moderate. Lower demarcation formed by a depression reaching cephalad to about two fifths of length of metasomite. Posterior edges of paranota in lateral aspect acuminate. Paranota of 5th and subsequent somites rather weakly prominent. In dorsal aspect lateral margin of poriferous paranota widely rounded, with a faint emargination from pore area to caudal edge. Lateral rounding of poreless paranota a little wider. Posterior edge of paranota narrowly rounded, but in poreless somites and in poriferous somites of caudal half of body posterior edges become more angular and quite weakly produced caudad, though not projecting behind the margin. Posterior border quite short, convex in poriferous to a little emarginate in poreless somites. In lateral aspect upper margin is faintly concave anteriorly and a little convex posteriorly in poriferous somites, straight or even faintly concave in poreless somites. Dorsal furrow curving a little upward anteriorly, not reaching waist but running cephalad to about four-fifths length of metasomite. Dorsal furrow caudally curving abruptly dorsad and briefly parallelling posterior margin of somite. Ventral impression demarcating the paranota visible up to about two-fifths of length of metasomite in both poriferous and poreless somites. Dorso-ventral width of paranota rather narrow, the poreless only a little narrower than the poriferous. Paranota not callous. Pores of moderate size, situated at anterior end of an oval excavation. Posterior edges of paranota in lateral aspect more or less acuminate.

Sternites and legs: Sternites of middle somites longer than wide (ratio: 1.6:1.0). Cross-impressions strongly developed, with deep longitudinal and transverse impressions. At bases of coxae rather large rounded conical protuberances projecting downward and a little caudad, distinct particularly at anterior pair of coxae and especially in 9th, 10th and 11th somites, becoming less distinct in posterior somites. Pubescence of sternites dense, with setae of moderate length. Sternite of 4th somite rather widely and moderately deeply excavate, moderately setiferous, with long setae. Sternite of 5th somite with a low hump between anterior legs, which is produced into a large shovel-like process a little in front of coxal bases. This process is directed cephalad at base, crooked halfway so as to become directed more ventrad distally. Process projecting distinctly in front of sternite. Posterior surface in lateral aspect convex at base, more distally concave; anterior surface convex in profile, apically provided with a dense brush of short setae. Process a little broader than distance between anterior coxae, distally quite broadly rounded, subangular in the middle. Posterior surface rather weakly pubescent with long setae. Transverse impression distinct and deep. Posterior part of sternite raised as a transverse, rounded wall, without longitudinal impression, densely set with long setae. Sternite of 6th somite not raised above ventral level of metasomal ring, deeply excavate. Coxal bases scarcely raised. Pubescence moderate, with long hairs. Transverse impression weak. Sternite of 7th somite with a large gonopod aperture pressing the ambulatory legs a little laterad. Latero-cephalad of aperture a rather low callous wall. Sternite of 8th somite anteriorly widely concave and only slightly raised above ventral level of metasomal ring. Anterior coxal bases not raised, distinctly more separated than posterior. Transverse impression weak. Pubescence dense, with long setae. Legs of moderate length, rather stout. Prefemur dorsally moderately convex, femora faintly arched. Pubescence dense on ventral side of all podomeres and on all sides of the tarsi and the anterior tibiae, remaining surfaces without apparent pubescence. Hairs rather long. Scopulae present on tibiae and tarsi of all legs up to 6th somite, absent on all postgonopodal legs. Relative length of podomeres 2 to 6 in middle somites: 0.60, 1.00, 0.65, 0.55, 0.75. First leg strongly incrassate, with the usual ventral femoral tubercle. Coxae of 2nd legs ventro-apically thickly rounded, but not projecting.

Anal somite: Upper profile faintly convex, almost straight. Surface somewhat wrinkled. Epiproct of moderate length and thickness, slightly concave on ventral side, broad at base with sides concavely converging, more distally straight and convex towards apex. Near apex a slight stepwise narrowing. Apex truncate and a little emarginate, lateral edges narrowly rounded. Setae not on tubercles. Valves with rather narrow and moderately high rims. Setae on minute tubercles. Hypoproct large and triangular, parabolically rounded with sides widely and apex more narrowly rounded. Setae on small tubercles which do not project outside margin.

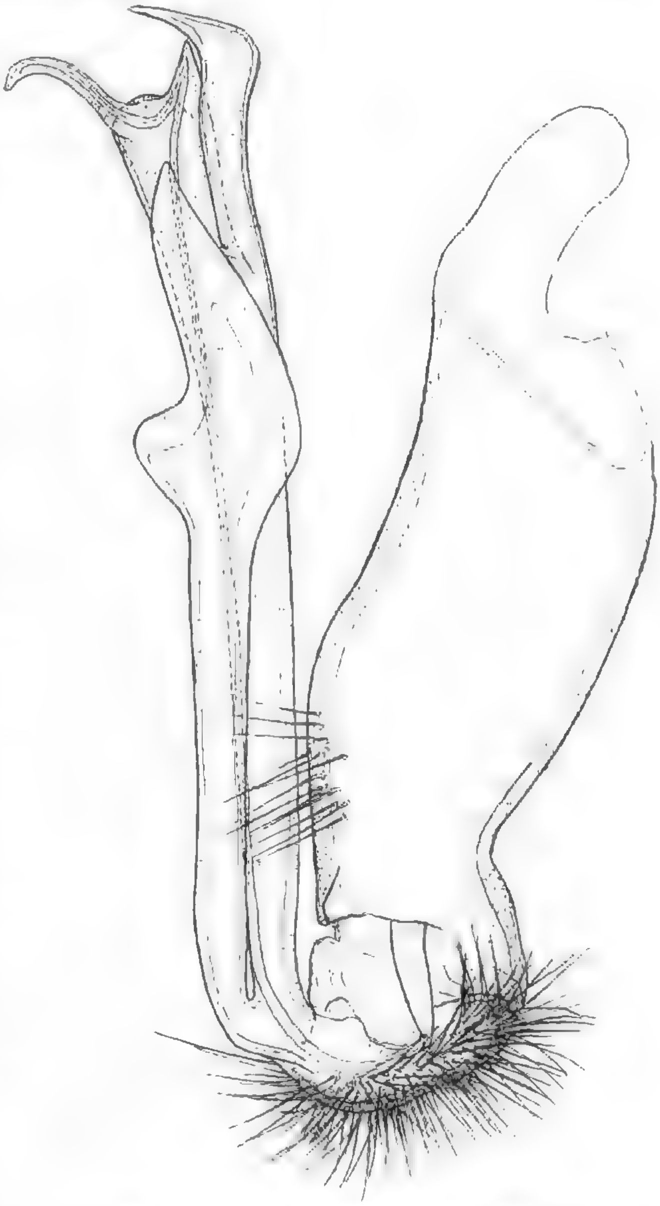


FIG. 3. *Somethus grossi* n. sp., holotype ♂, right gonopod, medial aspect.

Gonopods: (Fig. 3) Coxa long and stout, tapering a little towards apex and curving a little caudad. At medio-anterior side of apex a small conical process. Prefemur rather short, rounded, its longitudinal axis transverse to axis of acropodite. Demarcation from acropodite transverse. Acropodite split into two main branches: a caudal tibiotarsus, and a combined solenomerite and femoral process. Tibiotarsus long, narrow at its base but widening halfway to a laminate apical part. Combined solenomerite and femoral process split at about three quarters of length into a solenomerite proper and separate femoral process. Latter tapers apically and curves caudad. Spermal channel runs along anterior side of acropodite, and finally along medial side of solenomerite proper, making a loop in a triangular preapical process. Apex of solenomerite narrow, pointing caudad.

Female: Differing from the male, aside from the usual sexual characters, in having vertex of head transversely widely and evenly convex. Vertigial sulcus quite deeply impressed. Antennae shorter, with the antennomeres more obconical. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.95, 0.95, 0.90. Third somite with a low transverse pleural keel along posterior margin. Sternites flattened, impressions distinctly less deep than in the male, longitudinal ones very wide. Cones absent. Ratio of length/width: 1.1:1.0. Pubescence rather dense, hairs shorter than in male. Legs with straight femora. Relative length of podomeres 2 to 6 in middle somites: 0.80, 1.00, 0.55, 0.55, 0.70. Coxa of 2nd pair of legs distally produced into a large caudal transverse, callous process, giving coxa from behind a broad triangular aspect, as broad at base as long medially, and basally produced laterad of prefemoral basis. Epigynal structure consisting of two paramedian rather narrow emarginations embracing coxal bases of 2nd pair of legs, and medially separated by a triangular prominence.

Remarks

The new species is easily distinguished from the type-species, *S. fuscipes,* by the gonopods having a long, distally widening tibiotarsus (Chamberlin (1920) describes the "basal spur" as a "thin lanceolate blade narrowed at each end, a little twisted . . ."). the absence of pleural keels in the male, the presence of sternal cones in the male, and the larger size (in *S. fuscipes* 2.8 mm).

The species is named after its collector, apparently one of the very few people in South Australia who took the trouble to collect millipedes, including most of the material treated in this paper.

Oncocladosoma n. gen.

Generic diagnosis

Rather robust to small Australiosomatini with 20 somites and a normal pore formula. Head with vertex transversely flattened in male, normally convex in female. Antennae of moderate length, slightly to distinctly clavate, basal antennomeres subcylindrical, distal ones more obconical in shape.

Somites rather weakly to moderately constricted, waist rather narrow, distinctly longitudinally ribbed or beaded. Metatergites smooth, hairless. Transverse furrow present from 5th somite onwards, rather weakly to rather deeply impressed. Pleural keels vestigial or absent in male, moderately developed up to 4th somite in female.

Paranota rather weakly developed.

Sternites distinctly longer than wide in male, about as long as wide or a little longer than wide in female. Sternal cones weakly developed to vestigial. Sternite of 5th somite of male with a process between anterior legs. Legs rather long; first leg of male incrassate and with a ventral femoral tubercle. Tibial and tarsal scopulae present only in a number of legs in the anterior half of the body of male.

Gonopods with prefemur ovoid, its longitudinal axis almost transverse on the axis of the acropodite. Acropodite deeply split into two main branches, femoral part almost vestigial. Tibiotarsus undivided, more or less clubshaped, with a rather narrow "stem" and a widened, more or less complicated distal half. Seminiferous branch exceeding tibiotarsus in length, end typically uncate and recurved. Spermal channel running along posterior side of seminiferous branch, turning distally towards medial side, and running to extreme distal part of the seminiferous branch before abruptly recurving towards apex. Just proximad of distal edge of seminiferous branch and cephalad of course of spermal channel there is a vestige of the femoral process, which is completely absent, however, in the type-species. A little more proximad on mediocaudal side of seminiferous branch there is in the type-species a short spinelike process, vestigial or absent in the other species.

Type-species: Australiosoma castaneum Attems, 1944.

Remarks

This genus is characterized mainly by the peculiar shape of the acropodite of the gonopods, with its single clubshaped tibiotarsus, its typically uncate seminiferous branch, the absence or almost complete reduction of the femoral process, and the course of the spermal channel, which makes a slight loop before running towards the apex of the solenomerite.

In having the gonopod telopodite deeply split into two main branches, *Oncocladosoma* bears some similarity to the genera *Dicladosoma* Brolemann, 1913, *Dicladosomella* Jeekel, 1982, *Phyllocladosoma* Jeekel, 1968, and *Somethus* Chamberlin, 1920. *Dicladosoma,* from Mt. Kosciusko, is distinct in having the base of the tibiotarsus twisted towards the latero-anterior side of the seminiferous branch. It moreover seems distinct in having apparently no loop in the course of the spermal channel. *Dicladosomella, Phyllocladosoma* and *Somethus* have a more erect telopodite, and the spermal channel makes a loop in a distinctly developed process. *Dicladosomella,* from southeastern New South Wales, has a more laminate tibiotarsus, and the apex of the solenomerite is typically directed distad. *Phyllocladosoma,* from northeastern New South Wales and southeastern Queensland, resembles *Dicladosomella* in most of the characters mentioned, but it is distinguished by the abbreviate solenomerite, the apex of which extends scarcely beyond the loop-bearing process. *Somethus* is distinguished by having a distinctly developed femoral process. Both, *Dicladosomella* and *Phyllocladosoma,* lack any indication of a femoral process.

The new genus contains, besides its type-species, which is divided into two subspecies, two new species.

Geographically it seems to be confined to the Mt. Lofty Ranges.

Oncocladosoma castaneum (Attems)

Australiosoma castaneum Attems, 1944: 249; Jeekel, 1968: 26.

This species is represented by two subspecies, *O. c. castaneum* and *O. c. ingens* n. subsp., characterized by a significant difference in size

Material

O. c. castaneum (Attems):
Mt. Lofty, 21.IX.1883, leg. Tepper, 1 ♂, 1 ♀.
Belair, 15.V.1938, leg. R. V. Southcott, 2 ♂.
Belair, Mt. Lofty Ranges, leg. N. B. Tindale, 1 ♂.
O. c. ingens n. subsp.:
Near Mt. Lofty Station, IV.1883, Dr. Haacke don., ♂ holotype, 23 ♂, 11 ♀, 6 juv ♂ (19 somites), 2 juv. ♀ (19 somites) paratypes.
Bridgewater, 2.II.1884, leg. Tepper, 1 ♂ paratype.
Norton Summit, Mt. Lofty Ranges, 7.IV.1884, leg. Tepper, 2 ♂ paratypes.
Mt. Lofty, Waterfall Gully, 23.VI.1884, leg. Tepper, 1 ♂ paratype.
Onkaparinga River, near Mylor, 11.V.1947, leg. G. F. Gross, 2 ♂ paratypes.
Mylor, 20.IV.1957, leg. G. F. Gross, 1 ♂ paratype.
Upper Sturt, Soil Tx 104, 5.V.1962, leg. R. V. Southcott, 1 ♂ paratype.
Bridgewater, Lot no. 11-72a, IX.1972, leg. G. H. Baker, 1 ♂, 3 ♀ paratypes.
Without locality or other data, 9 ♂, 5 ♀, 1 juv ♀ (19 somites) paratypes.
Without locality or other data, 2 ♂, 2 ♀ paratypes.

Description

Colour: Head brown, vertex and lateral sclerites blackish. Area around the antennal sockets and margins of lateral sclerites pale brownish. Antennae brown, 6th antennomere and basal part of 7th infuscate; tip whitish; the intersegmental membranes pale brownish. Collum blackish, margin behind vertex reddish brown; a rather narrow zone along posterior margin, broadest medially and tapering towards sides, brownish yellow. Prosomites and anterior part of metasomites blackish brown, posterior part of metatergites, i.e. medially from just in front of transverse furrow caudad, yellowish brown. Posterior part of paranota and posterior zone of sides also yellowish brown. Demarcation between the darker and lighter colours not sharp. Venter, sternites and legs brownish, three distal podomeres infuscate, intersegmental membranes and tip of tarsi yellowish brown. Anal somite dorsally, including epiproct, yellowish, sides blackish. Paraprocts black, margined with yellowish brown. Hypoproct yellowish brown. More heavily infuscated specimens have pale colour only along posterior margin of metasomites. Specimens which have been stored in alcohol for a long time are brown in general, with the lighter colour only vaguely indicated. Juveniles dirty whitish, without colour pattern.

Width: O. c. castaneum: ♂: 2.8-3.2 mm, ♀: 3.0 mm. *O. c. ingens:* ♂: 3.5-4.3 mm, ♀: 3.4-4.0 mm, juv ♂ (19 s.): 2.9-3.2 mm, juv ♀ (19 s.): 2.7-2.9 mm.

Head and antennae: Labrum moderately widely and moderately deeply emarginate. Clypeus strongly impressed towards labrum, surface uneven due to presence of setiferous pits; on each side below antennal sockets wide impression. Lateral border of clypeus faintly convex, with a notch near labrum. Pubescence moderate becoming sparse in frontal region and on lateral sclerites; above labrum a series of hairs, hairs rather short. Frons not demarcated from vertex or clypeus. Antennal sockets separated by 1.4 times diameter of a socket or by 0.7 times length of 2nd antennomere. Vertex shiny, hairless, transversely faintly convex, a little more so near lateral edges, longitudinally almost evenly and rather widely convex. Postantennal groove rather deep and rather wide; wall moderately prominent. Beanshaped area at posterior side of antennal sockets well demarcated and inflated. Vertigial sulcus well impressed, not reaching upper level of antennal sockets, with short fine transverse wrinkles. Antennae of moderate length, moderately stout, slightly clavate. Antennomeres subcylindrical, but 5th more obconical, and 6th still more obconical but not inflated. Pubescence moderate in proximal antennomeres, becoming dense in distal ones. Relative length of 2nd to 6th antennomeres: 0.95, 1.00, 0.95, 0.85, 0.70.

Collum: Subtrapezoidal in dorsal outline, a little wider than head. Anterior border straight in middle, widely rounded more laterally and straight again towards lateral sides. Posterior border widely and weakly concave in middle, straight laterally. Lateral sides asymmetrically and rather widely rounded, with strongest convexity caudal. Surface hairless, shiny and almost polished, with weak irregular wrinkles. Surface transversely widely convex, more strongly so towards lateral sides and laterally even slightly incurved; longitudinally weakly convex, slightly more so towards anterior and posterior margins. Marginal rim laterally moderately wide, not particularly raised; premarginal furrow distinct, disappearing at lateral edge of vertex.

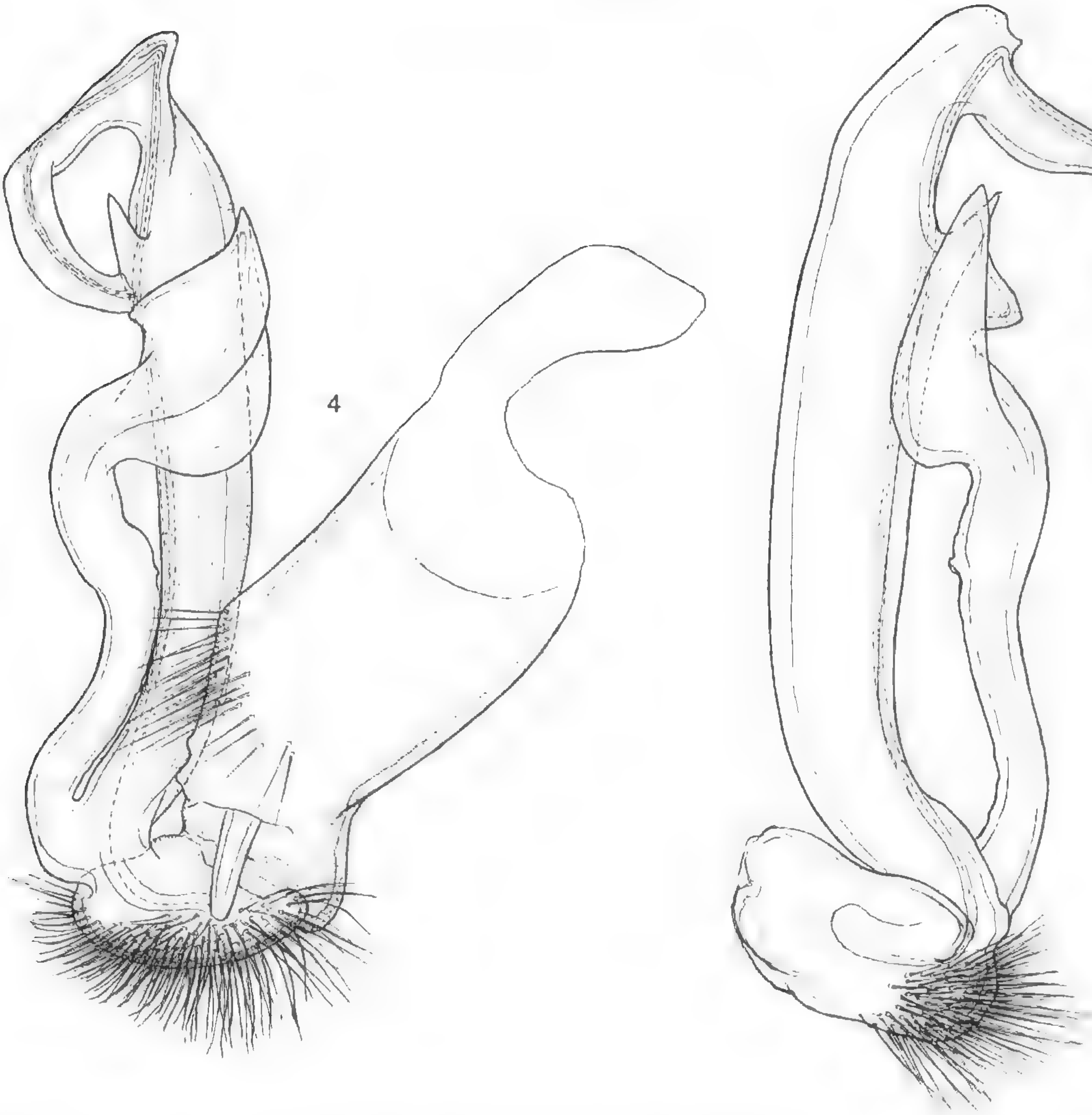
Somites: Constriction rather weak. Waist rather narrow, sharply demarcated from pro- and metasomites, distinctly longitudinally ribbed down to upper level of paranota, finely striate below that level. Prosomites dull, with a fine cellular structure and fine short striae. Metatergites smooth, hairless, shiny, with some irregular weak wrinkles. Transverse furrow finely and not deeply impressed, without apparent sculpturing, present from 5th to 17th somite, vaguely indicated on 18th. Furrow running laterad to about a distance from upper demarcation of paranota of about one and a half times or a little more the dorsoventral width of a poriferous paranotum. Sides smooth or slightly wrinkled, granulate up to 4th somite. Pleural keels abortive or absent.

Paranota: 2nd somite a little wider than collum; 3rd somite a little wider than 2nd and about as wide as 4th. Paranota of 2nd somite with anterior margin a little thrust forward, widely convex. Latero-anterior edge subangular, narrowly rounded, without distinct tooth. Lateral margin widely and almost evenly rounded, but behind middle a little more strongly convex and caudally straight, hardly diverging. Latero-posterior edge subangular, slightly produced and projecting slightly behind posterior margin of somite. Posterior margin short, widely convex. Paranota situated on a low level, rather weakly prominent, although margin visible from above. Upper margin in lateral aspect widely and weakly convex, sloping a little cephalad. Marginal callus rather wide from the middle onwards, narrower anteriorly, its lower side straight. Premarginal furrow distinct on all sides, briefly parallelling the posterior margin of the somite. Paranota of 3rd somite with anterior margin not shouldered at base, widely convex, merging via a stronger rounding into the widely convex lateral margin. Posterior edge subangular, slightly produced caudad. Posterior margin short, a little concave. In lateral aspect marginal callus moderately wide; ventral demarcation by a depression is present only in posterior half, converging dorsad somewhat convexly and meeting dorsal demarcation in an acute angle. Paranota of 4th somite similar to those of 3rd, but lateral margin a little more widely rounded, and posterior edge caudally not produced. Paranota of 5th and subsequent somites rather weakly prominent. Lateral margin in dorsal aspect weakly to faintly convex, anteriorly slightly more rounded; poriferous paranota caudally slightly more convex than the poreless. Latero-posterior edge subangular, quite narrowly rounded, faintly produced caudad in most somites, more so in the somites of posterior half of the body, but projecting behind the caudal margin of the somite only in the 18th. In lateral aspect upper demarcation of the callus convex (poriferous somites) or straight (poreless somites), premarginal furrow turning upward near waist but not reaching it. Ventral demarcation by a depression present only in the caudal half or three-fifths of the paranota, converging straight (poreless) or convexly (poriferous somites) towards the dorsal demarcation in an acute angle, more acute in poreless than in poriferous somites. Dorsoventral width of paranota moderate, in poreless somites about two-thirds of poriferous. Posterior margin finely rimmed, the premarginal furrow briefly parallelling caudal margin of metatergite. Pores situated quite near the ventral edge of the marginal callus, in a rather small oval pit.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.6:1.0). Cross impressions well developed, rather wide. Sternal cones present on all postgonopodial sternites up to 17th somite, rather small near anterior coxae, and still more weakly developed near posterior coxae. Pubescence rather dense to dense, located in four quadrants of each sternite. Median and transverse impressions hairless; hairs of moderate length. Sternite of 4th somite rather broad, with a well-developed median impression, no sternal cones. Pubescence rather dense. Sternite of 5th somite with a subtrapezoidal process arising between and a little in front of anterior coxal sockets; process broader than long, a little wider than width between coxae, directed downward and cephalad, bending abruptly downward in distal half, projecting distinctly in front of anterior margin of sternite. Anterior surface of process in profile convex halfway, apex with a dense brush of short setae. Posterior surface widely concave, moderately densely set with rather long setae. Apex of process in caudal aspect broadly rounded, medially faintly angulate, lateral edges narrowly rounded. Behind process a deep transverse impression. No longitudinal impression between posterior coxae, but posterior coxal sockets connected by a transverse wall which is densely set with long setae. Sternite of 6th somite scarcely (anteriorly) or not (posteriorly) raised above ventral level of metasomal ring. Coxal sockets scarcely raised and coxae not elongate. Pubescence consisting of two transverse zones of densely set long hairs. Sternite of 7th somite lateroanteriorly with a finely rugulose-granulose transverse wall. Gonopod aperture large, separating coxal sockets of posterior legs. Sternite of 8th somite anteriorly not raised above ventral level of metasomal ring; anterior coxae somewhat separated. Transverse impression weakly developed. Posterior part not modified, cones abortive. Pubescence moderate, hairs rather long. Legs in general rather long and stout, prefemora dorsally convex, femora faintly arched. Pubescence ventrally dense on all podomeres, hairs rather long. Dorsal pubescence not obvious, except on tibiae and tarsi and partly also on postfemora. Scopulae of tibiae and tarsi present up to anterior legs of 8th somite, totally absent from posterior legs of that somite onwards. Relative length of podomeres 2 to 6: 0.80, 1.00, 0.65, 0.60, 0.80. Legs of first pair strongly incrassate, with a ventral femoral process. Coxae of 2nd pair medially rather thickly rounded but only weakly produced distad.

Anal somite: Upper profile about straight or faintly convex. Epiproct broad, moderately thick, rather short, ventrally somewhat concave. Sides concavely converging, narrowing abruptly just before apex, which is truncate, caudally weakly emarginate, lateral edges narrowly rounded. Setae not on tubercles. Paraprocts with narrow and rather low rims; setae not on tubercles or latter abortive. Hypoproct parabolically rounded, setae on abortive tubercles.

Gonopods: (Figs 4-5) Characterized mainly by the shape of the tibiotarsus. Moreover there is no trace of



FIGS. 4-5. *Oncocladosoma castaneum ingens* n. subsp., holotype ♂. 4: right gonopod, medial aspect. 5: telopodite of left gonopod, anterior aspect.

a femoral process. On the other hand the species has a spinelike process arising from the medio-caudal side of the seminiferous branch a little proximad of the base of the distal hook. The morphological status of this process is not yet clarified.

Female: Head with the antennal sockets separated by 1.4 times diameter of a socket or by 0.8 times length of 2nd antennomere. Vertigial sulcus slightly less impressed, vertex transversely widely and evenly convex. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.90, 0.85, 0.80. Somite 2 with pleural keels represented by a strongly developed rounded ridge. A thick dorsally sharply demarcated rounded swelling in 3rd somite, in 4th an abortive swelling. Sternites about as wide as long. The cross-impressions much weaker, without sternal cones. Setation rather dense, but setae rather short. Legs with ventral pubescence rather dense, hairs of moderate length. Relative length of podomeres 2 to 6: 0.70, 1.00, 0.50, 0.45, 0.80. Coxa of 2nd pair of legs with a caudolateral callous process, pointed and directed caudolaterad, medially not produced. Epigynal structure consisting only of two emarginations of ventral side of 3rd somite, embracing coxae of 2nd pair of legs, and medially separated by a low triangular process pointing cephalad. Lateral border of emarginations raised.

Remarks

When we compare the present drawings of the gonopods with the one which Attems (1944) published, there can be but little doubt that the presently recorded material belongs to the same species. It will be noted, however, that there are important discrepancies between the drawings. In the first place Attems misidentified the small process at the medio-caudal side of the seminiferous branch as a side branch of the tibiotarsus (the latter erroneously called "Femoralfortsatz").

Furthermore, he illustrated a separate femoral process (erroneously indicated as "Tibiotarsus"), emanating distinctly proximad of the distal edge of the seminiferous branch. Such a process is not observed in the present material, and we must assume that Attems either misinterpreted the chitinous structures in his preparation or that the gonopod he examined was damaged.

The subspecies *ingens* appears to differ from the nominate subspecies mainly in its larger size. Differences in the details of the gonopods must be substantiated by future research when more material becomes available. Whereas the subspecies *castaneum* appears to be confined to Belair (unfortunately Attems gave only "Sudaustralien" as type locality), the subspecies *ingens* occurs in a much larger area of the Mt. Lofty Ranges.

Oncocladosoma conigerum n. sp.

Material

Without locality label, but found in a tube together with *O. castaneum ingens*: ♂ holotype, 4 ♂ paratypes.

Near Mt. Lofty Station, IV.1883, Dr Haacke don., 1 ♀ paratype.

Without locality label, 6 ♂ paratypes, 2 ♀ paratypes.

Description

Colour: Essentially the same as that of the preceding species, but less infuscate (possibly due to prolonged preservation in alcohol). Dark colour of head confined to vertex and frontal region; lateral sclerites of the head pale brownish. Antennae brown, joints paler. Collum and somites as in *castaneum* but pale and dark colours less contrasting. Distal podomeres scarcely infuscate.

Width: ♂ : 2.1-2.4 mm; ♀ : 2.3-2.6 mm.

Head and antennae: Lateral border of clypeus with notch indistinct. Antennal sockets separated by 1.3 times diameter of a socket or by 0.55 times length of 2nd antennomere. Postantennal bean-shaped area a little inflated, moderately demarcated. Antennae rather stout. Relative length of antennomeres 2 to 6: 1.00, 0.95, 0.80, 0.80, 0.75.

Collum: A little narrower than head. Lateral sides almost evenly rounded.

Somites: Waist distinctly beaded dorsally. Transverse furrow disappearing laterally at a distance from dorsal demarcation of paranota equal to dorso-ventral diameter of a poriferous paranotum. Pleural keels weakly developed up to 3rd somite, faintly indicated in 4th.

Paranota: 3rd somite about as wide as 2nd; 4th a little wider than 3rd. Paranota of 2nd somite with marginal callus of equal width. Paranota of 3rd somite without anterior edge, latero-anterior border rather strongly rounded. In lateral aspect upper demarcation of paranota of 3rd and 4th somites slightly concave, turning upward anteriorly and posteriorly; the upper demarcation not sloping caudad. Paranota of 5th and subsequent somites with posterior edge narrowly rounded, scarcely produced except very slightly so in posterior somites but not projecting behind posterior margin of somites. In lateral aspect ventral demarcation of paranota more strongly convex, meeting upper demarcation in a wider angle than in *castaneum*, giving posterior edge of paranota a more subtruncate appearance.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.65: 1.00). Process of sternite of 5th somite with process about as long as wide at base, about parabolical in posterior aspect. Posterior half of sternite with a median rather deep furrow; pubescence rather dense, setae longish. Sternite of 6th somite with a distinct transverse furrow, but without longitudinal impression. Sternite of 7th somite with a weak callus latero-cephalad of gonopod aperture. Legs with scopulae up to first pair of 8th somite as in preceding species. Pubescence on ventral side of legs long. Relative length of podomeres 2 to 6 in middle part of body: 0.65, 1.00, 0.60, 0.55, 0.80.

Anal somite: Upper profile faintly convex, weakly convex in front of base of epiproct. Epiproct longish, broad. Caudal emargination very weak. Hypoproct rather large, about evenly semicircularly rounded.

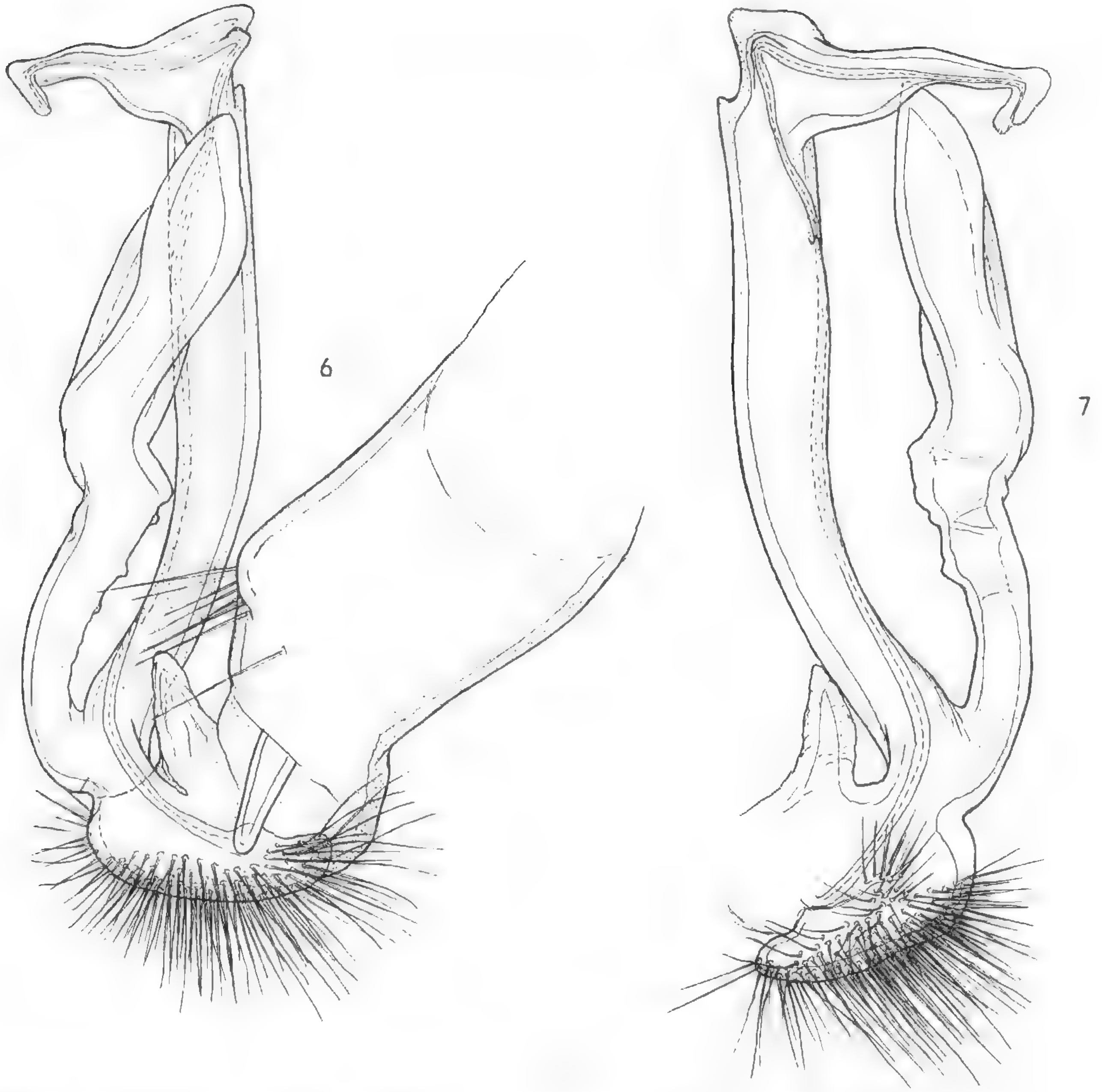
Gonopods: (Figs. 6-7) Coxa relatively a little more robust than in *O. castaneum*. Prefemur with a weakly chitinized conical process emanating from intersegmental membrane connecting coxa and prefemur. Acropodite largely similar to that of *O. castaneum*, differing mainly in shape of tibiotarsus. Seminiferous branch with a slight vestige of a femoral process. The larger spinelike process of *O. castaneum* is represented here by a tiny tooth.

Female: Head with clypeus moderately impressed towards labrum. Antennal sockets separated by 1.3 times diameter of a socket or by 0.7 times length of 2nd antennomere. Antennae relatively shorter; relative length of antennomeres 2 to 6: 1.00, 0.90, 0.85, 0.90, 0.75. Collum more evenly rounded transversely. Somites with pleural keels on 3rd somite represented by a low cone near caudal margin. On 4th somite a faint ridge. Sternites of middle somites 1.2 times longer than wide. Legs less incrassate, femora straight. Relative length of podomeres 2 to 6 in middle part of body: 0.70, 1.00, 0.55, 0.50, 0.70. Epigynal structure with paramedian emarginations deeper than in *castaneum*, surface of the ventral side of 3rd somite anteriorly raised, and median conical process directed more downward.

Remarks

In the characters not mentioned above, the description of *O. castaneum* applies.

This species looks like a diminutive form of *O. castaneum*, being even smaller than the subadult specimens of that species. It differs only in small proportional details of its external morphology, but it is well characterized by the structure of the gonopods.



FIGS. 6-7. *Oncocladosoma conigerum* n. sp., holotype♂. 6: right gonopod, medial aspect. 7: left gonopod, anterior aspect.

Although most of the material was lacking a locality label, the fact that part of it was found in a tube containing *O. castaneum ingens* seems to imply that it occurs sympatrically with that species in the Mt. Lofty Ranges.

Oncocladosoma clavigerum n. sp.

Material

Belair, VI.1883, leg. J. W. Haacke, ♂ holotype, 15 ♂, 8 ♀, 2 juv. ♂ (19 somites), 1 juv. ♀ (19 somites) paratypes.

Blackwood, VI.1883, leg. J. W. Haacke, 2 ♂, 1 ♀ paratypes.

Woodley's Vineyard (near Glen Osmond, SE Adelaide), soil, Berlese funnel, 30.VII-8.VIII.1950, leg. R. V. Southcott, 2 ♂ paratypes.

Sellick's Hill, 23.IX.1954 (E.S.I. 1592), leg. G. F. Gross, 1 ♂.

Description

Colour: Similar to that of the two preceding species, but less pronounced possibly due to preservation. Dark colour of head confined to vertex and frontal regions; lateral sclerites of head pale brownish. Antennae dark brown, distal annuli of antennomeres and intersegmental membranes pale brownish. Collum brown, without distinctly paler marginal areas. Somites brown, darkest in waist area, without paler bands; only posterior halves of paranota a somewhat paler brown, and posterior halves of metatergites also slightly paler. Anal somite also with a paler epiproct, and margins vaguely paler. Hypoproct pale brown. Sternites and legs pale brown; three distal podomeres somewhat infuscate, but no pale annuli. Tip of tarsi pale.

Width: ♂ : 1.5-1.8 mm, ♀ : 2.0-2.3 mm, juv. ♂ (19 somites) 1.4 mm, juv. ♀ (19 somites) 1.4 mm. The material from Belair seems slightly smaller (♂ : 1.5-1.8 mm, ♀ : 2.0-2.2 mm) than the specimens from elsewhere, which measure 1.8 mm and 2.3 mm for the two sexes respectively.

Head and antennae: Labrum rather widely emarginate. Clypeus rather strongly impressed towards labrum. Antennal sockets separated by 1.6 times diameter of a socket or by 0.85 times length of 2nd antennomere. Antennae rather stout, distinctly clavate (involving 5th and especially 6th antennomere), 6th antennomere a little inflated. Relative length of antennomeres 2 to 6: 1.00, 1.00, 0.95, 0.95, 0.90.

Collum: Distinctly narrower than head, subreniform to subtrapezoidal in dorsal outline. Anterior border almost evenly rounded, only slightly more convex behind edges of vertex. Posterior border laterally widely convex. Lateral sides rather narrowly and almost evenly rounded. Surface of collum longitudinally evenly and widely convex.

Somites: Constriction moderate. Waist dorsally distinctly beaded, laterally distinctly to finely striate. Prosomites dull, with rather pronounced fine cellular structure. Transverse furrow of metatergites sharply and rather deeply impressed, with fine longitudinal striation, disappearing laterally at about a distance from dorsal demarcation of paranota equal to dorso-ventral diameter of a poreless paranotum. Transverse furrow indicated on 4th, and very vaguely also on 18th somite. Pleural keels on 3rd somite weakly indicated by a furrow; abortive on 4th somite.

Paranota: 2nd somite scarcely wider than collum. Paranota of 2nd somite with latero-anterior edge narrowly rounded, without tooth. Lateral margin only faintly convex, a little more so towards posterior edge, scarcely visible from above. In lateral aspect margin almost straight, moderately thick and of equal width. Paranota of 3rd somite latero-anteriorly evenly and rather widely convex. Posterior edge angular, slightly produced caudad but not projecting behind margin of the somite. Paranota of 4th somite with posterior edge faintly produced. In lateral aspect dorsal demarcation of paranota of 3rd and 4th somites faintly concave, turning upward gradually at anterior end. Paranota of 5th and subsequent somites with ventral demarcation rather convexly converging with upper demarcation, giving paranota, particularly the poriferous ones, an obliquely truncate aspect in lateral view. Caudal edges not projecting behind margin of somites. Pores in a relatively large and deep pit, nearer ventral margin, rather near posterior edge.

Sternites and legs: Sternites of middle somites longer than wide (ratio 1.6: 1.0). Sternal cones not obvious, quite weakly developed. Pubescence moderately dense, all over sternite, the setae of moderate length. Sternite of 5th somite with the process between the anterior legs subtriangular, the apex rather widely rounded, about as long as wide. Anterior side in profile weakly convex, the process almost perpendicular, scarcely projecting in front of sternite. Caudal half of sternite widely transversely concave, rather densely set with longish setae. Sternite of 6th somite with coxal sockets conspicuously more widely separated. Sternite of 7th somite with pregonopodial wall weakly prominent. Sternite of 8th somite with anterior coxae widely separated. Sternite anteriorly flattened, a little raised. Transverse impression and posterior half of sternite not modified. Pubescence moderate, with setae longish. Legs of moderate length or longish, rather stout. Relative length of podomeres 2 to 6 in middle somites: 0.75, 1.00, 0.65, 0.70, 0.85. Coxae of 2nd pair not medially produced. Coxae of first pair of legs of 6th somite and of anterior pair of 8th somite slightly produced into a weak rounded cone. Ventral pubescence of legs rather dense.

Anal somite: Upper profile straight, slightly convex anteriorly. Apex of epiproct relatively narrowly truncate, scarcely emarginate. Hypoproct subtrapezoidal, with median part of apex somewhat triangularly produced; setae on faint tubercles which are faintly produced.

Gonopods: (Figs 8-9). Coxa relatively slightly more slender than in the other two species. Tibiotarsus typically club-shaped, with a relatively long stem. Seminiferous branch characterized by the rather strong curvature; femoral process reduced to a tiny lobe. The more proximal spine, present in *O. castaneum* and vestigial in *O. conigerum*, is totally absent here.

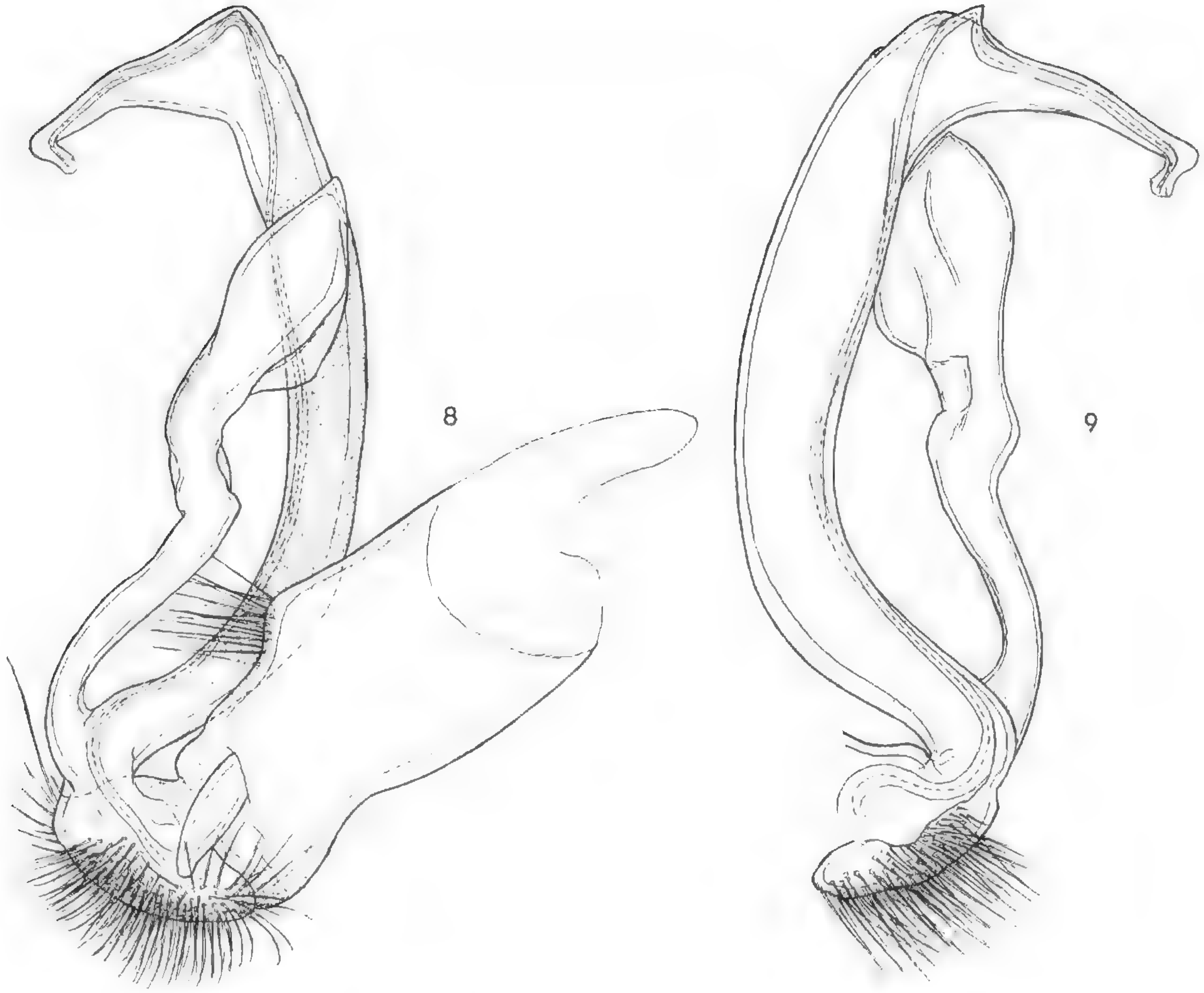
Female: Head with antennal sockets separated by 1.5 times diameter of a socket or by 0.9 times length of 2nd antennomere. Relative length of antennomeres 2 to 6: 1.00, 0.90, 0.85, 0.90, 0.85. Pleural keels of 2nd somite well developed, those of 3rd somite represented by a low conical swelling near posterior margin; in 4th somite this swelling is very weak and small. Keels are dorsally not demarcated by a furrow. Sternites of middle somites 1.1 times longer than wide. Setae of moderate length. Relative length of podomeres 2 to 6 in middle part of body: 0.80, 1.00, 0.55, 0.45, 0.95. Coxae of 2nd pair of legs on caudal side with a low rounded transverse callus. Epigynal structure with median point directed obliquely downward; lateral anterior projection also directed obliquely downward.

Remarks

In points not mentioned the description of *O. castaneum* applies.

This is the smallest representative of the genus *Oncocladosoma*, differing from the other species in small details of the external morphology and particularly in the structure of the gonopods.

It may be of interest to note that the specimens for Belair are slightly smaller on the average, parallelling the conditions in *O. castaneum*. In the present case, however, the differences seem insignificant.



FIGS. 8-9. *Oncocladosoma clavigerum* n. sp., holotype ♂. 8: right gonopod, medial aspect. 9: left gonopod, anterior aspect.

THE STATUS OF *POLYDESMUS (STRONGYLOSOMA) INNOTATUS* KARSCH, 1881

The taxonomic position of this species, allegedly based on a female specimen from Adelaide, has been uncertain since the publication of its description. Through the kindness of Dr M. Moritz of the Museum für Naturkunde der Humboldt-Universität in Berlin, I was able to re-examine the type-specimen, hoping that it could be associated with one of the paradoxosomatids received from the South Australian Museum.

The type-specimen is in bad condition; its antennae and most of its legs are missing. Moreover, it is not an adult female, but a juvenile with 19 somites. Nevertheless, on account of its external characters it has become clear that the species is different from other Paradoxosomatidae reported from South Australia. In case the species is rediscovered in South Australia its most salient characters are mentioned here.

"Strongylosoma" innotatum (Karsch)

Polydesmus (Strongylosoma) innotatus Karsch, 1881: 42.
Strongylosoma innotatum; Attems, 1898: 307.

Material

Adelaide, Schomburgk leg., 1 juv. ♀ (19 somites), ZMB Kat.Nr. 560, holotype.

Descriptive notes

Colour: Dull brownish, apparently faded.

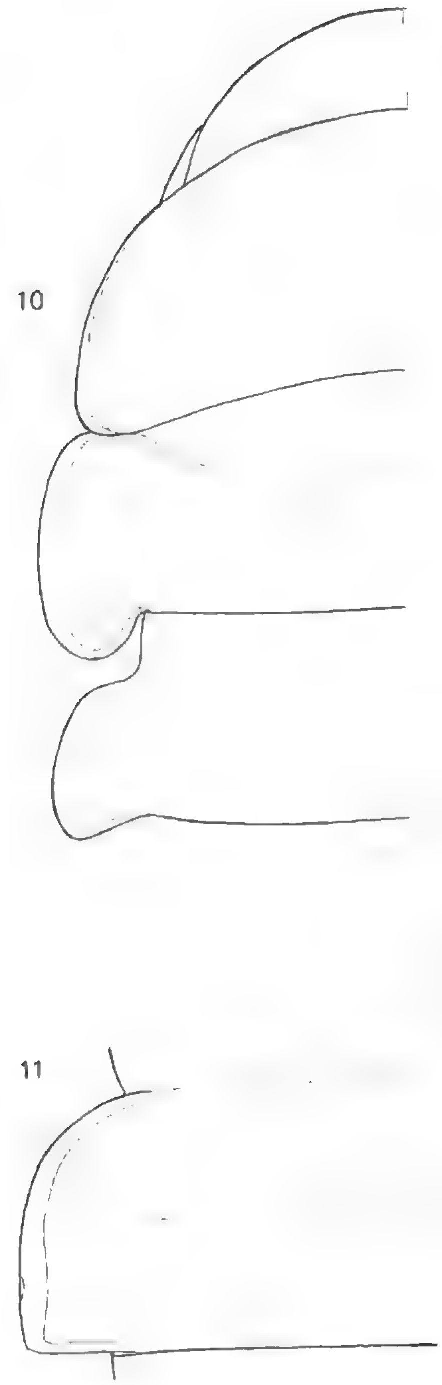
Width: 3.5 mm.

Head and antennae: Without particulars.

Collum: Wider than head (Fig. 10). Lateral sides flaring, rather widely rounded and without posterior edge; lateral border merging gradually into caudal border.

Somites: Waist rather narrow, without apparent sculpture. Metatergites of 4th to penultimate somite with a generally deeply impressed transverse furrow, running far laterad and reaching in most cases dorsal premarginal furrow of paranota.

Paranota: (Figs 10-11) 2nd somite distinctly wider than collum; 3rd and 4th each slightly narrower than preceding somite. Paranota of 2nd somite on a low level, well developed; anterior border shouldered at base and



FIGS. 10-11. *"Strongylosoma" innotatum* (Karsch), holotype ♀ juvenile (19 somites). 10: left side of head, collum and 2nd and 3rd somites, dorsal aspect. 11: left side of 9th somite, dorsal aspect.

thrust forward a little, widely rounded, merging into rather faintly convex lateral margin via a somewhat stronger rounding. Posterior edge rather narrowly rounded but not angular. Posterior border a little convex; posterior part of paranota projecting distinctly caudad of margin of somite. Paranota of 3rd and 4th somites also prominent, widely rounded anteriorly and laterally, more narrowly rounded caudally and projecting a little behind margin of somites. Paranota of 5th and subsequent somites at first subangular caudally, but in second half of body becoming more distinctly angular, though produced caudally and projecting only a little from 15th somite onwards.

Sternites and legs: Sternites without distinctive characters; legs mostly absent (in specimen).

Anal somite: Epiproct moderately developed, apex truncate with a weak caudal emargination. Hypoproct rather broadly triangular, with sides and apex rounded.

Remarks

Since the specimen is a juvenile, most of its external characters may be less pronounced than in the adult, in particular the adult male. The paranota are different from those of any of the other South Australian paradoxosomatid genera. In particular the relatively wide expansion of the paranota of the 2nd somite seems characteristic. In this respect the species appears to have a certain similarity with *Otoplacosoma bivittatum* Verhoeff, 1924, from the Kimberley district of Western Australia, which would mean that eventually it may prove to belong to the tribe Antichiropodini. It should be borne in mind though, that it is also possible that the locality label is wrong, in which case the systematic position of the species probably will be an enigma for ever.

SUMMARY OF SOUTH AUSTRALIAN PARADOXOSOMATIDAE

With the completion of the study of the Paradoxosomatidae of the collection of the South Australian Museum, it may be useful to summarize the results which have been obtained so far.

The number of known species has increased from two to ten and one subspecies. The list is as follows:

Tribe Antichiropodini
Antichiropus mammillifer Jeekel
Aulacoporus pruvoti (Brolemann)
Tridactylogonus obscurus Jeekel
Incertae sedis
"Strongylosoma" innotatum (Karsch)
Tribe Australiosomatini
Heterocladosoma zebratum n. sp.
Heterocladosoma galaxias n. sp.
Somethus grossi n. sp.
Oncocladosoma c. castaneum (Attems)
Oncocladosoma c. ingens n. subsp.
Oncocladosoma conigerum n. sp.
Oncocladosoma clavigerum n. sp.

Considering the fact that the southeastern part of South Australia, where these paradoxosomatids were obtained, is quite remote from the nearest occurrence of the family elsewhere and is moreover drier than the areas in eastern Australia where the majority of the other described species occur, it is remarkable that the number of endemic genera is so relatively low. To this category belong only *Tridactylogonus* and *Oncocladosoma*. The other genera, viz. *Antichiropus, Aulacoporus, Heterocladosoma* and *Somethus*, are shared with other Australian states, where, according to our present knowledge they all show a greater diversity. *Antichiropus* has quite a number of species occurring along the west coast of Western Australia. *Heterocladosoma* has three distinct species in the coastal area of Queensland from Cairns to Brisbane, and, according to as yet unpublished data, *Somethus* has two species in Tasmania and one in eastern Victoria. *Aulacoporus* has a number of species in Queensland and the northern part of New South Wales, but the South Australian record of *A. pruvoti* probably represents an introduced population. It is evident anyway that the fauna of South Australia, as far as the non-endemic genera are concerned, is composed of a mixture of western (*Antichiropus*), northeastern (*Heterocladosoma*), and southeastern (*Somethus*) elements (Fig. 12). Considering the diversity within each of these genera elsewhere it seems probable that South Australia became populated along these routes, rather than the reverse.

The relationship of the two endemic genera has not yet been satisfactorily determined. *Tridactylogonus* seems to belong to a group of small antichiropodine paradoxosomatids which focuses in Victoria, Tasmania and southern New South Wales. *Oncocladosoma* appears to be closely related to *Somethus*, *Dicladosomella* and *Phyllocladosoma*, indicating a faunistic connection between South Australia, Tasmania, eastern New South Wales and southern Queensland.

Oncocladosoma represents, moreover, a particularly interesting case. The genus has been found only in the Mt. Lofty Ranges, where it is represented by four partly sympatric taxa. No other paradoxosomatids have been reported from this probably best-explored part of South Australia, and the faunal composition shows the aspects

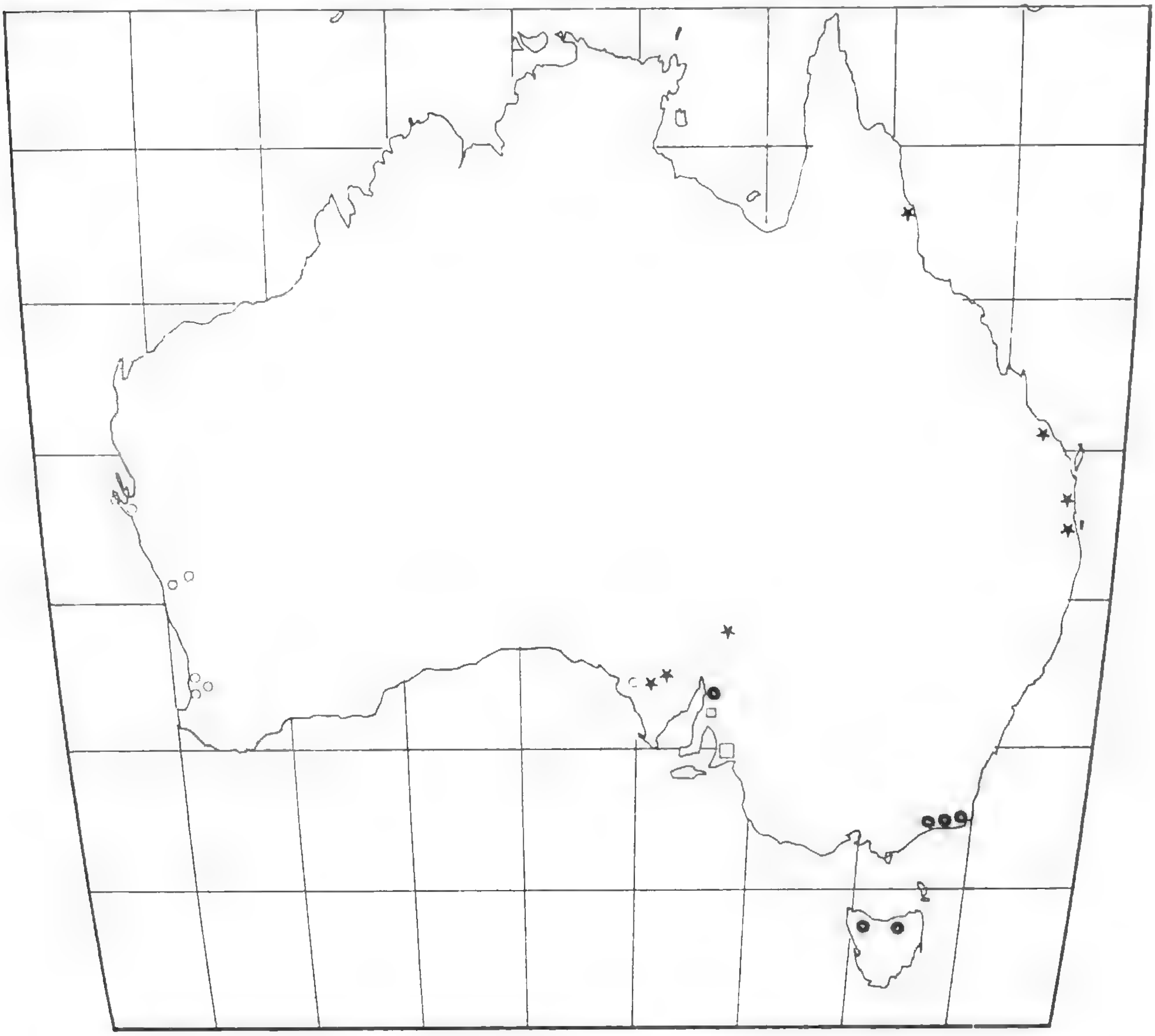


FIG. 12. Map showing the distribution of the non-endemic South Australian australiosomatine genera *Heterocladosoma* (*), *Somethus* (●), and *Antichiropus* (o), and the endemic genera *Oncocladosoma* (□) and *Tridactylogonus* (_).

of that of a long isolated island. During an early period this area must have been populated by a single species, possibly from the *Somethus*-stem, which, in the course of a long period of isolation, radiated in a number of closely related taxa.

The present picture of the distribution of the South Australian Paradoxosomatidae, incomplete as it undoubtedly is, seems to indicate that the fauna is the result of exchanges during at least two widely separated periods in history. The first of these periods, which may be more or less arbitrarily dated at the late Mesozoic or early Tertiary, saw a faunal connection between Victoria and southern New South Wales and South Australia, and is witnessed by *Tridactylogonus* and *Oncocladosoma*. The second, possibly occurring during the late Tertiary, brought representatives of *Heterocladosoma*, *Somethus* and *Antichiropus* to South Australia.

Of course, this is a very simplified explanation of what actually may have happened, but it will be interesting to assemble further data to verify and work out the details of the hypothesis.

RECORDS OF SOME MEDITERRANEAN JULIDAE INTRODUCED INTO SOUTH AUSTRALIA

Records of millipedes introduced into Australia from elsewhere are few. Baker (1978) extensively reported on the distribution and dispersal of the west Mediterranean julid *Ommatoiulus moreleti* (Lucas) in South Australia and Victoria. I have summarized the known records of European millipedes in Tasmania (Jeekel 1981) and more recently added the oriental paradoxosomatid *Orthomorpha coarctata* (De Saussure) to the Australian list (Jeekel 1982a)

The material of the South Australian Museum contained, besides some specimens of *Ommatoiulus*, also a number of samples of a Mediterranean species of *Brachyiulus* not previously known to occur in Australia.

Brachyiulus lusitanus Verhoeff

Brachyiulus pusillus lusitanus Verhoeff, 1898: 153, Pl. 6, Fig. 28.
Microbrachyiulus calcivagus Verhoeff, 1910: 225, Pl. 2, Figs. 33-34.
Brachyiulus lusitanus; Jawlowski, 1930: 183, Fig. 4; Strasser, 1976: 606, Fig. 37.

Material

Woodley's Vineyard (near Glen Osmond, SE Adelaide), soil, Berlese funnel, 30.VII-8.VIII.1950, leg. R. V. Southcott, 3♂, 5♀, 8 juvs.

Woodley's Vineyard, soil, Berlese funnel, 3.IX.1950, leg. R. V. Southcott, 4 juvs.

Sellick's Hill, 23.IX.1954 (E.S.I. 1953), leg. G. F. Gross, 1♀.

Burnside, 12.VI.1962, leg. Mr Waxman, 2♂, 3♀.

Burnside, 24.I.1963, leg. Mr Wasman, 1♂, 16♀.

Remarks

This species was originally described from Portugal, and has since been recorded from numerous localities in the Mediterranean region, eastward to Greece, Turkey, Syria and Turkestan. Apparently most of the records outside the western Mediterranean range concern synanthropic localities, and the species is obviously easily distributed by commerce. Outside the palearctic region records are still few, and since Jawlowski (1930) reported *B. lusitanus* from Mexico the species was only recently mentioned as occurring in the southeastern United States by Filka & Shelley (1980) where it seems to have been previously misidentified as *Brachyiulus pusillus* (Leach).

B. lusitanus is similar to *B. pusillus*, but differs in its slightly larger maximum size; it can be easily separated by the fanlike phylacum of the posterior gonopods (spiniform in *B. pusillus*) (see the illustrations in Verhoeff (1910), Jawlowski (1930) and Strasser (1976)).

Ommatoiulus moreleti (Lucas)

Iulus moreleti Lucas, 1860: 96.
Archiulus moreleti; Attems, 1928: 291, Pl. 18, Figs. 427-432.
Schizophyllum moreleti; Schubart, 1966: 23, Figs. 12-20.
Ommatoiulus moreletii; Baker, 1978: 1.

Material

North End Pt. Lincoln, 13.XI.1955, leg. M. Carrick, 2♀.

Remarks

This species originates from the Iberian Peninsula, where it apparently occupies a rather restricted range in the northern half of Portugal and adjacent Spain. It has been reported from a number of Atlantic islands (Canary Islands, Madeira, the Azores, Bermuda, St. Helena), the Cameroons and South Africa. In Australia it is known to become more and more wide-spread in South Australia and Victoria (Baker 1978) and it has also been reported from Tasmania, although as yet it does not seem to be so well established there.

Once it is introduced into a suitable environment it spreads rapidly and becomes a dominant element of the millipede fauna of the area. On Teneriffe (Canary Islands) for instance, it is seen almost anywhere in areas under human influence. Schubart (1966) gave an extended report on its distributional aspects in South Africa, where it appears to have spread over a large part of the country in the course of a few decades. Baker has described a similar phenomenon in South Australia.

Ommatoiulus and *Brachyiulus* are easily distinguished from the autochthonous juliform millipedes of South Australia by the longitudinal striation of the dorsal side of the metasomites and by the freely projecting cauda, the latter being particularly distinct in *Ommatoiulus*. *Brachyiulus* is further distinguished by having two yellowish dorsal paramedian bands.

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SARCOPTIFORMES (ACARI) OF SOUTH AUSTRALIAN SOILS.
4. PRIMITIVE ORIBATE MITES (CRYPTOSTIGMATA) WITH AN EXTENSIVE, UNFISSURED HYSTERONOTAL SHIELD AND APTYCHOID

BY DAVID C. LEE

Summary

A study of sarcoptiform mites from surface soil (greatest depth usually = 4cm) at 9 florally diverse sites in South Australia is continued. Opisthosternal shields, supernumerary leg setae, gnathosternal fissures and cheliceral spatulae are considered separately. The Cryptostigmata is treated as including 5 suborders: Palaeosomatida, Retrofissurida, Afissurida, Profissurida and Comalida. The Afissurida and primitive Comalida (i.e. Mixosomatina and Clinofissurae) are considered further in order to complete the lower oribate mites within this study.

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by

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(Manuscript accepted 20 December 1983)

ABSTRACT

LEE, D. C. 1985. Sarcoptiformes (Acari) of South Australian soils. 4. Primitive oribate mites (Cryptostigmata) with an extensive, unfissured hysteronotal shield and aptychoid. *Rec. S. Aust. Mus.* 19(4): 39-67.

A study of sarcoptiform mites from surface soil (greatest depth usually 4 cm) at nine florally diverse sites in South Australia is continued. Opisthosternal shields, supernumerary leg setae, gnathosternal fissures and cheliceral spatulae are considered separately. The Cryptostigmata is treated as including five suborders: Palaeosomatida, Retrofissurida, Afissurida, Profissurida and Comalida. The Afissurida and primitive Comalida (i.e. Mixosomatina and Clinofissurae) are considered further in order to complete the lower oribate mites within this study. Five families are discussed although not represented by specimens in this study: the Eulohmanniidae to confirm its inclusion in the Mixosomatina; the Malaconothridae, Trhypochthonidae, Trhypochthoniellidae and a new family, Allonothridae, to delineate the two infraorders (Mixosomatina and Holosomatina) of the Comalida. Seven species of Afissurida, Mixosomatina and Clinofissurae were collected. Four species are new: *Platynothrus brevisetosus, Crotonia jethurnerae, Nanhermannia grandjeani, Phyllhermannia eusetosa.* Two subspecies are new: *Epilohmannia cylindrica media, Epilohmannia pallida australica. Papillacarus pseudoaciculatus* is newly recorded from Australia. A new synonym is *Vepracarus* under *Papillacarus.* New combinations are *egyptica* and *indica* (ex *Papillacarus*) with *Lohmannia,* and *koreanus, ogawai* and *ramirezae* (ex *Vepracarus*) with *Papillacarus.*

INTRODUCTION

This publication is a further part of an ongoing study (Lee 1981, 1982). Its intent is to complete the systematics of what are generally regarded as the primitive, lower or macropyline oribate mites. Because the higher classification has changed so much since this study began, the oribate mites considered here are not all closely allied. They appear to be similar because they are primitive but have an extensive unbroken hysteronotal shield (a derived character state convergent in two suborders) and are aptychoid (a character state ancestral to the derived ability to fold the proterosoma back onto the hysterosoma which has arisen in three suborders). The mites to be considered include the Lohmannioidea (Afissurida), the Mixosomatina (Comalida) and the Clinofissurae (Comalida-Holosomatina). The following families from the Mixosomatina have already been dealt with: Phthiracaridae and Euphthiracaridae under Euptyctima Lee 1981) as well as Gehypochthoniidae under Monofissurae (Lee 1982).

The numerous higher categories of oribate mites may be reduced, some becoming superfamilies, if there is compensation for the disproportionate tendency to "upgrade" the classification (Krantz 1978). However, these categories are retained here. I follow the recent discarding by O'Connor (1984) of the abnormal use of "cohort" in acarology. Instead, between infraorder and superfamily, the rank of *section* is used as for crustaceans (Kaestner 1970).

The mounting procedures used have sometimes resulted in squashed specimens. The possibility of such distortion, always represented in illustrations of gnathosterna where it facilitates description, should be considered.

All mites described in this study are deposited in the South Australian Museum, Adelaide.

MORPHOLOGY

Opisthosternal Shields and Setae

The opisthosternal shields may be defined by the setae they bear. Unfortunately, in the reduction from the primitive three pairs of setal files, it is difficult to assess which files are lost or merged. Therefore, the *genital* and *anal shields* are regarded as the movable shields covering the relevant orifices and bearing setal files *Jg* and *Zg* or *Ja* and *Za;* and if these shields bear only one setal file it is referred to as either *JZg* or *JZa* whether or not it appears likely that a specific file (e.g. *Ja* in some cases) is missing. The more lateral shields are the *aggenital* shield bearing setal file *Sg* and the *adanal shield* bearing setal file *Sa,* which may be merged to form the *opisthoventral shield.* In the Retrofissurida and Afissurida, the anal shield may be split into a *peranal shield* (bearing one or two setae *Ja*) and a *paranal shield* (bearing two, three or four setae *Za*). In such cases, I have in the past (Lee 1982, Figs. 7 and 16) referred to these setal files with a different notation. In exceptional cases, as *Hoplophthiracarus shealsi* Lee, 1981 (see Fig. 25), the movable shield over the genital orifice bears three setal files indicating it is a merged genital and aggenital shield.

Chaetotaxy of Legs and Coxites

The leg tarsi of some species described below are hypertrichous. Lying proximally to the normal *complement setae*, the extra *supernumerary* setae are restricted to the four following positions: two dorsolateral—*da*, *dp* and two ventral—*av*, *pv*. The suffix "*x*" is added to the signature for each supernumerary setae, followed by a number indicating the position of the including whorl or rank, with "1" the most proximal.

The ventral coxite setae are in approximately single file and are numbered as such from the adaxial end without any attempt to homologize them with the files (anterior, median, posterior) from which they might be derived.

Gnathosternal Fissures and Cheliceral Spatula

Gnathosternal fissures are regarded as derived and may be functionally correlated with greater rigidity of the idiosoma requiring greater mobility of the mouthparts. The two types of fissure have been defined (Lee 1984). The species described below have *mentocoxal fissures*, whilst what was referred to as "diarthric" (Grandjean 1957) or a "quadrangulate mentum" (Lee 1982) occurs in more advanced taxa with *dicoxal fissures*. These two types of fissures split different parts of the gnathosternum (although the homologies of areas regarded as derived from either the palp coxite or mentum are not confidently held), whilst before the differences were regarded as due to a change in shape of the mentum. Apparently in rare cases both types of fissures occur on the same animal (see *Nothrus* species, Trägårdh 1931a: Fig. 6).

As previously (Lee 1984), the term *cheliceral spatula* is used for "Trägårdh's organ". The presence of a cheliceral spatula was regarded as a possible synapomorphy for the Holosomatina (Comalida) (Lee 1984). Norton (personal communication 1982) has since pointed out that the cheliceral spatula is present in a number of families of Mixosomatina (Comalida) and I discuss this further below under "Remarks" on that infraorder.

SYSTEMATICS

I accept the concept that the Cryptostigmata is a paraphyletic taxon as suggested by O'Connor (1984), with the Astigmata regarded as a sister-group to part of the Comalida (in the restricted sense used below). On the other hand, I do not in this instance follow the principle of Wiley (1981) that paraphyletic groups be rejected as unnatural, arbitrary, human constructs. I consider it useful to retain the Cryptostigmata as a grade, sharing similar primitive character states, and "left behind" by the considerable differentiation of the Astigmata.

The higher classification of the Cryptostigmata is modified so that it is regarded as including five suborders, sequenced to reflect their supposed level of advancement as follows: Palaeosomatida (see Bifemorata Lee, 1981), Retrofissurida (see Retrofissurae Lee 1982), Afissurida (see Afissurina Lee, 1984 and below), Profissurida (see Profissurae Lee, 1982 and Pediculochelidae) and Comalida (see Comalida, in part, Lee, 1984 and below). Changes from the classification presented at the 6th International Congress of Acarology in 1982 (Lee 1984) are that the Dismalida is disbanded and the included three distinct primitive lineages upranked to suborders, whilst the Profissurina is excluded from the Comalida and also upranked to a suborder. Four of these suborders may be regarded as clades, but the Comalida is not a complete clade since the Astigmata is excluded from it (although it may prove arguable that the entire Comalida is a sister-group to the Astigmata).

Upranking of the Profissurida is a response to the proposition (Norton, O'Connor and Johnston 1983) that the Pediculochelidae and Haplochthoniidae constitute the latest derivative lineage within the Protoplophoroidea (=Profissurida). Even if this phylogeny was well supported, I would maintain the Pediculochelidae as a separate superfamily on the basis of morphological divergence (widely separated coxites III-IV from I-II, terminal anus, pretarsal stalked pad), although I do tentatively accept that with the Protoplophoroidea it constitutes a monophyletic group. On the other hand the *late* derivative phylogeny of Pediculochelidae is not acceptable since there is no evidence suggesting an ancestor with hysteronotal intercalary sclerites and erectile setae, or that the absence of sclerotization and reduced setation (often a convergent similarity) are synapomorphies for a lineage composed of it and the Haplochthoniidae. I propose that the Pediculochelidae is regarded as an *early* derivative group as indicated by the primitively disjunct external malae. This suggests that the conjunct external malae of other Profissurida have arisen separately as an apomorphy convergent to a similar character state in the majority of the Comalida and therefore supports the upranking and exclusion of the Profissurida from the latter suborder.

Suborder **AFISSURIDA**

Diagnosis: Cryptostigmata. Hysteronotal shield lacks transverse fissures, but transverse furrows often present. Hysteronotal gland absent. Hysteronotal chaetotaxy holotrichous or hypertrichous. Setal file *s* with two setae, both similar in size and shape to other proteronotal setae. Coxites merged, forming two podosternal shields (coxites I, II or III, IV). Cheliceral spatula absent. External malae disjunct. Gnathosternal fissures absent, but mentocoxal furrow sometimes present. Adoral setae in transverse row, at least adaxial two pairs large and flattened. Pretarsi with one claw. Tarsus I and genu I each with two solenidia. Tibia I solenidia flagelliform. Femora undivided. Nymphs with similar facies to adult.

Remarks: The Afissurida, also referred to as Afissurina (Lee 1984), includes only one superfamily, the Lohmannioidea: Grandjean, 1969. The Lohmannioidea was then included in the Mixonomata which approximates to the Mixosomatina (Comalida) considered below. Despite this, Grandjean (1950), in a thorough work on the Lohmannidae, has indicated that this family is very distinct from other oribate mites, but with distant affinities to certain "Enarthronota". I agree that it shares a number of primitive character states with the Retrofissurida (part of old "Enarthronota") such as disjunct external malae and a complete notal chaetotaxy, including two large, well-separated setae in file *s* and sixteen pairs of hysteronotal setae. On the basis of this, it is reasonable to regard the absence of a hysteronotal gland as primitive and not secondary as in some Mixosomatina (Comalida). Therefore, my inclusion of the Lohmannioidea in a separate, primitive suborder, with its extensive hysteronotal shield considered as convergent with that state amongst the Comalida, reflects the earlier (1950) conclusions of Grandjean rather than his later (Grandjean 1969) work.

Besides the Lohmanniidae, two other families have been recognised in the superfamily, each including only a single species. The Nothrolohmanniidae Balogh, 1968 is recognisable by bifurcate seta *f*1, humeral processes bearing seta *S*1 and large triangular aggenital shield fused to posterior margin of coxite IV. The Xenolohmanniidae Balogh and Mahunka, 1969 has a "menton divided into two parts, not meeting medially". As illustrated, this structure appears as if it might represent a pair of broad flat processes extending forward from coxites I rather than an unusual gnathosternum.

Family **LOHMANNIIDAE** Berlese

Lohmannini Berlese, 1917b: 176
Lohmanniidae: Grandjean, 1950: 100
Lohmanniidae: Wallwork, 1962a: 457
Lohmanniidae: Corpuz-Raros, 1979: 315

Type-genus: *Lohmannia* Michael, 1898: 75

Diagnosis: Afissurida. Preanal shield present: either bar-shaped, T-shaped, or reduced to central knob. Aggenital shield sometimes present, but not fused to coxite IV or extending posteriorad to halfway along genital shield. No broad flat process extending forward from coxite I under gnathosternum. Hysteronotal seta *S*1 not on conspicuous humeral process. Proteronotal seta *f*1 not bifurcate.

Morphology: Small to large (480-900) dull yellow or brown mites. Proteronotum long (0.4x length of hysteronotum) and broad (as wide as hysteronotum). Opisthosternum usually shorter than podosternum. Legs short (leg I longest, less than 0.4x idiosomal length). Palp femur and genu fused or partially fused. Genital shield bears 10 or more setae in two files (usually 6*Jg*, 4*Zg*), may be divided into subequal anterior and posterior parts. Setal files *Sg* and *Sa* absent. Anal shield may be divided into petanal and paranal parts. Solenidiotaxy I (2-1-2), II (1-1-1 or 2), III (1-1-0), IV (1-0-0).

Distribution: Widespread in tropics, where greatest generic diversity occurs. Particular species may themselves be widespread. Achieved "a greater degree of evolutionary radiation in Africa than in South America" with "a wide distribution in those parts of the world which belonged, formerly, to Gondwanaland" (Hammer and Wallwork 1979). In temperate regions, but generic diversity decreases away from tropics, *Lohmannia* being most widespread. In northern hemisphere, genera other than *Lohmannia* only found south of 45°N.

Some species known to burrow in roots or bark. Represented both in deserts and moist habitats such as coastal bogs. Ecological notes on species collected in Philippines (Corpuz-Raros 1979) indicate wide variety of niches which family can occupy in limited geographical area.

Remarks: The above diagnosis distinguishes the Lohmanniidae from the two very similar monospecific families also in the Afissurida and is, therefore, relatively trivial. A number of further character states are listed under "Morphology" which may apply to all three families.

Balogh (1972) included 20 genera in the Lohmanniidae. Amongst these, authors have regarded the following four genera as similar to *Papillacarus* (which is represented in this study): *Cryptacarus* Grandjean, 1950; *Dendracarus* Balogh, 1960; *Lepidacarus* Csiszar, 1961; *Vepracarus* Aoki, 1965b. On the basis of the disposition of the opisthosternal shields *Cryptacarus* and *Dendracarus* can be excluded. Whilst, as elaborated on below, *Lepidacarus* can also be distinguished, *Vepracarus* is regarded as synonymous with *Papillacarus*.

PAPILLACARUS Kunst

Papillacarus Kunst, 1959: 70. Type designation (original): "*Lohmannia murcioides* Berlese v. *aciculata* Berlese 1905".

Vepracarus Aoki, 1965b: 142. Type designation (original): "*Vepracarus ogawai* Aoki,spec.nov."—**n.syn.**

Type-species: *Papillacarus aciculatus* (Berlese, 1905: 24).

Diagnosis: Lohmanniidae. Genital shield divided by transverse fissure into two subequal shields. Anal shield divided by longitudinal fissure into peranal and paranal shields. Preanal shield reduced to central, bicornate knob. Rostral tectum blunt, anterior margin either smooth arc or sinuous with four slight tubercles or with three conspicuous tubercles (lateral tubercles where lamellae meet margin). Proteronotal plasmic seta (*z2*) with long cilia on only one side of slim or lanceolate main stem. Notal setae with cilia which may be inconspicuous or so long that setae bush-like. Posterior notal hypertrichy, never anterior to seta *J2*. Notal integument papillate. Ventral ridges on femora I and II. Analchaetotaxy: 2*Ja*, 4*Za*. Tarsi III and IV each with 10 setae. Tarsus II with two solenidia.

Distribution: Possibly almost limited to Old World. Virgin Islands (NTa); Annobon Island, Ghana (Ew); Crimea, Moscow, Ukrainia (Pe); Bulgaria, Greece, Italy, Spain, Tunisia (Pm); Korea, Japan (Pe); India (Oi); Thailand (Os); Java, Philippines (Om); South Australia (Aa). Known Oriental fauna shows greatest morphological diversity.

Found in grassland, feeding on grass roots, also under trees, where grass may or may not have been present.

Remarks: Three genera (*Lepidacarus, Papillacarus,* and *Vepracarus*) have the disposition of opisthosternal shields given in the above diagnosis. *Lepidacarus* can be distinguished from the other two genera by the preanal shield being an undivided central knob, as well as by the hysteronotal setae being leaf-like.

The only species of *Papillacarus* and *Vepracarus* that has been described in enough detail to include characters of the gnathosoma and legs is *P. angulatus*. Therefore, characters used to delineate these genera and their included species have to be limited to those of the idiosoma and in some cases to the notum. On the basis of such characters I have not been confident about distinguishing the two genera. Instead I have merged them and regarded *Papillacarus* as including the four following species-complexes based on the form and chaetotaxy of the hysteronotal setae. This is intended as a temporary measure until more characters are considered. Although the *aciculatus*-complex (includes type of *Papillacarus*) and *ogawai*-complex (includes type of *Vepracarus*) are easily delineated, this is undermined by the other two complexes. The fact that the *hirsutus*-complex includes species from both genera illustrates this confusion. The type complex is considered last since it includes the species found in South Australia. *P. egypticus* Elbadry and Nasr, 1977 and *P. indicus* Hafeez Kardar, 1972 are grouped in *Lohmannia*, **n.comb.**

hirsutus-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J4* or *J5*, area bearing 50-60 setae. Supernumerary setae short (length subequal to or less than distance between posterior setal bases), bush-like (because long cilia). Complement setae similar, indistinguishable. If any longer seta (uncertain if supernumerary or complement), then around posterior margin.

Remarks: Three species included in the complex. *P. hirsutus* (Aoki, 1961), ex *Cryptacarus* —Pe, Om, Ap. *P. chamartinesis* Perez-Inigo, 1967—Pm. *P. koreanus* (Mahunka, 1973), ex *Vepracarus*, **n.comb.**—Pe.

ogawai-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J4*, area bearing 50-80 setae. Supernumerary setae short, bush-like. Complement setae at least twice as long, with inconspicuous cilia. Single rank of tubercles between setal ranks 5 and 6.

Remarks: Two species included in complex. *P. ogawai* (Aoki, 1965b), ex type of *Vepracarus*, **n.comb.**—Os. *P. ramirezae* (Corpuz-Raros, 1979), ex *Vepracarus*, **n.comb.**—Om.

ramosus-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J2*, area bearing 120-170 setae. Supernumerary setae short, bush-like. Complement setae *J4*, and those posterior to it, more than five times as long, with inconspicuous cilia.

Remarks: Two species included in complex. *P. ramosus* Balogh, 1961—Om. *P. cruzae* Corpuz-Raros, 1979—Om.

aciculatus-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J4*, area bearing 20-45 setae. Supernumerary setae short but similar in form to complement setae, so both with inconspicuous cilia, not bush-like.

Remarks: Six species included in complex. *P. aciculatus* Berlese, 1905—Pe, Pm. *P. angulatus* Wallwork, 1962a—Ew. *P. undirostratus* Aoki, 1965b-Os. *P. ondriasi* Mahunka, 1974—Pm. *P. pseudoaciculatus* Mahunka, 1980a—Pm, Aa. *P. vitis* Elbadry and Nasr, 1977—Pm.

Papillacarus pseudoaciculatus Mahunka

(Figs 1, 2)

Papillacarus pseudoaciculatus Mahunka, 1980a: 126

Tritonymph

Dull, ochre-coloured with yellowish brown cheliceral extremities, external malae and legs. Cuticle of shields mainly granulate except in transverse hysteronotal furrows and in small, usually marginal patches. Similar but less extensive areas papillate, protuberances being aciculate (as few on gnathosternum, illustrated Fig. 1). Cuticle of prehysteronotal fissure strongly striated suggesting propodosoma can flex downward. Idiosomal length 510 (1); appendage lengths—*ch* 42.5, *pa* 45, *I* 180, *II* 160, *III* 135, *IV* 175; femur breadths—*pa* 12.5, *I* 50, *II* 45, *III* 37.5, *IV* 42.5.

Cheliceral seta *ch*1 much shorter than *ch*2. Mentocoxal furrow present, clearly not fissure. Rostral tectum hyaline, indistinct, possibly smooth arc. Dorsolateral longitudinal fissure from anterior margin of hysteronotal shield back to level of preanal shield. This delineates dorsal margin of pleural shield which bears no setae but slit-like pore (*hf*1) at anterodorsal corner. Few supernumerary hysteronotal setae (?six) so area behind *J*4 bearing about 18 setae. Cilia on hysteronotal setae longer than depicted on type specimen, more like *P. ondriasi* (Mahunka 1974: 575, Fig. 8), but supernumerary setae relatively longer. Seta *J*6 conspicuously longer than surrounding setae. Six transverse hysteronotal furrows, only anterior furrow just behind seta *J*1 complete, posterior furrow level with seta *J*4 reduced to two indistinct pits. Indistinct structures may represent two pairs of genital papillae. Five pairs of setae on anterior genital shield and four pairs on posterior genital shield (7*Jg*, 2*Zg*), possibly *Zg*3 missing from adult complement.

Material examined: One tritonymph (N19831), bases of grasses and plantains, Glenthorne, 12.6.1974, D. C. Lee.

Distribution: Tunisia (Pm); South Australia (Aa). South Australia: Glenthorne, cultivated pasture, 1 tritonymph (- /8).

Remarks: The referral of this single specimen to be a tritonymph of *P. pseudoaciculatus* is not done with confidence. The identification is based mainly on the low number of supernumerary hysteronotal setae, but this may be related to it being an immature stage. The extensive somal coverage with aciculate protuberances in dense patches excludes some other species. Since the species are so similar in the *aciculatus*-complex, the above tritonymph could represent a new species.

Suborder COMALIDA

Diagnosis: Cryptostigmata. Hysteronotal shield usually lacks transverse fissures (exceptions: *TB*2 present in most Eumixosomatae, ?*TB*1 present in some *Platynothrus* and *Crotonia* species). Hysteronotal gland usually present (exceptions: absent in Eulohmanniidae, Nanhermanniidae, Phthiracaridae, Synichotritiinae). Hysteronotal chaetotaxy usually hypotrichous, with at least seta *J*4 and/or *Z*4 vestigial or absent (holotrichous exceptions: some Eumixosomatae, Eulohmanniidae, some Clinofissurae). Setal file *s* with one or two setae, if two, then at least one 0.5x length or less, of proteronotal seta *j*2. Coxites rarely discrete, varying degrees of fusion may merge into single podosternal shield. Cheliceral spatula present or absent. External malae conjunct or coarctate. Gnathosternal fissures absent or mentocoxal and/or dicoxal fissures present. Adoral setae positioned so that at least *ao*1 anterior to *ao*2. Pretarsus with one, three or rarely two claws. Genu I with one (true for all species with two solenidia on tarsus I), two or three solenidia. Tibia I solenidia baculiform, piliform or flagelliform. Femora undivided. Nymphs with similar or dissimilar facies to adult.

Remarks: The Comalida (Lee 1984) is diminished to exclude the Profissurina as commented on under "Systematics" above. This leaves it restricted to two infraorders: Mixosomatina and Holosomatina. The Mixosomatina and amongst the Holosomatina, the Clinofissurae, are dealt with below. Thus, within my study of South Australian oribate mites, three sections (Pherenotae, Gymnonotae and Poronotae) of Holosomatina will not have been considered.

The synapomorphy of the Comalida is still regarded as the conjunct or coarctate position of the external malae, but it is now treated as convergent with that character state in the upgraded Profissurina. A general trend can be recognised in the adults to derived character states such as a strongly sclerotized integument, fused somal shields, fissured gnathosternum, conspicuous somal ridges (lamellae, pteromorphs, tecta), fewer hairs (setae, solenidia), heteromorphic leg segments and a more complex respiratory system (pores, tracheae). Since a similar trend does not occur in the immature stages, they tend to be dissimilar to the adults in all but the more primitive taxa.

Relationships within the Comalida, which includes the great majority of extant oribate species, are not well understood. I have assigned the advanced taxa to the Holosomatina, which is regarded as monophyletic. The remaining distantly related taxa are provisionally referred to the Mixosomatina, which is regarded as a primitive grade.

The Comalida is regarded as paraphyletic because the Astigmata is not included (see "Systematics" above). This is preferred since it provokes the search amongst the Comalida for the sister-group to the Astigmata, a more acceptable phylogeny, since the primitive nature of *Parhypochthonius* suggests that it is ancestral within a lineage including both of these taxa. If this search is not fruitful, however, it may prove desirable to regard the entire Comalida as a sister-group to the Astigmata and so monophyletic.

Infraorder MIXOSOMATINA

Diagnosis: Comalida. Transverse midpodosternal fissure between coxites II and III. Often two solenidia on genu I, if only one solenidium then either transverse hysteronotal fissure *TB*2 present (some Gehypochthoniidae) or opisthosternal setation reduced (at least setae *Sg* absent and usually only one seta *JZa*—

Neomixosomatae). Adanal shields never merge behind anal shields. Cheliceral spatula present or absent.

Remarks: The Mixosomatina includes three sections (Eumixosomatae, Mesomixosomatae and Neomixosomatae) much as before (Lee 1984) except that the latter section has been extended to include the Trhypochthoniidae and Trhypochthoniellidae. Within my study of South Australian oribate mites, members of the Eumixosomatae have already been considered under "Monofissurae" within the "Arthronotina" (Lee 1982), but it should be noted that the recently included (Lee 1984) North American Nehypochthoniidae Norton and Metz, 1980 lacks a transverse hysteronotal fissure, which requires a change in the diagnosis. The other two sections are considered below, although no members of the Neomixosomatae were found in this study.

The Mixosomatina has no synapomorphy, but is recognisable by the primitive character state of a podosternal fissure which allows the propodosoma to move in relation to the metapodosoma. In some taxa with a strongly sclerotized cuticle, this flexibility is accentuated by a number of derived states such as in ptychoidy, when the legs are pulled up into the soma and the proteronotum flexed downward to close on a forward facing section of the genital shield, or when the propodosoma can partially telescope into the metapodosoma.

Relationships within the Mixosomatina are uncertain, partly because some primitive character states may or may not be secondarily reverted to in advanced taxa. The weakly sclerotized cuticle of the Eumixosomatae is primitive in the Parhypochthioidea and the Nehypochthoniidae but in the Neomixosomatae it may be either reverted to or there may not have been any strongly sclerotized ancestors. Furthermore, whilst I (Lee 1984) considered that the absence of cheliceral spatulae was primitive but diagnostic of the Mixosomatina, Norton (personal communication, 1982) has pointed out that cheliceral spatulae do occur in some Mixosomatina. He has observed cheliceral spatulae in *Collohmannia gigantea* and a new North American species of Collohmanniidae. Also, their presence in Perlohmanniidae is suggested in an illustration by Grandjean (1958: Fig. 5A), and I have now included the Trhypochthoniidae and Trhypochthoniellidae in Mixosomatina, both of which have cheliceral spatulae. Trägårdh (1931b) recorded cheliceral spatulae on *Phthiracarus maculatus*, but this was refuted by Grandjean (1959) who considered the structure to be an oncophysis. Cheliceral spatulae are considered to be absent in all Eumixosomatae, some Mesomixosomatae (Epilohmanniidae, Eulohmanniidae, Phthiracaridae, Euphthiracaridae) and some Neomixosomatae (Malaconothridae). Therefore, although primitively absent, some taxa without cheliceral spatulae may have ancestors that possessed them.

The three sections within the Mixosomatina are grades. The Mesomixosomatae include a number of specialized lineages, whilst the Eumixosomatae are apparently primitive (certainly so in the case of *Parhypochthonius*, but possibly *Elliptochthonius* reflects specialization to living in the deeper soil layers) and the Neomixosomatae include advanced lineages which may be ancestral to the Holosomatina. Regarding the relationships of the Astigmata, I hold to a conservative belief that weak sclerotization in the Astigmata is an ancestral character state and not a reflection of neoteny as proposed by O'Connor (1984). Therefore, a sister-group to the Astigmata would have a weakly sclerotized adult, as well as lacking a rostral tectum and cheliceral spatulae. Possibly, reduction in the fourth hysteronotal setal rank would be the synapomorphy, placing this sister-group within the Eumixosomatae. However, a stringent analysis will be a necessary prelude to developing a durable model for the areas only speculated on here.

Section MESOMIXOSOMATAE

Diagnosis: Mixosomatina. Hysteronotal shield without transverse fissures. Rostral tectum present. Gnathosternum with Λ-shaped mentocoxal fissure. Adoral setae in three conspicuous pairs. Opisthosternal setal files *Sg* with at least one seta, *JZa* with at least two setae. Proteronotal setal file *s* with one or two setae. Genu I with two or rarely three solenidia.

Remarks: The Mesomixosomatae is a diverse group of small families which, although having a strongly sclerotized adult cuticle, have maintained flexibility by developing various specialized ways of moving the propodosoma in relation to the hysterosoma. I have not attempted any superfamily groupings. Even grouping the six families into aptychoid (Collohmanniidae Grandjean, 1969; Epilohmanniidae Oudemans, 1923; Eulohmanniidae Grandjean, 1931; Perlohmanniidae Grandjean, 1954a) and ptychoid (Euphthiracaridae Jacot, 1930; Phthiracaridae Perty, 1841) taxa is questionable. The ptychoid families have already been considered in this study (Lee 1981) as the Euptyctima. The Epilohmanniidae is represented in collections for this study and is considered below. Although not represented, the Eulohmanniidae is also considered in order to confirm its grouping in this section despite possessing some primitive character states suggesting it might even be grouped with the Afissurida.

Family EPILOHMANNIIDAE Oudemans

Lesseriidae Oudemans, 1917: 78

Epilohmanniidae Oudemans, 1923: 79

Epilohmanniidae: Grandjean, 1954a: 430.

Epilohmanniidae: Grandjean, 1969: 144.

Epilohmanniidae: Norton, Metz & Sharma, 1978: 145.

Type-genus: *Epilohmannia* Berlese, 1917b.

Diagnosis: Mesomixosomatae. Minute to medium-sized (320-800) yellow to brown mites. Extensive non-sclerotized cuticle at transverse midpodosternal fissure between coxites II and III allows propodosoma to partially telescope in and out of metapodosoma. Otherwise, extensive sclerotized somal shields, with coxites fused to each other, aggenital shield and usually mentum (exception *Epilohmannoides jacoti*). Posterior end of aggenital and anterior end of adanal shields truncated or fused together so that ventrolateral longitudinal fissure straight. Adanal shield merges medially as broad band in front of anal shields. Cheliceral spatula absent. Palpal segments fused so that only two separate. Adoral seta *ao*1 bifurcate. Hysteronotal gland present, pore opens into depression also containing alveolus of relic seta *Z*4, whilst seta *J*4 similarly absent. Opisthosternal setal file *Sg* includes 3-7 pairs. Opisthosternal pores *Zaf* and *Saf* present. On tarsus I seta *pd*3 reduced to scale closely associated with distal face of solenidium *so*4. On tibia I solenidium flagelliform, longer than segment.

Distribution: Possibly cosmopolitan. Wallwork (1962b) states that Epilohmanniidae "appears to be widely distributed through the warmer regions of the world". Records from southern Canada (Nn) and Moscow (Pe) could be most northerly, with records from South Australia (Aa) being most southerly, suggesting predominantly pantropical distribution becoming sparse in temperate regions up to 57°N and 35°S. Outside Antarctica and Subantarctic, South Ethiopian and New Zealand-Australian may be only minor regions in which family not represented.

Microhabitats range widely from grass roots, vineyards and forests, but possibly do not include arid or semi-arid environments.

Remarks: The Epilohmanniidae includes the typegenus and *Epilohmannoides*. Norton, Metz and Sharma (1978) in describing two species of *Epilohmannoides* also give a diagnosis for the family on which the above diagnosis is based.

EPILOHMANNIA Berlese

Epilohmannia Berlese, 1917b: 176. Type designation (original): "*Lohmannia cylindrica* Berl.".

Lesseria Oudemans, 1917: 78. Type designation (original): by monotypy ("*Lesseria szanisloi* Oudms. 1915", synonym of *Epilohmannia cylindrica* by van der Hammen 1959: 54).

Type-species: *Epilohmannia cylindrica* (Berlese, 1905: 23).

Diagnosis: Epilohmanniidae. Opisthoventral shield divided into two parts by transverse fissure just posterior to genital shield. Genital and anal shields oblong rather than suboval; posterior margin of genital shield and anterior margin of anal shield being broad-shouldered. Trochanter III and IV with distal axis at right angles to proximal axis. Acetabulum IV on same longitudinal line as III, both divided by spurs into double opening.

Distribution: As for Epilohmanniidae.

Remarks: The more complex form of trochanter III and IV and their acebatula with double openings, suggest that these legs can lock into either of two basic positions and, further, indicates that *Epilohmannia* may be derived from the much less diverse (four compared with 26 species) *Epilohmannoides* with simpler posterior trochanters and acetabula.

Balogh and Mahunka (1979) have distinguished within *Epilohmannia* a subgenus, *Sinolohmannia*, by the presence of a spine-like seta *d* associated with the solenidium on tibia IV. The *cylindrica*-complex of Schuster (1960) can be regarded as equivalent to the nominate subgenus. A more conspicuous character state, the position of the acetabulum on coxite IV, has not been referred to in grouping species. Both the species considered below have the acetabulum IV on the posterior margin of coxite IV, but it may be near the anterior margin or in between. However, the included species are similar and, unfortunately, the specimens collected in this study belong to species with a number of even more similar subspecies. Since I am not confident about grouping them in any of the subspecies, new subspecies have had to be established. Because of the similarity of the established subspecies, references to them are included under the new subspecies.

The illustrations of one species in this paper are intended to show character states delineating the family and genus rather than the subspecies.

Epilohmannia cylindrica (Berlese) ***media*** n.ssp.
(Figs 3-5)

Lohmannia cylindrica Berlese, 1905: 23.

Lesseria szanisloi Oudemans, 1917: 78.

Epilohmannia szanisloi Schuster, 1960: 202 (including *minima*, p. 205).

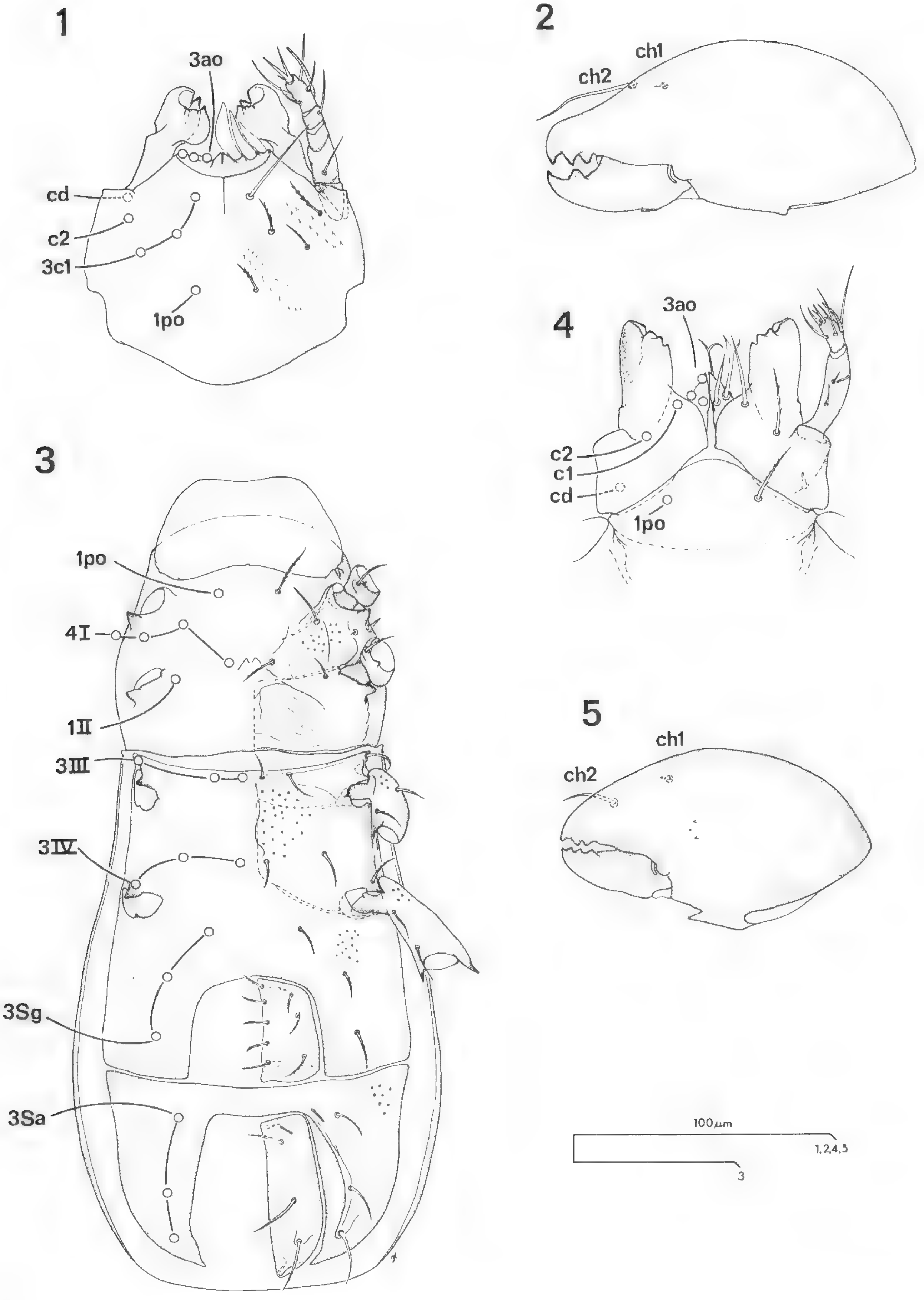
Epilohmannia cylindrica Aoki, 1965e: 309.

Epilohmannia cylindrica Bayoumi and Mahunka, 1976: 6.

Female

Dull (slight greasy shine) chestnut brown, slightly darker cheliceral extremities and external malae, extensive pale straw-coloured cuticle between proterosoma and hysterosoma when extended. Most of hysterosternum with sparse puncta, limited in other parts of venter to areas illustrated (Fig. 3). Idiosomal length (abutting margins to midpodosomal fissure, possible extension 50, retraction 30) 465 (10, 415-525); appendage lengths (for 475)—*ch* 45, *pa* 50, *I* 195, *II* 175, *III* 195, *IV* 275; femur breadths—*pa* 7.5, *I* 20, *II* 20, *III* 15, *IV* 20; broadest segment breadth—*I*, genu 32.5, *II* genu 30, *III* trochanter 25, *IV* trochanter 37.5.

Appendage setae: *ch* (2), *pa* (3-8), *I* (1-4-5-5-17), *II* (1-4-5-5-12), *III* (2-3-4-4-10), *IV* (2-3-4-4-9). Solenidia: *I* (2-1-3), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Solenidia of



FIGS. 1-5. *Papillacarus* and *Epilohmannia;* 1-2, *Papillacarus pseudoaciculatus* Mahunka, tritonymph; 1, gnathosternum; 2, right chelicera, anterior surface; 3-5, *Epilohmannia cylindrica* (Berlese) *media* n.ssp., female; 3, idiosternum; 4, gnathosternum; 5, right chelicera, anterior surface.

genua and tibiae flagelliform with minute, closely associated seta *d* (possibly partially coupled—see *Epilohmannoides terrae:* Norton, Metz and Sharma, 1978), on legs III and IV seta *d* only recognised when separated from solendium by preparation of specimen. Solenidium *so*4 (*so*3 regarded as absent) on tarsus I also flagelliform with minute seta *pd*3 closely associated with distal face. Other solenidia on tarsi I and II ceratiform.

Chelicera without spatula, small process (Fig. 5) posterior to movable digit probably chitinous plate representing reduced trochanter. Adoral setae *ao*1 and *ao*2 bifurcate. Genital shield setae: *5Jg, 3Zg.*

Tarsus IV with length 5.5x breadth, and setae *v*1 and *v*2 (see Schuster 1960: Fig. 5 a- *k*1 and *k*2) spine-like, but less robust than for *E. cylindrica minima* (see Schuster 1960: Fig. 5b). Seta *v*2 nearer to *v*1 than to *v*3.

No eggs observed, specimens assumed female since, amongst eight pairs of setae on positor, three *pg* pairs well apart from rest, two *dg* pairs longer. One to three boli in each specimen, light to dark brown heterogeneously granular contents without recognisable cellular structures.

Material examined: South Australia (Aa). Holotype female (N19832), nine paratype females (N19833-N198311), bases of grasses and plantains, Glenthorne, 12.6.1974, D. C. Lee.

Distribution: E. cylindrica (subspecies *media* only known from South Australia). Tennessee (Na); Tchad (Ee); Austria, Egypt, Hungary, Italy, Moscow, Sicily, Spain (Pe); Turkestan (Ps); Philippines (Om); South Australia (Aa); Hawaii (Ap). South Australia: Glenthorne, cultivated pasture, 10 (2/8).

Remarks: E. cylindrica media lies between *E. c. cylindrica* and *E. c. minima* in a gradation of character states. As indicated by Schuster (1960), *E. c. cylindrica* is 435-573 long, has tarsus IV length 5.6x breadth, with setae *v*1 and *v*2 setose, whilst *E. c. minima* is 370-440 long, has tarsus IV length 3.6x breadth with setae *v*1 and *v*2 robust and spine-like (more so than *E. c. media*).

Epilohmannia pallida Wallwork ***australica*** n.ssp.

(Fig. none)

Epilohmannia pallida Wallwork, 1962b: 689.

Epilohmannia pallida pacifica Aoki, 1965c: 312.

Epilohmannia pallida aegyptica Bayoumi & Mahunka, 1976: 8.

Epilohmannia pallida indica Bhattacharya & Banerjee, 1980: 19.

Epilohmannia pallida americana Balogh & Mahunka, 1981: 59.

Female

Dull brown, paler but similar to *E. cylindrica.* Idiosomal length (abutting margins to midpodosomal fissure, possible extension 42.5, retraction 25) 400 (2 ex Piccaninnie Ponds, 420-425; 3 ex Chambers Gully, 350-405); appendage lengths (for 405)—*ch* 40, *pa* 45, *I* 155, *II* 130, *III* 140, *IV* 190; femur breadths—*pa* 10, *I* 22.5, *II* 20, *III* 15, *IV* 15; broadest segment breadths—*I* genu 27.5, *II* genu 25, *III* trochanter 17.5, *IV* trochanter 25.

Appendage setae: *ch* 2, *pa* (3-8), *I* (1-3-4-5-15), *II* (1-4-4-4-12), *III* (2 or 3-3-3-3 or 4-10), *IV* (2-3-3-4-9). Compared with *E. c. media* seta *va* absent on femur I, genua I and III, whilst seta *vp* absent on genua III and IV. On genu I seta *v* small. Solenidia similar in number, shape and size to *E. c. media,* except on genua III, IV and tibiae III, IV, solenidia relatively longer.

Chelicera without spatula. Adoral setae *ao*1 and *ao*2 bifurcate. Genital shield setae: *5Jg, 3Zg.*

Characters previously used to delineate subspecies as follows. Hysteronotal setae sparsely ciliate and tapering, seta *Z*1 posterior to *J*1, distance *J*1-*Z*1 subequal to *J*1-*J*1. Anterior apodeme to coxite I curves back to single apodeme separating coxites I and II without connecting ridge to partner, coxite seta *III* 2 subequal in length to *III* 3, lateral margin of coxite IV straight. Opisthosternal seta *Sg*2 level with *Jg*1, setal file *Zg* separate from file *Jg* by distance subequal to length of *Zg*1, slit pore *Saf* inclined at angle less than 25° from transverse axis. Distal end of trochanter III without dorsal spur, on tarsus IV seta *v*2 nearer *v*1 than *v*3.

No eggs observed, specimens assumed female since amongst eight pairs of setae on positor, three *pg* pairs well apart from rest, two *dg* pairs longer. One or two boli in each specimen, light to dark brown heterogeneously granular contents without recognisable cellular structures.

Material examined: South Australia (Aa). Holotype female (N198312) and two paratype females (N198313, N198314), grass and moss or litter under *Eucalyptus viminalis,* Chambers Gully, 12.6.1974, D. C. Lee. Two paratype females (N198315, N198316), litter and sparse grass under *Acacia sophorae,* Piccaninnie Ponds, 20.8.1975, D. C. Lee.

Distribution: E. pallida (subspecies *australica* only known from South Australia). Texas, Minnesota, North Dakota, South Dakota (Na); Paraguay (NTb); Ghana (Ew); Egypt (Pe); West Bengal (Oi); Hong Kong (Os); South Australia (Aa); Hawaii (Ap). South Australia: Chambers Gully, savannah woodland, 3 (2/8); Piccaninnie Ponds, coastal closed-scrubland 2 (2/8).

Remarks: E. pallida is not very different from *E. cylindrica* (especially if the comparison is made to *E. c. minima*) except that seta *d*2 on tarsus IV is conspicuously spine-like.

The other five subspecies of *E. pallida* are very similar. *E. p. australica* can be distinguished from these by the character states listed above. On the basis of these it is most similar to *E. p. indica* and *E. p. pacifica,* but differs in two states regarded as important: the shape of the anterior coxite apodemes and the position of seta *v*2 on tarsus IV. One character, the chaetotaxy of the genital shield sometimes used to distinguish subspecies, has not been listed as such because of its intraspecific variation (see McDaniel and Bolen 1983).

Family EULOHMANNIIDAE Grandjean

Eulohmanniidae Grandjean, 1931: 144
Eulohmanniidae: Grandjean, 1954a: 429

Type-genus: *Eulohmannia* Berlese, 1910.

Diagnosis: Mesomixosomatae. Medium-sized (650-700) straw-coloured mites. Extensive nonsclerotized cuticle at transverse midpodosternal fissure between coxites II and III allows propodosoma to partially telescope in and out of metapodosoma. Otherwise, extensive sclerotized somal shields, with coxites fused to each other and aggenital shield. Posterior end of aggenital and anterior end of adanal shields taper so that ventrolateral longitudinal fissure V-shaped. Adanal shield not merged medially in front of anal shields. Cheliceral spatula absent. Palpal segments fused so four separate. Adoral seta *ao*1 not bifurcate. Hysteronotal gland absent. Hysteronotal chaetotaxy holotrichous, fourth setal rank not reduced. Opisthosternal setal file *Sg* hypertrichous and dispersed, 15 or more setae. Opisthosternal pore *Saf* present, *Zuf* absent. On tarsus I, seta *pd*3 setose and well separated from solenidium *so*4. On tibia I, solenidium piliform, shorter than segment.

Distribution: Holarctic.

Remarks: The Eulohmanniidae includes one species, *Eulohmannia ribagai* Berlese, which has been described a number of times, perhaps the most accurate and comprehensive illustration being that by Lebrun and Wauthy (1981: Fig. 2). But there appears to be no detailed description of the gnathosternum. Since the species has a number of primitive character states such as a holotrichous hysteronotal chaetotaxy and no hysteronotal gland, it was necessary to check the gnathosternum to evaluate whether or not the species was correctly grouped in the Comalida. This was made possible by a gift of two specimens from Dr. Georges Wauthy.

Eulohmannia ribagai Berlese
(Fig. none)

Lohmannia (Eulohmannia) ribagai Berlese, 1910: 223.

Adult

Idiosomal length 655 and 695. Cheliceral spatula absent. Mentocoxal fissure present, Λ-shaped. External malae conjunct, distally with two lateral robust refractile teeth and median hyaline flap. Gnathosternal chaetotaxy reduced: *3ao, 2cv, 1po*. Gnathosternum elongate much as *Perlohmannia dissimilis* (see Woolley 1969: Fig. 10). Tarsus I with 23 setae and three solenidia. The shape and positioning of plasmic seta *d*I and three solenidia much as *Perlohmannia dissimilis* (see Grandjean 1958: Fig. 6C); seta *d*I short with distal knob, solenidia well separated from setae.

Material examined: Two adults (N1983103, N1983104), litter and humus, Lauzella Wood, Belgium, 4.1980, G. Wauthy.

Remarks: Having seen details of the gnathosternum, there is no doubt that *Eulohmannia* is well placed in the Comalida, and therefore that some apparently primitive character states, such as the absence of hysteronotal glands and holotrichous hysteronotal chaetotaxy, are derived reversals. Although *Eulohmannia* in general form and extent of sclerotization resembles *Epilohmannia*, it exhibits similarities to *Perlohmannia* of the gnathosternum and tarsus I which suggests they may be regarded as sister-groups.

Section NEOMIXOSOMATAE

Diagnosis: Mixosomatina. Hysteronotal shield without transverse fissures. Rostral tectum present. Gnathosternum either without fissure or Λ-shaped or what may be transverse linear mentocoxal fissure present. Adoral setae present or absent. Opisthosternal setal file *Sg* absent, *JZa* usually with only one seta (exception: *Mucronothrus*—2*JZa*). Proteronotal setal file *s* absent, plasmic seta *z*2 may be reduced and setiform. On genu I, one solendium.

Remarks: The Neomixosomatae was established (Lee, 1984) to include the Malaconothridae which has a conspicuous fissure between coxites II-III and lacks a cheliceral spatula, but is in some ways similar to the Nothroidea, the most primitive of the Holosomatina. As indicated in the above "Remarks" under Mixosomatina, it has now been established that cheliceral spatulae occur on some of its members. This means that the Trhypochthoniidae: Balogh, 1972 is not excluded from the Mixosomatina by possessing cheliceral spatulae and so the relevant literature has been examined, even though no representatives were collected in this study. The result is that a number of changes are made to the classification, most genera of Trhypochthoniidae including the type-genus being included in the Mixosomatina. On the other hand, two genera have been grouped in a new family retained within the Holosomatina. The three families (Malaconothridae, Trhypochthoniidae and Trhypochthoniellidae) now in the Neomixosomatae are briefly commented on below.

I wish to emphasize the provisional nature of this classification and that I have ignored some character states considered in the more comprehensive studies of relevant families by Knulle (1957) and van der Hammen (listed by van der Hammen, 1959) because they are only known for a few species. Since those studies, four genera have been added to the eight genera (included by Balogh, 1972 within the Trhypochthoniidae and Malaconothridae) and, both before and after the studies, the majority of species descriptions have not been extensive enough, in some cases with debatable generic combinations. Therefore, a thorough reinvestigation of established taxa is needed before reliable diagnoses can be given to them, and their considerable relevance to the classification of Comalida understood.

Family MALACONOTHRIDAE Berlese, 1917b

Diagnosis: Neomixosomatae. Cheliceral spatula absent. Adoral setae reduced to two pairs or all absent. Gnathosternal fissure absent or, if part of mentocoxal fissure present, lateral parts never meet at mid-point. Proteronotum without setal file *s* and seta *z*2 setiform and less than 0.5x length *j*2. Hysteronotal seta *Z*2 nearer *Z*3 than *J*2. Coxite II posterolateral corner extended as carina with backward facing socket. Opisthosternal setal file *Sa* with three setae. On tarsus I, three solenidia clustered between level of setae *pd*2-*pd*3. On tibia I, one solenidium.

Remarks: The posterolateral corner of coxite II may act as a socket into which trochanter III fits, possibly functioning as a pivot when the propodosoma flexes to one side. Such a movement could be limited in some species by a large tectum, projecting laterally from just posterodorsally to acetabulum II, hitting a similar smaller tectum anterior to acetabulum III.

The Malaconothridae, as by Balogh (1972), includes the following four genera: *Fossonothrus* Hammer, 1962; *Malaconothrus* Berlese, 1905; *Trimalaconothrus* Berlese, 1917c; *Zeanothrus* Hammer, 1966.

Family TRHYPOCHTHONIIDAE Willmann, 1931

Diagnosis: Neomixosomatae. Cheliceral spatula present. Adoral setae with three pairs present. Mentocoxal fissure present, Λ-shaped. Proteronotum with seta *z*2 club-like or, if setiform, either subequal in length to *j*2 or, if less than 0.5x length *j*2, seta *s* present. Hysteronotal seta *Z*2 nearer *J*2 than *Z*3. Coxite II posterolateral corner sometimes extended as carina with backward facing socket. Opisthosternal setal file *Sa* with two or three setae. On tarsus I, three solenidia usually widely spaced between level of setae *pd*2-*pd*4 (exception: *Hydronothrus*). On tibia I, usually two solenidia (exceptions: *Hydronothrus* and *Mucronothrus* with one solenidium).

Remarks: The eight genera included by Balogh (1972) in the Trhypochthoniidae are decreased in number by subdivision either into the Trhypochthoniellidae or the Allonothridae (Clinofissurae). The following four genera are still included *Archegozetes* Grandjean, 1931; *Hydronothrus* Aoki, 1964; *Mucronothrus* Trägårdh, 1931c; *Trhypochthonius* Berlese, 1905. The conservative emphasis on notal setae results in *Hydronothrus* being grouped in this family, although the leg I setation is similar to that of the Malaconothridae. *Archegozetes* differs considerably from the other three genera, especially with regard to its long leg tarsi and seta *z*2. But some recorded differences, the absence of both a cheliceral spatula and a fissure between coxites II and III (Beck, 1967), are regarded as errors. The presence of a cheliceral spatula and a coxite II/III fissure was recorded by Grandjean (1959) and van der Hammen (1955) and has been confirmed by Dr. R. A. Norton (personal communication, 1983) on specimens from Mexico, Panama (NTm), Brazil (NTb) and Malaysia (Om).

Family TRHYPOCHTHONIELLIDAE Knulle, 1957

Diagnosis: Neomixosomatae. Cheliceral spatula present. Adoral setae with three pairs present. Gnathosternal line (?fissure) present, transverse, linear. Proteronotum with seta *z*2 club-like or setiform and less than 0.5× length j2. Hysteronotal seta *Z*2 nearer *J*2 than *Z*3. Coxite II posterolateral corner not extended as carina. Opisthosternal setal file *Sa* with two setae. On tarsus I, three solenidia widely spaced between level of setae *pd*2-*pd*4. On tibia I, one or two solenidia.

Remarks: Trhypochthoniellidae includes two genera: *Trhypochthoniellus* Willmann, 1928; *Afronothrus* Wallwork, 1961. The grouping together of these genera is mainly based on an assumption about gnathosternal structure. They can be regarded as having a quadrate mentum: a "hypostome rechteckig" for *Trhypochthoniellus* (Knulle 1957: 151) or as illustrated for *Afronothrus* (Wallwork 1961: Fig. 7, Hammer 1972: Fig. 19a). The line illustrated on *Afronothrus* could not be the dicoxal fissure which delineates the anterior margin of the "quadrate mentum" of advanced Holosomatina. It is therefore assumed that it is a mentocoxal fissure and there may be a valid quadrate mentum, but careful evaluation of what the drawn line represents is still needed.

Infraorder HOLOSOMATINA

Diagnosis: Comalida. Coxites fused together into a single shield. On genu I, one solenidium. Tibia I solenidia baculiform, piliform or, if flagelliform, closely associated with similar seta. No transverse hysteronotal fissures (exception: *?TB*1 present in some *Crotonia* and *Platynothrus* species). Usually two setae in file *JZa*, always when adanal shields not merged behind anal shields. Cheliceral spatula present.

Remarks: The Holosomatina is regarded as monophyletic, whilst its four subordinate sections (Clinofissurae, Pherenotae, Gymnonotae and Poronotae) are likely to be grades. The lineages have not been identified, although the Poronotae (being the most derived) could be a clade. Only the most primitive section, the Clinofissurae, is considered in detail below.

A major taxon, the Circumdehiscentiae Grandjean, 1954a (= either the Euoribatida Balogh and Mahunka, 1979 or a major part of the Brachypylina: Balogh, 1972 or the Pherenotae, Gymnonotae plus Poronotae), is regarded as monophyletic but remains unnamed in this classification as before (Lee 1984). This is because it approximates to the Holosomatina (excluding only the six families of the Clinofissurae) and because the fusion of coxites into one shield (which is the synapomorphy of the Holosomatina) is regarded as a predominant step that precludes conditions such as ptychoidy and is a prelude to other states correlated with a thick, rigid idiosomal integument, such as a circular hysterosomal dehiscence line, a dicoxal gnathosternal fissure and a tracheal system opening ventrolaterally between legs II-III or in the acetabular cavities of legs I or III. The presence of a dicoxal gnathosternal fissure may be correlated with the circular hysterosomal dehiscence line of the "Circumdehiscentiae", but a *Nothrus* species is clearly described by Trägårdh (1931a) as having both a dicoxal and a mentocoxal gnathosternal fissure, although this needs confirmation since it is difficult to conceive the function of such a double-jointed system. The presence of a tracheal system appears to be the synapormorphy of a slightly smaller taxon than the "Circumdehiscentiae" since it is absent from the Hermanniellidae.

Section CLINOFISSURAE

Diagnosis: Holosomatina. Gnathosternum usually with Λ-shaped mentocoxal fissure present (exceptions: no fissure in Allonothridae, possibly both mentocoxal and dicoxal fissure present in one *Nothrus* species). If adanal shields separate from hysteronotal shield (i.e. exclude Nanhermanniidae) they do not fuse behind anal shields. Genua subquadrangulate in outline and similar in size to tibiae. Hysterosomal dehiscence line T-shaped, midnotal.

Remarks: The Clinofissurae is diagnosed by character states primitive to the Holosomatina. It is equivalent to the majority of the Nothroidea plus the Nanhermannioidea and Hermannioidea in the previous classification of Balogh (1972), when the latter two superfamilies were included in the higher oribate mites (as "Brachypylina"), although they are excluded from the similar Circumdehiscentiae Grandjean, 1954a. On the other hand, this is the first time that members of the Nothroidea have been included amongst the higher oribate mites (if considered as referring to the Holosomatina).

The following six families are included in this Section: Allonothridae **n.f.**; Camisiidae Oudemans, 1900; Crotoniidae Thorell, 1876; Hermanniidae Sellnick, 1928; Nanhermanniidae Sellnick, 1928; Nothridae Berlese, 1885. All but the Allonothridae and Nothridae are represented in this study and the Allonothridae is considered further as it has to be defined. The Allonothridae, Camisiidae, Crotoniidae and Nothridae can be grouped in the Nothroidea Grandjean, 1954a, but superfamilies will not be considered here.

Family ALLONOTHRIDAE n.f.

Type-genus: *Allonothrus* van der Hammen, 1953

Diagnosis: Clinofissurae. Gnathosternal fissures absent, or, if part of mentocoxal fissure present, lateral parts never meet at mid-point. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic setae *z2* at least 2x as long as distance *j2-z2*, and setiform or slightly swollen distally. Hysteronotal seta *J4* absent. Hysteronotal gland present. Notal setae *z1* and *J5* not on apophyses. Coxite setae not hypertrichous (3-1-3-3). Setal file *Sg* absent, combined setal file *JZg* on median margin of genital shield. Idiosoma not almost covered in continuous shield. No separate preanal shield. Palp tarsus with nine setae. No dorsolateral supernumerary setae on tarsus I. Nymphs without small shields around hysteronotal setal bases.

Remarks: The Allonothridae includes the following two genera: *Allonothrus* van der Hammen, 1953; *Pseudonothrus* Balogh, 1958. The genera are similar to each other and were included in the Trhypochthoniidae (Neomixosomatae, see above), but because of the apparent fusion of all the coxites into one shield they are now grouped in the Holosomatina as a new family. The Allonothridae exhibits similarities to both the Neomixosomatae and Clinofissurae suggesting that they belong to the same lineage, but much more data is needed before a cladistic classification can be proposed within the Comalida.

Family CAMISIIDAE Oudemans

Camisiidae (part) Oudemans, 1900: 142.
Camisiidae (part): Sellnick, 1928: 18.
Camisiidae: Grandjean, 1954a: 431.
Camisiidae (part): Sellnick and Forsslund, 1955: 473.
Camisiidae: van der Hammen, 1959: 65.

Type-genus: *Camisia* von Heyden, 1826

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta *z2* may be reduced and globular but never enclosed in bothridium, if filamentous length 0.75x-1.5x distance *j2-z2*. Hysteronotal seta *J4* present or absent. Hysteronotal gland present. Notal setae *z1* and *J5* sometimes on apophyses. Coxite setae not hypertrichous (3-1-3-3 or 4). Coxite shields usually not merged with aggenital shields. Setal file *Sg* includes two setae, combined setal file *JZg* on median margin of genital shield. Idiosoma not almost covered in continuous shield. Discrete preanal shield usually as wide as anal shield. Palp tarsus with seven setae. Tarsus I with four or fewer dorsolateral supernumerary setae. Nymphs without small shields around hysteronotal setal bases.

Distribution: Possibly cosmopolitan, greatest diversity in temperate regions, represented in tropical montane or oceanic regions.

Remarks: Camisiidae are small to gigantic (530-1225) dull brown mites, usually covered in cerotegument, thick in parts and with adhering detritus and fungus. Camisiidae has been considered as synonymous with Nothridae, but both names have been in use since Grandjean (1954a) separated them. The family is now still as regarded by Balogh (1972) except that *Austronothrus* is grouped in Crotoniidae (Ramsay and Luxton 1967). Comprehensive descriptions have been made for *Camisia* (Behan 1978; André 1980) and *Platynothrus* (Fujikawa 1982).

The following four genera are included in Camisiidae: *Camisia* von Heyden, 1826; *Heminothrus* Berlese, 1914; *Neonothrus* Forsslund (in Sellick and Forsslund 1955); *Platynothrus* Berlese, 1914. *Heminothrus* and *Neonothrus* are very similar to *Platynothrus*, *Heminothrus* being established earlier (p. 38) in the same reference.

PLATYNOTHRUS Berlese

Platynothrus Berlese, 1914: 99. Type designation (original): "*Nothrus palliatus* K. (=*N. bistriatus* K.)".

Type-species: *Platynothrus peltifer* (Koch, 1839: 29/9).

Diagnosis: Camisiidae. Proteronotal plasmic seta *z2* vermiculate, usually slightly dilated and ciliate distally. One seta in file *s*. Seta *z1* without conspicuous apophysis (at most, shorter than 0.5x distance *z1-z1*). Bothridial cavity with only one side pocket situated near base of seta *z2*. Hysteronotal seta *J4* absent or minute. Seta *J5* without conspicuous apophysis (at most, shorter than its own diameter). Two setae in file *Sg* on inner margin of aggenital shield. Two setae in file *JZa*. Coxites I, II, III merge across midsternal line, coxites IV may be partially or completely separated from each other by fissure. Leg I with six solenidia (1-2-3).

Distribution: Widespread within temperate regions, usually montane or oceanic in tropics. Canada, Greenland (Nn); Argentina, Bolivia, Chile, Peru (NTe); St. Helena (Es); Finland, Norway, Sweden, U.S.S.R., other parts of Europe (Pe); Japan (Ps); Himalayas (Oi); South Australia (Aa); New Zealand (An); South Georgia (ACs).

Remarks: Major works on *Platynothrus* are included in studies on the Swedish fauna (Sellick and Forsslund 1955: 513), Berlese's collection (van der Hammen 1959: 71), Himalayan collections with a key to species (Aoki 1965a: 290) and the northern Japanese fauna (Fujikawa, 1982: 279). Balogh (1972) regards *Platynothrus* as having one pretarsal claw so his keys do not work for species, such as the one described below, which have three pretarsal claws. *Heminothrus* and *Neonothrus* are very similar to *Platynothrus*, and might be grouped in this genus. *Platynothrus* includes seventeen species and two of these have a subspecies.

Platynothrus brevisetosus n.sp.

(Figs 6-12)

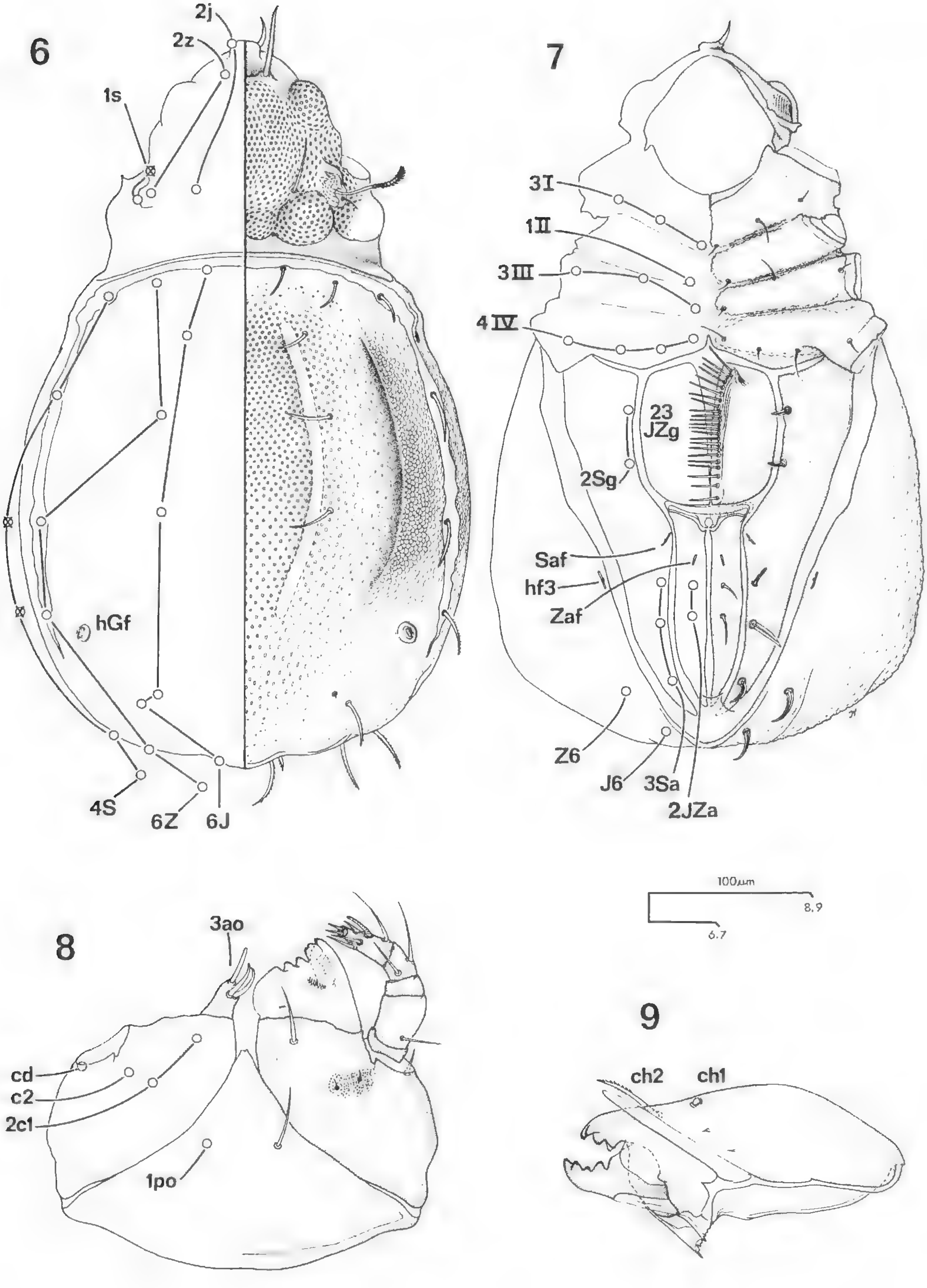
Female

General appearance and measurements: Red-brown, covered in cerotegument, thick with adhering detritus and fungus laterally and posteriorly on hysterosoma and proximally on legs. Notal minute pits and lateral low bumps distributed as illustrated (Fig. 6), whilst all shields covered with fine punctuation except on rostral tectum. Legs similar sculpturing, mainly proximal, ventral and sometimes anterior on individual segments. Setae, claws, external malae, cheliceral digits clear or light brown and refractile. Idiosomal length 1140 (1); appendage lengths—*ch* 65, *pa* 100, *I* 580, *II* 490, *III* 470, *IV* 615; femur breadths—*pa* 25, *I* 75, *II* 75, *III* 65, *IV* 62.5.

Prosternum: Lateral refractile half of external malae in vertical plane when unsquashed (i.e. not flattened as illustrated, Fig. 8) and bears two rows of cilia on dorsal surface. Adoral setae *ao1* blunt-ended. Setae *pc1* and *c2* in shallow, punctated depressions. Coxites all fused into one shield, but clearly delineated by grooves, and separate from aggenital shields.

Proteronotum: Seta *z2* vermiculate, but slightly dilated and ciliate distally. Bothridial cavity with only one side pocket just median to base of seta *z2*, so posterior median wall forms unbroken arc. Surface has central flat-topped mound with two mounds behind it, and mounds above acetabula for legs.

Opisthosternum: Opisthoventral shield separate from coxites, without protrusions from inner margin to bear *Sg* setae. Preanal shield abuts more closely on to anal shield than illustrated (Fig. 7) and appears foreshortened since extends upward in vertical plane. Opisthosternal setae in file *Sa* blade-like, with hyaline flaps on setal core. Genital shield with anteriorly twisted downward median margin bearing setae (Fig. 7) rather than median ridge, also transverse central unpigmented zone. Twenty-three marginal *JZg* setae flattened with slightly ragged, blunt ends. Pores *Zaf* and *Saf* present.



FIGS. 6-9. *Platynothrus brevisetosus* n.sp., female; 6, notum; 7, idiosternum; 8, gnathosternum; 9, right chelicera, anterior surface.

Hysteronotum: Fissure runs transversely along first setal rank and backward along setal files *Z* and *S* (*S1*, *S2*, *Z3*, *Z4*) possibly representing longitudinal pleural fissure. Setae *J2*, *Z2*, *J3* lie between median ridge and lateral furrow. Many hysteronotal setae appear bladelike with hyaline flaps to setal core and marginal cilia, not always illustrated (Fig. 6). Seta *J4* apparently present but minute.

Appendages: Chelicerae relatively small. On fixed digit five teeth including distal point; anterior and posterior teeth in two pairs. Seta *ch1* originally present, but both lost during dissection. Setae: *ch* (2), *pa* (1-0-3-7), *I* (0-10-5-6-28 or 29), *II* (1-10-5-6-23), *III* (4 or 5-6-5-6-23), *IV* (0-5-4-6-23). Solenidia: *pa* (0-0-1), *I* (1-2-3), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Pretarsus with three subequal claws, lateral claws with inconspicuous dorsal cilia file. Terminal plasmic setae on palp tarsus spine-like, in recess. Solenidia baculiform, relatively short never 2x length of associated seta, longest on genu I. Tarsi all with supernumerary setae. Setae colourless, on tarsi have strongly refractile bases but hyaline tips.

Somal inclusions: No eggs or boli. Ovipositor involuted, if extended would be about 3x length of genital shield. Breadth slightly less than that of one genital shield. Bears eight pairs of setae, two *dg* pairs longer than setae *JZg*, three *pg* pairs more than length of genital shield away from three *mg* pairs.

Male

Unknown.

Material examined: Holotype female (N198328), litter under *Pinus pinea*, Knott Hill Forest, 22.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Knott Hill, cultivated pine forest, 1 (1/2).

Remarks: P. brevisetosus, with three pretarsal claws, short hysteronotal setae and well-spaced setae *J2*, keys to *P. altimontanus* Hammer, 1958 from Bolivia in Aoki's (1965a) work as would *P. tenuiclava* Hammer, 1966 from New Zealand which is possibly even more similar. *P. brevisetosus* is distinguishable from these two species by the presence of a rudimentary *J4*, hysteronotal fissures, large size, blade-like hysterosomal setae and stout setae *j1* and *z1*.

Family CROTONIIDAE Thorell

Crotonoides Thorell, 1876: 452-508.
Holonothridae Wallwork, 1963: 727.
Crotoniidae: Ramsay and Luxton, 1967: 479.

Type-genus: *Crotonia* Thorell, 1876.

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta *z2* reduced, globular and enclosed within bothridium. Hysteronotal seta *J4* present. Hysteronotal gland absent. Notal setae *z1* and *J5* usually on conspicuous apophyses. Coxite *I* or *II* setae sometimes hypertrichous but not *III* and *IV* (3 or 4 - 1 or 2-3-2 or 3). Coxite shields merged with aggenital shields. Setal file *Sg* includes two or three setae, combined setal file *JZg* on median margin of genital shield. Idiosoma not almost covered in continuous shield. Discrete preanal shield as wide as anal shield. Palp tarsus with nine setae. Tarsus *I* with five pairs of dorsolateral supernumerary setae. Nymphs with small shields around hysteronotal setal bases.

Distribution: Southern temperate regions as for *Crotonia*. *Austronothrus* from New Zealand, *Holonothrus* from New Zealand and Macquarie Island (An, Sa).

Found in plant litter, and on lichen, liverworts, moss, ferns and above-ground parts of shrubby plants.

Remarks: Crotoniidae are large to gigantic (801-1500), dull, dark brown mites, extensively covered in cerotegument and detritus which may be accompanied by nymphal skins and fungi. The unique structure of the bothridium enclosing a globular *z2* is regarded as the family synapomorphy.

The following three genera are included in Crotoniidae: *Austronothrus* Hammer, 1966; *Holonothrus* Wallwork, 1963; *Crotonia* Thorell, 1876.

CROTONIA Thorell

Westwoodia Pickard-Cambridge, 1875: 383-390. Type designation (original): "*Westwoodia obtecta* sp.nov."
Crotonia Thorell, 1876: 452-508. Type designation (original): "*Crotonia obtecta* (Pickard-Cambridge, 1875)".
Acronothrus Berlese, 1917a: 65. Type designation (original): "*Nothrus (Acronothrus) cophinarius* Mich. 1908".

Type-species: *Crotonia obtecta* (O. Pickard-Cambridge, 1875: 386).

Diagnosis: Crotoniidae. Hysteronotal setation reduced to thirteen pairs (*J2*, *J3*, *Z1* missing). Bases of setae *J1* and *Z2* without connecting ridge. Rostral tectum with single prominence bearing both setae *j1*. Setae *z1* on separate conspicuous apophyses. Setae *J5* (and other posterior setae) on separate apophyses or on single median branched apophysis. Posterior margin of coxites *IV* in smooth arc not broken by median notch. Opisthosternal file *JZa* includes three setae.

Distribution: Widespread in southern temperate regions (NTc; Ee, Es; Aa, Ap, An; Sa)—see Hammer and Wallwork (1979) for a review. Note that South

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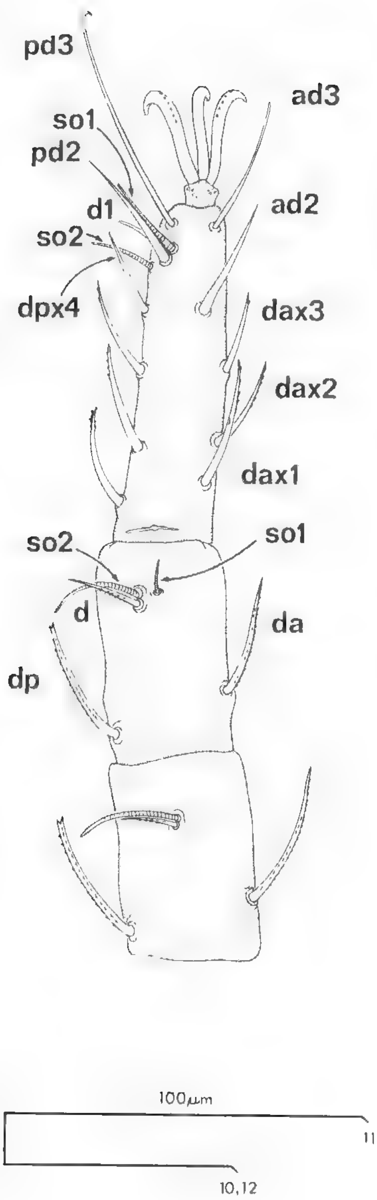

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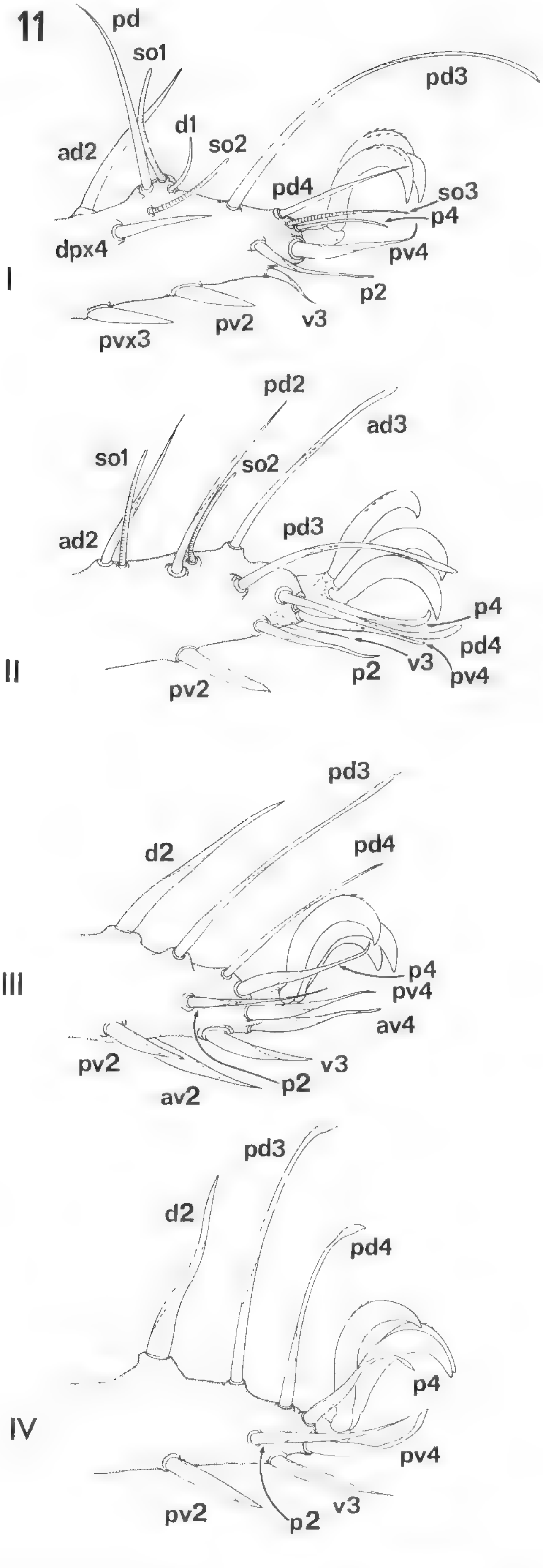

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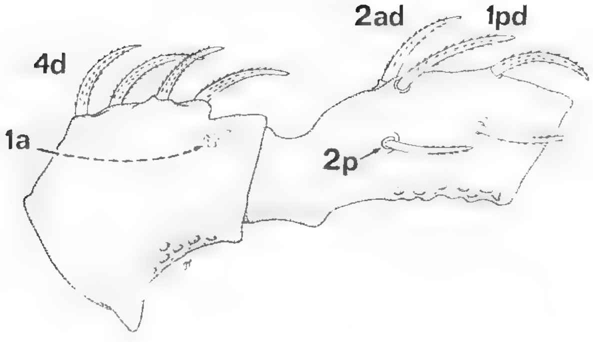

FIGS. 10-12. *Platynothrus brevisetosus* n.sp., female; 10, leg I, dorsal surface of genu, tibia and tarsus; 11, leg tarsi, posterior surface of distal ends; 12, leg III, posterior surface of trochanter and femur.

Ethiopian record is St. Helena. More recent records from Tierra del Fuego (Mahunka 1980b) and New Zealand (Luxton 1982).

Usually found in moist forest or heath in the plant litter, moss or on the above-ground parts of shrubby plants (Luxton 1982).

Remarks: The thick layer of cerotegument, detritus and nymphal skins obscures the dorsal features of *Crotonia* mites as illustrated by photograph of *C. obtecta* (O. Pickard-Cambridge) (Ramsay and Luxton 1967: Fig. 8). *Crotonia* may currently include twenty-four species, and Luxton (1982) provides a key for fifteen adequately described species.

Crotonia jethurmerae n.sp.

(Figs 13-19)

Female

General appearance: Dark brown, thick cerotegument with adhering detritus (including charcoal, left by forest fires), fungal hyphae and tritonymphal integument. Encrustation forms anterior protrusion encompassing setae *z*1 and posterior protrusion encompassing setae *J*4, *J*5, *Z*5, *S*5 (small on some specimens, then bilobed). Notal minute pits and low bumps distributed as illustrated (Fig. 13). Setae, claws, external malae, cheliceral digits clear or light brown and refractile. Idiosomal length 1400 (3, 1390-1405). Proportions of appendages similar to those for male holotype (see below).

Prosternum: Lateral refractile half of external malae in vertical plane when unsquashed (i.e. not flattened as illustrated, Fig. 15) and bears two rows of cilia on dorsal surface. Three adoral setae, *ao*1 bifurcate, flattened, one branch forming denticulate hyaline flap. Coxites all fused into one shield, partly delineated by grooves but leaving broad, flat mid-sternal zone, fused to aggenital shields. Hyaline cap on coxite seta may be broken off, leaving slim setal core. Coxite setae *III*3 and *IV*1 on apophyses.

Proteronotum: Seta *z*2 globular, enclosed in bothridial cavity with faint reticulate markings on lining, and appears as if slit-like opening to exterior between pair of ear-like folds. Cuticular pits confined to concavities at sides of high, flat median zone, which falls steeply to rostral prominence. No setae observed in file *s*, but if small would be difficult to distinguish amongst adhering detritus. Apophysis to seta *z*1 medium length (about equal to distance *z*1-*z*1) with curved lateral flap.

Opisthosternum: Aggenital shield fused to coxites and only narrowly joined to adanal shield, with raised median rim near preanal shield and small notch anterior to seta *Sg*2 (one female has 3*Sg* on one side). Preanal shield well separated from other shields, foreshortened as illustrated (Fig. 14) since extends upward in vertical plane. Number of opisthosternal setae blade-like, with hyaline flap on setal core. Genital shield has central transverse unpigmented zone embracing setae *JZg*5, *JZg*6 and notch between them (structure suggests shield may fold along this line). No pore *Zaf* located on anal shield although *Saf* and *hf*3 conspicuous.

Hysteronotum: Fissure runs transversely along beside first setal rank and backward along setal files *Z* and *S* (*S*1, *S*2, *Z*3, *Z*4) possibly representing dorsolateral longitudinal fissure. Ventrolateral longitudinal fissure terminates anteriorly, dorsal to posterior margin of acetabulum *IV*, so that anterior part of opisthosomal pleural shield merges with podosomal shield. Comparison with Camisiidae, adult and nymphs, suggests seta "*d*1" is *Z*2 not *J*2, so hysteronotal chaetotaxy 4*J*, 5*Z*, 4*S*, but concept of centralward migration of *Z*2 and lost *J*2 debatable.

Appendages: Chelicerae relatively small, both digits terminating in paired, nearly parallel teeth (including distal points), with single large tooth proximally. Setae: *ch* (2), *pa* (1-1-3-9), *I* (0-12-5-6-38), *II* (0-12-5-6-30 to 32), *III* (5-7-5-5-28 or 29), *IV* (1-8-5-5-29 to 31). Solenidia: *pa* (0-0-1), *I* (1-1-2), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Pretarsus with three subequal claws, lateral claws with dorsal cilia file. Four terminal plasmic setae on palp with minute distal knob. Solenidia piliform, never more than 1.25x length of associated setae. Solenidia on genua and tibiae *II*, *III*, *IV* similar to one on genu I (Fig. 17), but similar-sized or smaller than associated setae. Tarsi all with supernumerary setae. Setae pale brown, or colourless on tarsi with strongly refractile base but hyaline distally.

Somal inclusions: Three paratype females each with four or five eggs. Eggs smooth, suboval, 305-310 long, 170-175 broad. Ovipositors involuted, extended would be about 2x length of genital shield. Breadth slightly less than that of one genital shield. Difficult to make out setae, setae *dg* longer than *JZg*. Two clearly delineated boli present per specimen, mainly cellular material, spores, hyphae, cellular sheets of plant tissue.

Male

Measurements and spermapositor (otherwise as female): Idiosomal length 1185 (8, 1125-1290); appendage lengths (for 1185, holotype)—*ch* 77.5, *pa* 110, *I* 1220, *II* 747.5, *III* 762.5, *IV* 905; femur breadths—*pa* 22.5, *I* 110, *II* 100, *III* 92.5, *IV* 87.5. Opisthosoma contains large, granular horseshoe-shaped organ (open end at posterior), possibly gonad. Spermapositor short, breadth about half that of one genital shield, setae *dg* about half length of *JZg*.

Material examined: Holotype male (N198317), seven paratype males (N198318-N198324), three paratype females (N198325-N198327), litter and sparse moss,

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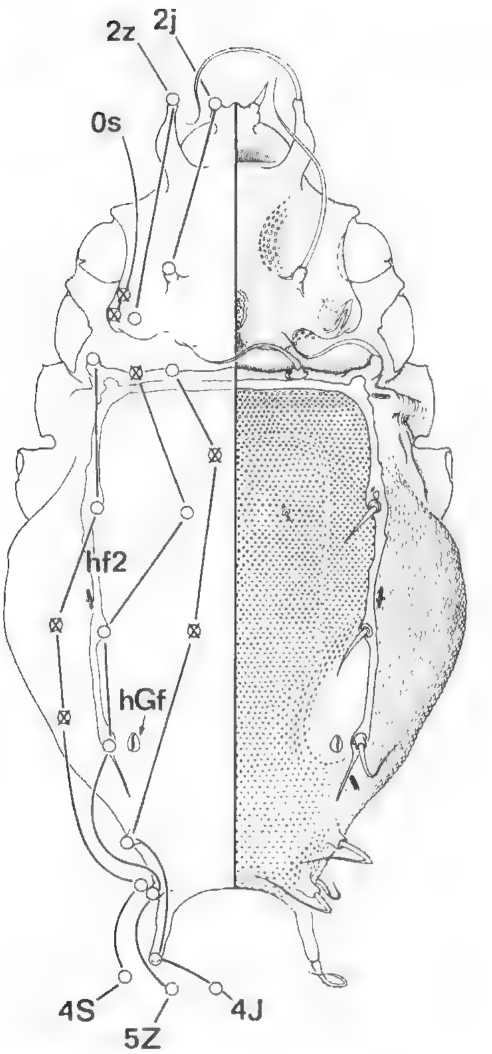

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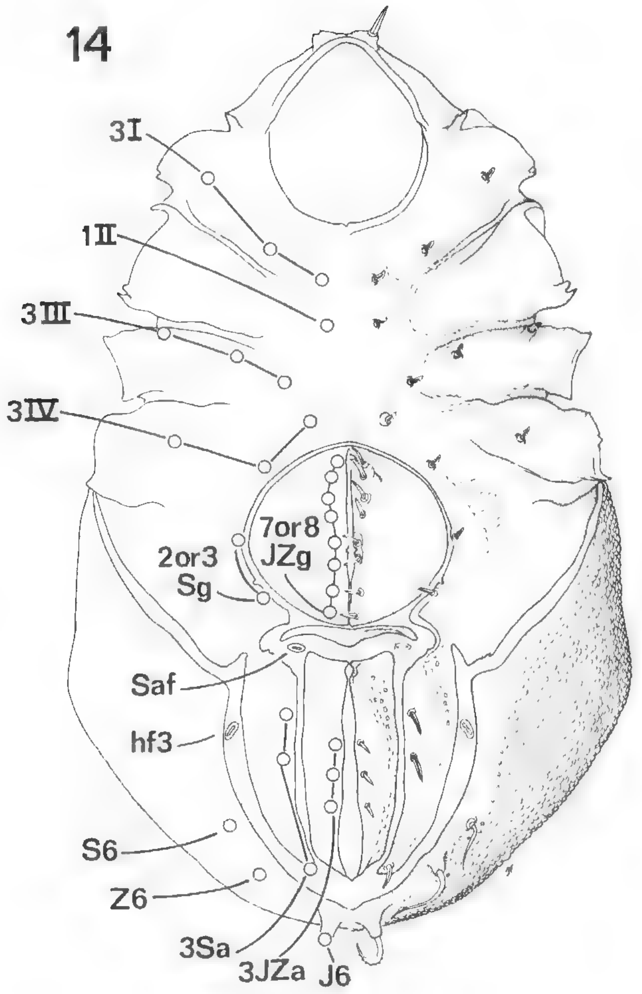

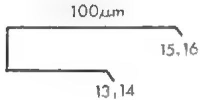

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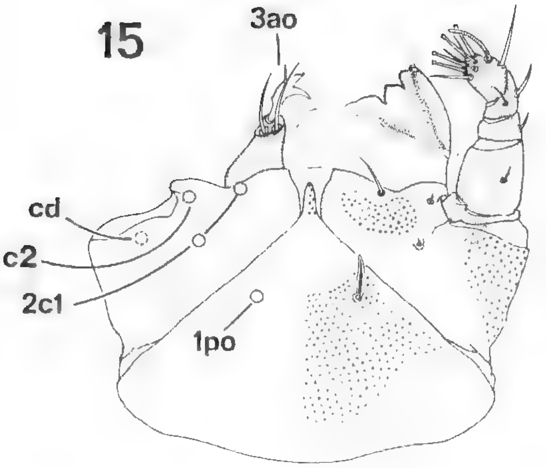

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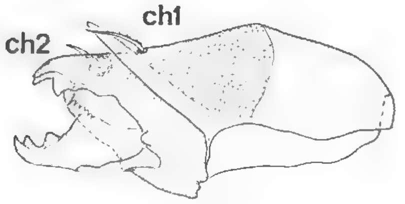

FIGS. 13-16. *Crotonia jethurmerae* n.sp., male except when otherwise indicated; 13, notum; 14, female idiosternum; 15, gnathosternum; 16, right chelicera, anterior surface.

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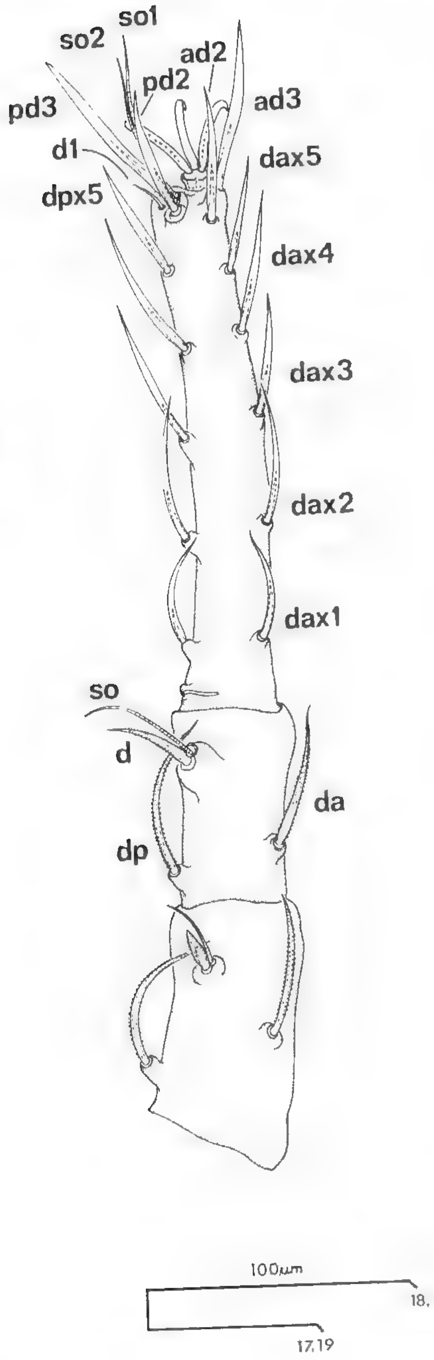

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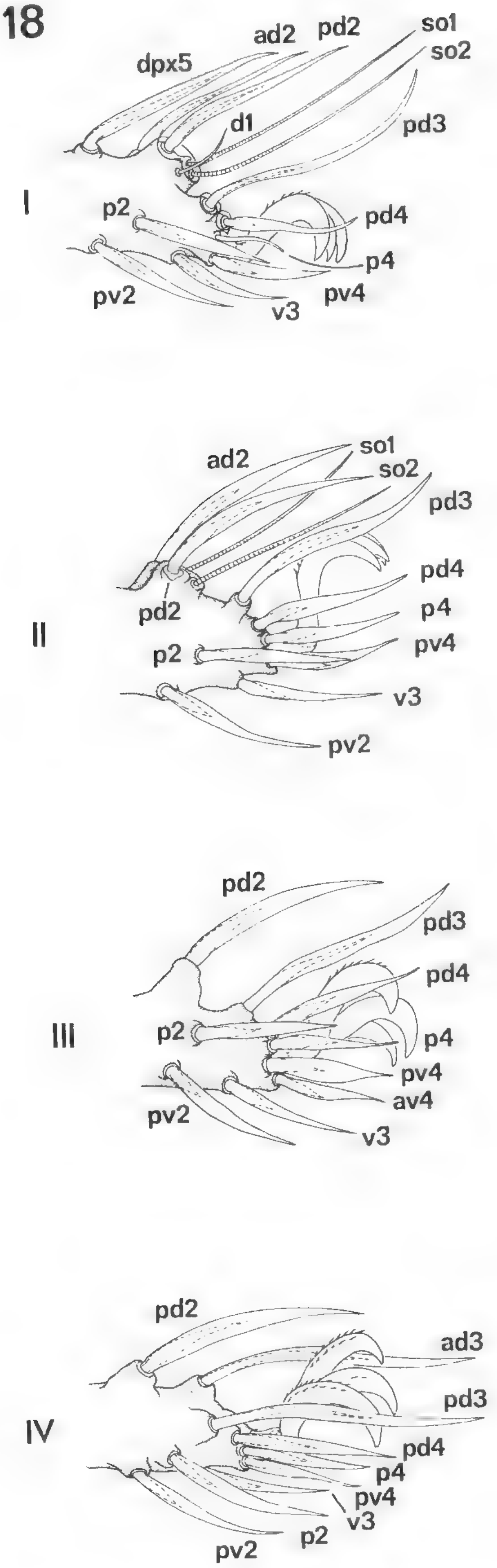

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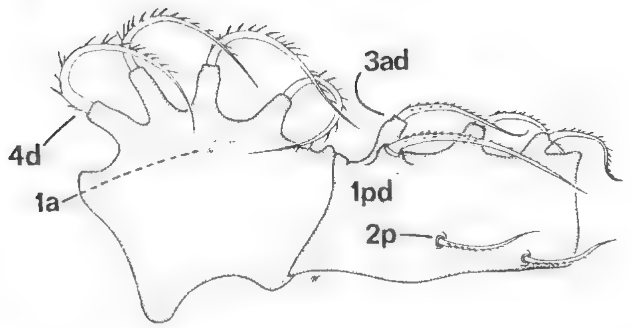


FIGS. 17-19. *Crotonia jethurmerae* n.sp., male; 17, leg I, dorsal surface of genu, tibia and tarsus; 18, leg tarsi, posterior surface of distal ends; 19, leg III, posterior surface of trochanter and femur.

under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll open-forest, II (5/8).

Remarks: Because one male has little pigment or cerotegument and therefore is easy to examine, it is designated holotype in contrast to the usual procedure of so designating a female.

Luxton (1982) divides *Crotonia* into five species-complexes, amongst which *C. jethurmerae* would be grouped in the *cophinaria*-complex. The inclusion of *C. jethurmerae* requires modification of the characteristics of that complex in that hysteronotal setae *J1* and *S1* are approximately equal in length, also setae *j1* is thorn-like and straight. The curved lateral flap on the apophysis to seta *z1* appears unique within the genus.

Family NANHERMANNIIDAE Sellnick

Nanhermanniidae Sellnick 1928: 17
Nanhermanniidae: Woolley and Higgins, 1956: 913.

Type-genus: *Nanhermannia* Berlese, 1914: 100.

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta *z2* baculiform or dilated and ciliate distally, length 1x-3x distance *j2*-*z2*. Hysteronotal seta *J4* present. Hysteronotal gland absent. Notal setae *z1* and *J5* not on apophyses. Coxites *II*, *III* and *IV* may be hypertrichous. Setal file *Sg* includes two setae, combined setal file *JZg* on median margin of genital shield. Idiosoma almost covered in continuous shield except for relatively well separated genital and anal orifices, and prehysteronotal fissure extending ventrally (? anterior part of ventrolateral longitudinal fissure) as crescentric split nearly meeting midway between genital and anal orifices. Discrete preanal shield but internal under anterior margin of anal shields. Palp trochanter fused to femur, tarsus with seven setae. Tarsus *I* with one or two pairs of dorsolateral supernumerary setae (solenidium *so1* level with them). Nymphs without small shields around hysteronotal setal bases.

Distribution: Probably cosmopolitan. Beside *Nanhermannia*, *Masthermannia* may be cosmopolitan. *Cyrthermannia* is tropical (Cuba, NTa; Thailand, Os) as well as occurring in Japan (Pe). Whilst *Cosmohermannia* is known from southern Japan (Pe) and New Guinea (Am).

Found in woodland and forest litter (both fermentation and humus layers).

Remarks: The only thoroughly described species in Nanhermanniidae is *Masthermannia* (as *Posthermannia*) *nematophora* (Grandjean, 1954b). The family was revised by Woolley and Higgins (1956). Although two genera and a number of species have been described since then, the form of Nanhermanniidae is without great variations from that of the original species.

Nanhermanniidae includes the following four genera: *Cosmohermannia* Aoki and Yoshida, 1970; *Cyrthermannia* Balogh, 1958; *Masthermannia* Berlese, 1914; *Nanhermannia* Berlese, 1914.

NANHERMANNIA Berlese

Nanhermannia Berlese, 1914: 100. Type designation (original): "*Hermannia nana* Nic".

Type-species: *Nanhermannia nana* (Nicolet, 1855: 458).

Diagnosis: Nanhermanniidae. Hysteronotal setae not on swollen tubercles, simple, either setose or lanceolate, sometimes minute forwardly directed proximal spur. Posterior margin of hysteronotum evenly convex without prominent protuberances. Coxites *III*, *IV* with two to four and three or four setae respectively. Trochanter *IV* with three dorsal setae.

Distribution: Probably cosmopolitan. Canada (Nn); Washington (Nc); Colorado, Idaho (Nr); Maryland, North Carolina (Na); Chile, Patagonia, Peru (NTc); Angola, Rhodesia (Ee); St. Helena (Es); Europe—most northern records Iceland and Kola Peninsula (Pe); Italy (Pm); Altay Mountains, Kunashir Island, Sakhalin Island, Samarkand (Ps); Japan (Pe); Thailand (Os); Philippines (Om); New Guinea (Am); Queensland, South Australia (Aa); New Zealand (An).

Remarks: Nanhermannia is the most widely recorded genus in the family and currently includes at least nineteen species. Balogh and Mahunka (1978), in describing *N. domrowi* from Queensland, refer to a *thaiensis*-complex based on *N. thaiensis* Aoki, 1965b characterized by "medially confluent posterior protuberances of the prodorsum and that they do not have longitudinal furrows among interlamellar setae". For convenience, I will redefine the *thaeinsis*-complex which includes the species from this study.

thaiensis-complex

Diagnosis: Nanhermannia. Pair of posterior proteronotal protuberances basically semicircular, each with four to seven minor protuberances. Furrow between setal pair *j2* absent or shallow, not breaking connection between protuberances. Genua and tibiae *I* and *II* seta not bifurcate.

Remarks: Unfortunately the diagnosis has to be based on the posterior sculpturing of the proteronotum, which is difficult to use for some intermediate species. The *thaiensis*-complex is regarded as including the following six species: *N. domrowi* Balogh and Mahunka, 1978—Queensland (Aa); *N. forsslundi* Karppinen, 1958—Finland (Pe); *N. gorodkovi* Sitnikova, 1975—Altay Mountains and Kunashir Island (Ps); *N. grandjeani* **n.sp.**—South Australia (Aa); *N. pectinata* Strenzke, 1953—Germany (Pe); *N. thaiensis* Aoki, 1965b—Thailand (Os).

Nanhermannia grandjeani n.sp.
(Figs 20-26)

Female

General appearance and measurements: Light brown generally, darker around leg acetabula and posterior proteronotal protuberances. Shallow, clear cerotegument, some adhering detritus around leg bases. Setae, claws, external malae, cheliceral digits clear and refractile. Coarse puncta over much of soma excluding lateral regions of proteronotum, coxites, genital and anal shields, and crescent shape on both sides of setal file *Sa* (see Fig. 21). Much smaller but deeper puncta located dorsally on proteronotum and central part of each coxite. Idiosomal length 637.5 (1); appendage lengths—*ch* 42.5, *pa* 55, *I* 265, *II* 250, *III* 220, *IV* 280; femur breadths—*pa* 12.5, *I* 52.5, *II* 55, *III* 40, *IV* 40.

Prosternum: External malae without adaxial hyaline flap, but midanterior flap ventral to discrete tubercle, two rows of long cilia on dorsal surface. Three adoral setae, *ao1* very fine. Coxites merged with each other and surrounding shields, although delineated by grooves.

Proteronotum: Seta *z2* club-like, ciliate on dilated area. Seta *j2* has inconspicuous posterior spur at base. Middorsal T-shaped flat-topped mound with setae *z1* at anterior end and setae *z2* at end of lateral arms. Region often used in species diagnosis illustrated in detail (Fig. 24). Furrow between setae *j2* shallow, accentuated by absence of small puncta that cover T-shaped mound. Posterior proteronotal protuberances obscure matching but smaller ventral protuberances (Fig. 20).

Opisthosternum: Shields distributed in manner unique to *Nanhermannia*. File *JZg* with nine setae and *Sa* with three setae. Pores *Zaf* and *Saf* present, other two pores illustrated (Fig. 22) regarded as hysteronotal (*hf*).

Hysteronotum: Some setae (at least *J2*, *Z2*, *Z3*, *S1*, *S2*, *S5*) with inconspicuous anterior spur at base. All setae blade-like, with hyaline dorsal and ventral flaps along entire length, not long enough in first three ranks to reach base of following seta.

Appendages: Chelicerae relatively small. On fixed digit five teeth including distal point, two small adaxial teeth parallel to main two proximal teeth. Movable digit with three teeth, including paired distal points and large proximal tooth. Setae: *ch* (2), *pa* (1-0-2-7), *I* (1-5-5-6-23), *II* (1-7-5-5-22), *III* (5-2-2-3-18), *IV* (1-3-2-2-16). Solenidia: *pa* (0-0-1), *I* (1-1-2), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Pretarsus with one claw. Terminal pair of plasmic setae on palp tarsus spine-like, in recess. Anterodorsal edge of tarsal tibia with refractile spur. Solenidia baculiform, relatively short, never as long as associated setae. Tarsi *I* and *II* each with two supernumerary setae; possibly both *dp*. On tibiae *III* and *IV* (only illustrated on *IV*—Fig. 25) seta *uv* conspicuously longer than segment.

Somal inclusions: No eggs. Ovipositor involuted, extended would be about 2x length of genital shield. Breadth slightly less than that of one genital shield. Bears eight pairs of setae, two *dg* pairs about 0.6x length of setae *JZg* and 4x length of setae *pg*. One small bolus, granular, particles many shapes, no complete cell walls present.

Male

Unknown.

Material examined: Holotype female (N198329), litter and sparse moss, under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll open-forest, 1 (1/8).

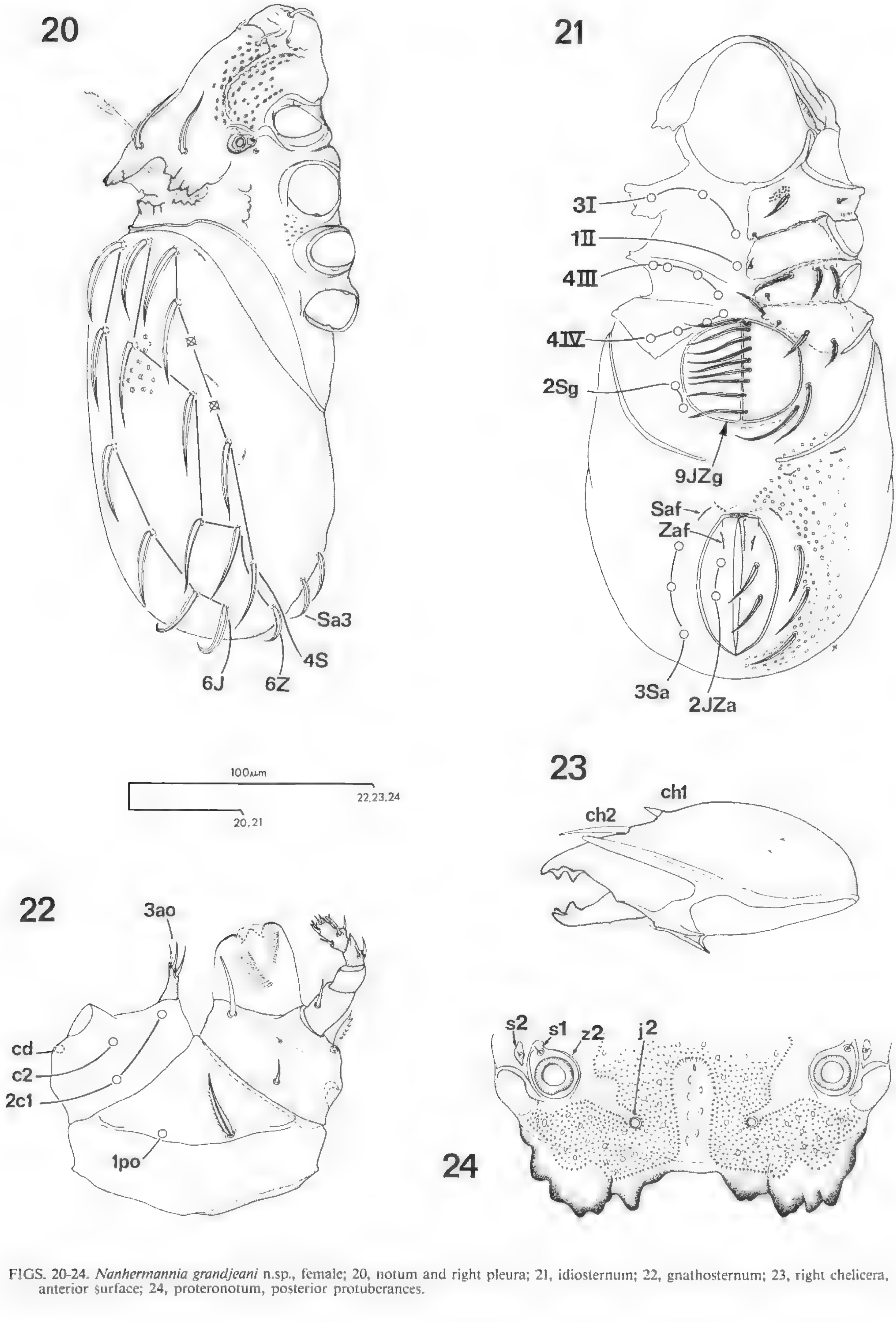
Remarks: Amongst the *thaiensis*-complex, differences between species in the description of proteronotal protuberances and the intermediate furrow may be actual or represent different interpretations by authors. Within such variations *N. grandjeani* lies between *N. pectinata* and *N. domrowi*. The shortness of the hysteronotal setae distinguishes *N. grandjeani* from *N. domrowi*, *N. forsslundi* or *N. gorodkovi*. *N. pectinata* has no large puncta on the proteronotal T-shaped mound and seta *z2* is not dilated distally. *N. thaiensis* has shorter, laterally biased protuberances, hysteronotal puncta are larger and uneven in size and shape whilst opisthosternal file *Sa* includes only two setae and the coxites bear only nine setae ventrally (3-1-2-3).

Family **HERMANNIIDAE** Sellnick

Hermanniidae Sellnick, 1928: 18.
Hermanniidae: Woas, 1981: 7.

Type-genus: *Hermannia* Nicolet, 1855.

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present, at least median part. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta (*z2*) filamentous or club-like; length 0.75x-1.5x distance *j2*-*z2*. Hysteronotal seta *J4* present. Hysteronotal gland present. Notal setae *z1* and *J5* not on apophyses. Coxites *III* and *IV* setae

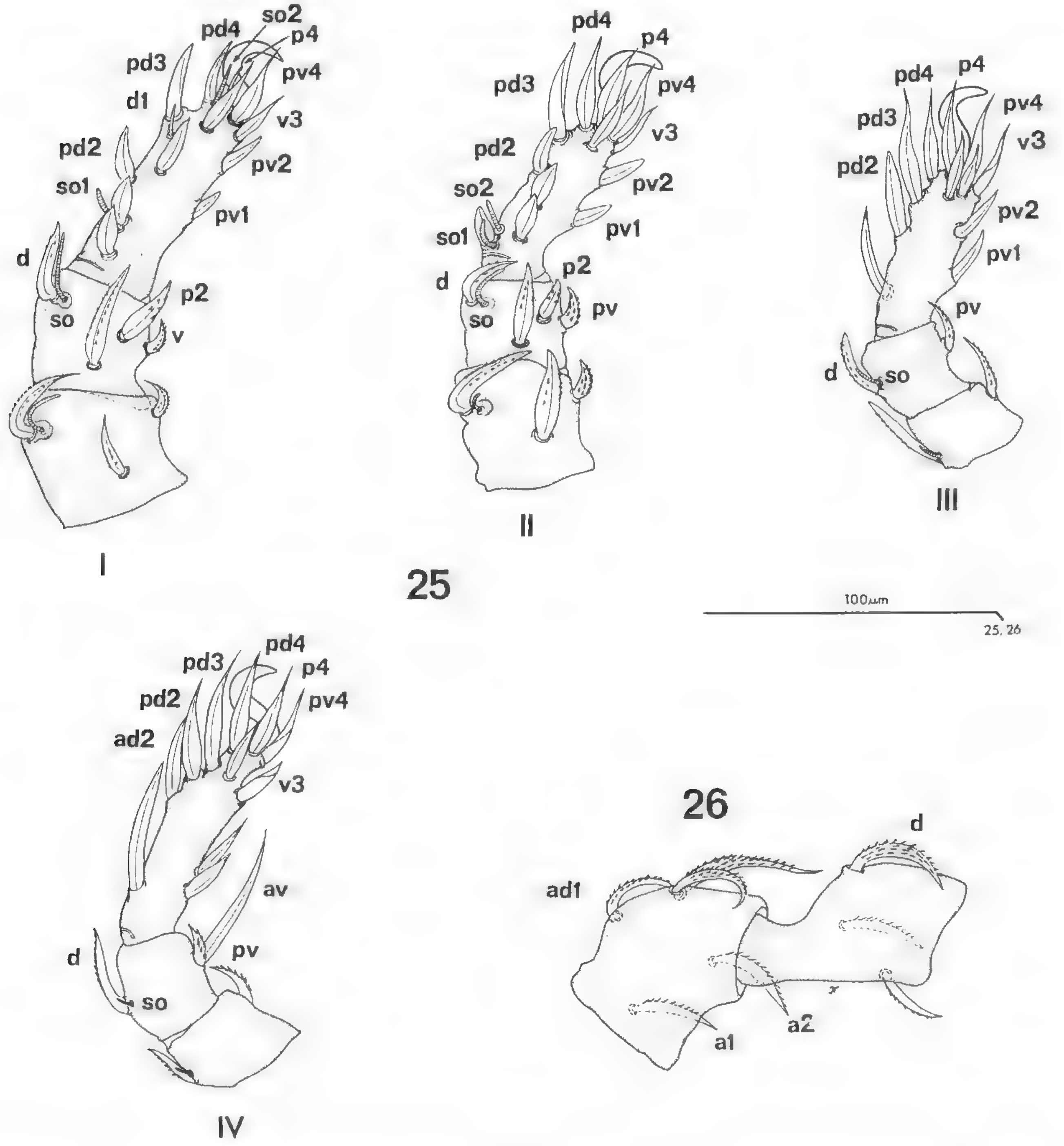


FIGS. 20-24. *Nanhermannia grandjeani* n.sp., female; 20, notum and right pleura; 21, idiosternum; 22, gnathosternum; 23, right chelicera, anterior surface; 24, proteronotum, posterior protuberances.

hypertrichous (3-1-4 or 5-5 or 7). Setal file *Sg* includes two to five setae, setal files *Jg, Zg* separate but may be close together. Idiosternum almost covered in continuous shield but well separated from notal shield. Discrete preanal shield, narrow (width about distance *JZa1-JZa2*). Palp tarsus with nine setae. Tarsus *I* without dorsolateral supernumerary setae. Nymphs without small shields around hysteronotal setal bases.

Distribution: Possibly cosmopolitan. *Phyllhermannia* found mainly in southern hemisphere (see below) whilst *Hermannia* confined to Palaearctic and Nearctic regions. Species of *Hermannia* occur on bark of living trees, regularly in forest litter, often at high altitudes, also in littoral habitats and salt marsh (Krantz, 1978).

Remarks: A recent study of the Hermanniidae by Waos (1981) makes *Phyllhermannia* a junior synonym of *Hermannia,* so that all species are in a single genus, with both types in the *gibbia/convexa*-complex. His study is disadvantaged by the brief descriptions of southern hemisphere species, i.e. those previously grouped in *Phyllhermannia.* The below description is the first comprehensive study of a *Phyllhermannia* species,



FIGS. 25-26. *Nanhermannia grandjeani* n.sp., female; 25, legs, dorsal and posterior surfaces of genua, tibiae and tarsi; 26, leg III posterior surface of trochanter and femur.

and character states such as the reduced setation of the palp coxite, palp femur and legs, as well as the shape of adoral seta *ao*2, suggest that *Phyllhermannia* may still be a valid taxon. Therefore, I have chosen what may appear a weak character (the position and shape of seta *z*1) to diagnose the two genera, because it has always been described and it makes a conservative grouping, requiring only one species to be excluded from *Phyllhermannia*. This is a temporary measure until *Phyllhermannia phyllophora* is properly described.

The following two genera are included in Hermanniidae: *Hermannia* Nicolet, 1855; *Phyllhermannia* Berlese 1917a.

PHYLLHERMANNIA Berlese

Phyllhermannia Berlese, 1917a: 65. Type designation (original): "*Hermannia phyllophora* Michl."
Phyllhermannia: Trägårdh, 1931b: 576.
Hermannia (in part): Woas, 1981: 36.

Type-species: *Phyllhermannia phyllophora* (Michael, 1908: 140).

Diagnosis: Hermanniidae. Proteronotal seta *z*1 with distal half tapered off to a point, and marginal, lateral to line *j*1-*j*2. Opisthoventral shield with transverse strip between genital and anal shields. Mentocoxal fissure usually complete, reaching edge of gnathosternum (exception: *Phyllhermannia tuberculata*).

Distribution: Widespread in southern hemisphere, known range extending into northern hemisphere along western border of Pacific ocean. Chile, Juan Fernandez Islands (NTc); Cape Province, Natal (Es); Madagascar, Mauritius (Em); Tanganyika (Ee); southern Japan (Pc); Thailand, Vietnam (Os); Java, Philippines (Om); South Australia (Aa); New Zealand (An); Puntas Arenas (Sm).

Remarks: Phyllhermannia was established without any diagnosis, probably on the basis of the leaf-like leg setae. The first detailed consideration of the genus was by Trägårdh (1931b) and keys to some species are given by Aoki (1965b) and Balogh and Mahunka (1966). Woas (1981) regards this genus as a synonym of *Hermannia* and includes most species in his *gibba/convexa*-complex.

The diagnosis of the genus used here is weak since the character states of the opisthoventral shield and mentocoxal fissure also occur in the small (after the exclusion of *Phyllhermannia* species) *gibba/convexa*-complex within *Hermannia*. My approach has been to maintain *Phyllhermannia* until more extensive descriptions of included species, especially the type, are available. Only one species has to be excluded from this genus: *Hermannia aerolata* (Aoki, 1970) from Japan. This is still grouped in the *gibbia/convexa*-complex as by Woas (1981: 36).

Twenty-four species and one subspecies are included in *Phyllhermannia*. One species (*P. africana* Balogh, 1958) has not been considered because of the insufficient description. Of the remainder, ten species are considered similar to the new species described below and these are grouped in a species-complex.

eusetosa-complex

Diagnosis: Phyllhermannia. Hysteronotal seta *Z*1 central, not migrated laterally in front of *S*1, distance *Z*1-*J*2 subequal to or less than *J*1-*J*2. Hysteronotal setae short, *J*1 not reaching *J*2 base. Apodemes between coxites *I-II* and *II-III* oblique, at least at 22.5° angle to transverse axis. Genital setal file *Zg* with at least one seta twice length of *Sg* setae, or more. Leg setae never leaf-like or spatulate and number reduced, tarsus I with 23 or fewer setae and one solenidium.

Remarks: Members of the *eusetosa*-complex are usually only known by idiosomal character states. The three species from Mauritius, with only one setae in opisthosternal file *Sg*, may form a separate complex. *P. tuberculata* from Chile is included although unique within the genus in having a restricted mentocoxal fissure as in many *Hermannia* species.

Eleven species are included in the complex. *P. bimaculata* Hammer, 1979—Java (Om); *P. eusetosa* **n.sp.**—South Australia (Aa); *P. foliata* Hammer, 1966—New Zealand (An); *P. mauritii* Mahunka, 1978—Mauritius (Em); *P. modesta* Mahunka, 1978—Mauritius (Em); *P. mollis* Hammer, 1966—New Zealand (An); *P. pacifica* Hammer, 1972—Tahiti (Ap); *P. pauliani* Balogh, 1962—Madagascar (Em); *P. rubra* Hammer, 1966—New Zealand (An); *P. tremicta* Mahunka, 1978—Mauritius (Em); *P. tuberculata* Covarrubias, 1967—Chile (NTc).

Phyllhermannia eusetosa n.sp.
(Figs 27-32)

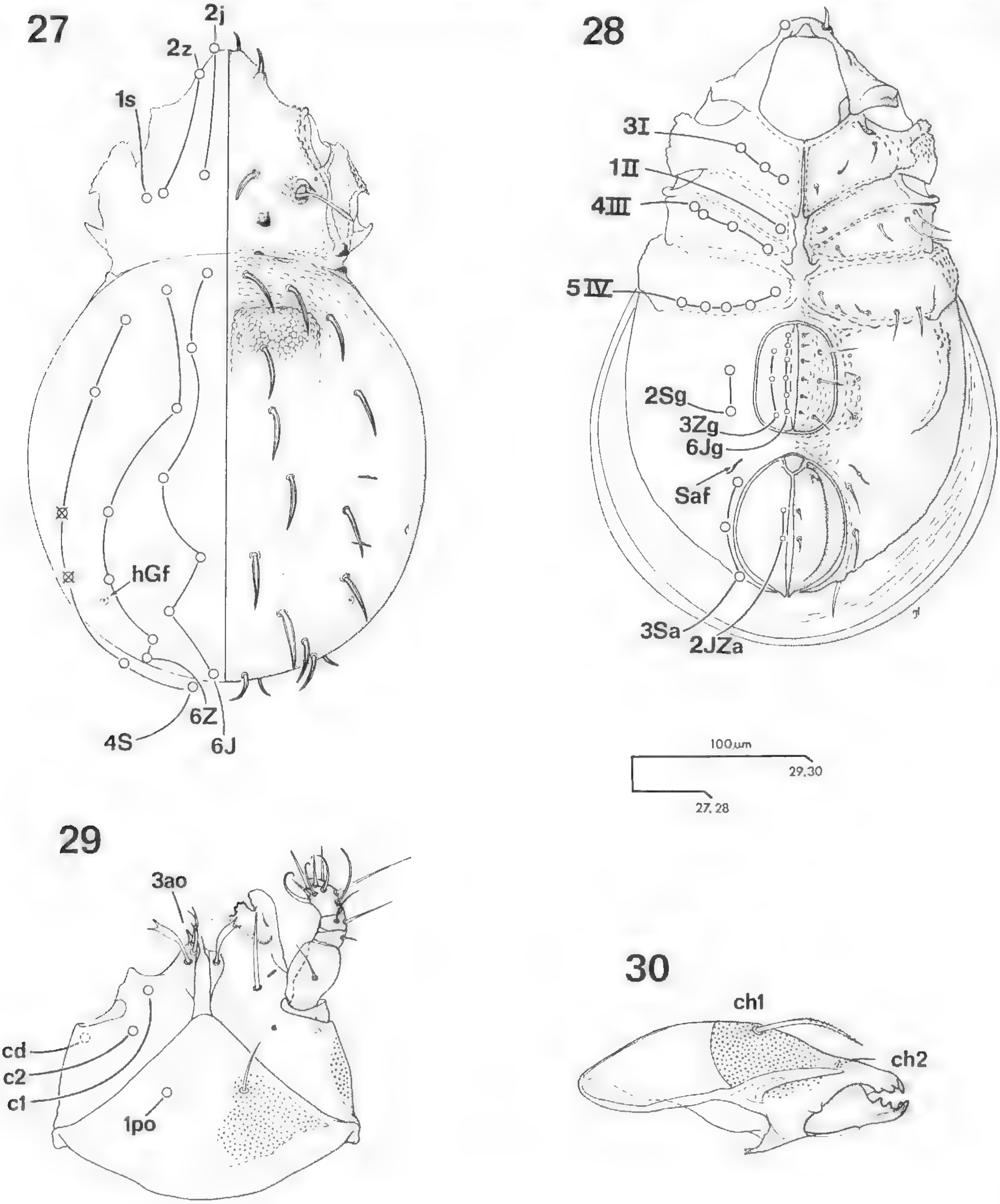
Female

General appearance and measurements: Red-brown, covered in cerotegument, thin with sparse adhering detritus. Beside small tubercles laterally and around coxites, acetabula and genital and anal orifices, soma (excepting proteronotum) covered in low, minute, superficial bumps, with pale strips between forming a reticulate pattern. All shields covered with fine puncta. Similar puncta and pattern on legs. Idiosomal length 795 (25, 675-917.5); appendage lengths (for holotype, 915)— *ch* 57.5, *pa* 90, *I* 580, *II* 430, *III* 440, *IV* 585; femur breadths— *pa* 27.5, *I* 117.5, *II* 105, *III* 90, *IV* 95.

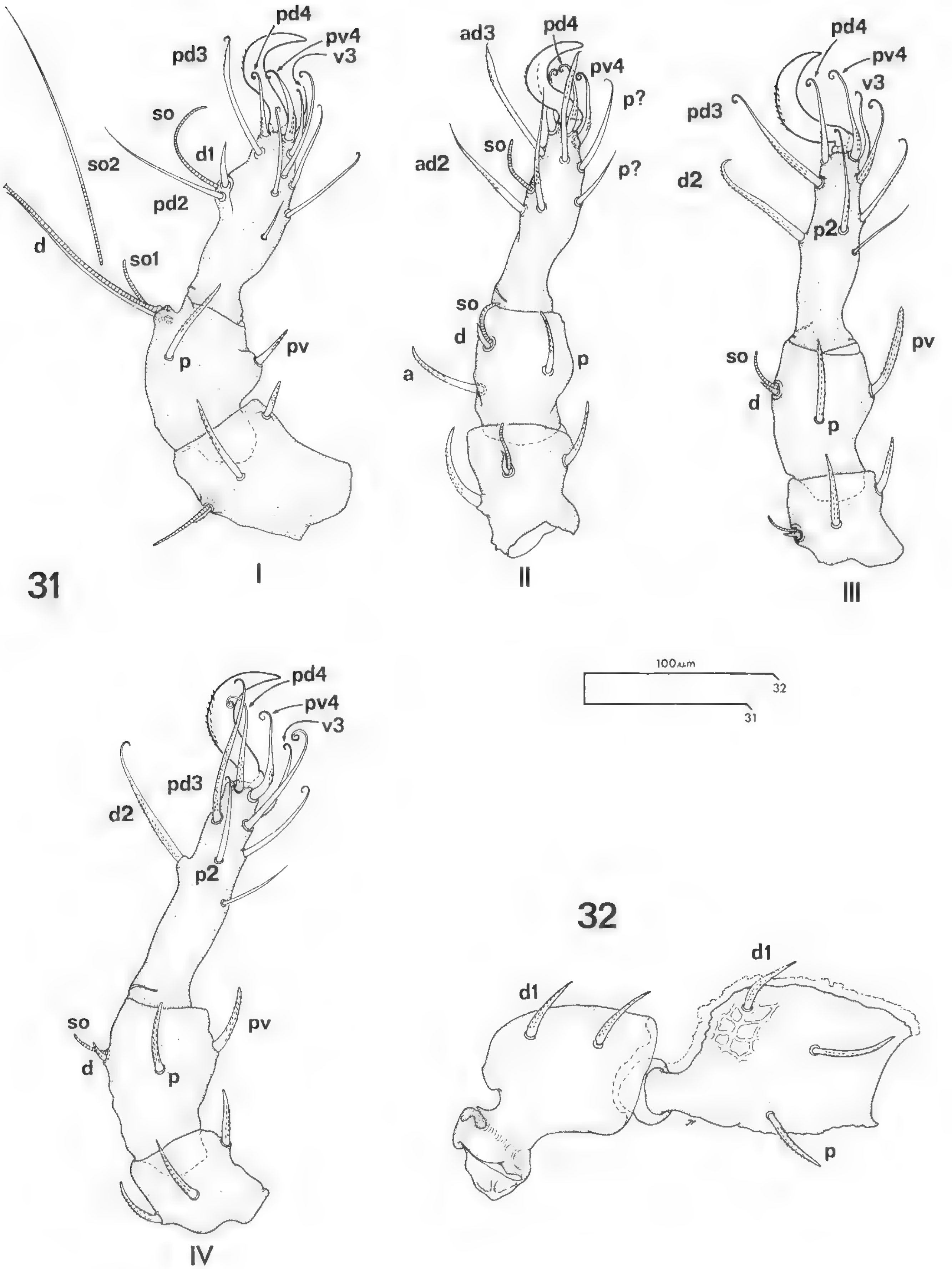
Prosternum: On external malae median hyaline flap horizontal with posterior notch through which adoral seta *ao*3 protrudes. Internal mala with distal spike leading back to minute dorsal furrow. Lateral refractile part of external malae bears two rows of cilia on dorsal surface. Lateral and central gnathosternum with finely punctate patches as illustrated (Fig. 29). Coxites all fused into one shield but clearly delineated by grooves, deep along midsternal line.

Proteronotum: Seta *z*2 vermiculate, but slightly dilated and ciliate distally. Bothridial cavity for seta *z*2 with number of short pockets and one long pocket. Two pairs of sharp tubercles near posterior margin face backwards, dark and conspicuous although small: one lies at posterior end of ridge running backwards from acetabulum *I*, other lies posterior to setae *j*2 and *z*2 and equidistant from both.

Opisthosternum: Continuous opisthoventral shield with strip between genital and anal shields, broadly fused to coxites, but not fused together posterior to anal



FIGS. 27-30. *Phyllhermannia eusetosa* n.sp., female; 27, notum; 28, idiosternum; 29, gnathosternum; 30, left chelicera, anterior surface.



31

32

FIGS. 31-32. *Phyllhermannia eusetosa* n.sp., female; 31, legs, dorsal and posterior surfaces of genua, tibiae and tarsi; 32, leg III posterior surface of trochanter and femur.

shields. Groove behind coxite *IV*. Cresent-shaped thickening of integument behind acetabulum *IV*. Anal shield with longitudinal ridge ending anteriorly in tubercle that fits around preanal shield. Both this tubercle and crescent-shaped thickening behind acetabulum *IV* conspicuously dark-coloured, although with pale shading (Fig. 28) because they stand proud from surrounding shields. Pore *Saf* present but not *Zaf*.

Hysteronotum: Two pairs of tubercles near anterior margin, ventral to circumhysteronotal fissure and opposing proteronotal tubercles, central pair small and inconspicuous. Pair of dark semicircular integument thickenings behind first rank of hysteronotal setae (*J1*, *Z1*, *S1*), from which central arm borders on inconspicuous furrow running back to bend as faint ridge around seta *J4*. All hysteronotal setae blade-like.

Appendages: Chelicerae relatively small. Both digits with four teeth, terminating in paired, nearly parallel teeth (including distal points). Palp femur with anteroventral flange. Setae: *ch* (2), *pa* (0-1-1-3-9), *I* (0-6-5-5-22), *II* (1-7-5-5-17), *III* (2-3-2-4-15), *IV* (2-4-3-4-14). Solenidia: *pa* (0-0-1), *I* (1-2-1), *II* (1-1-1), *III* (1-1-0), *IV* (0-1-0). Pretarsus with single claw bearing pair of inconspicuous dorsal cilia files. Terminal pair of plasmic setae on palp tarsus spine-like, with anterodorsal flange around their bases. All but one solendium baculiform, relatively short, less than 0.5x length of segment bearing them. Solendium *so*2 on tibia I flagelliform, very long, about equal to length of genu, tibia and tarsus I together. On genua *I*, *II*, *III*, and on all tibia (excluding *so*l on tibia I) solenidia coupled with dorsal setae, whilst solenidia on tarsi *I*, *II* and *so*l on tibia *I* at most only associated with dorsal setae. Reticulate pattern on dorsal and lateral surfaces of most leg segments (Fig. 32—part drawn on femur), but not on dorsal surface of trochanter or any part of tarsi. This pattern consists of darker raised ridges unlike similar hysteronotal pattern.

Somal inclusions: Amongst twenty-five registered specimens, three contain two eggs, one contains three eggs, five contain four eggs, remainder without eggs. Eggs about 240 (225-265) long, ellipsoid, with uniform smooth surface. Ovipositor 2x length of genital shield. Breadth about 1.5x that of one genital shield. Bears eight pairs of setae, two *dg* pairs subequal in length to setae *Zg*2 but thorn-like (x2 breadth) and more refractile, three *pg* pairs about length of genital shield away from three *mg* pairs. Only one bolus seen with mainly unrecognisable fragments, but some spherical spores and one multicellular strip of tissue.

Male

Unknown.

Material examined: Holotype female (N198330), and twenty-four paratype females (N1983417-N1983440), under *Eucalyptus obliqua*, sclerophyll forest, Mt. Lofty; 9.5.1974.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll forest, 118 (6/8).

Remarks: P. eusetosa is distinguishable from other members of the *eusetosa*-complex in possessing the following combination of character states: hysteronotal setae blade-like without cilia, no proteronotal ridge runs either between setae *j2*-*j2* or seta *j2* and the median tubercle near posterior margin; coxite *IV* bears five setae.

ACKNOWLEDGMENTS

I am indebted to the Interim Council of the Australian Biological Resources Study for funds for equipment, and to the Science and Industry Endowment Fund for funds for travel in connection with this project.

Special thanks are due to Mr D. MacFarlane, Commonwealth Institute of Entomology, London, for an English translation of a paper written in French (Grandjean, 1954a) and to Dr G. Wauthy, Catholic University of Louvain, Belgium, for a gift of specimens of *Eulohmannia ribagai*. Thanks are also due to Dr B. G. M. Jamieson, University of Queensland, Brisbane and Dr R. A. Norton, S.U.N.Y. College of Environmental Science and Forestry, Syracuse, for commenting on the manuscript.

My greatest debt of gratitude is to Ms Jenni Thurmer for her excellent illustrations and to Mrs Debbie Melloy for typing this manuscript.

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MOLLUSC TYPE-SPECIMENS IN THE SOUTH AUSTRALIAN MUSEUM
2. GASTROPODA: CONIDAE

BY WOLFGANG ZEIDLER

Summary

Type-specimens of 21 species of Conus in the South Australian Museum are catalogued and illustrated. All are holotypes or syntypes. Of these at least three, C. cumingii Reeve, 1848, C. metcalfei Angas, 1877 and C. sydneyensis Sowerby, 1887 are almost certainly not types while the status of another two, C. kermadecensis Iredale, 1912 and C. rossiteri Brazier, 1870 is in doubt. Only 10 of the specimens are from Australian waters, another 10 are from various South Pacific islands and one is from Mauritius. Species are listed alphabetically according to the original name of the species or variety. In addition, four species of cones recorded as types for which no reference can be found are listed in an Appendix.

MOLLUSC TYPE-SPECIMENS IN THE SOUTH AUSTRALIAN MUSEUM

2. GASTROPODA: CONIDAE

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(Manuscript accepted 29 August 1983)

ABSTRACT

ZEIDLER, W. 1985. Mollusc type-specimens in the South Australian Museum. 2. Gastropoda: Conidae. *Rec. S. Aust. Mus.* 19(5): 69-75

Type-specimens of 21 species of *Conus* in the South Australian Museum are catalogued and illustrated. All are holotypes or syntypes. Of these at least three, *C. cumingii* Reeve, 1848, *C. metcalfei* Angas, 1877 and *C. sydneyensis* Sowerby, 1887 are almost certainly not types while the status of another two, *C. kermadecensis* Iredale, 1912 and *C. rossiteri* Brazier, 1870 is in doubt. Only 10 of the specimens are from Australian waters, another 10 are from various South Pacific islands and one is from Mauritius. Species are listed alphabetically according to the original name of the species or variety. In addition, four species of cones recorded as types for which no reference can be found are listed in an Appendix.

INTRODUCTION

Most of the indigenous Conidae collection in the South Australian Museum (SAM) was collected, or otherwise obtained by Sir Joseph C. Verco around the turn of the century. However, most of the exotic species were acquired by purchasing other people's collections. One of the most significant of these was the A. F. Kenyon collection which the Museum purchased early this century. Mrs Kenyon accumulated a considerable collection and acquired many types, particularly of cowries and cones. She also acquired much of the J. W. Brazier collection which accounts for about half of the cone types listed here and only three of Brazier's species are not represented: *C. cooki* Brazier, 1870 (two syntypes in Australian Museum, Sydney), *C. coxeni* Brazier, 1875 (type in Coxen collection—lost?) and *C. sophiae* Brazier, 1875 (type in Australian Museum, Sydney). Unfortunately, several of the original labels are missing and the type status of some specimens is in doubt. There are also a number of specimens which have been labelled "type" but for which no reference can be found and these are listed in the Appendix and are only included because future workers may stumble upon a reference to them.

The South Australian Museum holds 21 *Conus* "types" of which three, *C. cumingii* Reeve, 1848, *C. metcalfei* Angas, 1877 and *C. sydneyensis* Sowerby, 1887 are almost certainly not types while the status of another two, *C. kermadecensis* Iredale, 1912 and *C. rossiteri* Brazier, 1870 is in doubt.

The species are listed under the original name at the time of description and in alphabetical order of species or variety. All of the types are represented by shells only, and only two have the operculum with them indicating that they were alive when collected. Measurements for height and maximum width are given for each specimen, as these were often inaccurate or not given in the original description. Each specimen has also been photographed (Figs. 1-3) as the types were rarely figured and photographs of only a few have appeared in recent publications.

The present status of each species is, in most cases, according to Walls (1978).

LIST OF TYPES

Conus kenyonae var. *arrowsmithensis* Brazier, 1896
(Fig. 1a)

Proc. Linn. Soc. New South Wales **21**: 346.

Holotype: SAM Reg. No. D5459. Kenyon No. 337. Dimensions, 35.5 × 20.5 mm (Brazier gives 36 × 21 mm).

Type-locality: Arrowsmith Island, Marshall Islands; collected by J. Brazier, 22.ix.1872.

Present Status: Synonym of *C. distans* Hwass, 1792.

Remarks: A very worn specimen with Brazier's original label. Considered a juvenile of *C. distans*. Type figured by Cotton (1945), pl. 4, Fig. 4.

Conus barbara Brazier, 1898

(Fig. 1b)

Proc. Linn. Soc. New South Wales **22**: 784.

Holotype: SAM Reg. No. D6176. Kenyon No. 83. Dimensions, 40.0 × 20.3 mm (Brazier gives 40 × 20 mm).

Type-locality: Solomon Islands; collected by Mrs A. F. Kenyon, date of collection unknown.

Present Status: Synonym of *C. monachus* Linnaeus, 1758.

Remarks: A worn specimen with Brazier's original label. Type figured by Cotton (1945), pl. 4, Fig. 2.

Conus cumingii Reeve, 1848

(Fig. 1c)

Conchologia Iconica I (*Conus* Suppl.): Pl. 3, species 282.
Holotype: SAM Reg. No. D6208. Kenyon No. 372. Dimensions, 48.5 × 24.5 mm (Reeve gives none).
Type-locality: None given on any labels but Island of Mindanao, Philippines; collected by Mr Cuming, according to Reeve.
Present Status: Valid species.
Remarks: This specimen cannot be Reeve's type of *C. cumingii* despite the label which says "Reeve's type". It does not agree with Reeve's description and is too large for the species. It seems to be *C. anemone* Lamarck, 1810 and was not listed by Cotton (1945).

Conus flindersi Brazier, 1898

(Fig. 1d)

Proc. Linn. Soc. New South Wales 22: 780.
Holotype: SAM Reg. No. D14129. Kenyon No. 139. Dimensions, 28.0 × 15.0 mm (Brazier gives 29 × 19 mm).
Type-locality: Flinders, Western Port, Victoria, under stone at low water. (Not Flinders Island, Bass Strait). Probably collected by Mrs A. F. Kenyon, date of collection unknown.
Present Status: Synonym of *C. anemone* Lamarck, 1810.
Remarks: This specimen does not match up with the dimensions given by Brazier, but as the original label by Brazier is present and in the absence of any other possible types, we must accept it as Brazier's type and conclude that his measurements are inaccurate. Cotton (1945) maintained that he had not seen the type.

Conus frostiana Brazier, 1898

(Fig. 1e)

Proc. Linn. Soc. New South Wales 22: 781.
Holotype: SAM Reg. No. D6170. Kenyon No. 138. Dimensions, 18.2 × 9.5 mm (Brazier gives 18 × 10 mm).
Type-locality: Solomon Islands; collected by Mrs A. F. Kenyon, date of collection unknown.
Present Status: Uncertain. Walls (1978) thinks this species could be synonymous with *C. nigropunctatus* Sowerby 1858 or *C. monachus* Linne, 1758 or even *C. magus* Linne, 1758. I am inclined to believe that the type may be a small *C. monachus*.
Remarks: Specimen with Brazier's original label.

Conus kenyonae Brazier, 1896

(Fig. 1f)

Proc. Linn. Soc. New South Wales 21: 346.
Holotype: SAM Reg. No. D14194. Kenyon No. 336. Dimensions, 42.0 × 23.5 mm (Brazier gives 43 × 24 mm).
Type-locality: Shark's Bay, Western Australia; collected by Mr Podesta, date of collection unknown.
Present Status: Synonym of *C. distans* Hwass, 1792.
Remarks: A very worn specimen with Brazier's original label. Considered a juvenile of *C. distans*. Type figured by Cotton (1945), pl. 4, Fig. 6.

Conus kermadecensis Iredale, 1912

(Fig. 1g)

Proc. Mal. Soc. Lond. 10(3): 227, pl. 9, Figs. 15 and 16.
Syntype: SAM Reg. No. D6169. Kenyon No. 420. Dimensions, 43.0 × 23.4 mm.
Type-locality: Original label lost? Iredale gives Sunday (=Raoul) Island, Kermadec Group.
Present Status: Valid species.
Remarks: Specimen with operculum, corresponding generally to Iredale's description. The type status of the specimen, however, is in doubt as Iredale stated that the type would go to the Canterbury Museum, New Zealand (which apparently has two) and the paratypes would go to the Australian Museum, Sydney. The Australian Museum has three lots of *C. kermadecensis* collected by Iredale and Oliver from the type-locality, but none have been designated type or paratypes. Since Iredale mentions only three specimens, and two are accounted for, the above could be a syntype corresponding to the one Iredale measured as 42 × 25 mm. Cotton's (1945) measurement of 45 mm for this specimen is obviously an error.

Rhizoconus klemae Cotton, 1953

(Fig. 1h)

Trans. Roy. Soc. South Aust. 76: 24, pl. 3, Figs. 1 and 3.
Holotype: SAM Reg. No. D14465. Dimensions: 46.5 x 26.0 mm (Cotton gives 47 × 26 mm).
Type-locality: Corny Point, Yorke Peninsula, South Australia; collected by Miss M. Klem, date of collection unknown.
Present Status: *Conus klemae* (Cotton, 1953), valid species.
Remarks: Most of the specimens mentioned by Cotton (1953) are in the SAM collections but none were designated paratypes. A juvenile specimen (SAM Reg. No. D16233), collected with the type, was also figured by Cotton (pl. 3, Fig. 2).

Conus metcalfei Angas, 1877

(Fig. 2a)

Proc. Zool. Soc. (London): 173, pl. 26, Fig. 13.
Holotype: SAM Reg. No. D6207. Kenyon No. 200. Dimensions, 17.6 × 9.5 mm (Angas gives 21.2 × 12.7 mm).
Type-locality: Dredged at "Sow and Pigs" reef, Port Jackson, New South Wales; probably collected by J. Brazier, date of collection unknown.
Present Status: Synonym of *C. angasi* Tyron, 1883.
Remarks: This specimen is almost certainly not the type. The original label is missing and the measurements do not correspond to those given by Angas. The type is most likely in the Australian Museum, Sydney who have a specimen (C103598) with an old label marked "Type" measuring 20.5 × 11.4 mm which is a closer

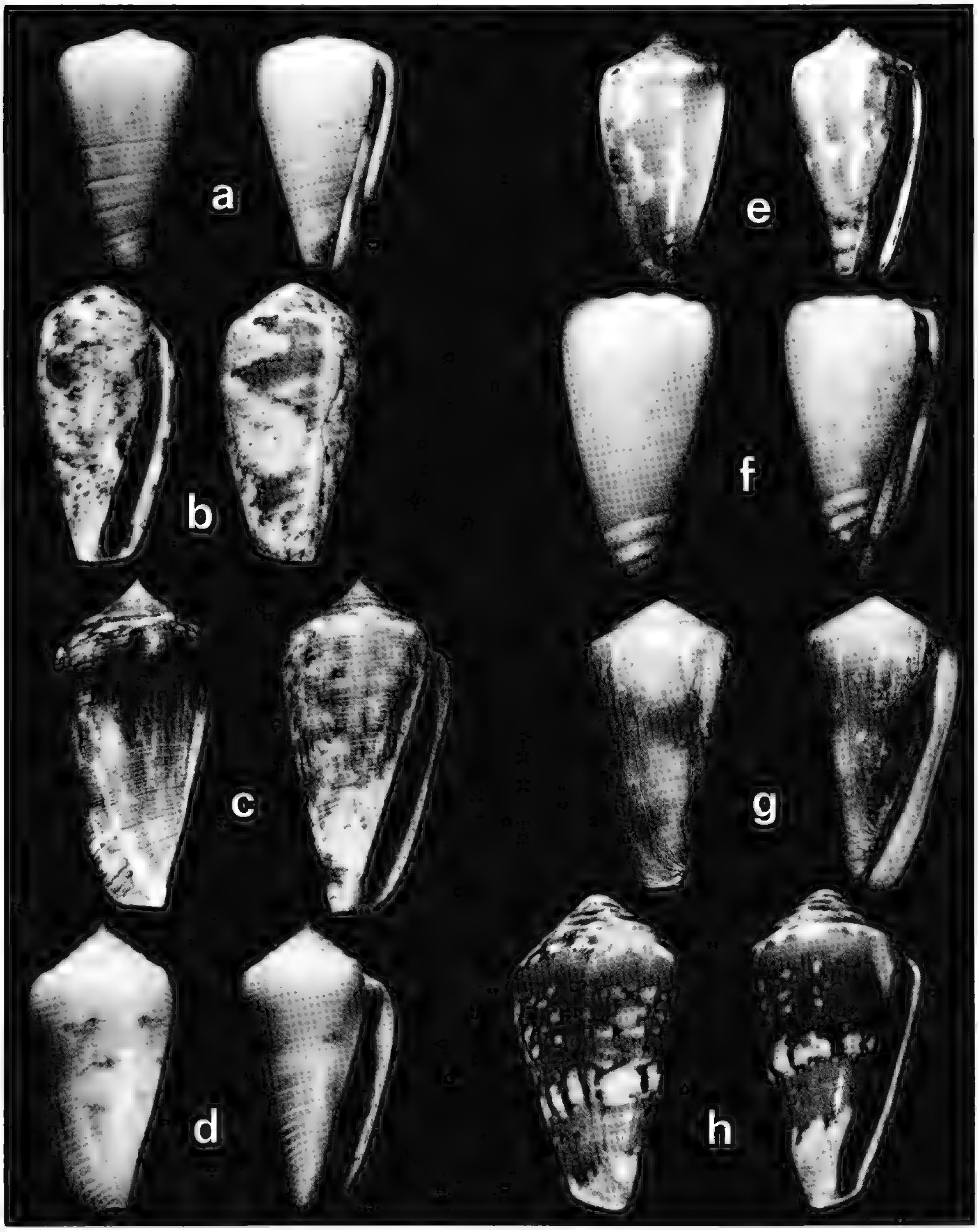

FIG. 1. a. *Conus kenyonae* var. *arrowsmithensis*, holotype 35.5 × 20.5 mm (×1): b. *Conus barbara*, holotype 40.0 × 20.3 mm (×1): c. *Conus cumingii*, 48.5 × 24.5 mm (×1): d. *Conus flindersi*, holotype 28.0 × 15.0 mm (×1.5): e. *Conus frostiana*, holotype 18.2 × 9.5 mm (×2): f. *Conus kenyonae*, holotype 42.0 × 23.5 mm (×1): g. *Conus kermadecensis*, ? syntype 43.0 × 23.4 mm (×1): h. *Rhizoconus klemae*, 46.5 × 26.0 mm (×1).

approximation to Angas's description. Not to be confused with *C. metcalfii* Reeve, 1843.

Kenyonia pulcherrima Brazier, 1896

(Fig. 2b)

Proc. Linn. Soc. New South Wales **21**: 347.
Holotype: SAM Reg. No. D6181. Kenyon No. 175.
Dimensions, 28.0 × 9.4 mm (Brazier gives 28 × 10 mm).
Type-locality: New Hebrides; collected by Mrs. A. F. Kenyon, date of collection unknown.
Present Status: Uncertain. This is almost certainly not a cone. It is most likely a turrid similar to *Conopleura* Hinds, 1844 (Cernohorsky, 1974).
Remarks: A worn specimen with Brazier's original label. Not to be confused with *Conus pulcherrimus* Brazier, 1894 or *Conus pulcherrimus* Heilprin, 1879—a fossil.

Conus pulcherrimus Brazier, 1894

(Fig. 2c)

Proc. Linn. Soc. New South Wales **9**(1): 187.
Holotype: SAM Reg. No. D6172. Kenyon No. absent.
Dimensions, 80.0 × 27.2 mm (Brazier gives none)
Type-locality: Tanna, New Hebrides, on beach after

FIG. 2. a. *Conus metcalfei*, 17.6 × 9.5 mm (×2): b. *Kenyonia pulcherrima*, holotype 28.0 × 9.4 mm (× 1.5): c. *Conus pulcherrimus*, holotype 80.0 × 27.2 mm (× 0.5): d. *Conus remo*, lectotype 35.0 × 17.5 mm (×1): e. *Conus rossiteri*, ?holotype 10.6 × 6.4 mm (×3): f. *Floraconus saundersi*, holotype 57.0 × 32.0 mm (×1): g. *Floraconus singletoni*, holotype 43.5 × 22.0 mm (×1): h. *Conus superstes*, syntype 3.3 × 1.7 mm (×10).

submarine volcanic eruption; collected in 1878; collector unknown.

Present Status: Synonym of *C. excelsus* Sowerby, 1908.

Remarks: A worn specimen with Brazier's original label indicating the species and locality but not the fact that it was Brazier's type. Cotton (1945) apparently ignored the original label and did not realize that Brazier had given a short description under "Notes and exhibits" and thus described this specimen as the unique type of a new species, *Asprella tannaensis*.

Not to be confused with *Kenyonia pulcherrima* Brazier, 1896 which is now considered a turrid or *C. pulcherrimus* Heilprin, 1879—a fossil.

Conus remo Brazier, 1898

(Fig. 2d)

Proc. Linn. Soc. New South Wales **23**: 271.

Lectotype: SAM Reg. No. D14128. Kenyon No. 186. Selected by Cotton (1945), p. 265, pl. 4, Fig. 9. Dimensions, 35.0 × 17.5 mm (Cotton gives none but Brazier gives 35 × 15½-17 mm for the type).

Type-locality: San Remo, Port Phillip Bay, Victoria; collected by Mrs A. F. Kenyon, date of collection unknown.

Paralectotypes: SAM Reg. No. D15948, 8 specimens with same collection data as type.

Present Status: Synonym of *C. anemone* Lamarck, 1810.
Remarks: Specimens with Brazier's original label but the type had not been indicated.

Conus rossiteri Brazier, 1870

(Fig. 2e)

Proc. Zool. Soc. (London) (1870): 109.
Holotype: SAM Reg. No. D5975. Kenyon No. 312. Dimensions, 10.6 × 6.4 mm (Brazier gives approx. 16 x 8 mm).
Type-locality: Cape Solander, Botany Bay, New South Wales; collected by J. Brazier, date of collection unknown.
Present Status: Synonym of *C. anemone* Lamarck 1810.
Remarks: This is a doubtful type-specimen as it is much smaller than the measurements given by Brazier. Also the original label is missing and there is no indication that this is the type apart from the museum register referring to it as "type" and Cotton's (1945, 1958) reference to it as the type. The Austalian Museum, Sydney, has a specimen registered as type in 1902, from material purchased from Brazier in 1889, measuring 14.5 × 9 mm.

Floraconus saundersi Cotton, 1945

(Fig. 2f)

Rec. S. Aust. Mus. 8(2): 264, pl. 4, Fig. 8.
Holotype: SAM Reg. No. D14198. Dimensions, 57.0 x 32.0 mm (Cotton gives none).
Type-locality: Levens Beach, Edithburgh, Yorke Peninsula, South Australia; collector and date of collection unknown.
Present Status: Synonym of *C. anemone* Lamarck, 1810.
Remarks: Two specimens, SAM Reg. No. D16232, were with the holotype and may have been used in the original description but were not designated paratypes.

Floraconus singletoni Cotton, 1945

(Fig. 2g)

Rec. S. Aust. Mus. 8(2): 263, pl. 4, Fig. 10.
Holotype: SAM Reg. No. D14195. Dimensions, 43.5 x 22.0 mm (Cotton gives 45 × 22 mm).
Type-locality: Western Port, Victoria; collected by C. J. Gabriel, date of collection unknown.
Present Status: Synonym of *C. anemone* Lamarck, 1810.
Remarks: Considered an albino variant of *C. anemone.* Two specimens, SAM Reg. No. D16236, were with the type but were not designated paratypes.

Conus superstes Hedley, 1911

(Fig. 2h)

Zool. Results F.I.S. Endeavour 1904-10, part 1: 111, pl. 20, Figs. 35, 36.
Syntypes: SAM Reg. No. D15904, 11 specimens, the specimen figured here measures 3.3 × 1.7 mm.
Type-locality: Forty miles south of Cape Wiles, South Australia in 100 fms; collected by F.I.S. *Endeavour*, 28.viii.1909.
Present Status: The species description is based on small juveniles, so that it would be difficult to determine the specific status until the life histories of South Australian cones are better known.
Remarks: Specimens with the original label with the word "Co-type" and registration number "E.3800".

Conus sydneyensis Sowerby, 1887

(Fig. 3a)

Thesaurus Conchyliorum, 5 (*Conus Suppl.*): 260, pl. 32 (510), Fig. 694.
Holotype: SAM Reg. No. D6183. Kenyon No. 192. Dimensions, 17.0 × 9.0 mm (Sowerby gives 24 × 12 mm).
Type-locality: Port Jackson, New South Wales, collected by Brazier; date of collection unknown.
Present Status: Synonym of *C. aplustre* Reeve, 1843 according to Walls (1978) or of *C. angasi* Tyron, 1883 according to Cotton (1945). The specimen at hand looks more like *C. angasi* than *C. aplustre.*
Remarks: This specimen cannot be Sowerby's type, even though the original label with the specimen, designating it as a type, appears to be in Brazier's handwriting. The locality data is given as Port Stephens and the measurements do not agree with the original description given by Sowerby. According to Moolenbeek (pers. comm.) the type appears to be in the Institut Royal des Sciences Naturelles de Belgique (Brussels).

Asprella tannaensis Cotton, 1945

(Fig. 2e)

Rec. S. Aust. Mus. 8(2): 270, pl. 4, Fig. 3.
Holotype: SAM Reg. No. D6172.
Remarks: Based on the same specimen as the type of *C. pulcherrimus* Brazier, 1894 also listed in this paper.

The operculum figured with the type by Cotton (1945) probably belongs to another species as the type is worn and faded and was obviously collected devoid of the animal.

Hermes triggi Cotton, 1945

(Fig. 3b)

Rec. S. Aust. Mus. 8(2): 267, pl. 4, Fig. 11.
Holotype: SAM Reg. No. D14324. Kenyon No.—absent. Dimensions, 61.5 × 27.4 mm (Cotton gives 60 × 27 mm).
Type-locality: New Hebrides; collector and date of collection unknown.
Present Status: Synonym of *C. ximenes* Gray, 1839.
Remarks: Described from a unique specimen from the Kenyon collection.

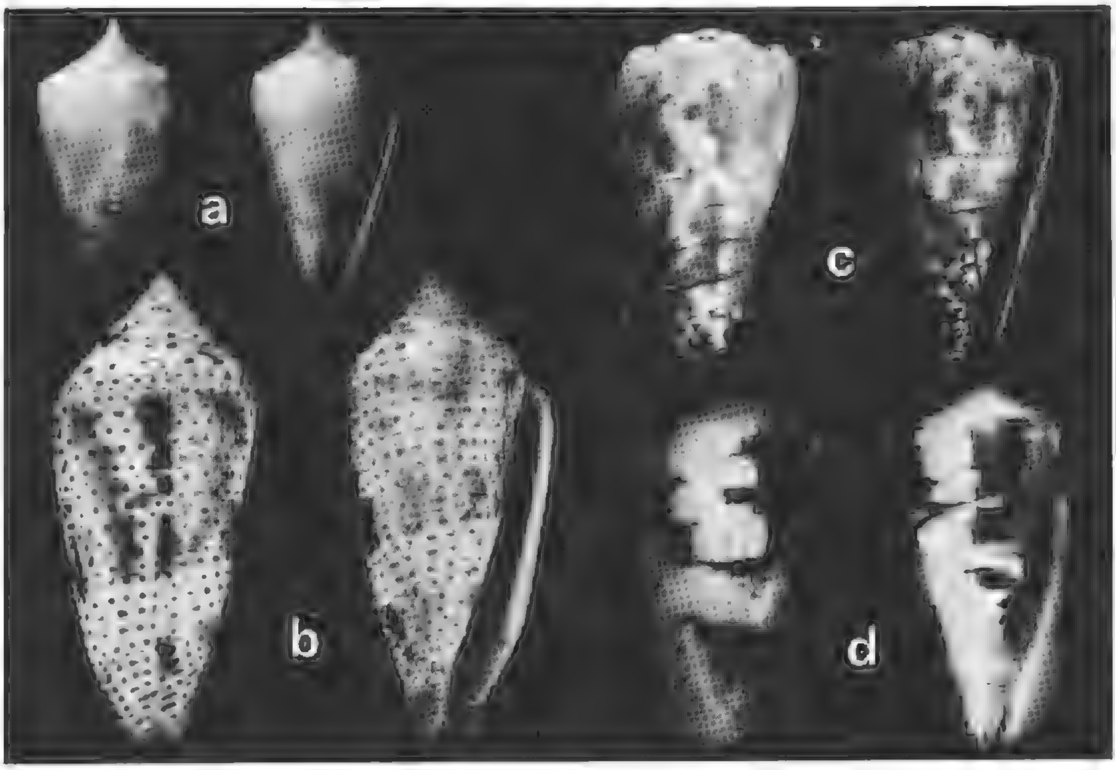

FIG. 3. a. *Conus sydneyensis*, 17.0 × 9.0 mm (×2); b. *Hermes triggi*, holotype 61.5 × 27.4 mm (×1); c. *Conus waterhouseae*, holotype 28.5 × 16.0 mm (×1.5); d. *Conus worcesteri*, holotype 47.6 × 24.5 mm (×1).

Conus waterhouseae Brazier, 1896

(Fig. 3c)

Proc. Linn. Soc. New South Wales **21**: 471.
Holotype: SAM Reg. No. D5786. Kenyon No.—absent.
Dimensions, 28.5 × 16.0 mm (Brazier gives 30 × 15 mm).
Type-locality: Solomon Islands; collected by Mrs. G. J. Waterhouse, date of collection unknown.
Present Status: Synonym of *C. distans* Hwass, 1792.
Remarks: Specimen with Brazier's original label. Type figured by Cotton (1945) pl. 4, Fig. 2. Another specimen (SAM Reg. No. D5787) with the type and marked "type of variety" was also figured by Cotton (pl. 4, Fig. 7). This specimen, from Mauritius, was introduced as a new variety by Kenyon (1906) who gave a brief description but it was not given a name as it was considered to be a juvenile of *C. distans.*

Conus (Chelyconus) worcesteri Brazier, 1891

(Fig. 3d)

Proc. Linn. Soc. New South Wales **6**: 276, pl. 19, Fig. 4.
Holotype: SAM Reg. No. D6178. Kenyon No. 155.
Dimensions, 47.6 × 24.5 mm (Brazier gives 48 × 25 mm).
Type-locality: Island of Mauritius; collected by Mr Robillard, date of collection unknown.
Present Status: Synonym of *C. magus* Linnaeus, 1758.
Remarks: The original label by Brazier is missing but there is little doubt that this is the type. The specimen was collected live as the operculum is present. Type figured by Cotton (1945), pl. 4, Fig. 1.

ACKNOWLEDGMENTS

I wish to thank Mr I. Loch of the Australian Museum, Sydney for supplying information on the cone types in that institution and Dr R. G. Moolenbeek, Institut Voor Taxonomische Zoologie, Zoologisch Museum, Universiteit van Amsterdam, The Netherlands, for his comments on the status of *C. kermadecensis* and *C. sydneyensis.* Thanks are also due to Mrs J. Forrest, South Australian Museum, who took, and also prepared, the photographs.

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APPENDIX

Specimens labelled or registered as "type" for which no reference can be found.

Conus noumeensis Brazier, SAM Reg. No. D5729. Kenyon No. 69. (68.5 × 39.5 mm).
Locality: Anse Vata, Noumea, New Caldonia.
Remarks: Specimen with Brazier's label marked "Type specimen". Cotton refers to this specimen and says that it is *C. chenui* Crosse, 1857 and has nothing to do with *C. suffusus* var. *Noumeensis* Crosse, 1872 which is a synonym of *C. marmoreus* Linnaeus, 1758.

Conus pilcheri Brazier, SAM Reg. No. D6171. Kenyon No. 247 (22.3 × 14.0 mm).
Remarks: Specimen with Brazier's label marked "Type specimen" but no locality data. It is very similar to *C. cyanostoma* A. Adams, 1854.

Conus sydneyensis var. *sowerbyi* Kenyon, SAM Reg. No. D6184. Kenyon No. 192 (27.0 × 15.5 mm).
Locality: Port Stephens, New South Wales.
Remarks: Specimen with Kenyon's label marked "type". Another specimen with a similar label but not marked "type" is also in the collection. The specimens seem to be juvenile *C. purpurascens* Sowerby, 1933.

Conus wisemani Brazier, SAM Reg. No. D6179. Kenyon No. 199. (28.2 × 17.3 mm).
Locality: Low Island, Trinity Bay, north Queensland.
Remarks: Specimen with Brazier's label but not marked "type" yet registered as a type in Museum register. It seems to be a white form of *C. suturatus* Reeve, 1844.

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by KARL J. WITTMANN

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A REVISION OF THE TROGLOPHILIC GENUS BRISES PASCOE, WITH A DISCUSSION OF THE CYPHALEINI (COLEOPTERA, TENEBRIONIDAE)

BY E. G. MATTHEWS

Summary

Eight species and one subspecies of Brises Pascoe are recognized, keyed, and briefly described. Four of the species are new and named caraboides, katherinae, occidentalis and nullarboricus. The specific name duboulayi Bates becomes a subspecies of acuticornis Pascoe, and granulatus Carter becomes a synonym of the latter. There is a brief discussion of the cave and burrow frequenting habits of Brises.

A number of former subfamilies and tribes of Australian Tenebrionidae are combined into the single tribe Cyphaleini and adult diagnostic characters for the latter are proposed.

A REVISION OF THE TROGLOPHILIC GENUS *BRISES* PASCOE, WITH A DISCUSSION OF THE CYPHALEINI (COLEOPTERA, TENEBRIONIDAE)

by

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(Manuscript accepted 5 November 1984)

ABSTRACT

MATTHEWS, E. G. 1986. A revision of the troglophilic genus *Brises* Pascoe, with a discussion of the Cyphaleini (Coleoptera). *Rec. S. Aust. Mus.* 19(6): 77-90.

Eight species and one subspecies of *Brises* Pascoe are recognized, keyed, and briefly described. Four of the species are new and named *caraboides*, *katherinae*, *occidentalis*, and *nullarboricus*. The specific name *duboulayi* Bates becomes a subspecies of *acuticornis* Pascoe, and *granulatus* Carter becomes a synonym of the latter. There is a brief discussion of the cave and burrow frequenting habits of *Brises*.

A number of former subfamilies and tribes of Australian Tenebrionidae are combined into the single tribe Cyphaleini and adult diagnostic characters for the latter are proposed.

INTRODUCTION

The genus *Brises* Pascoe, 1869, comprises eight known species whose distributions are practically confined to the arid zone of Australia, with most known records being within South Australia (Fig. 23). It is unique among Australian Tenebrionidae in that the majority of species have been recorded from caves and mammal burrows.

Brises belongs to the very large and diverse Australasian endemic tribe Cyphaleini (subfamily Tenebrioninae) which represents the most important of the three dominant elements of the Australian tenebrionid fauna, the others being the Adeliini (subfamily Lagriinae) and Amarygmini (subfamily Tenebrioninae) (Kaszab 1982). Having probably originated as forest-inhabiting, rotten-wood-feeding forms (as many still are) certain elements of the Cyphaleini invaded the arid zone to become soil inhabiting as larvae and ground foraging as adults, but they do not remain active under daytime conditions as do many African desert tenebrionids. The concept of the tribe Cyphaleini adopted here largely conforms to that implied by Doyen and Tschinkel (1982) and includes all the members of the "subfamilies" Helaeinae, Nyctozoilinae, Briseinae, and Cyphaleinae of Carter (1926), a total of 46 genera and some 450 species in Australia and New Guinea, plus the 14 species of *Mimopeus* Pascoe in New Zealand (Watt 1968).

The following abbreviations for institutional names are used in the text and follow the four-letter system proposed by Watt (1979):

AMSA	—Australian Museum, Sydney.
ANIC	—Australian National Insect Collection, Canberra.
BMNH	—British Museum (Natural History).
MVMA	—Museum of Victoria (Natural History and Anthropology), Melbourne.
QMBA	—Queensland Museum, Brisbane.
SAMA	—South Australian Museum, Adelaide
UQBA	—University of Queensland Entomology Department, St Lucia.
WAMA	—Western Australian Museum, Perth.

The primary types of all the taxa of *Brises* have been seen by the author.

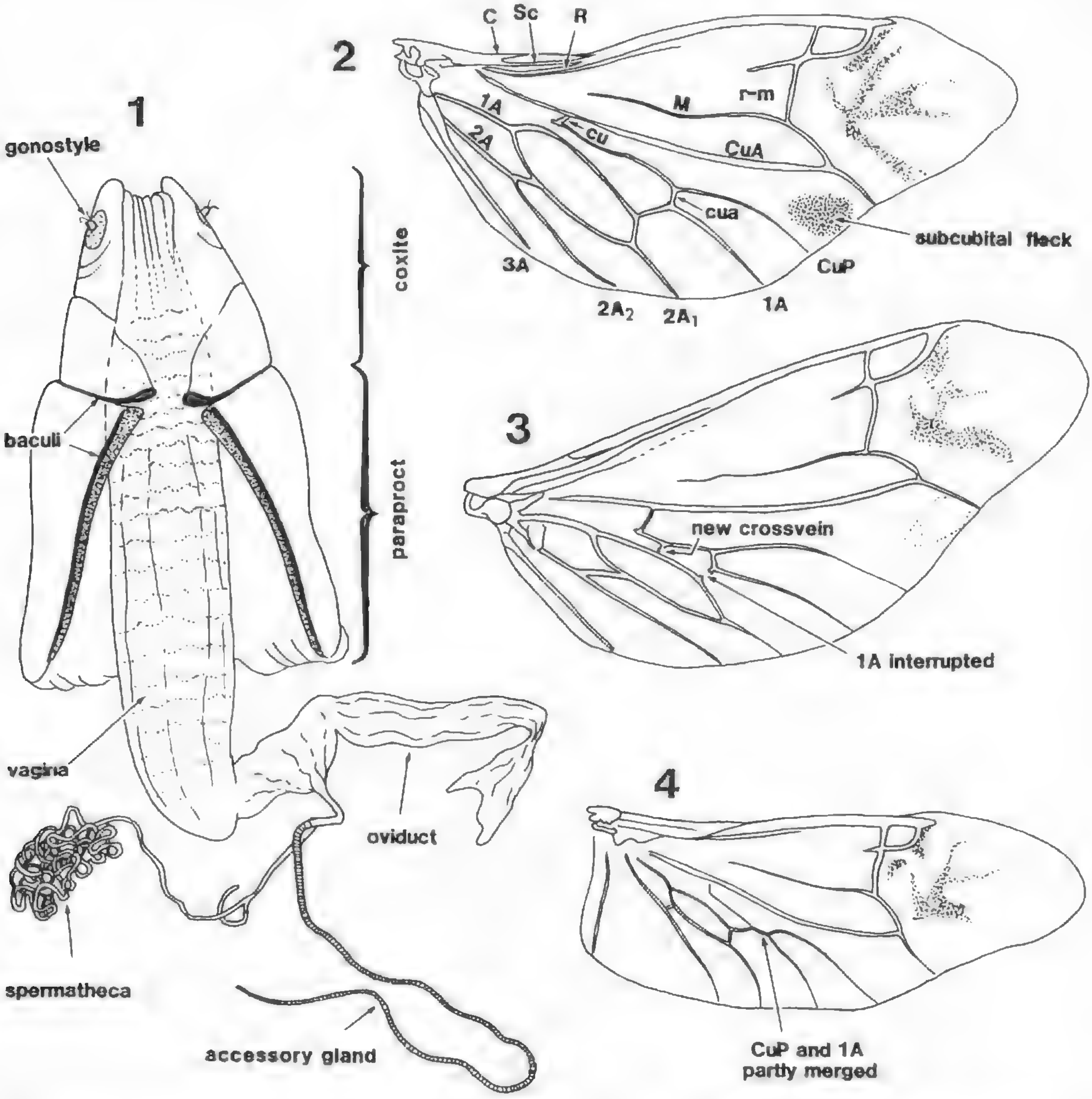
The Limits of the Cyphaleini and Tenebrionini

As discussed by Doyen and Tschinkel (1982), these two tribes belong to the "tenebrionine lineage" which is characterised in part by having the spermatheca derived from the original bursa copulatrix (which has disappeared as a recognizable entity), by the orientation of the coxite and paraproct baculi of the ovipositor being transverse and oblique respectively (Fig. 1), and by the defensive gland reservoirs opening between sternites 7 and 8 and being small and not reinforced by helical thickenings (Tschinkel and Doyen 1980). These three features are shared with the closely related toxicine and opatrine lineages (best treated as further tribes of the Tenebrioninae) and sharply distinguish these lineages collectively (in effect the subfamily Tenebrioninae) from other subfamilies. The above authors do not propose any formal classification, but I equate the subfamily Tenebrioninae with their tenebrionine, toxicine, and opatrine lineages.

The Tenebrioninae (as understood here) are further characterised by a number of primitive features, including the almost complete absence of the clustered antennal sensoria termed "tenebrioid sensory organs" by Medvedev (1977) and, inconsistently in apparently primitive elements, internally open fore coxal cavities and a subcubital fleck on the wings (Fig. 2).

The two tribes Tenebrionini and Cyphaleini share all of the above features, at least in part, and in a natural system could not be satisfactorily separated. However, the resulting group would be rather unwieldy on a world-wide basis and it is desirable for purely practical purposes to try to find an arbitrary line of separation. Watt (1974) suggests a larval character—a crenulate spiracular peritreme, combined with a primitive adult character—the subcubital fleck, to characterise Cyphaleini. However, too few larvae are known for us to be able to understand the significance of the spiracular character, and the adult one is not only plesiomorphic but also by no means universal in the Cyphaleini. For practical reasons I prefer to draw the line at an adult apomorphic character—the absence of original elytral striae—to recognise Cyphaleini, when combined with certain other features.

Specifically, Cyphaleini may be considered to be members of the Tenebrioninae which share the following adult characters (A—apomorphic; P—plesiomorphic): (1) absence of tenebrioid sensoria (P),(2) internally open fore coxal cavities (P), (3) the third antennal segment longer than the preceding or following ones (A), (4) the original nine elytral striae entirely absent, the elytra either non-striate or with secondary, usually supernumerary striae (A), (5) no sexual dimorphism in the shape of the fore legs (P), and (6) the parameres of the aedeagus with a vestiture of minute spines (A?). As far as I know, all Cyphaleini share the above features, but conversely none of the features are exclusive to the group. *Meneristes* Pascoe,



FIGS. 1-4. 1. Ovipositor and internal female genital apparatus of *Brises a. acuticornis* Pascoe. 2. The tenebrionine wing venation (*Meneristes australis* Blessig). Venation nomenclature after Medvedev (1968). 3. The cyphaleine wing venation (*Brises a. acuticornis* Pascoe). 4. The coelometopine wing venation (*Encyalesthus atroviridis* Macleay).

in particular, is a transitional genus between Cyphaleini and Tenebrionini, since it displays characters 1, 2, 3, and 6, but not 4 and 5, and it was placed in the Cyphaleini by Watt (1974), a position supported by Doyen and Tschinkel (1982). I prefer to consider the elytral character (4) to be decisive, because of the ease with which it can be seen, and so place *Meneristes* in the Tenebrionini.

Additional characters which are frequent but not universal in the Cyphaleini are the presence of a subcubital fleck on the hind wings (P) (in ten of the 20 winged genera examined, but not in *Brises*), the last maxillary palpal segment triangular or securiform (A) (29 of 33 genera), a shortening of the parameres in relation to the tegmen of the aedeagus (A) (14 of 33 genera examined) and a sclerotisation of the median lobe, often in a characteristic form (arrow-shaped in *Brises*) (A). In addition, eight of the winged genera examined (*Brises* Pascoe, *Pterohelaeus* Breme, *Emcephalus* Kirby, *Paraphanes* Macleay, *Ospidus* Pascoe, *Barytiphia* Pascoe, *Anausis* Bates and *Chartopteryx* Westwood) display a venational peculiarity illustrated in Fig. 3, whereby 1A is broken at one spot and a new cross vein appears, usually only as a stub, further proximad between CuP and 1A (compare the normal tenebrionine venation seen in *Meneristes*, Fig. 2). The latter configuration also appears in at least 12 genera of Cyphaleini, so wing venation cannot be used reliably as a tribal character.

The genus *Titaena* Erichson clearly belongs in the Cyphaleini as here conceived since it shows all the diagnostic features mentioned above except (3) and some of the additional characters (a subcubital fleck, securiform maxillary palpal segment, and sclerotisation of the median lobe). However, *Titaena* is apparently also close to *Artystona* Bates of New Zealand and *Callismilax* Bates of New Caledonia, all three placed in a tribe Titaenini by Kaszab (1982). The latter two genera display the full complement of original elytral striae (at least in some species) and so do not fall within the Cyphaleini as here arbitrarily defined. I have not closely examined *Artystona* and *Callismilax* and prefer to leave the question of their relationship (and therefore that of *Titaena*) in abeyance.

It should also be mentioned here that the subfamily Coelometopinae, which is sharply distinctive on female genitalic and gland reservoir characters (Doyen and Tschinkel 1982), can often also be recognized by a characteristic wing venation in which the veins CuP and 1A have completely merged for a short distance, swallowing crossvein cu-a (Fig. 4). This modification is accompanied by a reduction of the vannal area. However, a few coelometopines have a normal tenebrionine venation (e.g. *Tetragonomenes* Chevrolat, *Chariotheca* Pascoe). Coelometopinae strongly resemble Tenebrionini in external form but can always be recognized without dissection by the presence of tenebrioid sensoria on the antennae, universal in the group. The following coelometopine genera were erroneously placed in the Tenebrioninae by Carter (1926): *Hypaulax* Bates, *Hydissus* Pascoe, *Encyalesthus* Motschulsky, *Setenis* Motschulsky, *Promethis* Pascoe, *Tetragonomenes* Chevrolat, *Oectosis* Pascoe and *Zophophilus* Fairmaire (the correct placement of some of these genera has already been proposed by Doyen and Tschinkel (1982)).

The Australian genera which I consider to be true Tenebrionini are *Asphalus* Pascoe, *Sloanea* Carter, *Meneristes* Pascoe, an unnamed genus comprising the species *colydioides* Erichson, *rectibasis* Carter and *sydneyanus* Blackburn, all three erroneously put in *Menephilus*, and *Paratoxicum* Champion.

The 46 genera of Cyphaleini will not be listed here but can be obtained from Carter's (1926) checklist under the "subfamilies" Helaeinae, Nyctozoilinae, Briseinae, and Cyphaleinae.

Subgroups of Cyphaleini and Recognition of *Brises*

The placing of the cyphaleine genera in four separate subfamilies by Carter (1926) suggests that some natural groupings may exist within the tribe, perhaps at subtribal level. In the course of the present study I dissected representatives of 33 cyphaleine genera but was unable to arrive at any arrangement, and believe that the former categories cannot be maintained at any level. There is no concordance in the pattern of variation of characters, whose states consequently follow a mozaic distribution. This is a characteristic feature of the Tenebrionidae as a whole and one which has so far defeated all attempts to arrive at a convincing natural classification of the family (Doyen and Lawrence 1979; Doyen and Tschinkel 1982).

Brises itself was singled out by Carter in 1914, and placed in its own subfamily in 1926, because of a number of ostensibly unique features, specifically the narrowly triangular shape of the last maxillary palpal segment (normally strongly securiform in Cyphaleini), the narrow posterior intercoxal process, the elongate legs, and the long tibial spurs and tarsal claws. After a detailed examination of representative Cyphaleini I find it difficult to understand just what is so unusual about *Brises*. All of the above characters recur in other genera (but not in the same combination). Like all cyphaleine genera *Brises* may be recognized only through a unique *combination* of a number of characters, enumerated for *Brises* below under "Diagnosis". It also has a distinctive habitus resembling that of cursorial carabid beetles, due mainly to its relatively narrow prothorax and long legs. This characteristic build is the principal feature distinguishing it from some species of *Pterohelaeus* Breme, in which the outlines of the pronotum and elytra are confluent, but which in other respects resemble *Brises*. *Pterohelaeus* itself appears to be a composite taxon.

Adaptations of *Brises*

The Cyphaleini are a relatively primitive group of Tenebrioninae which has radiated extensively in the Australian region in the absence of the subfamily Pimeliinae (Tentyriinae), which elsewhere tends to become dominant in similar xeric situations. *Brises* itself has evolved a strategy of utilising caves and burrows for daytime shelter at least. Six of the nine taxa have been recorded from caves (*caraboides, a. acuticornis, a. duboulayi, katherinae, occidentalis,* and *trachynotoides*), and three of these (the two subspecies of *acuticornis,* and *trachynotoides*) from rabbit burrows as well. Two of the remainder are recorded from rabbit burrows only (*blairi* and *parvicollis*), only *nullarboricus* being without any data on shelters used.

G. B. Monteith (*in litt.*) writes that south of Birdsville *blairi* once came out at night in August in enormous numbers foraging on the crests of sandhills, even though it was freezing cold. *B. a. acuticornis* feeds inside caves and so, presumably, does *katherinae* (see accounts under species). Feeding habits of the other species are not known. Larvae which have been found in caves and burrows in association with *Brises* adults are assumed to belong to the latter, but some *Helaeus* species also use burrows (Matthews 1985) and it is necessary to rear larvae through to confirm their identity.

By examination of gut contents and through observation of captive specimens of *acuticornis* I infer that the adults are general scavengers like most tenebrionids. In burrows they (and presumably all other species of the genus) are probably coprophagous on the droppings of the mammal inhabitants, and in caves they appear to feed on all faecal matter available and on carrion.

Adaptation of *Brises* to life in caves and burrows is barely reflected in their structure. Long appendages, small eyes and a large hind body are features often seen in cavernicolous beetles, as is wing reduction. In all these respects *Brises* is only at the earliest stage of modification, *caraboides* being the most modified. Only two species appear to be flightless and only five have eyes measurably smaller than those of winged epigean genera. Intensity of pigmentation is at normal levels, but paler specimens are common in *duboulayi.* Altogether, the morphology of the species suggests that there is frequent migration from one burrow or cave to another.

SYSTEMATICS

Brises Pascoe

Brises Pascoe, 1869, p. 145; Carter, 1914, pp. 45, 46; Carter 1926, pp. 127, 145.

Ephidonius Pascoe, 1869, p. 151; Carter, 1914, p. 45 (syn.).

Type Species: Of *Brises: Brises trachynotoides* Pascoe, 1869, by monotypy. Of *Ephidonius: Ephidonius acuticornis* Pascoe, 1869, by monotypy.

Description: Entirely black.

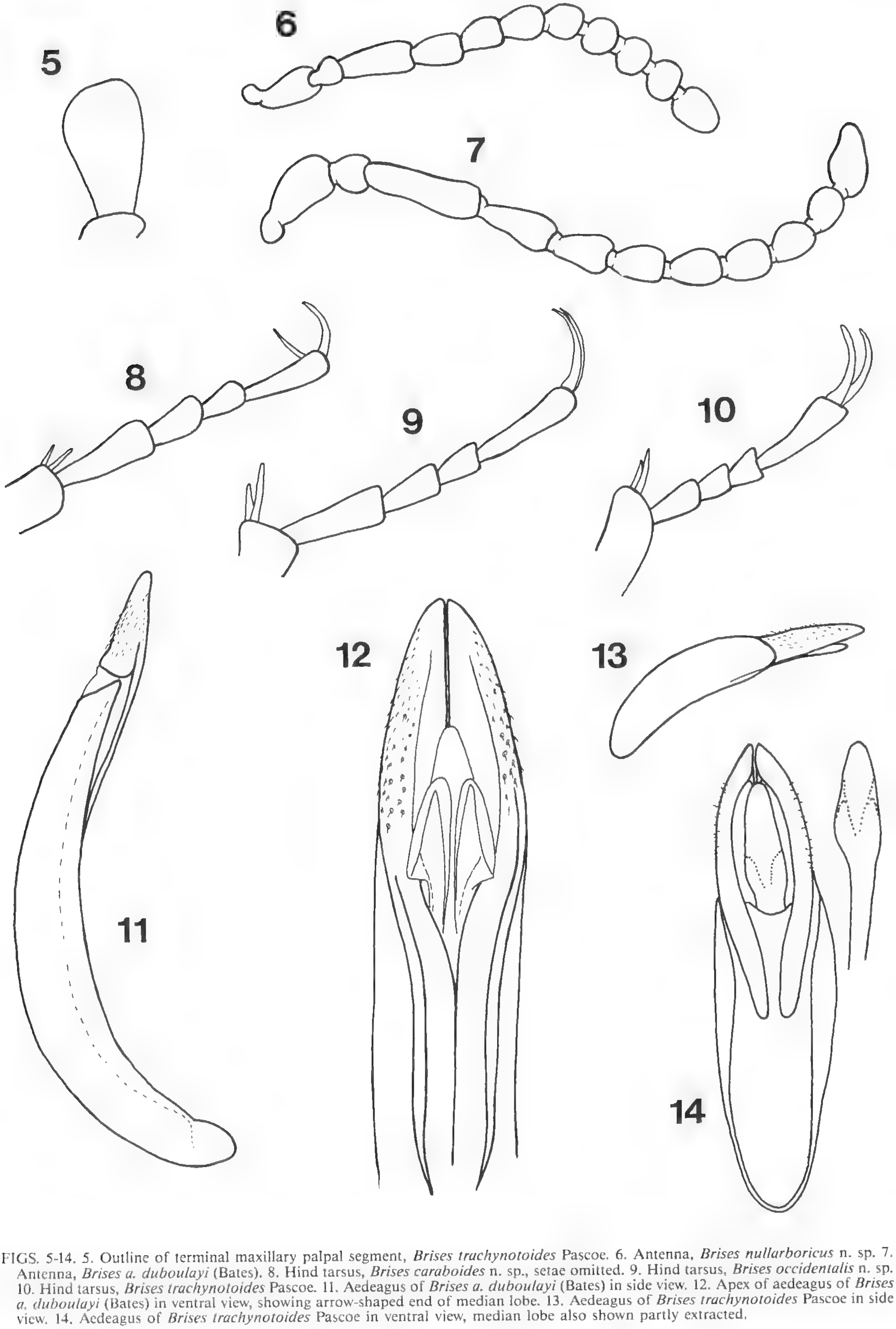
Head: Anterior margin of clypeus concave. Clypeofrontal suture complete or not. Basal membrane of labrum visible from above. Eyes entire but constricted by both canthus and edge of occiput, the dorsal interocular distance 2½-5 times width of one eye. Gular sutures meet near middle, no gular pits, anterior edge of gula unmodified. Bridge of tentorium straight. Third antennal segment longer than 2nd or 4th. Tormae of labrum transverse, without prominent anterior extensions. Mandibles bidentate, mola not striate. Lacinia unarmed. Terminal segment of maxillary palpus narrowly triangular to sublinear (Fig. 5), of labial palpus sublinear. Angles of mentum anterior, subacute.

Thorax: Margins of pronotum prominent but rarely strongly explanate, anterior edge evenly arcuate. Outline of pronotum not confluent with that of elytra, narrower. Pronotum glabrous or with minute, very fine setae. No sharp prosternal keel. Fore coxal cavities open internally. Mesosternum strongly excavate to receive prosternal process. Metendosternite Y-shaped, with laminae. Scutellum visible, small, in form of subequilateral triangle. Elytra glabrous or with minute setae, true striae absent, carinae present or not. Epipleura moderately wide, complete. Wings without subcubital fleck or with faint trace of one, with base of first branch of 1A broken and partial supplementary cross vein cu-a present (Fig. 3). Tarsi slender, claws long, equal in length to about ⅔ of last tarsal segment. Tarsal vestiture in form of long bristles. Tibial spurs equal in length to ⅓-½ length of metatarsus. Legs slender, without carinae.

Abdomen: Intercoxal process of first visible abdominal sternite narrowly triangular. Reservoirs of defensive glands small, simple. Ovipositor and internal female genital tract of tenebrionine type (Fig. 1). Parameres of aedeagus spinose, comprising ⅕-⅓ of total aedeagal length, with backward prolongations. Median lobe arrow-shaped or simply expanded subapically (Figs. 11-14).

Total length 10-25 mm.

Diagnosis: Eyes in dorsal view ovoid or subquadrate, not strongly transverse, interocular distance equal to 2½-5 eye widths. Membrane at base of labrum exposed by concavity of clypeal margin. Last segment of maxillary palpus narrowly triangular. Pronotum glabrous, markedly narrower than elytral bases and not confluent in outline with elytral edges. Elytra glabrous or with minute setae, the lateral margins not expanded. Wings (when present) without distinct subcubital fleck. Legs slender, femora extending for about ¼-⅓ of their length beyond body sides. Tibial spurs equal to ⅓ to



FIGS. 5-14. 5. Outline of terminal maxillary palpal segment, *Brises trachynotoides* Pascoe. 6. Antenna, *Brises nullarboricus* n. sp. 7. Antenna, *Brises a. duboulayi* (Bates). 8. Hind tarsus, *Brises caraboides* n. sp., setae omitted. 9. Hind tarsus, *Brises occidentalis* n. sp. 10. Hind tarsus, *Brises trachynotoides* Pascoe. 11. Aedeagus of *Brises a. duboulayi* (Bates) in side view. 12. Apex of aedeagus of *Brises a. duboulayi* (Bates) in ventral view, showing arrow-shaped end of median lobe. 13. Aedeagus of *Brises trachynotoides* Pascoe in side view. 14. Aedeagus of *Brises trachynotoides* Pascoe in ventral view, median lobe also shown partly extracted.

½ length of metatarsus. Claws long, equal in length to about ⅔ of last tarsal segment. Tarsi bristled beneath, not tomentose. Intercoxal process of first visible abdominal sternite narrowly triangular.

Distribution (Fig. 23): All of South Australia except the southeastern portion; New South Wales west of the Great Dividing Range; southwestern Queensland; the Northern Territory from Katherine southward; the Nullarbor, Central, and North West districts of Western Australia. Probably occurring in all parts of Australia receiving less than 300 mm of annual rainfall, with populations substantially outside this area possibly isolated and restricted to caves.

KEY TO THE SPECIES AND SUBSPECIES OF *BRISES*

1 (2) Humeral angles strongly explanate. Elytral length about 1.3 times basal elytral width. Wingless (Fig. 24) ... 1 *blairi* Carter
Humeral angles rounded. Elytral length 1.6-2.1 times basal elytral width. Wings present but may be reduced ... 2

2 (1) Elytral surface with punctures arranged in rows, sometimes irregular. Granules or spines, if present, also in rows. Head and pronotum usually shagreened and punctate. Terminal antennal segment more or less acuminate (Fig. 7). No sexual dimorphism ... 3
Elytral surfaces coarsely reticulo-punctate and granulate, the punctures and granules never in rows on disc at least. Head and pronotum densely vermiculate or granulate. Terminal antennal segment not acuminate, at most somewhat narrowed apically (Fig. 6). Male with middle and hind femora modified (Figs. 19-22) ... 8

3 (2) Pronotal surface shiny, finely shagreened and punctate only, without granules ... 4
Pronotal surface matt, with at least a few small granules ... 6

4 (3) Hind body oval (Fig. 25), flightless. Elytra with the intervals between low, rounded carinae coarsely and densely punctate, without granules ... 2. *caraboides* n. sp.
Hind body oblong (Fig. 26), wings normal. Elytral surface finely punctate, with or without granules and carinae ... 5

5 (4) Elytra without trace of spines, granules or sharp carinae ... 3 *acuticornis acuticornis* (Pascoe)
Elytra with at least a few small granules, may be distinctly granulate and carinate ... 4 *acuticornis duboulayi* (Bates)

6 (3) Head and pronotum coarsely rugose and granulate. Prosternal process with the margins sharply raised between fore coxae. Elytral surface with short setae, more prominent laterally, elytral edges nearly straight in middle (Fig. 29) ... 5 *katherinae* n. sp.
Head and pronotum with small granules, the surface between them shagreened and finely rugose. Prosternal process with margin not raised. Elytra without setae, elytral edges distinctly convex throughout (Figs. 30 and 31) ... 7

7 (6) Eyes wider than long, separated by about 4 eye widths (Fig. 17). Elytral carinae very prominent, the surface between them concave and distinctly granulate ... 6 *occidentalis* n. sp.
Eyes about as long as wide and separated by about 3 eye widths (Fig. 18). Elytral carinae fine, the surface between them flat, minutely granulate, with fine supplementary longitudinal ridges ... 7 *parvicollis* (Blackburn)

8 (2) Clypeus in lower plane than frons, clearly demarcated at base. Front edges of eyes strongly oblique (Fig. 15). Elytra with a short humeral carina (Fig. 32) 8 *nullarboricus* n. sp.
Clypeus in same plane as frons, not sharply delimited at base. Front edges of eyes more or less transverse (Fig. 16). Elytra without a humeral carina ... 9 *trachynotoides* Pascoe

1. *Brises blairi* Carter
(Fig. 24)

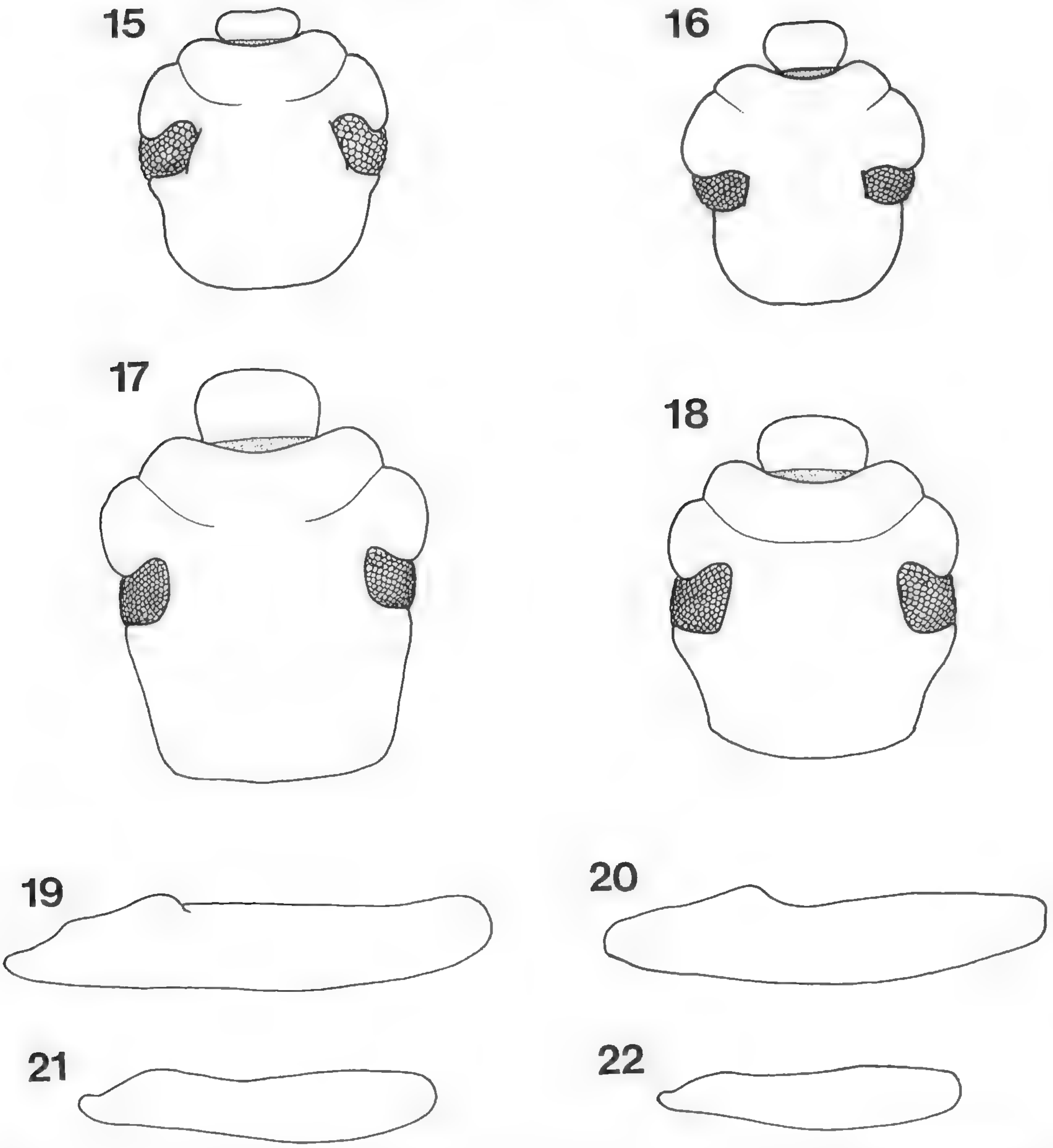
Brises blairi Carter, 1914, p. 58; Carter, 1926, p. 145.

Description: Mentum with two pits and broad anterior membranous area. Terminal antennal segment apically narrowed but obtuse. Clypeus in lower plane than frons. Eyes with length subequal to width in dorsal view, separated by a distance equal to about 2½ eye widths. Edges of prosternal process not raised. Pronotum 1.7-1.9 times as wide as long with margins strongly explanate. Pronotal surface alutaceous, with scattered very fine punctures. Elytral surfaces with very small granules, denser anteriorly, and very small punctures more evident anteriorly and along sides, the surface between them alutaceous, without setae. Two incomplete raised carinae or rows of granules on each elytron. Ratio of elytral length to width across bases about 1.3:1. Hind wings almost entirely atrophied. Longest hind spur equal to more than ½ length of metatarsus. Parameres making up about ¼ of total aedeagal length. No sexual dimorphism. Total length 15-20 mm.

Distribution and habitat: The north-east quarter of South Australia and adjacent areas of Queensland and the Northern Territory. Not recorded from caves but found in rabbit burrows and in the open on sand ridges at night, sometimes in large numbers. Collected from July to May.

Type: Killalpanima, S.A., 100 miles east of Lake Eyre (H. J. Hillier), ♂. BMNH.

Specimens examined (119): SOUTH AUSTRALIA. Alton Downs (old) H.S., 48 km SW by W of Birdsville. Birdsville, 25 mi S of Clayton R., near bore drain. Cooper's Creek. Diamantina R., 25 mi S of Birdsville. Hay R., 24 mi W of camp 13. Innamincka, Brodie's Water Hole. Lake Eyre, Madigan Gulf, Sulphur Peninsula. Lake Eyre, Prescott Peninsula. Lake Kittakittaooloo, S shore. Lake Palankarinna. Minnie Downs, NE corner. Mt. Gason, 41 km SSW of Clifton Hills. Mungeranie Sta., water hole. Mungeranie, 20 mi S of. Purni Bore, Simpson Desert, 6 km WSW of, pit traps in sand ridge. Simpson Desert. Warburton R., 2 km NE of Kalamurina H.S. Warburton R., New Kalamurina H.S. NORTHERN TERRITORY. Andado H.S., 15 km ENE of. Finke R., McDonnell Ranges. Hermannsburg. Indracowra, 5 mi N of, ex pit traps in rabbit burrows. QUEENSLAND. Arrabury, 20 mi N



FIGS. 15-22. 15. Head, *Brises nullarboricus* n. sp. 16. Head, *Brises trachynotoides* Pascoe. 17. Head, *Brises occidentalis* n. sp. 18. Head, *Brises parvicollis* (Blackburn). 19. Hind femur of ♂, *Brises trachynotoides* Pascoe. 20. Middle femur of ♂, *Brises trachynotoides* Pascoe. 21. Hind femur of ♂, *Brises nullarboricus* n. sp. 22. Middle femur of ♂, *Brises nullarboricus* n. sp.

of, on road to Planet. Birdsville. Birdsville, 30 km W of. Bluff Sta. Diamantina R. Kaliduwarry Sta., Camp 20. Specimens are located in AMSA, ANIC, QMBA, SAMA, UQBA, and WAMA.

2. *Brises caraboides*, n. sp.

(Figs 8, 25)

Description: Mentum without pits, with irregular surface and narrow anterior membrane. Terminal antennal segment subacuminate. Clypeus in lower plane than frons. Eyes somewhat wider than long in dorsal view, separated by a distance equal to about 3½ eye widths. Edges of prosternal process not raised. Pronotum about 1.3 times as wide as long. Pronotal surface finely shagreened, with scattered fine punctures. Humeri rounded. Elytral surfaces with about 15 rows of coarse punctures in straight lines, closely spaced between four low, more or less evenly spaced rounded longitudinal ridges on each elytron, without carinae, with short fine setae. Ratio of elytral length to width across bases about 1.9:1. Hind wings reduced to about half of elytral length. Longest hind spur equal to about ⅓ of metatarsus. Parameres making up about ¼ of total aedeagal length. Total length 18-19 mm.

Remarks: The species is closely related to *acuticornis*, within whose range it occurs and from which it differs mainly in pronotal and elytral shape and puncturation, by being flightless, and by having longer legs. The narrow humeri indicate that wing atrophy is of long standing and no intermediate forms are known to exist between *caraboides* and *acuticornis*.

Distribution and habitat: The type locality only. Collected in an "alcove at base of cliffs".

Type: Twilight Cove, Eucla Basin, W.A., 5.XI.1966, J. Lowry, ♂, ANIC. *Paratype:* One ♂, with same data as holotype, ANIC.

Brises acuticornis (Pascoe)

Description: Mentum without pits, sparsely punctate, with posterior V-shaped grooves enclosing raised area. Terminal antennal segment acuminate. Clypeus in lower plane than frons. Eyes about as wide as long, separated by a distance equal to about 4 eye widths. Edges of prosternal process not raised. Pronotum 1.4-1.5 times as wide as long. Pronotal surface alutaceous, finely and sparsely punctate. Elytral surfaces variable (see under subspecies), with short setae. Ratio of elytral length to width across bases 1.6-1.7:1. Hind wings fully developed. Longest hind spur equal to about ½ length of metatarsus. Parameres making up about ⅕ of total aedeagal length. No sexual dimorphism. Total length 15-25 mm.

I recognize the following two subspecies (taxa 3 and 4).

3. *Brises acuticornis acuticornis* (Pascoe)
(Figs 1, 3, 26)

Ephidonius acuticornis Pascoe, 1869, p. 151.

Brises acuticornis, Carter, 1914, pp. 45-46; Carter, 1926, p. 145; Hamilton-Smith, 1967a, pp. 37-39, 41; Hamilton-Smith, 1967b, pp. 115-116; Richards, 1971, pp. 17-45 *passim*.

Description: Elytral surfaces with small punctures set in longitudinal rows between three low ridges on each elytron, without granules or spines.

Distribution and habitat: This subspecies generally occurs in the coastal areas of South Australia and the Nullarbor Plain. There are numerous records from caves, from both the light and dark zone, often associated with guano and carrion. Probable larvae have been collected inside caves and one collector (M. Gray) reports that adults and larvae feed on weta (raphidophorid cricket) excreta in Weebubbie Cave. Collected from July to April.

In her study of the cavernicolous fauna of the Nullarbor Plain, Richards (1971) reports *B. acuticornis* from 25 caves throughout the region, mostly in the dark zone up to 4 km from the entrance. Dry, powdery bat guano supports large populations of adults and larvae, and this species is the only coprophage to occur in both bird (swallow) and mammal faeces, including human excrement and fox droppings. It also occurs in rabbit burrows on the plain.

Type: Lectotype (sex undetermined) from Gawler, S.A., herby designated from two syntypes in the Pascoe Collection (BMNH).

Specimens examined (174): SOUTH AUSTRALIA. Ardrossan. Ceduna. Cook, 9 mi E of. Denial Bay, 1 mi S of. Diprose Cave No. 3. Eucla Basin, cave N 149. Fisher, E-W Railway. Fowler's Bay. Gawler. Koonalda Cave sinkhole. Koonalda H.S., 10 km SE by E of. Koonalda Sta., blowhole entrance. Koonalda, N 33 sinkhole (amongst dead birds). Koonibba. Kooringabie Sta. Murrawijinee Cave N 7, Nullarbor. Murray R. Ooldea. Pt Pierce Mts, Yorke Peninsula. Swan Reach, Punyelroo Cave. Thylacine Hole, Eucla Basin. Wardang I. White Wells Cave. Winbirra Cave, Eucla Basin. Yorke Peninsula. WESTERN AUSTRALIA. Abrakurrie Cave N 3, Nullarbor. Caiguna and Cocklebiddy, halfway between, ex rabbit burrow. Cocklebiddy Cave, doline. Dingo Cave N 160, Nullarbor Plain, on guano. Eucla. Eucla, 32 mi SE of Coongana, Nullarbor. Eyre's Sand Patch. Madura, 6 mi S of, cave. Madura, 8 mi Cave. Madura, main cave N 62. Moonera Tank Cave, Nullarbor. Mullamullang Cave, Nullarbor, dark zone, feeding on dead bat. Murra-el-elvyn Cave, Nullarbor, light and dark zones, on dry guano. Nullarbor, 50 km W of; 64 km E of; 7 km WSW of. Nullarbor H.S. Pannikin Plain Cave, dark zone. Petrogale Cave, ½ mi S of, N 79, E of Madura. Swallow Cave, Cocklebiddy, near dead bat. Tommy Graham's Cave N 56, Nullarbor. Weebubbie Cave N 2, Nullarbor. Specimens are located in AMSA, ANIC, BMNH, QMBA, SAMA, UQBA, and WAMA.

4. *Brises acuticornis duboulayi* (Bates), new status
(Figs 7, 11, 12, 27, 28)

Ephidonius duboulayi Bates, 1872, p. 279.

Brises duboulayi, Carter, 1914, p. 45; Carter, 1926, p. 151.

Brises granulatus Carter, 1921, p. 316 (new synonymy).

Description: Distinguished from *a. acuticornis* only by the sculpturing of the elytra, which show at least a trace of small granules or spines and an accentuation of the ridges. In the extreme form, the elytra are distinctly spinose and strongly carinate. There is a gradual intergradation between typical *a. acuticornis* and *a. duboulayi* along geographical gradients (see below).

Distribution and habitat: This widespread subspecies is essentially the inland race of *acuticornis*, but it reaches the coast on Eyre Peninsula, where it is also in its least granulate form. This form could have been ascribed to *a. acuticornis*, but it is more convenient for nomenclatorial purposes if the latter name is arbitrarily restricted to specimens without any trace of granules, spines, or carinae. Moderately granulate forms without carinae (the former *granulatus*, Fig. 27) are to be found in eastern South Australia from the Adelaide Hills northward and in New South Wales as far east as the foothills of the Great Dividing Range, whilst the most strongly carinate and spinose form (*a. duboulayi* proper, Fig. 28) occurs in northern South Australia from Port Augusta northwards to adjacent states and westwards through the driest parts of Western Australia to the west coast. In parts of South Australia it is difficult to assign specimens to one form or the other.

The Ashford Cave (N.S.W.) population of this subspecies seems to be isolated by many hundreds of kilometres from the nearest other records in western New South Wales, but the intervening area is too poorly collected for us to be sure of this. The few Ashford Cave specimens seen are smaller and paler than other *duboulayi*. The other extreme eastern record, Yiddah, N.S.W., is based on a single old specimen and needs investigation.

There are several other records of the occurrence of this subspecies in caves, and in rabbit burrows (see below). Records are from October to July.

Types: Of *duboulayi:* Champion Bay, W.A., Duboulay, ♂, BMNH. Of *granulatus:* Broken Hill, N.S.W., R. J. Burton, 1/21, ♀, MVMA.

Specimens examined (108): SOUTH AUSTRALIA. Adelaide. Buckalowie Creek, from small cave a little beyond light. Clara St Dora Cave. Cleve. Coober Pedy. Evelyn Downs Sta., Oodnadatta. Everard Ranges to Warburton Ranges. Franklin I. Kingoonya. Kokatha H.S., 17 km SE of, ex pit traps in rabbit burrows. Leigh Creek. Minnipa. Mt Finke, 40 km S Malbooma H.S., ex rabbit warren. Mt Lofty Ranges. Moralana H.S., 22 km WNW of. Murray R. Pt Augusta. Pt Lincoln. Purple Downs, 160 mi NW of Pt Augusta. Streaky Bay. Stuart Ranges. Tarcoola. Whyalla. Wilgi near Loveday, Gilbert's Well. Wilpena Pound, in bat cave in dung. Wooltana Cave, 200 ft underground in bat guano. NEW SOUTH WALES. Ashford Caves via Inverell. Broken Hill. Culpaulin, Darling R. Yiddah. QUEENSLAND. Diamantina. NORTHERN TERRITORY. Alice Springs, 15 km S of, bat caves.

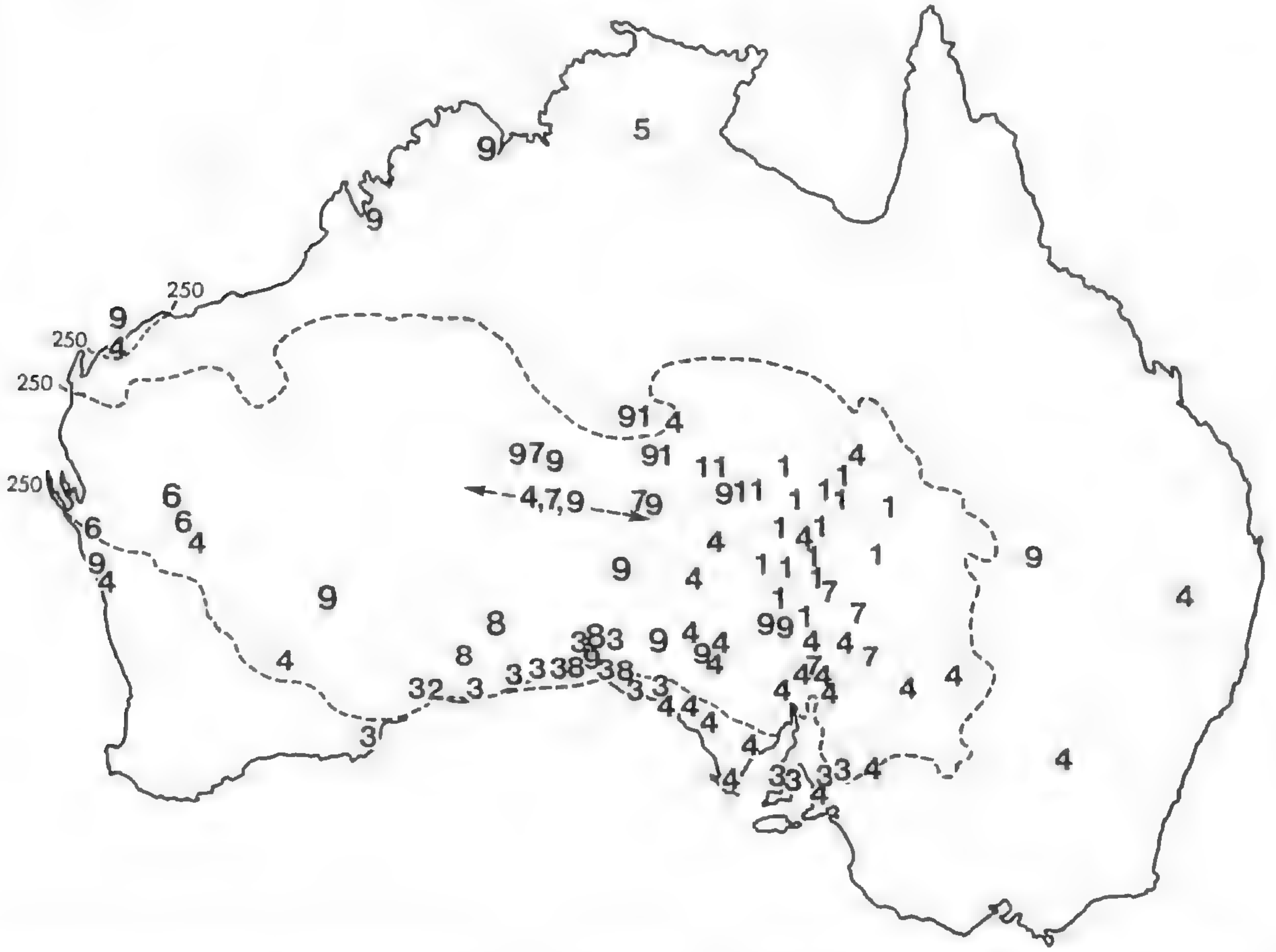


FIG. 23. Distribution of the species of the genus *Brises*. 1—*B. blairi* Carter. 2—*B. caraboides* n. sp. 3—*B. a. acuticornis* (Pascoe). 4—*B. a. duboulayi* (Bates). 5—*B. katherinae* n. sp. 6—*B. occidentalis* n. sp. 7—*B. parvicollis* (Blackburn). 8—*B. nullarboricus* n. sp. 9—*B. trachynotoides* Pascoe. 250 mm annual isohyet shown.

WESTERN AUSTRALIA. Coolgardie. Cue. Onslow. Specimens are located in AMSA, ANIC, SAMA, and UQBA.

5. *Brises katherinae*, n. sp.
(Fig. 29)

Description: Mentum variable, without groove but with either large punctures or oblique depression posterolaterally. Terminal antennal segment acuminate. Clypeus in same or higher plane than frons, not delimited by a sharp depression. Eyes wider than long, the anterior edge strongly oblique, separated by a distance equal to about 2 eye widths. Prosternum feebly ridged before coxae, edges of prosternal process strongly raised between coxae. Pronotum 1.3-1.5 times as wide as long. Pronotal surface irregularly rugose and shagreened, with numerous large shallow punctures and some slightly raised shiny spots on disc. Elytra each with three nearly complete carinae and part of a fourth, and a sutural row of granules, surface between carinae flat, shagreened, with rows of fine but deep punctures and sparse short, curved setae. Ratio of elytral length to width across bases 1.8-2.1:1. Hind wings fully developed. Longest hind spur equal to about ⅓ of length of metatarsus. Parameres making up about ¼ of total aedeagal length. No sexual dimorphism. Total length 15-25 mm.

Distribution and habitat: Known only from the complex of caves near Katherine, N.T. It occurs well inside the dark zone, and has not been collected from outside caves. More collecting in inland northern Australia is needed to establish the distribution limits of this and any other species in the region, in order to determine whether *katherinae* is really as isolated as it appears to be.

Type: Kintore Cave, Katherine, N.T., BS 2134, 12.v.1974, ♂, SAMA, I 21, 155. *Paratypes:* Same data as holotype, 5, SAMA. Cutta Cutta Cave, N.T., 200 m from entrance, 5.xii.1983, W. D. Williams, 2, SAMA. Cutta Cutta Cave, Katherine, N.T. 13.ix.1973, A. Goede, 1, SAMA. Three Mile Cave, Katherine, N.T. 24.vi.1962, R. V. Southcott and N.T. Cave Exploration Group, 2, SAMA. Katherine, N.T., ½ mile from entrance to 16 Mile Cave, June 1962, 1, ANIC. Katherine, N.T., 16 Mile Cave, 12.iv.1963, W. Penman, 2, WAMA.

6. *Brises occidentalis*, n. sp.
(Figs 9, 18, 30)

Description: Mentum with postero-lateral grooves, not joining. Terminal antennal segment acuminate. Clypeus in somewhat lower plane than frons but not sharply delimited. Eyes about as wide as long, separated by a distance about equal to 4 eye widths. Head somewhat elongated behind eyes. Prosternum distinctly carinate before coxae, edges of prosternal process not raised. Pronotum 1.5-1.6 times as wide as long. Pronotal surface shagreened, with indistinct punctures and very small granules regularly spaced. Elytra each with two strong, nearly complete carinae and two indistinct ridges externally, intervals between them with sparse granules and punctures in irregular rows, without setae. Lateral edges of elytra markedly convex. Ratio of elytral length to width across bases 1.8-1.9:1. Hind wings fully developed. Largest hind spur equal to about ½ of length of metatarsus. Parameres making up about ¼ of total aedeagal length. No sexual dimorphism. Total length 19-22 mm.

Distribution and habitat: Known only from three localities in Western Australia situated between Meekatharra and the coast. One of the Wilgie Mia specimens bears the label "Found in cave".

Type: Weld Range, W.A., 2.iii.1963, A. Douglas, ♂, WAMA. *Paratypes:* Same data as holotype, 4, SAMA, WAMA. Mileura H.S. 4 mi W of, 8.xii.1966, W. H. Butler, 1, WAMA. Wilgie Mia W.A. (27 28 S 114 21 E), ix. 1961, D. Merilees, 2, WAMA. Ditto, 1963, A. Douglas, 3, WAMA. Ditto, 16.v.1973, M. Thomas, 1, SAMA.

7. *Brises parvicollis* (Blackburn)
(Figs 17, 31)

Ephidonius parvicollis Blackburn, 1895, p. 52.

Brises parvicollis, Carter, 1926, p. 151.

Description: Mentum with postero-lateral depressions, not meeting. Terminal antennal segment narrowed distally but bluntly rounded. Clypeus in lower plane than frons but not sharply delimited. Eyes large, longer than wide, separated by a distance equal to about 3 eye widths. Head surface finely, densely granulate and shagreened. Prosternum moderately ridged before coxae. Pronotum 1.5-1.7 times as wide as long. Pronotal surface shagreened with numerous very small granules. Elytra each with two sharp but fine, nearly complete carinae, and one or two indistinct ones laterally. Intervals between them shagreened, with distinct straight rows of small punctures and minute granules, without setae. Lateral edges of elytra markedly convex. Ratio of elytral length to width across bases 1.8-2.0:1. Hind wings fully developed. Longest hind spur equal to about ½ length of metatarsus. Parameres making up about ⅔ of total aedeagal length. No sexual dimorphism. Total length 17-22 mm.

Distribution and habitat: The few available records suggest one focus of distribution in the east central part of South Australia in low-lying areas and another in the mountains of the north-west corner and adjacent ranges of neighbouring states. This species has been collected from rabbit burrows on several occasions but is not known from caves and may be an open-ground forager like *blairi*. September to March.

Type: Lake Callabonna, S.A., A. Zietz, ♀, SAMA. There is no specimen by this name in BMNH. The one in SAMA is not marked type but it bears the name *Ephidonius parvicollis* in Blackburn's writing and the correct locality and collector, and has been designated as lectotype. Two other specimens with the same data are labelled co-types (that is, paratypes) in Blackburn's hand, and there are five others with the Zietz label, determined by A. M. Lea as co-types, all designated paralectotypes and all in SAMA.

Specimens examined (36): SOUTH AUSTRALIA. Agnes Creek Sta. ex pitfalls in rabbit burrows. Etadunna H.S., 15 km W of. Everard Ranges to Warburton Ranges. Glenmanyie Bore E of Lake Frome, ex rabbit burrows. Lake Callabonna. Lake Mulligan (possibly Mulligan Springs near Lake Callabonna). Lake Palankarinna (28 46 S 138 25 E), rabbit burrows. Moralana, 22 km NNW of, rabbit burrows. NORTHERN TERRITORY. Petermann Ranges, Hull R. 33 km ESE of Dorker R. Specimens are located in AMSA, ANIC, and SAMA.

8. ***Brises nullarboricus***, n. sp.

(Figs 6, 16, 21, 22, 32)

Description: Mentum with transverse ridges and lateral concavities. Terminal antennal segment broadly rounded. Clypeus in lower plane than frons, sharply set off by a step. Eyes with anterior edges oblique, a little longer than wide, separated by a distance equal to about 3 eye widths. Head surface densely granulate. Prosternum not ridged. Pronotum 1.6-1.7 times as wide as long. Pronotal surfaces densely granulate. Elytra each with two nearly complete carinae and one short humeral carina, rest of surface coarsely reticulo-punctate and granulate, the punctures and granules not in rows, without setae. Ratio of elytral length to width across bases 1.8-1.9:1. Hind wings fully developed. Longest hind spur equal to about ⅔ length of metatarsus. Parameres making up about ⅓ of total aedeagal length. Sexual dimorphism evident in shape of middle and hind femur, the hind margin of which is slightly expanded at base in the male. Total length 13-17 mm.

Distribution and habitat: Known only from the Nullarbor Plain, without habitat data.

Type: Nullarbor H.S., 7 km WSW of, S.A., 31 28 S 130 50 E, 11.ii.1978, D. C. F. Rentz and M. J. D. White, Stop 25, ♀, ANIC. *Paratypes:* Same data as holotype, 3, ANIC. Nullarbor H.S., S.A., 10.i.1960, P. Aitken, 1, SAMA. Kooringibbie (Well), S.A., 3, SAMA. 744 Mile Camp, East-West Railway, W.A., F. Mack, 1, SAMA. Fisher, East-West Railway, S.A., Troughton and Wright, 1, AMSA. Reid, 40 mi N of, W.A., 4.ii.1968, 59/3 A. M. Richards, 1, ANIC.

9. ***Brises trachynotoides*** Pascoe

(Figs 5, 10, 13, 14, 15, 19, 20, 33)

Brises trachynotoides Pascoe, 1869, p. 146, pl. xi, fig. 5; Carter, 1914, p. 46; Carter, 1926, p. 151.

Description: Mentum with indistinct postero-lateral depressions. Terminal antennal segment broadly rounded. Clypeus in same plane as frons. Eyes with anterior edges nearly transverse, wider than long, separated by a distance equal to about 2½ eye widths. Head surface vermiculate. Prosternum slightly ridged before coxae. Pronotum 1.6-1.9 times as wide as long. Pronotal surface vermiculate-granulate. Elytra each with two sharp, nearly complete carinae, no humeral carina, rest of surface reticulo-punctate and granulate, the punctures and granules not in rows, without setae. Ratio of elytral length to width across bases 1.6-1.8:1. Hind wings fully developed. Longest hind spur equal to about ⅔ of length of metatarsus. Parameres making up about ⅓ of total aedeagal length. Sexual dimorphism evident in shape of legs, the males having the hind margin of the middle and hind femora angularly expanded and all tibiae distinctly arcuate (straight in the female). Total length 10-17 mm.

Remarks: There is considerable variability both in size and shape in this species, the larger individuals having more explanate and sinuate pronotal margins.

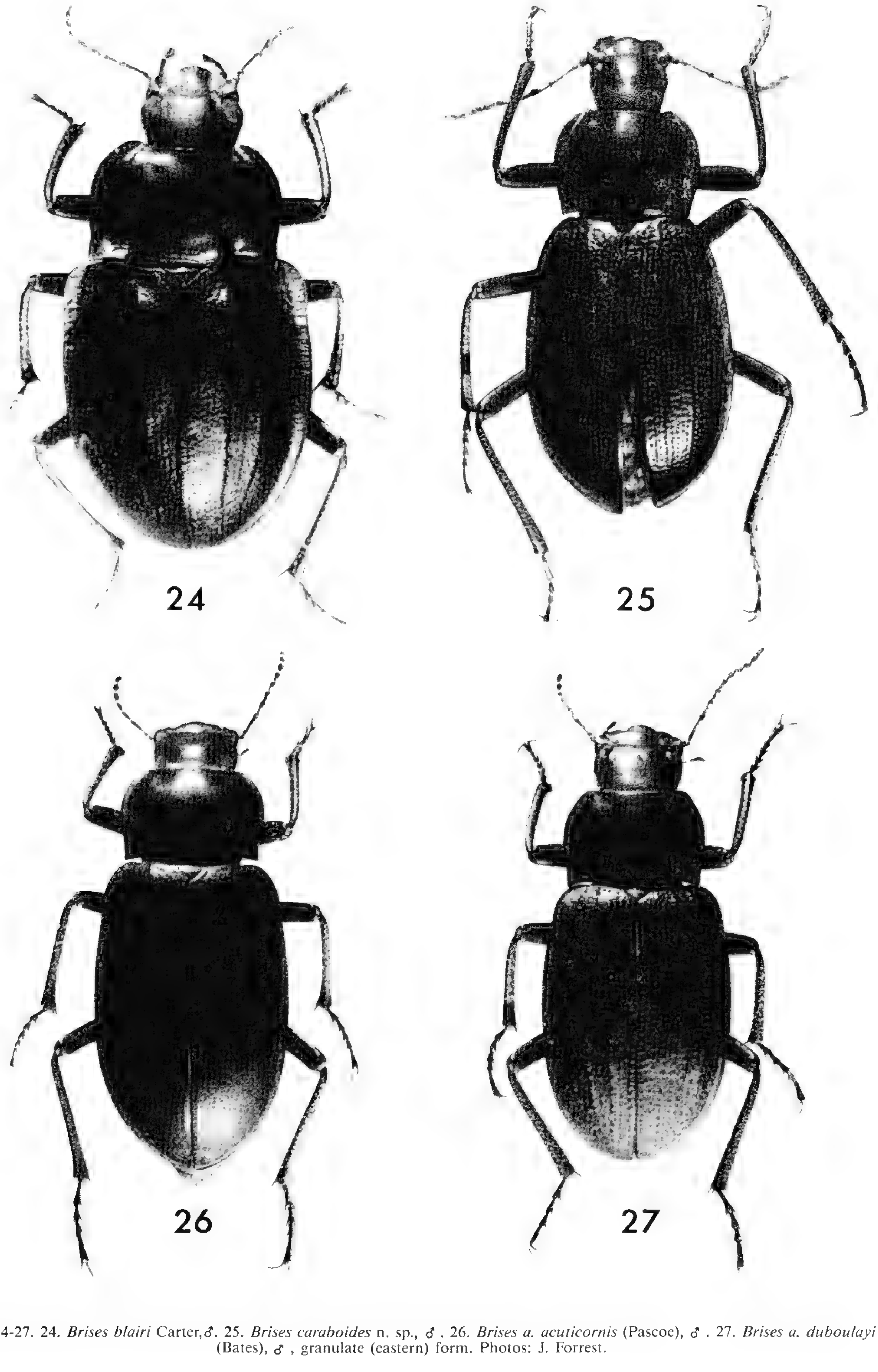
Distribution and habitat: A widespread species occurring in the northern half of South Australia, south-western Queensland, the south of the Northern Territory and all of Western Australia except the South West. It is not frequently encountered, however. Found in rabbit burrows, and there is one series from a cave on Barrow Island, W.A. August to May.

Type: Champion Bay, W.A., ♀, BMNH.

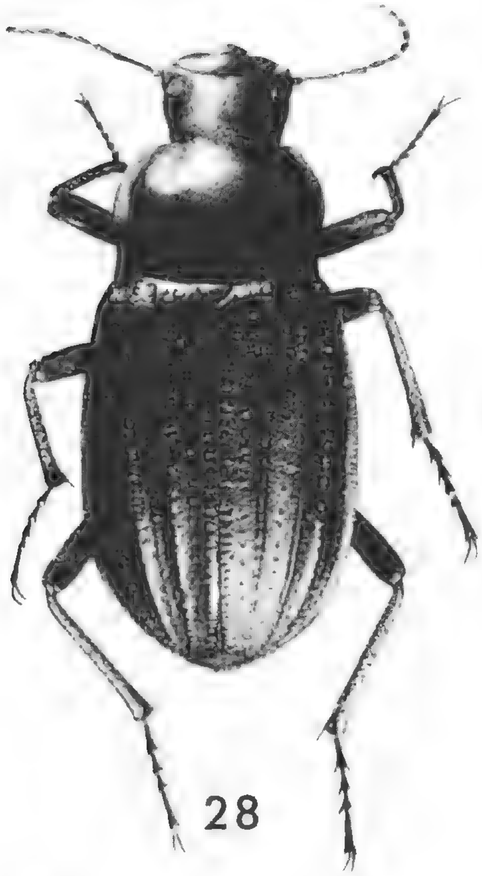
Specimens examined (52): SOUTH AUSTRALIA. Agnes Creek, ex pitfalls in rabbit burrows. Ediacara. Emu, 300 mi NW of Woomera. Everard Ranges to Warburton Ranges. Mt Finke, 40 km S of Malbooma H.S., ex rabbit warren. Purni Bore, Simpson Desert, 6 km WSW of, pit traps on sand ridge. Stuart Creek H.S., 10 km E of. Wynbring. QUEENSLAND. Cunnamulla. NORTHERN TERRITORY. Hermannsburg. Idracowra H.S., 5 mi N of, ex pit traps in rabbit burrows. MacDonnell Ranges. Petermann Ranges. WESTERN AUSTRALIA. Barrow I., cave N of Flacourt Bay. Forrest River District. Gill Pinnacle. Mural Crescent. King Sound. Kookynie. Mt Linden, 7.5 km NNW of. Specimens are located in ANIC, BMNH, QMBA, SAMA, and WAMA.

ACKNOWLEDGMENTS

I wish to thank the curators of the collections consulted for arranging loans of specimens, in particular Mr M. J. D. Brendell (British Museum), Mr G. Holloway (Australian Museum), Dr T. F. Houston (Western Australian Museum), Dr J. F. Lawrence (Australian National Insect Collection), Dr G. B. Monteith (Queensland Museum), and Dr A. Neboiss (Museum of Victoria, Division of Natural History and Anthropology).



FIGS. 24-27. 24. *Brises blairi* Carter, ♂. 25. *Brises caraboides* n. sp., ♂. 26. *Brises a. acuticornis* (Pascoe), ♂. 27. *Brises a. duboulayi* (Bates), ♂, granulate (eastern) form. Photos: J. Forrest.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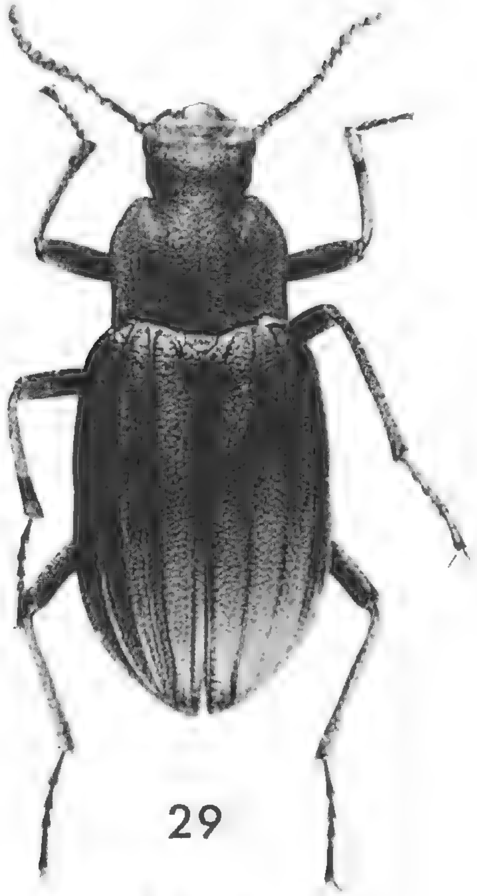
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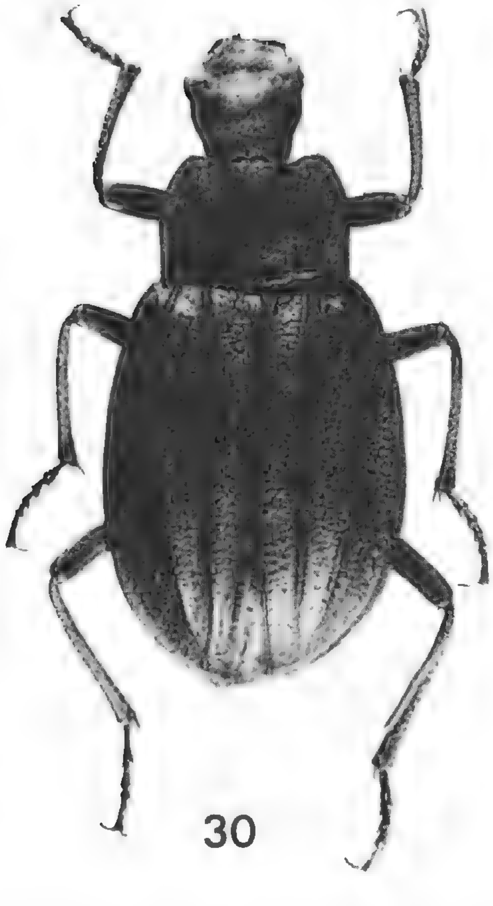
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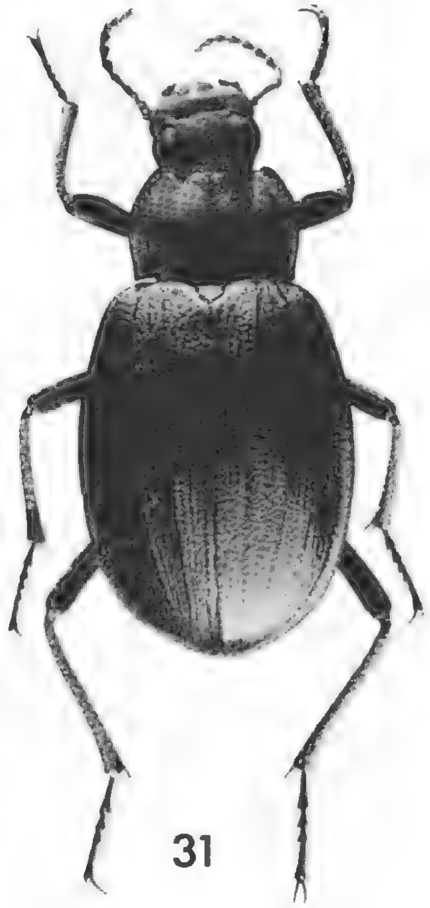
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FIGS. 28-31. 28. *Brises a. duboulayi* (Bates), ♂ , carinate (western) form. 29. *Brises katherinae* n. sp., ♂ . 30. *Brises occidentalis* n. sp., ♂. 31. *Brises parvicollis* (Blackburn), ♂ . Photos: J. Forrest.

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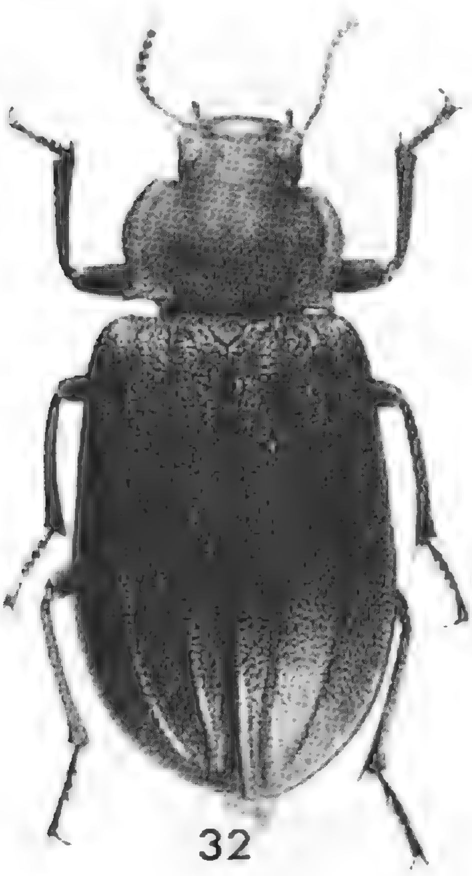

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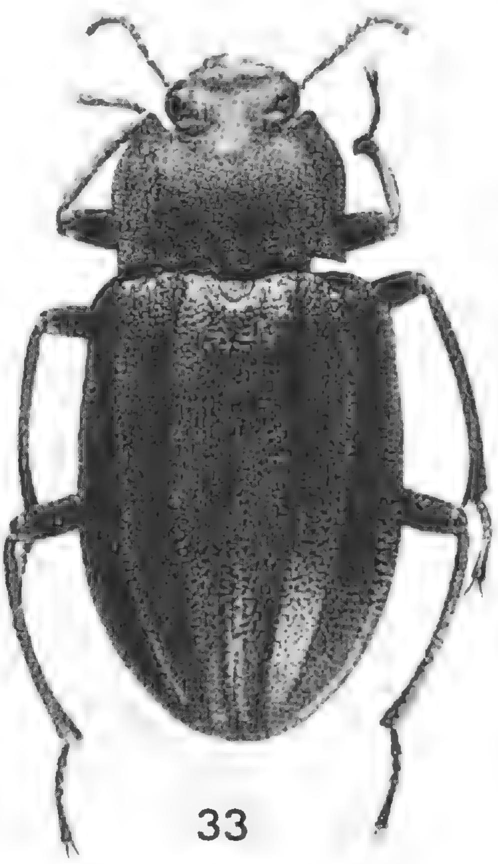

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FIGS. 32-33. 32. *Brises nullarboricus* n. sp., ♀. 33. *Brises trachynotoides* Pascoe, ♂. Photos: J. Forrest.

ADDITIONS TO THE COLLEMBOLAN FAUNA OF HEARD ISLAND

BY PENELOPE GREENSLADE

Summary

The fauna now consists of 8 species and 2 doubtful records. Friesea tilbrooki, Cryptopygus caecus, Cryptopygus tricuspis, Isotoma (Sorensia) punctata and Isotoma sp. indet. Are new records for the island, and the presence of Tullbergia bisetosa and Cryptopygus antarcticus antarcticus is confirmed. Tullbergia templei was described from Heard I. As was Friesea viennei which is here synonymised with Friesea tilbrooki, and Cryptopygus quadrioculatus is synonymised with C. tricuspis after examination of types. Records of Isotoma (Sorensia) subflava and Parisotoma octooculata from Heard I. Are no longer valid since they depend on incorrect identifications and Tullbergia antarctica and Cryptopygus antarcticus reagens are considered doubtful records. The fauna consists mainly of widely distributed species and there is no sign of endemism.

ADDITIONS TO THE COLLEMBOLAN FAUNA OF HEARD ISLAND

by

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(*Manuscript accepted 30 April 1985*)

ABSTRACT

GREENSLADE, PENELOPE 1986. Additions to the collembolan fauna of Heard Island. *Rec. S. Aust. Mus.* 19(7): 91-96.

The fauna now consists of 8 species and 2 doubtful records. *Friesea tilbrooki, Cryptopygus caecus, Cryptopygus tricuspis, Isotoma (Sorensia) punctata* and *Isotoma* sp. indet. are new records for the island, and the presence of *Tullbergia bisetosa* and *Cryptopygus antarcticus antarcticus* is confirmed. *Tullbergia templei* was described from Heard I. as was *Friesea viennei* which is here synonymised with *Friesea tilbrooki*, and *Cryptopygus quadrioculatus* is synonymised with *C. tricuspis* after examination of types. Records of *Isotoma (Sorensia) subflava* and *Parisotoma octooculata* from Heard I. are no longer valid since they depend on incorrect identifications and *Tullbergia antarctica* and *Cryptopygus antarcticus reagens* are considered doubtful records. The fauna consists mainly of widely distributed species and there is no sign of endemism.

INTRODUCTION

Heard I. is a small (43 km×19 km) ice-capped Antarctic island lying in the South Indian Ocean at 53°06′S, 77°30′E about 440 km SE of the Kerguelen Is and 4100 km WSW of Perth. Parts of the island are permanently glaciated and it is dominated by a quiescent volcano, Big Ben, which rises to 2745 m (Law and Burstall 1953; Horne 1984). Other areas near the coast and on headlands are free of ice and snow for some months of the year and support vegetation. Seven vascular plants have been recorded. Several collections of Collembola have been made from the island (Table 1). Wise (1970b) dealt with the fauna in detail and listed seven species while the most recent review is that of Deharveng (1981) who did not examine previous collections and gave three definite records and five doubtful identifications. A new collection of Collembola from Heard I. was found to contain two species not recorded before and this prompted an examination of material collected previously and a review of the faunal list. Identifications were made using Deharveng's (1981) keys, descriptions, figures and specimens identified by him unless indicated otherwise. Subspecies have been retained although this should not be taken as support by the author for the concept generally.

TABLE 1. SUMMARY OF COLLECTIONS OF COLLEMBOLA FROM HEARD ISLAND

Collection	Year	Records published by	Institution of Deposition
Deutsche Sud-Polar Expedition	1901-3	Vanhoffen 1908 Enderlein 1909	Berlin?
BANZARE (T. H. Johnston)	1929	Womersley 1937	SAMA
ANARE (K. G. Brown)	1951-2	Brown 1964	USPHTM
P. Temple	1965	Wise 1970b	ANIC (holotypes) BPBM
S. Tremont	1983	Tremont 1983 Greenslade this work	SAMA

The following abbreviations are used: AMNZ, Auckland Institute and Museum, New Zealand; ANIC, Australian National Insect Collection, Canberra; BANZARE, British, Australian and New Zealand Antarctic Research Expedition; BPBM, Bernice P. Bishop Museum, Honolulu, Hawaii; LDColl, Louis Deharveng Collection, University Paul Sabatier, Toulouse, France; NMNZ, National Museum of New Zealand, Wellington; SAMA, South Australian Museum, Adelaide; USPHTM, Department of Public Health and Tropical Medicine, Sydney University.

SYSTEMATICS

KEY TO HEARD ISLAND SPECIES

1 Thorax 1 carrying setae, not reduced, abdomen V and VI separate 2
Thorax 1 without setae, reduced, abdomen V and VI fused 5
2 White, ocelli absent, two spines posterodorsally on abdomen VI, grinding mandibular plate and pseudocelli present, furca absent 3
Grey, ocelli 3+3, 7–11 spines posterodorsally on abdomen VI, no grinding mandibular plate or pseudocelli, furca present .... *Friesea tilbrooki* Wise
3 Empodial appendage present with seta at least half as long as claw .... *Tullbergia bisetosa* Börner
Empodial appendage absent or rudimentary, lacking seta 4
4 Postantennal organ with 50 tubercles or less, small species, less than 1.5 mm long .... *Tullbergia templei* Wise
Postantennal organ with 80 tubercles or more, large species, more than 2 mm long .... *Tullbergia antarctica* Lubbock
5 White, ocelli and pigmented eye patch absent 6
Greyish or black, ocelli and pigmented eye patch present 7

6 Dens about 3 times longer than manubrium, with more than 15 anterior setae and more than 6 posterior setae, mucro with three teeth .... *Isotoma* sp. indet.
Dens about the same length as manubrium, with 9-13 anterior and 4-5 posterior setae, mucro with 5 teeth .... *Cryptopygus caecus* Wahlgren

7 Ocelli 2+2 or less, no clavate tenent hairs, mucro with 3 teeth 8
Ocelli 6+6, 2 clavate tenent hairs present on all legs, mucro with 2 teeth 9

8 White with sparse black speckles, ocelli 1+1, dens nearly 3× longer than manubrium with about 8 posterior and more than 50 anterior setae, body with long ciliated macrochaetae distally abundant about 4× longer than ordinary setae on abd V/VI, distal inner anterior margin of the manubrium with 1+1 spines with swollen bases ..... *Isotoma (Sorensia) punctata* Wahlgren
Grey, ocelli 2+2, dens with 5-6 posterior setae and 13-15 anterior setae, dorsal macrochaetae smooth and about 2× as long as ordinary setae on abdomen V/VI, distal inner anterior margin of the manubrium without spines .... *Cryptopygus tricuspis* Enderlein

9 Dens shorter than manubrium with 5 anterior setae and four posterior setae, mucro with two teeth, macrochaetae smooth and only about a third as long again as ordinary setae on abdomen V/VI .... *Cryptopygus antarcticus* Willem

i 5 (rarely 4) posterior subcoxal setae on fureal segment and 15-18 anterior sub-coxal setae, 11-18 posterior manubrial setae .... *Cryptopygus antarcticus reagens* Enderlein

ii 4 (rarely 5) posterior subcoxal setae on fureal segment and 8-14 anterior sub-coxal setae, 9+9 (range 8-10) posterior manubrial setae ....

Family NEANURIDAE

1. *Friesea tilbrooki* Wise 1970

=*Friesea viennei* Deharveng 1981 syn. nov.
(Figs 1, 2)

Type Locality: South Georgia.

Material Examined: Holotype: South Georgia, Busen Peninsula, Enten Bay, under rocks on beach, 7.xi.1963, H. D. Clagg, SG 28A, KWSG 216c (BPBM); Heard I., Mt Aubert de la Rue, grassy lawn, 26.ii.1941. Dr Vienne, KWHI 39, (Holotype of *Friesea viennei*) ?LDColl.; Macquarie I., various localities, 32 exs.

Wise (1970a) described *F. tilbrooki* from three specimens apparently with 10 anal spines collected on South Georgia. In 1981 Deharveng described *F. viennei* from Heard I. from a single specimen with seven anal spines. He mentioned that *F. viennei* was close to *F. tilbrooki* differing only in the number of anal spines and in having at least four sensory setae (soies s') on antenna IV compared to *F. tilbrooki*'s three. Re-examination of the type of *F. tilbrooki* shows that it possesses five sensory setae (Fig. 2) in this position and that in all other respects apart from the anal spines it is identical to Deharveng's description of *F. viennei*. The two paratypes of *F. tilbrooki* have recently been examined and possess 7 and 8 spines respectively on abdomen VI (K. Wise pers. comm.). *Friesea viennei* was described with a small tooth to the claw and although *F. tilbrooki* lacks this tooth according to Wise, a small tooth was observed by the present author on claws I and II of the *F. tilbrooki* holotype.

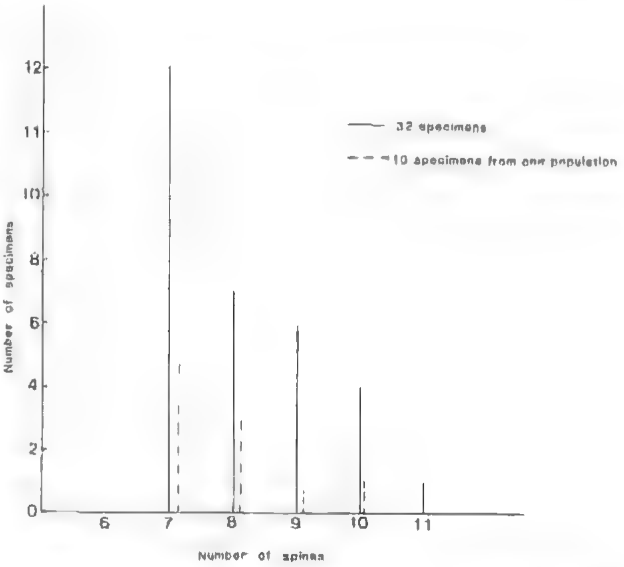

FIG. 1. Number of spines on abdomen VI found on *Friesea tilbrooki* Wise specimens from a number of localities on Macquarie I.

Morphological variation: Examination of a long series of specimens of *F. tilbrooki* from a single locality on Macquarie I. showed that the number of anal spines ranged from 7-11 in adults (Fig. 1) and that this variation had a similar distribution within a single population to that found for all specimens examined. A third of the specimens were asymmetric and seven was the most common number of spines with $a_1m_1m_2$ and p_0 always spinose. The holotype of *F. tilbrooki* from South Georgia had m_0 and a_3 spinose also (Wise 1970a, Fig. 2E); one of the paratypes was asymmetric. A single specimen from Macquarie I. had 11 spines (Fig. 2E). No correlation was found between age, size or sex of specimens and the number of anal spines. Bifurcate and double spines inserted in a single position were seen occasionally.

The sensory setae on antennae IV varied in size in adults. Occasionally individuals with 4 or 6 well developed sensory setae were found. The tooth on the claw was small and hard to distinguish. It appeared to be absent in some specimens and on some legs.

Other variation found in the Macquarie I. specimens was in the tenent hairs from fairly short to long and slightly clavate or bent at the tip. The length of the abdominal macrochaetae varied also and when longest they were slightly serrated and bent at the tip.

Deharveng mentions that *F. viennei* has a tendency to plurichaetocity and was asymmetric in its setal arrangement particularly on thorax II and abdomen IV. He compared its plurichaetocity to *Friesea fara* which was studied by Grow and Christiansen (1974).

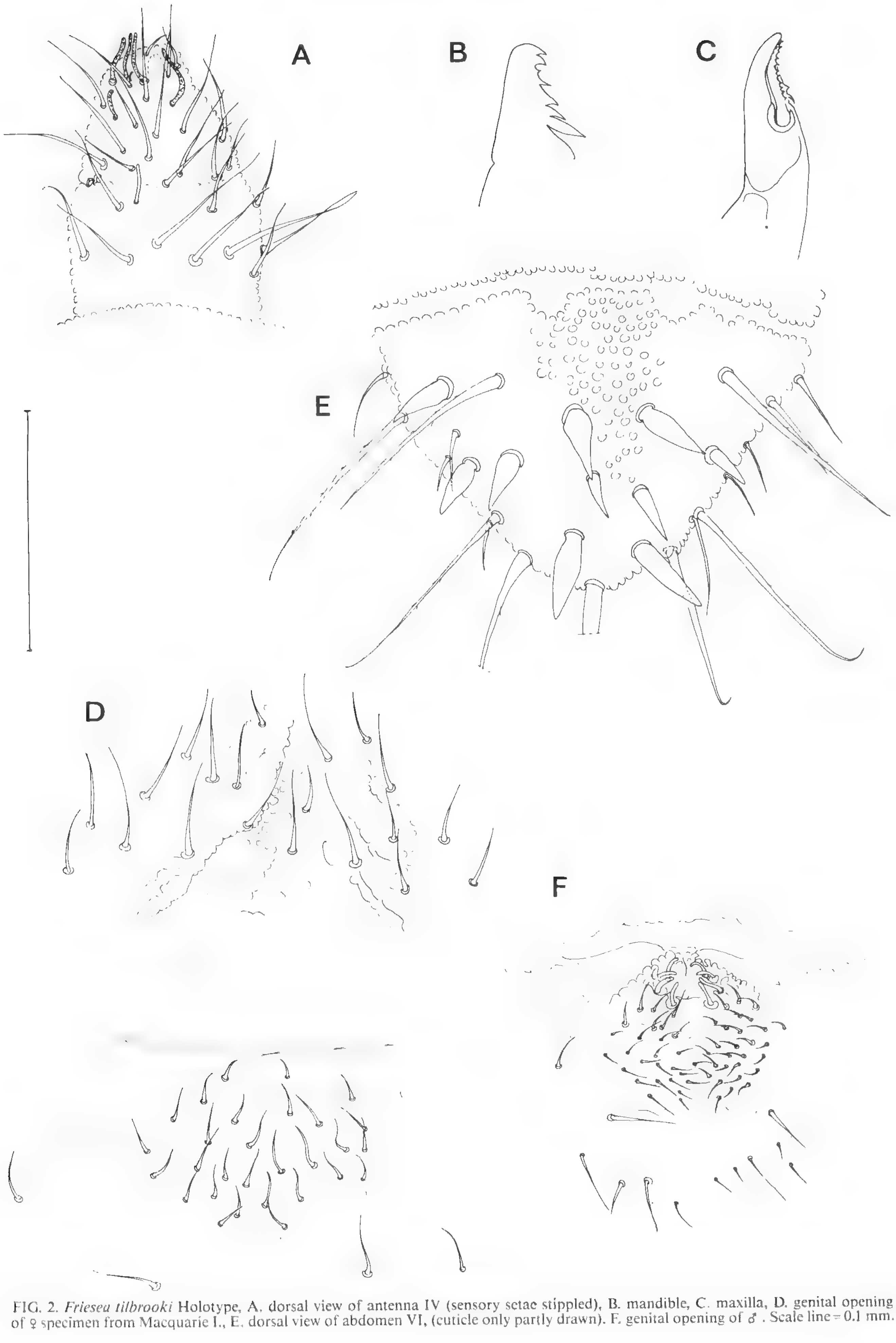

FIG. 2. *Friesea tilbrooki* Holotype, A. dorsal view of antenna IV (sensory setae stippled), B. mandible, C. maxilla, D. genital opening of ♀ specimen from Macquarie I., E. dorsal view of abdomen VI, (cuticle only partly drawn). F. genital opening of ♂. Scale line = 0.1 mm.

These authors noted that another species, *Friesea grandis*, had a "remarkable amount of setal variation" and that specimens were rarely symmetrical. Series of specimens of *F. tilbrooki* from Macquarie I. also showed much variation in setal number and arrangement.

TABLE 2. MORPHOMETRY OF *FRIESEA* SPECIMENS FROM HEARD ISLAND AND MACQUARIE ISLAND

I Macquarie I. Specimens

Number of specimens = 17

Ratio

A dorsal tenent hair III: Int. claw III = 1,062 mean $\sigma = .255$
95% C.I. 1,17, .95 range .75-1.45
$\gamma = .1153$

B Int. claw III: diam. oc A = 3.2 mean $\sigma = .9481$
95% C.I. 3.6, 2.8 range 2.1-5.7
$\gamma = .1484$

C anal spine p_0: Int. claw III = .811 mean $\sigma = .19$
95% C.I. .89, .73 range .56-1.4
$\gamma = .2950$

II Comparison of Ratios

	A	B	C
Holotype *F. viennei* (Heard I.) (according to Deharveng (1981))	1.25	3	7-9 (0.7-0.9)
Holotype *F. tilbrooki* (S. Georgia)	1.46	2.5	0.866
Macquarie I. specimens	1.06	3.2	0.811

Measurements of the dorsal tenent hair and internal claw length of leg III, diameter of ocellus A and anal spine p_0 were made and ratios of their lengths compared with those given by Deharveng (1981) for *F. viennei* (Table 2). Deharveng's value of 1.25 for ratio A (dorsal tenent hair: internal length of claw III), is higher than the mean found here but within the range of these observations. Ratio B (internal length of claw III: diameter of ocellus A) he gives as 3 and ratio C (anal spine: internal length of claw III) as 7-9. The latter figure is certainly a misprint for 0.7-0.9 which falls well within limits found here. This is good agreement considering the variation in size of different spines on a single animal and that Deharveng does not state which spine he measured.

In view of the measured variation within the Macquarie I. populations and known variation in other *Friesea* species (Grow and Christiansen 1974) I consider the specimens from Macquarie I., Heard I. and South Georgia to be conspecific.

No other southern hemisphere species of *Friesea* has the same combination of eye number (3+3), anal spines (7-11) and well developed furca. *Friesea multispinosa* Denis 1947 is nearest, described as having 14-15 spines (13 in Denis' figure), 3+3 ocelli and with a similar furca. Denis (1947) based his description on a single specimen from Kerguelen Island found in a similar littoral habitat in which *F. tilbrooki* is found. In view of the considerable variation in the number of abdominal spines of *F. tilbrooki* and its similarity to *F. multispinosa* in habitat, ocelli number and furca, it seems possible that it is a synonym of *F. multispinosa*. However until the holotype of *F. multispinosa* is examined no change of status of these two species is advisable.

Some additions to the description of *F. tilbrooki* are given below, although details given by Deharveng and by Wise, apart from those already corrected above, still stand.

Antenna IV: 5 well developed sensory setae (soies s), small organite and accessory sensory setae present, single apical bulb with slight suggestion of division.

Mouthparts: mandible with 7 teeth; maxilla with dentate lamella carrying about 12 teeth.

Genital Aperture: ♀ with up to 30 short setae and one pair on anterior lip of genital opening; ♂ with 4+4 broad round sensillae internally and about 50 short setae.

Chaetotaxy: abdomen VI with tendency towards plurichaetocity and asymmetry, $a_i m_i m_2 p_0$ (practically) always spinose, m_0 usually absent.

Comments on the biology of this species and details of Macquarie I. collections will be given in a later paper (Greenslade and Wise unpubl. results).

Distribution: Heard I., Macquarie I., South Georgia.

Family **ONYCHIURIDAE**

2. ***Tullbergia antarctica*** Lubbock 1876

Type Locality: Kerguelen I.

First recorded for Heard I. by Vanhoffen (1908) and Enderlein (1909). This record was noted by Salmon (1949), Brown (1964) and Wise (1970b) but it has not been recollected.

The specimens have not been found. This is a doubtful identification according to Deharveng (1981).

Distribution: Antarctica, Kerguelen I.

3. ***Tullbergia bisetosa*** Börner 1903

Type Locality: Kerguelen Is.

First recorded for Heard I. by Womersley (1937). This record was noted by Denis (1947), Salmon (1949), and Deharveng (1981). The species was recollected by Brown and by Tremont.

Material Examined: Heard I., Skua Beach, detritus under rocks, in *Azorella* and in rock crevices, 18.ii.1983, S. Tremont, 26 exs (SAMA); Atlas Cove, beneath *Poa* near elephant seal wallows, 20.ii.1983, S. Tremont, 50 exs (SAMA); Atlas Cove, beneath rocks, in *Azorella* near elephant seal wallows, 20.ii.1983, S. Tremont, 31 exs (SAMA); Heard I, BANZARE coll. 356, det. H. Womersley, 3 exs (SAMA); 31 slides (about 100 exs) K. G. Brown, no further data, (USPHTM).

Distribution: Kerguelen Is, Macquarie I., Heard I.

4. ***Tullbergia templei*** Wise 1970

Type Locality: Heard I.

Not recollected but record noted by Deharveng (1981).

Material Examined: Holotype: Heard I., S. Barrier, Cairn 5, 457 m, 8.ii.1965, P. Temple, (ANIC).

Distribution: at present only known from Heard I. and Macquarie I. (Greenslade & Wise unpubl. results). Deharveng (1981) recorded a species from the Kerguelen Is which he identified tentatively as *Tullbergia* cf. *templei*.

Family **ISOTOMIDAE**

5. ***Cryptopygus antarcticus antarcticus*** Willem 1901

Type Locality: Antarctica.

First recorded for Heard I. as *Cryptopygus antarcticus* by Womersley (1937) and recollected by Brown, Temple and Tremont.

Material Examined: Heard I., Atlas Cove, beneath *Poa* near elephant seal wallows, 20.ii.1983, S. Tremont, 2 exs, (SAMA); beneath *Azorella* on hillside, 1.12.1929, BANZARE coll. 349, det. H. Womersley, 3 exs (SAMA); 12 slides (about 20 specimens) K. G. Brown, no further data (USPHTM).

Distribution: Widespread in Antarctica and Subantarctic islands, ?New Zealand, ?Australia.

6. ***Cryptopygus antarcticus reagens*** Enderlein 1909

Type Locality: Crozet I.

First recorded for Heard I. by Vanhoffen (1908) and Enderlein (1909) as *Cryptopygus reagens* Enderlein. Not recollected although the record was noted by Brown (1964) and Wise (1970b). Deharveng (1981) considers this to be a probable misidentification for *C. a. antarcticus* Willem. The specimens have not been found.

Distribution: Crozet I., Possession I., Ile des Cochons.

7. ***Cryptopygus caecus*** Wahlgren 1906

Type Locality: South Georgia.

First collected from Heard I. by Tremont.

Material Examined: Heard I., Skua Beach, detritus under rocks near *Azorella* and in rock crevices, 18.ii.1983, S. Tremont, 38 exs (SAMA); Atlas Cove, beneath *Poa* grass near elephant seal wallows, 20.ii.1983, S. Tremont, 5 exs (SAMA).

Distribution: widespread in S. America, Australia, New Zealand, Subantarctic islands and Antarctica.

8. ***Cryptopygus tricuspis*** Enderlein 1909

= *Parafolsomia quadrioculata* Wise 1970

= *Cryptopygus quadrioculatus* Wise 1974 nec (Rapoport 1963), nec (Martynova 1967)*

* The two different species described by Rapoport and Martynova and named *Isotomina quadrioculata* were automatically transferred to the genus *Cryptopygus* when *Isotomina* was synonymised with *Cryptopygus* by Massoud and Rapoport (1968).

Type Locality: Kerguelen Is.

First collected from Heard I. by Tremont.

Material Examined: Heard I., Atlas Cove, beneath *Poa* grass near elephant seal wallows, 20.ii.1983, S. Tremont, 2 exs (SAMA); Atlas Cove, beneath rocks near *Azorella*, 20.ii.1983, S. Tremont, 1 ex (SAMA).

Deharveng (1981) notes that *C. tricuspis* from Kerguelen I. and Wise's *C. quadrioculatus* from South Georgia are very close except that *C. quadrioculatus* has only 9 'ventral' (anterior) setae on the dens and that according to Wise's text the species seemed not to have differentiated macrochaetae on the thorax or abdomen except at the extreme posterior end of the body. Examination of the holotype of *Parafolsomia quadrioculata* showed that both dentes carried 13 anterior and 6 posterior setae. Macrochaetae were present as follows; on thorax II 1, thorax III 1, abdomen I 3, II 3, III 2+empty sockets and IV 3+empty sockets. This pattern conforms with that given by Deharveng. The macrochaetae seem to be easily detached. A paratype carried 12+5 and 13+5 setae on the dentes. Other details of chaetotaxy were as follows:

Numbers of setae

	C. tricuspis det Deharveng	*P. quadrioculata* Holotype	*P. quadrioculata* Paratype
Manubrium	13-15	?	13
Furcal subcoxa			
Anterior	13-20	14, 17	17, 21
Posterior	4-6	5, 6	6, 6

In all other respects the holotype and a paratype of *Parafol-somia quadrioculata* agree with the description given by Deharveng (1981) for *C. tricuspis*, and I therefore consider them conspecific.

Distribution: Kerguelen Is., Crozet I., Marion I., South Georgia, Heard I.

9. ***Isotoma (Sorensia) punctata*** Wahlgren

Type Locality: Tierra del Fuego.

Material Examined: Heard I., "from damp situation", 1.xii.1929, BANZARE Coll 356, 1 example, labelled *Isotoma octo-oculata* Willem, det. H. Womersley; Heard I., Poly Gully, from dove prion's (*Pachyptila desolata*) nesting material, 8.ii.1965, P. Temple KWH121, about 19 exs (BPBM); 2 slides (3 exs) K. G. Brown, (labelled *Parisotoma octo-oculata*), no further data, (USPHTM).

This species was recorded by Womersley (1937) and Brown (1964) as *Isotoma octooculata* Willem 1901. Wise (1970b) recorded Temple's specimens as *Sorensia subflava* Salmon (now *Isotoma (Sorensia) subflava* according to Deharveng (1981)). Material has been compared with the holotype of *I. (S) subflava* and found to differ from it in a number of characters of specific importance; i.e. sensory setae on abdomen V and VI, and chaetotaxy of the manubrium. Specimens are similar to *I. (S) punctata* in these characters and are identified as this species. A revision of the genus is in preparation.

Distribution: Tierra del Fuego, Crozet I., Possession I., Argentina, Heard I. (all other records of this species require verification).

10. *Isotoma (Parisotoma) octooculata* Willem 1901

Type Locality: Antarctica.

This species was determined by Womersley (1937) and Brown (1964). Both Womersley's and Brown's specimens are now found to belong to *I. (S) punctata* (see above). Wise (1970b) noted the species record but Deharveng (1981) considers the record of this species doubtful. There is clearly now no evidence to suggest it is present on Heard I

Distribution: Antarctica only (all records of this species from Subantarctic islands, such as South Georgia (in Wise 1970a), require re-examination).

11. *Isotoma* sp. indet.

Material Examined: Heard I., Poly Gully, Winston Lagoon, P. Temple, 2.ii.1965, KWH12, 3 exs (BPBM).

These three specimens were identified by Wise (1970b) as *Sorensia subflava.* They are in poor condition and it is not possible to determine them further than to genus. They are unlikely to be *I. (P) octooculata* since the postantennal organ and chaetotaxy of the manubrium differ from those of that species. Similarly the structure and chaetotaxy of the manubrium differ from *I. (S) punctata.*

DISCUSSION

Of the eight species definitely recorded, six occur widely on Subantarctic islands and the seventh, *T. templei* occurs on Macquarie I. as well as Heard I. (Greenslade & Wise unpubl. results). One species is of unknown distribution. No island endemism was detected. Deharveng (1981) noted some island endemism for the Kerguelen Is, but the fauna of these islands is richer in species, and the islands are larger in area and further north. However the fauna of Macquarie I. with 22 species also shows little island endemism (Greenslade and Wise unpubl. results) and it is at about the same latitude and of the same size as the Kerguelens and near the rich source area of the Auckland and Campbell Islands.

A large amount of morphological variation, particularly in chaetotaxy, was found in these Subantarctic species. Other invertebrates from polar regions have been found to exhibit a high degree of variability (Downes 1965). It has been suggested by Greenslade (1983) that this is because these faunas are subject to A selection where relaxation of constraints on conservative morphology occurs. Whether the variation documented here is due to a genuine divergence of lineages on different islands, or to relaxation of selection pressures or even to the founder effect can probably only be determined by breeding, cytological or biochemical techniques.

ACKNOWLEDGMENTS

I would particularly like to thank K. A. J. Wise of the Auckland Institute and Museum for much help of various kinds during the preparation of this paper and for critically reviewing the manuscript and also for the loan of specimens. Thanks are also due to Dr R. G. Ordish, National Museum, Wellington, Professor J. Brian of the University of Sydney's Department of Public Health and Tropical Medicine, L. Deharveng, University Paul Sabatier, Toulouse, and the Bernice P. Bishop Museum for the loan of specimens and to the British Trans-Antarctic Fund for financial support.

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MOLLUSC TYPE-SPECIMENS IN THE SOUTH AUSTRALIAN MUSEUM.
3. POLYPLACOPHORA

BY W. ZEIDLER AND K. L. GOWLETT

Summary

The South Australian Museum collection of chiton types is the largest in the Southern hemisphere. It contains primary type material, and some secondary types, of 123 species, subspecies or varieties. A further 15 species are represented only by secondary types. The type status of at least 11 of the primary types is considered very doubtful or, in the case of neotypes, invalid. Listed in an appendix are an additional 21 specise represented by types of dubious status from the Dupuis collection. Species are listed alphabetically according to the original name of the genus or species.

MOLLUSC TYPE-SPECIMENS IN THE SOUTH AUSTRALIAN MUSEUM. 3. POLYPLACOPHORA

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(*Manuscript accepted 6 February 1985*)

ABSTRACT

ZEIDLER, W., and GOWLETT, K. L. 1986. Mollusc type-specimens in the South Australian Museum. 3. Polyplacophora. *Rec. S. Aust. Mus.* 19(8): 97-115.

The South Australian Museum collection of chiton types is the largest in the Southern hemisphere. It contains primary type material, and some secondary types, of 123 species, subspecies or varieties. A further 15 species are represented only by secondary types. The type status of at least 11 of the primary types is considered very doubtful or, in the case of neotypes, invalid. Listed in an appendix are an additional 21 species represented by types of dubious status from the Dupuis collection. Species are listed alphabetically according to the original name of the genus or species.

INTRODUCTION

Most of the chiton types in the South Australian Museum are due to the early work of W. G. Torr and E. Ashby at the turn of the century, particularly Ashby who continued his active interest in chitons well into the 1930s.

Ashby donated his collection of chitons, including most of the types of Torr, to the South Australian Museum in 1932, but he continued to borrow material freely for his research. In 1934 Ashby's home at Blackwood in the Adelaide Hills was destroyed by fire and some type material of chitons and birds was lost. As there are no accurate records of the material on loan to Ashby at the time of the fire, one must assume that any Ashby or Torr types, listed in the literature as being in the Ashby or Torr collection, and which cannot now be located in an Australian museum were destroyed at that time.

Ashby also acquired a small collection of chitons from Commandant Paul Dupuis, once conchologist at the Museum Royal d'Histoire Naturelle de Belgique, Brussels, including some important historical and probable type material of Blainville, D'Orbigny, Quoy and Gaimard, Rochebrune, Jousseaume and Dupuis. The Dupuis collection is not well curated and original labels are often missing. Types have been indicated by a small label "TYPE" in red print glued to the label with the specimen and appears to be a later addition. As the type status of most of these specimens is very doubtful they have not been included in the main part of the following list but are listed separately in an appendix.

Other chiton types in the South Australian Museum came from the May collection, acquired by J. C. Verco and presented to the museum in 1929, and as a result of studies by Cotton, mostly in conjunction with Ashby, Godfrey and Weeding. Since Cotton and Godfrey (1940) little of consequence has been published on Australian chitons and type material of only one species, *Lucilina tilbrooki* Milne, 1958 (a paratype), has been added to the collection.

In their monograph on South Australian chitons, Cotton and Godfrey (1940) and also Cotton (1964) selected neotypes for South Australian Bednall and Matthews species on the basis of Ashby (1918) who recounts the loss of Bednall and Matthews types at sea. However they failed to verify which types were lost as at least some of the original type material (syntypes) of Bednall is known to exist (Davis *et al.* 1979). Similarly, neotypes were also designated for other species where the type was presumed lost. We believe that in most cases these neotypes were designated in a somewhat arbitrary manner, the possible existence of type material was not sufficiently investigated and there were no further statements regarding the specimens, other than the locality and that they had been designated as neotypes and given museum registration numbers. We therefore regard all of the neotypes selected by Cotton and Godfrey (1940) and Cotton (1964) and listed here, with the possible exception of *Acanthochites tatei* Torr & Ashby, 1898, as invalid.

We further believe that the South Australian Museum collection of chiton types is the largest in the southern hemisphere and one of the more significant collections in the world. It includes type material for 138 species or subspecies (excluding the Dupuis collection) and the type status of only 11 is in doubt or, in the case of neotypes, considered invalid, the remainder have been verified by us according to available material and information. A further 21 species are represented by types of dubious status in the Dupuis collection.

In the following list species are arranged alphabetically in families under the original name at the time of description. Changes in familial status have been cross-referenced. The present status of each species is, unless indicated otherwise, according to Kaas and van Belle (1980). The specimens are all dry except for some of the paratypes of *Ischnochiton johnstoni* and *I. mawsoni* and are listed as "entire" when the articulated valves and girdle are present or as "entire with animal" when the dried animal is also present.

The following abbreviations are used in the text. AIM=Auckland Institute and Museum, New Zealand; AM=The Australian Museum, Sydney; ANSP=Academy of Natural Sciences of Philadelphia, U.S.A.; BANZARE=British, Australian and New Zealand Antarctic Research Expedition, 1929-31; MCZ=Museum of Comparative Zoology, Harvard University, U.S.A.; MNHN=Museum National D'histoire Naturelle, Paris; NMNZ=National Museum of New Zealand; MV=Museum of Victoria; N.S.W.=New South Wales; N.Z.=New Zealand; Qld.=Queensland; QM=Queensland Museum; S.A.=South Australia; SAM=South Australian Museum; Tas.=Tasmania; TM=Tasmanian Museum and Art Gallery; W.A.=Western Australia; WAM=Western Australian Museum.

Family **ACANTHOCHITONIDAE**

Genus *Acanthochites* Risso, 1826

Acanthochites cornutus Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 217, pl. 6, fig. 3a-f.
=*Craspedochiton cornutus* (Torr & Ashby, 1898).
Holotype: D12188, 5 articulated median valves and associated girdle, from Marino, near Adelaide, S.A., at low tide, collected by E. Ashby, date of collection unknown.
Note: Rest of type presumed lost. Type unique.

Acanthochites crocodilus Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 216, pl. 6, fig. 2a-f.
=*Notoplax crocodilus* (Torr & Ashby, 1898)
Holotype: D12137, posterior valve, one median valve and several fragments of valves and girdle, from Marino, near Adelaide, S.A., collected by W. G. Torr, date of collection unknown.

Paratype: D12195, entire specimen with animal with same collection data as holotype, labelled "cotype".

Acanthochites exilis Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 218, pl. 7, fig. 6a-f.
=*Craspedochiton cornutus* (Torr & Ashby, 1898)
Holotype: D12251, posterior valve and 3 disarticulated median valves, from Spencer Gulf or Investigator Strait, S.A., dredged by J. C. Verco in 10-15 fathoms, date of collection unknown.
Note: Rest of type presumed lost.

Acanthochites jucundus Rochebrune, 1882
Bull. Soc. Philom. Paris Ser. 7, **6**: 194.
=*Acanthochitona jucunda* (Rochebrune, 1882)
Holotype: D12267, 1 median valve only, from New Holland, collected by Belligny, date of collection unknown.
Note: According to Ashby (1926) this valve came from the holotype and was given to him by Dr Lamy. Recent enquiries indicate that the rest of the type cannot be located in MNHN although Ashby (1922) apparently saw the type and says "there are a number of specimens in spirit ---- all much worn".

Acanthochites kimberi Torr, 1912
Trans. R. Soc. S. Aust. **36**: 167, pl. 6, fig. 5a-f.
=*Acanthochitona kimberi* (Torr, 1912).
Neotype: D13758, entire specimen with animal, from Aldinga, near Adelaide, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 522, fig. 515).
Syntypes: D12220, 3 entire specimens with animal, from Corny Point, Yorke Peninsula, S.A., collector and date of collection unknown. D12221, 2 entire specimens with animal and a median, posterior and anterior valve, from Kangaroo Island, S.A., collector and date of collection unknown. D12227, entire specimen with animal, stuck on card with other specimens from various localities—since removed, from Port Noarlunga, S.A., collector and date of collection unknown.

Note: In the presence of syntypes a neotype should not have been erected. The type status of D12220 and particularly D12227 is very doubtful as the locality data do not match the original description which was based on 4 specimens from Aldinga and Kangaroo Island. However, D12220 and D12221 has the label "Type CO-59" which corresponds to the number of the species in the publication, indicating that these specimens may have been part of the original material. D12221 also has a label which says "cotypes type to be selected". Therefore these are almost certainly syntypes. The loose valves with D12221 could have come from the specimen illustrated by Torr and thus the intended type, although Torr apparently intended the specimen collected by Kimber from Aldinga to be the type. None of the above specimens are as large as 10×4 mm which is a measurement given by Torr and it must be presumed that this specimen has been lost.

Acanthochites (Loboplax) mariae Webster, 1908
Trans. Proc. N.Z. Inst. **40**: 254, pl. 20, figs 1-11.
=*Notoplax mariae* (Webster, 1908).
Paratype: D11108, median valve 4, girdle fragment, and radula, without collection data.
Note: With label "valve from Webster's paratype". Webster apparently did not designate paratypes although he mentions at least 7 specimens in addition to the type. Type in AIM (TM-1).

Acanthochites matthewsi Bednall & Pilsbry, 1894
Nautilus 7 (10): 120.
=*Notoplax (Bassethullia) matthewsi* (Bednall & Pilsbry, 1894).

Neotype: D13741, entire specimen with animal, from Sultana Bay, Yorke Peninsula, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 536, fig. 534).
Note: Iredale and Hull (1925b) selected a neotype for this species presuming the type to be lost (probably AM, C10411). Cotton and Godfrey (1940) unaware of this selected yet another neotype. However, according to Davis *et al.* (1979) the holotype is in ANSP (Shell Cat. No. 64916). We therefore consider both neotypes invalid.

Acanthochites maughani Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 218, pl. 7, fig. 5a-f.
=*Acanthochitona pilsbryi* (Sykes, 1896).
Holotype: D12264, 5 articulated median valves with remains of girdle and animal, plus one loose median valve, from Victor Harbor (Port Victor), S.A., collected by M. M. Maughan, date of collection unknown.
Note: Rest of type presumed lost.

Acanthochites rubrostratus Torr, 1912
Trans. R. Soc. S. Aust. **36**: 169, pl. 7, fig. 7a-f.
=*Notoplax rubrostrata* (Torr, 1912).
Holotype: D13717, entire specimen with animal, from St Francis Island, Nuyts Archipelago, S.A., collector and date of collection unknown.
Paratype: D16020, entire specimen with animal, from Corny Point, Yorke Peninsula, S.A., collector and date of collection unknown.
Note: A label with the holotype says "valves figured pl.vii have been lost". The type status of D16020 is in doubt as Torr (1912) only lists specimens from St Francis Island and Henley Beach; however a label with the specimen says "CO-TYPES 61" which corresponds to the number of the species in the publication.

Acanthochites rufus Torr, 1912
Trans. R. Soc. S. Aust. **36**: 167, pl. 6, fig. 4a-f.
=*Craspedochiton variabilis* (Adams & Angas, 1864).
Holotype: D12208, entire specimen with part of animal, from Kangaroo Island, S.A., collector and date of collection unknown.
Note: Type unique.

Acanthochites subviridis Torr, 1911
Trans. R. Soc. S. Aust. **35**: 104, pl. 25, fig. 3a-f.
=*Notoplax subviridis* (Torr, 1911).
Holotype: D12872, 4 articulated median valves with girdle and animal, plus the 4 remaining valves disarticulated, from Rabbit Island, Albany, W.A., presumably collected by Torr, Christmas, 1910-11.
Paratype: D14490, entire specimen with animal, with same collection data as holotype and labelled "co-type".

Acanthochites tatei Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 219, pl. 7, fig. 7a-f.
=*Acanthochitona granostriata* (Pilsbry, 1894).
Neotype: D13732, entire specimen with animal, from Middleton, Encounter Bay, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 527, fig. 523).
Note: The neotype was selected from a lot from the Torr collection (D12260) with the label "our type of *Acan. tatei* was very diminutive and was ruined in dissecting. These are from the same spot . . .".

Acanthochites tristis Rochebrune, 1882
Bull. Soc. Philom. Paris Ser 7, **6**: 194.
=Nom. inquir.
Holotype: D12269, 1 median valve only, from New Holland collected by Dussumier, date of collection unknown.
Note: According to Ashby (1926) this valve came from the holotype and was given to him by Dr Lamy. Rest of type in MNHN.

Acanthochites verconis Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 217, pl. 6, fig. 4a-f.
=*Notoplax verconis* (Torr & Ashby, 1898).
Holotype: D12201, 3 articulated median valves with fragments of girdle and animal, plus fragments of the posterior valve and median valves, from Gulf St Vincent, S.A., dredged by J. C. Verco, date of collection unknown.
Note: Anterior valve presumed lost. Kaas and van Belle (1980) regard this species as a synonym of *Notoplax wilsoni* (Sykes, 1896) however, one of us (K.L.G.) has examined this species in detail and regards it a valid species.

Genus *Acanthochiton* Gray, 1821 em. Iredale, 1915.

Acanthochiton bednalli var *johnstoni* Ashby, 1923
Trans. R. Soc. S. Aust. **47**: 231.
=*Acanthochitona bednalli* (Pilsbry, 1894).
Holotype: D12185, entire specimen, from Carnarvon, Shark Bay, W.A., collected by W. C. Johnston, date of collection unknown.
Note: Kaas and van Belle (1980) follow Cotton and Weeding (1939) who elevate this variety to specific rank, however, one of us (K.L.G.) has examined this species in detail and regards it as a deep-water form of *A. bednalli*.

Acanthochiton brookesi Ashby, 1926
Proc. Malac. Soc. Lond. **17**(1): 14, pl. 1, fig. 3a-c, pl. 2, fig. 7
=*Acanthochitona brookesi* Ashby, 1926.
Holotype: D11025, 5 disarticulated median valves and girdle fragments from Auckland Harbour, N.Z., collected by H. Suter, date of collection unknown.
Paratype: D11031, entire specimen without girdle, with same collection data as holotype.
Note: Remainder of holotype in AIM (TM-2).

Acanthochiton gatliffi Ashby, 1919
Trans. R. Soc. S. Aust. **43**: 398, pl. 42, figs 2-5.
=*Acanthochitona gatliffi* Ashby, 1919.
Holotype: D12189, 2 median valves, a valve fragment, remains of girdle and animal, from Port Lincoln, S.A., collected by E. Ashby, Jan. 1917.
Note: Rest of type presumed lost.

Acanthochiton heterochaetus Bergenhayn, 1931
Arkiv. Zool. **23A** (13): 20, pl. 1, figs 38-42, pl. 3, figs 67-74.
=*Acanthochitona gracilis* (Jeffreys, 1859).
Syntype: D16185, entire specimen with animal but with anterior valve missing, from off La Luz, Gran Canaria, Canary Islands, dredged in 100 m on red algae by N. Odhner, 1930.
Note: Bergenhayn (1931) records 17 specimens but apparently did not designate a holotype. Our specimen is labelled "cotyp".

Acanthochiton kimberi yallingupensis Ashby, 1925
Rep. Aust. Assoc. Adv. Sci. **17**: 382.
=*Acanthochitona kimberi* (Torr, 1912).
Holotype: D13718, entire specimen with animal, from Yallingup, W.A., collected by E. Ashby, 23.x.1920.

Acanthochiton macrocystialis Ashby, 1924
Trans. R. Soc. S. Aust. **48**: 324, pl. 31, figs 3, 3a.
=*Acanthochitona macrocystialis* Ashby, 1924.
Holotype: D12248, 5 articulated median valves with remains of girdle, plus disarticulated anterior, posterior and median valve, from Point Puer, near Port Arthur, Tas., amongst holdfasts of *Macrocystis pyrifera*, collected by E. W. Mawle, date of collection unknown.
Paratypes: D10704, one entire specimen with same collection data as holotype. D12563, one entire specimen, one lot of 6 disarticulated median valves and one lot of 3 disarticulated median valves together with 2 anterior and one posterior valves, all with the same collection data as holotype.
Note: The label with D12563 indicates that the paratype measuring 20×9 mm was sent to Thackway.

Acanthochiton maxillaris Ashby, 1919
Trans. R. Soc. S. Aust. **43**: 397, pl. 41, figs 5 & 6, pl. 42, fig. 1.
=*Acanthochitona kimberi* (Torr, 1912).
Holotype: D12253, 4 median valves and anterior valve articulated with girdle, plus one loose median valve, from Marino, near Adelaide, S.A., on rocks at low tide, collected by E. Ashby, date of collection unknown.
Note: Rest of type presumed lost. Type unique.

Acanthochiton pilsbryi maughaneanus Ashby, 1919
Trans. R. Soc. S. Aust. **43**: 395, pl. 41, fig. 4.
=*Acanthochitona pilsbryi* (Sykes, 1896).
Holotype: D15536, 3 disarticulated median valves, anterior valve and valve fragments and remains of girdle, from Middle Harbour, Sydney, N.S.W., collected by E. Ashby, 6.x.1903.
Note: Rest of type presumed lost.

Acanthochiton (Notoplax) porcina Ashby, 1919
Trans. R. Soc. S. Aust. **43**: 395, pl. 41, figs 7-10.
=*Notoplax (Bassethullia) matthewsi* (Bednall & Pilsbry, 1894).
Holotype: D12250, specimen in two pieces with articulated median valves and remains of girdle and animal, plus disarticulated anterior, posterior and one median valve, from Gulf St Vincent, S.A., dredged by J. C. Verco, date of collection unknown.
Note: Type unique.

Acanthochiton retrojectus var. *pustulosus* Ashby, 1922
Trans. R. Soc. S. Aust. **46**: 15.
=*Acanthochitona retrojecta* (Pilsbry, 1894).
Holotype: D12205, entire specimen with animal, from Quarantine Station, Sydney Harbour, N.S.W., collected by E. Ashby, Nov. 1918.

Acanthochiton shirleyi Ashby, 1922
Trans. R. Soc. S. Aust. **46**: 13, pl. 3, fig. 2a-c
=*Acanthochitona shirleyi* Ashby, 1922.
Paratype: D10715, disarticulated valves stuck on card, from Northwest Reef, Capricorn Group, Qld., collector and date of collection unknown.
Note: Type in QM (MO 4043).

Acanthochiton (Notoplax) spongialis Ashby, 1923
J. Roy. Soc. W. Aust. **10**(4): 13, pl. 1, fig. 1.
=*Notoplax spongialis* (Ashby, 1923).
Holotype: D13733, entire specimen from D'Entrecasteaux Channel, southern Tas., dredged in 9-10 fathoms by W. L. May, date of collection unknown.
Note: Cotton (1964) indicated that this specimen may not be the holotype presumably because it does not match the measurements given (38×16 mm for D13733; 38×18 mm given for the type) and does not appear to match the rather poor photo of the type. However, SAM seems to have the other 3 specimens mentioned by Ashby (D12803 and D14471) and as none approach the dimensions of the type, and in the absence of evidence to the contrary, we must assume that D13733 is the holotype.

Acanthochiton thackwayi Ashby, 1924
Trans. R. Soc. S. Aust. **48**: 318, pl. 31, figs 1 & 2.
=*Acanthochitona thackwayi* Ashby, 1924.
Holotype: D10716, entire specimen with animal, from Fly Point, Port Stephens, N.S.W., collected by E. Ashby, October, 1923.
Paratype: D16548, entire specimen with animal, from same locality as holotype, collected by A. E. J. Thackway, date of collection unknown.
Note: Smith and Robertson (1970) list 2 paratypes in the MV (F16376) with the locality as Shell Harbour.

We regard these specimens as very doubtful paratypes as Ashby only mentioned one other specimen which is the paratype in SAM.

Acanthochiton turtoni Ashby, 1928
Proc. Malac. Soc. Lond. **18**(2): 79, pl. 6, figs 1-4.
=*Acanthochitona garnoti* (Blainville, 1825).
Holotype: D10985, 5 disarticulated median valves and girdle fragment, from Port Alfred, South Africa, collected by W. H. Turton, date of collection unknown.
Paratypes: D10984, one entire specimen and two broken median valves, with same collection data as holotype.
Note: The type status of some of the valves labelled "holotype" is in doubt. There are two lots. One lot of 4 valves does not appear to belong to the type. The valves are from two different specimens and measure 5.3×3.2, 5.0×3.2, 4.1×2.5 and 2.1×1.8 mm respectively. The first two valves are too large for the type and the last one too small (Ashby gives a width of 4.5 mm for the type) and the third valve, and also the last one, are green in colour and not pink as stated for the type. The other lot, consisting of only one valve, with the label "valves 6 & 7 not photo'd" would appear to belong to the type.

Giles and Gosliner (1983) record another valve from the holotype in the South African Museum (A32649).

Acanthochiton zealandicus doubtlessensis Ashby, 1926
Proc. Malac. Soc. Lond. **17**(1): 12, pl. 1, fig. 2a-c; pl. 2, fig. 6.
=*Acanthochitona zealandica* (Quoy & Gaimard, 1835).
Holotype: D11109, disarticulated specimen, from Doubtless Bay, N.Z., collected by A. E. Brookes, date of collection unknown.
Paratypes: D11118, 3 entire specimens, with same collection data as holotype.
Note: Paratypes correspond to Ashby's paratypes No. 1, 3 and 4.

Genus *Craspedochiton* Shuttleworth, 1853

Craspedochiton jaubertensis Ashby, 1924
Trans. R. Soc. S. Aust. **48**: 326, pl. 31, fig. 5a-c.
Holotype: D11234, 2 articulated median valves with fragments of one valve and remains of girdle and animal, plus disarticulated anterior, posterior and remaining 3 median valves, dredged in 70 ft, 42 miles W.S.W. of Cape Jaubert, northern W.A., by Dr E. Mjoberg, 26.v.1911. (Swedish Scientific Expeditions 1910-1913).

Genus *Lophoplax* Ashby, 1926

Lophoplax finlayi Ashby, 1926
Proc. Malac. Soc. Lond. **17**(1): 30, pl. 3, fig. 4; pl. 4, figs 1-4.
=*Craspedochiton rubiginosus* (Hutton, 1872).
Holotype: D14318, 5 disarticulated median valves, dredged in 60 fathoms off Otago Heads, N.Z., by H. J. Finlay, date of collection unknown.
Note: Rest of type presumed lost. Type unique.

Genus *Notoplax* Adams, 1861

Notoplax (Amblyplax) brookesi Ashby, 1929
Trans. Proc. N.Z. Inst. **60**: 370, pl. 32, figs 1-4.
=*Notoplax brookesi* Ashby, 1929.
Holotype: D11030, 2 disarticulated median valves, from Tauranga Harbour, N.Z., dredged in 3 fathoms, collector and date of collection unknown.
Paratype: D11113, entire specimen with same collection data as holotype.
Note: Rest of type presumed lost.

Notoplax (Amblyplax) foveauxensis Ashby, 1926
Proc. Malac. Soc. Lond. **17**(1): 20 pl. 1, fig. 5a-c
=*Craspedochiton rubiginosus* (Hutton, 1872).
Holotype: D16021, 1 median valve, from Foveaux Strait, N.Z., dredged in 15 fathoms on oyster shell, collected by W. R. B. Oliver, date of collection unknown.
Paratype: D16022, 4 articulated median valves with remains of girdle and animal, plus disarticulated anterior, posterior and 2 median valves, with same collection data as holotype.
Note: Rest of type in NMNZ (M1584).

Notoplax (Amblyplax) mariae haurakiensis Ashby, 1926
Proc. Malac. Soc. Lond. **17**(1): 26, pl. 2, fig. 3a-c.
=*Notoplax mariae* (Webster, 1908).
Holotype: D11043, 4 articulated median valves and remains of girdle, plus one disarticulated median valve, from Hauraki Gulf, N.Z., dredged in 20 fathoms, off *Atrina* shell, collected by A. E. Brookes, date of collection unknown.
Paratype: D16550, remains of girdle, stuck on card, with same collection data as holotype.
Note: Rest of type in AIM (TM 535).

Notoplax (Amblyplax) oliveri Ashby, 1926
Proc. Malac. Soc. Lond. **17**(1): 18, pl. 1, fig. 4a-c.
=*Craspedochiton rubiginosus* (Hutton, 1872).
Holotype: D11044, 1 median valve, from between Kawau and Tiritiri islands, Hauraki Gulf, near Auckland N.Z., dredged in 20 fathoms in dead *Atrina* shell, collected by A. E. Brookes, date of collection unknown.
Paratype: D16551, 5 articulated median valves with remains of girdle, plus disarticulated anterior, posterior and median valve, with same collection data as holotype.
Note: Rest of type in NMNZ (M1585). Paratype has label "Ashby's No. 2."

Notoplax rottnestensis Ashby, 1929
J. Roy. Soc. W. Aust. **15**: 47, figs 10-13.

Holotype: D12565, 3 disarticulated median valves (2, 3, & 7), fragments of girdle and radula mounted on slide, from Bathurst Point, Rottnest Island, W.A., collected by L. Glauert, date of collection unknown. Note: Rest of type in WAM (12885).

Family **CALLISTOPLACIDAE**

Genus *Callistochiton* Dall, 1882

Callistochiton antiquus mayi Ashby, 1919
Trans. R. Soc. S. Aust. **43**: 401, pl. 42, figs 8 & 9.
=*Callistochiton antiquus meridionalis* Ashby, 1919.
Holotype: D12550, 1 median valve from Penguin rocks, north-western Tas., collected by E. Ashby, 11.x.1916.
Note: Rest of type presumed lost.

Callistochiton antiquus meridionalis Ashby, 1919
Trans. R. Soc. S. Aust. **43**: 400, pl. 42, fig. 7.
Holotype: D13716, disarticulated valves and piece of girdle and radula, from Marino, near Adelaide, S.A., collected by E. Ashby, date of collection unknown.

Ischnochiton (Lepidozona) asthenes Berry, 1919
=*Callistochiton asthenes* (Berry, 1919).
see ISCHNOCHITONIDAE

Callistochiton augustensis Ashby & Cotton, 1937
Trans. R. Soc. S. Aust. **61**: 145, pl. 8, figs 2-4.
Holotype: D12952, anterior valve, 6 disarticulated median valves with one broken and remains of animal, from Port George IV, Augustus Island, northern W.A., collected by B. Bardwell, October, 1933.
Note: According to Ashby and Cotton (1937) there were only six detached valves so presumably the posterior valve was lost before the description of the species. Type unique.

Callistochiton broomensis Ashby & Cotton, 1934
J. Roy. Soc. W. Aust. **20**: 213, pl. 13, fig. 3.
Holotype: D10723, entire specimen with animal, from Gantheaume Point, Broome, W.A., collected by MCZ expedition to Australia, September, 1929.
Note: Type unique.

Callistochiton clenchi Ashby & Cotton, 1934
J. Roy. Soc. W. Aust. **20**: 214, pl. 13, fig. 1.
Holotype: D10724, entire specimen with animal, from Gantheaume Point, Broome, W.A., collected by MCZ expedition to Australia, September, 1929.
Note: Type unique.

Callistochiton mawlei Iredale & May, 1916
Proc. Malac. Soc. Lond. **12**(2/3): 113, pl. 4, fig. 5.
Paratypes: D12019, one disarticulated specimen with dried radula, locality not indicated but probably Tas., collector and date of collection unknown; D12026, disarticulated valves of one specimen with same collection data as D12019.
Note: An old label with the specimens says that they were disarticulated by Iredale and used in the original type description but there is no indication that they were designated paratypes. Types in TM (E 201/7542).

Callistochiton occidus Ashby & Cotton, 1934
J. Roy. Soc. W. Aust. **20**: 215, pl. 13, fig. 4.
Holotype: D10725, entire specimen with animal, from Gantheaume Point, Broome, W.A., collected by MCZ expedition to Australia, September, 1929.
Note: Type unique.

Genus *Lophochiton* Ashby, 1923

Lophochiton johnstoni Ashby, 1923
Trans. R. Soc. S. Aust. **47**: 234, pl. 16, fig. 7a-c; pl. 17, fig. 1a-d.
=*Callistochiton coccus* (Menke, 1844).
Holotype: D12152, disarticulated specimen with one median valve fragmented, dried radula and piece of girdle, from Carnarvon, in extreme north of Shark Bay, W.A., collected by W. C. Johnston, date of collection unknown.
Note: Type unique.

Family **CALLOCHITONIDAE**

Genus *Acutoplax* Cotton & Weeding, 1939

Acutoplax cottoni Weeding, 1940
Trans. R. Soc. S. Aust. **64**(1): 48, pl. 4, fig. 1, 1a.
=*Callochiton cottoni* (Weeding, 1940).
Holotype: D13766, entire specimen with animal, dredged in shallow water, Spencer Gulf, S.A., by Fisheries launch "Whyalla", K. Sheard, March, 1938.
Note: P. Kaas, Rijksmuseum, Leiden, has examined the type and considers it a synonym of *Callochiton mayi* Torr, 1912.

Genus *Callochiton* Gray, 1847

Callochiton elongatus May, 1919
Pap. Proc. R. Soc. Tas. 1919: 55, pl. 14, fig. 1a-b.
Paratypes: D12696, 7 entire specimens (3 with animal), from Norfolk Bay, Tas., collected by E. Mawle, 1915. D10681, 6 entire specimens stuck on card, 2 from Port Arthur, Tas., collector and date of collection unknown, and 4 from Woodbridge, Tas., collected by E. Ashby, 26.iii.1920.

Note: D12696 are from the May collection (No. 230) and are labelled "cotypes". D10681 are from the Ashby collection and are also labelled "cotype", probably referring to the two specimens from Port Arthur, however May notes only 7-8 specimens so the type status of these specimens is in doubt. The 4 specimens from Woodbridge cannot be types. Type in TM (E177/7518).

Callochiton klemi Ashby, 1926
Trans. R. Soc. S. Aust. **50**: 243, fig. 4.
Holotype: D11703, 1 median valve, from amongst shell grit, Daly Head, Yorke Peninsula, S.A., collected by W. Klem, date of collection unknown.
Note: Type description was based on this single valve.

Callochiton platessa var. *fossa* Ashby, 1922
Trans. R. Soc. S. Aust. **46**: 19, pl. 3, fig. 4.
=*Callochiton crocinus* (Reeve, 1847)
Syntypes: D11699, 3 entire specimens (2 with animal remains), from Watson's Bay, Port Jackson, N.S.W., collector and date of collection unknown.
Note: The above three specimens were sent to Ashby by May and Ashby refers to them in his description and illustrated the larger specimen. The other specimens mentioned by Ashby do not appear to be in SAM although one specimen, D11694, with the label "variety with pits on valve 7" could be the SAM specimen mentioned by Ashby. Another specimen in SAM, D10671, is labelled "Holotype" but it does not match Ashby's description as the pits on valve 7 are poorly defined and only 6-7 in number. It is stuck on a card with 3 other specimens and is the only one labelled "var *fossa*" and we suspect that this information was added after the publication of the original description.

Callochiton rufus Ashby, 1900
Trans. R. Soc. S. Aust. **24**: 87, pl. 1, fig. 2a-g.
Holotype: D11700, specimen with first median valve removed and anterior valve missing, presumed lost, with animal, from Gulf St Vincent, S.A., dredged by J. C. Verco, date of collection unknown.
Note: Type unique.

Family **CHITONIDAE**

Genus *Acanthopleura* Guilding, 1829

Acanthopleura gemmata var. *queenslandica* Ashby, 1921
J. Roy. Soc. W. Aust. **8**: 30.
=*Acanthopleura gemmata* (Blainville, 1825).
Holotype: D12459, disarticulated specimen with girdle fragments, from Dunk Island, Qld., collected by J. Shirley, date of collection unknown.
Note: There is also a radula, mounted on a slide, labelled "*Acanthopleura gemmata* Bl. var 1, Dunk Id. Q.", which could have come from the above specimen. This same specimen was selected by Ashby (1928) as the neotype of *Chiton gemmatus* Blainville, 1825 (also listed here).

Acanthopleura gemmatus maudensis Ashby, 1928
Trans. R. Soc. S. Aust. **52**: 172, pl. 12, figs 8 & 9.
=*Acanthopleura gemmata* (Blainville, 1825).
Holotype: D10775, disarticulated anterior, posterior and 4 median valves, from Maud's Landing, north of Shark Bay, northern W.A., collected by T. Curton, date of collection unknown.
Note: Median valves 2 and 6 presumed lost.

Genus *Chiton* Linnaeus, 1758

Chiton aureomaculata Bednall & Matthews, 1906
Proc. Malac. Soc. Lon. **7**(2): 91, pl. 9, figs 3 & 3a-f.
=*Chiton (Rhyssoplax) tricostalis* Pilsbry, 1894.
Neotype: D14135, entire specimen with animal, from Cape Banks, S.A., collector and date of collection unknown. Selected by Cotton (1964: 94).
Note: From Torr collection. Listed by Cotton (1964) as neotype without discussion and considered, by us, as invalid.

Chiton bednalli Pilsbry, 1895
Nautilus **9**: 90.
=*Chiton (Rhyssoplax) bednalli* Pilsbry, 1895.
Holotype: D13742, disarticulated specimen with remains of animal, from Sultana Bay, Yorke Peninsula, S.A., collected by W. T. Bednall, date of collection unknown.
Note: From Bednall collection.

Chiton exoptandus Bednall, 1897
Proc. Malac. Soc. Lond. **2**(4): 152.
=*Chiton (Rhyssoplax) exoptandus* Bednall, 1897.
Neotype: D13744, entire specimen, from Sultana Bay, Yorke Peninsula, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 559).
Note: Listed by Cotton and Godfrey (1940) as neotype without discussion and considered, by us, as invalid.

Chiton gemmatus Blainville, 1825
Dict. Sci. Nat. **36**: 544.
=*Acanthopleura gemmata* (Blainville, 1825).
Neotype: D12459, the same specimen as the holotype of *Acanthopleura gemmata* var *queenslandica* Ashby, 1921, also listed here. Selected and figured by Ashby (1928: 172, fig. 6 & 7).

Chiton (Rhyssoplax) kimberi Ashby, 1928
Trans. R. Soc. S. Aust. **52**: 170, pl. 12, figs 10-12.
Holotype: D12393, disarticulated anterior, posterior and 3 median valves plus fragments of girdle and radula mounted on slide, from Capricorn Group, Qld., collected by W. J. Kimber, date of collection unknown.
Note: Rest of type presumed lost. Type unique.

Chiton marmoreus var. *coeruleus* Winkley, 1894
Nautilus **8**(4): 78.
=*Tonicella marmorea* (Fabricus, 1780) (ISCHNOCHITONIDAE)
Paratype: D10467, entire specimen, from Eastport, Maine, U.S.A., collected by H. W. Winkley, date of collection unknown.

Note: Specimen with original MCZ label and with the number "1707" written on the shell. From Ashby collection. Type in MCZ (MCZ 32856).

Chiton oruktus Maughan, 1900
Trans. R. Soc. S. Aust. **24**: 89, pl. 1, fig. 3a-g.
=*Chiton (Rhyssoplax) oruktus* Maughan, 1900.
Holotype: D1489, disarticulated specimen, plus girdle fragment, from MacDonnell Bay, S.A., collected by W. G. Torr, date of collection unknown.
Paratype: D12383, entire specimen, from Robe, S.A., collector and date of collection unknown.
Note: The type status of D12383 is doubtful as the only locality listed by Maughan (1900) was MacDonnell Bay.

Chiton scaber Blainville, 1825
Dict. Sci. Nat. **36**: 553.
=Nom. inquir.
Holotype: D12271, 1 median valve only, from New Holland, collector and date of collection not indicated.
Note: From Ashby collection with label "valve of type" presumably obtained by Ashby during his visit to Europe in 1922. However, the species is not mentioned by Ashby (1922).

Chiton tulipa alfredensis Ashby, 1928
Proc. Malac. Soc. **18**(2): 87, pl. 8, figs 19-21.
=*Chiton (Rhyssoplax) tulipa* Quoy & Gaimard, 1835.
Holotype: D10983, 3 disarticulated median valves, girdle fragments and loose girdle scales, from Port Alfred, South Africa, collected by W. H. Turton, date of collection unknown.
Paratypes: D11157, 3 entire specimens with same collection data as holotype.
Note: Holotype with label "these valves not photo'd". Rest of type presumed lost.

Chiton verconis Torr & Ashby, 1898
Trans. R. Soc. S. Aust. **22**: 215, pl. 6, fig. 1a-f.
=*Chiton (Mucrosquama) verconis* Torr & Ashby, 1898.
Lectotype: D16546, entire specimen with animal, from Gulf St Vincent, S.A., dredged by W. J. Kimber, date of collection unknown. (Lectotype chosen here).
Paralectotype: D16547, entire specimen with animal, with same collection data as lectotype.
Note: The SAM register and Cotton (1964) list D12380 as the holotype but this lot consists of one complete specimen, one median valve and the dried remains of a specimen from which the valves have been removed, none of which corresponds to the original description and is not even *C. verconis* but *Callochiton cottoni* (Weeding, 1940). In view of this confusion we have selected the above lectotype and paralectotype from a lot which we believe constituted syntype material. The lectotype (Fig. 1A) matches the original description and measures 17×11 mm (curled) and 31 mm along the curled dorsal surface, which approximates to the measurement of 24×12 mm given by Torr and Ashby, and may have been the specimen for which this measurement was given. The paralectotype (Fig. 1B)

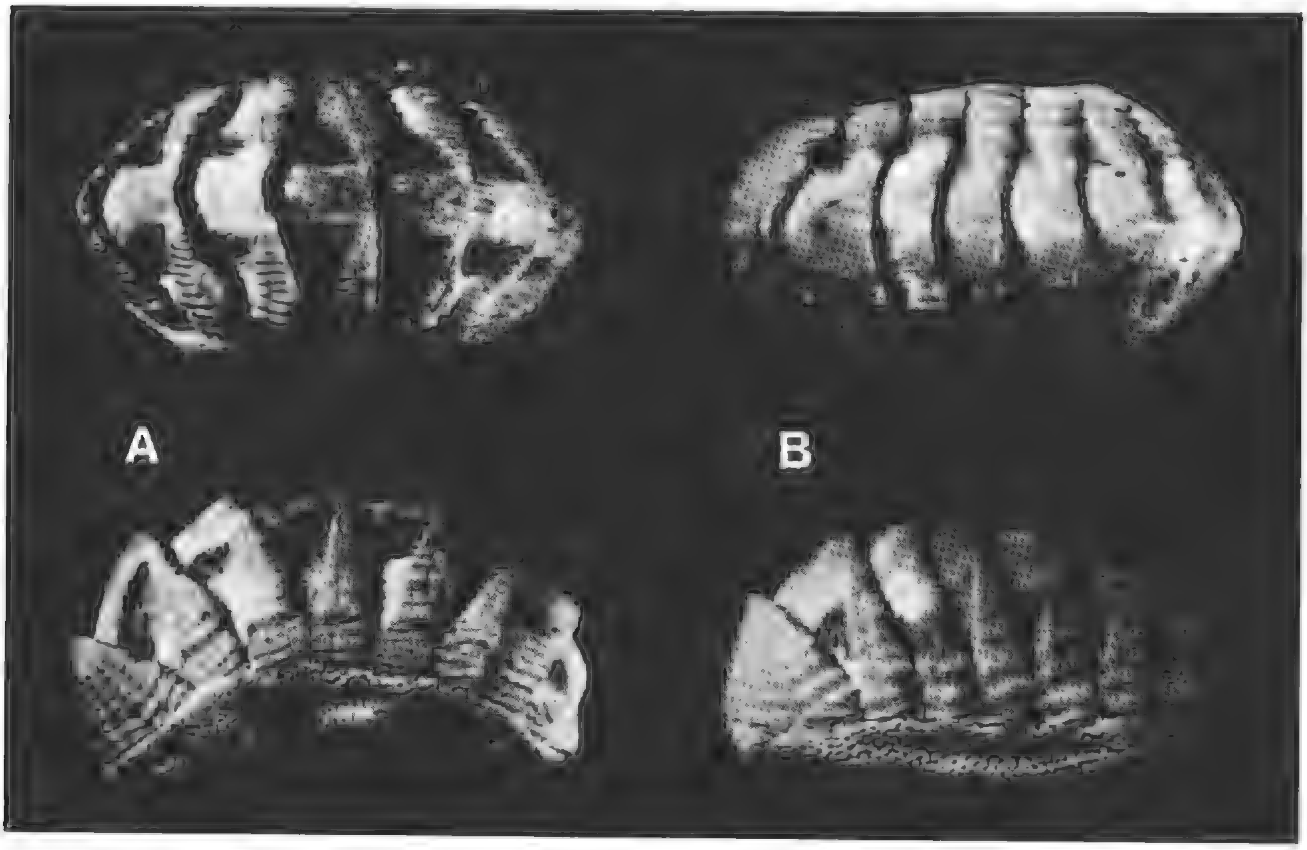

FIG. 1. *Chiton verconis* Torr & Ashby, 1898. A. Lectotype, 17×11 mm (curled). B. Paralectotype, 11.5×6.6 mm.

which was collected with the lectotype is less curled and measures 11.5×6.6 mm.
Another 3 specimens (D10739, D12379 and D12674) all dredged in Gulf St Vincent by Verco may also have belonged to the original type series but they are not given type status by us.
The valves figured by Torr and Ashby are presumed lost

Genus *Liolophura* Pilsbry, 1893

Plaxiphora pustulosa Torr, 1911
=*Liolophura (Clavarizona) hirtosa* (Blainville, 1825).
see MOPALIIDAE.

Genus *Lucilina* Dall, 1882

Lucilina rainfordiana Hull, 1924
Proc. R. Soc. Qld. **36**: 115, pl. 21, fig. 3.
=*Tonicia (Lucilina) fortilirata* (Reeve, 1847).
Paratype: D14496, entire specimen with animal, from North Head, Port Denison, Qld, collected by E. H. Rainford and A. F. B. Hull, 18.ix.1923.
Note: From Hull collection. Type in QM (MO 1139).

Lucilina tilbrooki Milne, 1958
Proc. R. Zool. Soc. N.S.W. 1956-57: 152, fig. 1-4.
=*Tonicia (Lucilina) tilbrooki* (Milne, 1958).
Paratype: D14591, entire specimen with animal remains, from Heron Island, Qld., collected by K. L. Milne, 1952.
Note: Type in MV (F18471).

Genus *Mucrosquama* Iredale & Hull, 1926

Mucrosquama nielseni Cotton & Weeding, 1939
Trans. R. Soc. S. Aust. **63**(2): 190, pl. 7, fig. 8.
=*Chiton (Mucrosquama) carnosus* Angas, 1867.
Holotype: D13720, entire specimen, from Hardwicke Bay, Yorke Peninsula, S.A., dredged by J. C. Verco, date of collection unknown.
Note: Type unique.

Mucrosquama sheardi Cotton & Weeding, 1939
Trans. R. Soc. S. Aust. **63**(2): 190, pl. 7, fig. 3.
=*Chiton (Mucrosquama) verconis* Torr & Ashby, 1898.
Holotype: D13721, entire specimen with animal, from Spencer Gulf, S.A., dredged by Fisheries Launch "Whyalla", K. Sheard, March, 1938.

Genus *Onithochiton* Gray, 1847

Onithochiton ashbyi Bednall & Matthews, 1906
Proc. Malac. Soc. Lon. **7**(2): 92, pl. 9, figs 2; 2a-e.
Neotype: D13745, entire specimen with animal, from south of Port Willunga jetty, near Adelaide, S.A., collected by E. Ashby, 2.iv.1926. Selected by Cotton and Godfrey (1940: 566).
Note: From Ashby collection. Listed by Cotton and Godfrey (1940) as neotype without discussion and considered, by us, as invalid.

Onithochiton quercinus occidentalis Ashby, 1929
Trans. R. Soc. S. Aust. **53**: 65.
Holotype: D12527, entire specimen, from Dongarra, W.A., from exposed outer reef, collected by E. Ashby, 10.xi.1920.

Genus *Rhyssoplax* Thiele, 1893

Rhyssoplax jacksonensis Ashby, 1921
Proc. R. Soc. Vic. (NS) **33**: 153, pl. 8, fig. 1a-b.
=*Chiton (Mucrosquama) carnosus* Angas, 1867.
Holotype: D10720, entire specimen, from Quarantine Station, Port Jackson, N.S.W., collected by E. Ashby, 23.xi.1918.

Rhyssoplax surrecta Hull, 1922
Aust. Zool. **2**(3): 84, pl. 24B, figs 1-4.
=*Chiton (Rhyssoplax) bednalli* Pilsbry, 1895.
Holotype: D12671, entire specimen, from Port Willunga, near Adelaide, S.A., collected by W. J. Kimber, date of collection unknown.
Note: Type unique.

Genus *Sypharochiton* Thiele, 1893

Sypharochiton pellisserpentis septentriones Ashby, 1924
Trans. R. Soc. S. Aust. **48**: 321.
=*Chiton pellisserpentis* Quoy & Gaimard, 1835.
Holotype: D17238, entire specimen with animal, from Nelson Bay, Port Stephens, N.S.W., collected by H. W. Thackway, October, 1923.

Genus *Tonicia* Gray, 1847

Tonicia hullianus Torr, 1911
Trans. R. Soc. S. Aust. **35**: 104, pl. 25, figs 4a-f.
=*Tonicia (Lucilina) hulliana* Torr, 1911.
Holotype: D12873, entire specimen from Ellenbrook, south of Cape Naturaliste, W.A., collected by W. G. Torr, Christmas, 1910-11.
Note: Type unique.

Family **CHORIPLACIDAE**

Genus *Choriplax* Pilsbry, 1894

Choriplax grayi pattisoni Ashby, 1921
Trans. R. Soc. S. Aust. **45**: 137, pl. 9, fig. 1a-c.
Holotype: D15019, entire specimen, found with giant kelp (*Laminaria*) washed ashore near Cape Banks Lighthouse, S.A., collected by G. Pattison, 1921.
Note: One of us (K.L.G.) has examined this species in detail and regards it a synonym of *Choriplax grayi* (Adams & Angas, 1864). Type unique.

Family **CRYPTOPLACIDAE**

Genus *Cryptoplax* Blainville, 1825

Cryptoplax iredalei Ashby, 1923
Trans. R. Soc. S. Aust. **47:** 238, pl. 19, fig. 4.
Holotype: D12306, entire specimen, from Port Lincoln, collected by E. Ashby, January, 1917.

Cryptoplax striatus var. *westernensis* Ashby, 1923
Trans. R. Soc. S. Aust. **47:** 238.
=*Cryptoplax striata westernensis* Ashby, 1923.
Holotype: D10717, entire specimen with animal remains, from Rottnest Island, W.A., collected by E. Ashby, 2.x.1920.
Note: Type unique.

Family **ISCHNOCHITONIDAE**

Genus *Anisoradsia* Iredale & May, 1916

Anisoradsia mawlei saundersi Ashby, 1918
Trans. R. Soc. S. Aust. **42:** 82.
=*Ischnochiton (Heterozona) cariosus* Pilsbry, 1892.
Holotype: D11961, specimen with anterior, posterior and 1 median valve disarticulated, from Port Lincoln, S.A., collected by E. Ashby, January, 1917.

Genus *Dinoplax* Dall, 1882

Dinoplax gigas var. *validfossus* Ashby, 1934
Ann. Durban Mus. **3**(4): 79, pl. 9, fig. 3.
=*Dinoplax validfossus* Ashby, 1934.
Holotype: D10971, entire specimen, from Durban, Natal, South Africa, collector and date of collection unknown.
Note: From J. D. Casey collection.

Genus *Ischnochiton* Gray, 1847

Ischnochiton (Lepidozona) asthenes Berry, 1919
Lorquinia **2**(6): 47.
=*Callistochiton asthenes* (Berry, 1919) (CALLISTOPLACIDAE).
Paratype: D10404, entire specimen, from White's Point, Los Angeles County, California, U.S.A., collected by A. G. Smith, 14-18.vii.1916.
Note: Label with specimen has the number "SSB 1196". Type in Berry Collection.

Ischnochiton atkinsoni Iredale & May, 1916
Proc. Malac. Soc. Lon. **12**(2/3): 110, pl. 4, fig. 3.
Paratypes: D15678, 8 entire specimens with animals, from Stanley to Devonport, Tas., collected by W. G. Torr, date of collection unknown.
Note: From May collection (No. 233). Type in TM (E179/7520).

Ischnochiton atkinsoni bruniensis Ashby, 1927
Pap. Proc. R. Soc. Tas. 1926: 111.
Holotype: D11966, entire specimen, from Lunawanna, South Bruny Island, D'Entrecasteaux Channel, Tas., collector and date of collection unknown.

Ischnochiton atkinsoni lincolnensis Ashby, 1920
Trans. R. Soc. S. Aust. **4:** 275, pl. 12, fig. 5a-b.
=*Ischnochiton variegatus* (Adams & Angas, 1864).
Holotype: D11763, entire specimen, from Port Lincoln, S.A., collected by E. Ashby, January, 1917.

Ischnochiton auratus Ashby, 1920
Trans. R. Soc. S. Aust. **44:** 277, pl. 12, fig. 6a-b.
=*Ischnochiton variegatus* (Adams & Angas, 1864).
Holotype: D11850, entire specimen with animal, from Marino, near Adelaide, S.A., collected by E. Ashby, date of collection unknown.
Paratype: D10738, entire specimen with animal, with same collection data as holotype.

Ischnochiton bakeri Torr, 1912
Trans. R. Soc. S. Aust. **36:** 169, pl. 7, fig. 8a-c, f.
=Nom. inquir.
Holotype: D12145, entire specimen with animal but posterior valve missing, from Henley Beach, Adelaide, S.A., collected by W. H. Baker, date of collection unknown.
Note: The specimen is very eroded and the posterior valve was missing at the time of collection. Type unique.

Ischnochiton (Isochiton) bardwelli Ashby & Cotton, 1934
J. R. Soc. W. Aust. **20:** 217, pl. 13, fig. 5.
=*Ischnochiton bardwelli* Ashby & Cotton, 1934.
Holotype: D11978, disarticulated specimen and girdle scales mounted on slide, from off Broome, W.A., dredged in 7 fathoms by B. Bardwell, date of collection unknown.
Paratypes: D11979, 2 entire specimens with same collection data as holotype.
Note: Smith and Robertson (1970) list the holotype as being in the MV (F17977). However, our specimens match the original description and are clearly marked "holotype" and "paratypes". Also we have the original label "*Solvaga recens* Thiele" as mentioned by Ashby and Cotton, so that the type status of the MV specimen must be very doubtful.

Ischnochiton bednalli Torr, 1912
Trans. R. S. Aust. **36:** 166, pl. 5, fig. 3a-f.
=*Subterenochiton bednalli* (Torr, 1912) (SUBTERENOCHITONIDAE)
Holotype: D11792, entire specimen and radula mounted on slide, from St Francis Island, Nuyts Archipelago, S.A., collector and date of collection unknown.

Ischnochiton (Haploplax) broomensis Ashby & Cotton, 1934
J. R. Soc. W. Aust. **20:** 216, pl. 13, fig. 2.

Holotype: D10729, disarticulated specimen with radula and girdle remains mounted on slides, from Gantheaume Point, Broome, W.A., collected by MCZ expedition to Australia, September, 1929.
Paratype: D15537, entire specimen with animal, with same collection data as holotype.

Ischnochiton (Heterozona) curiosus var. *occidentalis* Ashby, 1921
Trans. R. Soc. S. Aust. 45: 42.
=*Ischnochiton (Heterozona) cariosus* Pilsbry, 1892.
Holotype: D11884, entire specimen with animal, from Point Peron, near Rockingham, W.A., collected by E. Ashby, 1920.

Ischnochiton (Radsiella) delagouensis Ashby, 1931
Ann. S. Afr. Mus. **30**(1): 40, pl. 6, figs 63-66.
=*Ischnochiton delagoaensis* Ashby, 1931.
Holotype: D16019, girdle fragments mounted on slide only, from Delagoa Bay, South Africa, collected by K. H. Barnard, date of collection unknown.
Note: Rest of type in South African Museum (A 6589). Type unique.

Ischnochiton hewitti Ashby, 1931
Ann. S. Afr. Mus. **30**(1): 33, pl. 5, figs 50-53.
=*Ischnochiton bergoti* (Velâin, 1877).
Holotype: D10997, entire specimen and radula mounted on slide from Table Bay, South Africa, collector and date of collection unknown.
Note: The above specimen is labelled "type" and with the South African Museum No. "6757". However, Ashby (1931) figured the specimen from the Albany Museum (No. 8085) as the type. The above specimen therefore cannot be the type but is probably a paratype. Giles and Gosliner (1983) are similarly in error as they list a valve from the type, also numbered A 6757.

Ischnochiton iredalei Dupuis, 1918
Bull. Mus. Nat. Hist. Nat. **24**(7): 526.
=*Ischnochiton lineolatus* (Blainville, 1825).
Syntypes: D12718, 7 entire specimens, 6 from Penguin and one from Stanley, north-western Tas., collector and date of collection unknown.
Note: From May collection (No. 236) labelled "paratypes". The type status of these specimens is very doubtful as Dupuis (1918) did not give specific details of specimens and says that he did not see any local examples.

Ischnochiton iredalei kingensis Ashby & Hull, 1923
Aust. Zool. **3**(2): 81, pl. 8, figs 1-4.
=*Ischnochiton lineolatus* (Blainville, 1825).
Holotype: D13731, median valves 3-5 and parts of girdle stuck on card, remaining valves disarticulated, from Fraser Bay, King Island, Bass Strait, collected by A. F. B. Hull, December, 1922.

Ishnochiton (sic.) *jervisensis* Ashby & Cotton, 1937
Trans. R. Soc. S. Aust. **61**(1): 147, pl. 8, fig. 1.
=*Ischnochiton pilsbryi* Bednall, 1897.
Holotype: D13282, entire specimen, from Cape Jervis, S.A., in a sheltered pool at low tide, collected by E. Ashby, 28.i.1937.
Note: Type unique?

Ischnochiton johnstoni Cotton 1937
BANZARE Rep. Ser. B. **4**(1): 11, figs 10-18.
Holotype: D14456, disarticulated valves stuck on glass and radula mounted on slide, from BANZARE Stn. 47 (49°50′S, 63°33′E), off Kerguelen Island, depth 150 m, collected by BANZARE, 7.ii.1930.
Paratypes: D14456, disarticulated valves of one specimen stuck on glass with holotype and radula mounted on slide, with same collection data as holotype. D15162, 2 entire specimens with animal, with same collection data as holotype. D16015, 3 entire specimens with animals, in spirit, with same collection data as holotype.

Ischnochiton levis Torr, 1912
Trans. R. Soc. S. Aust. **36**: 168, pl. 6, fig. 6a-f.
=*Ischnochiton (Autochiton) levis* Torr, 1912.
Holotype: D11976, 5 articulated median valves with girdle and animal and disarticulated posterior valve, from Edithburgh, Yorke Peninsula, S.A., collected by E. H. Matthews, date of collection unknown.
Note: Rest of type presumed lost. Type unique.

Ischnochiton (Anisoradsia) mawlei Iredale & May, 1916
Proc. Malac. Soc. Lond. **12**(2/3): 108, pl. 4, fig. 4.
=*Ischnochiton mawlei* Iredale & May, 1916.
Paratype: D12546, disarticulated specimen and remains of girdle, from South Tas., collector and date of collection unknown.
Note: A label with the specimen says "dissected by Iredale", a later SAM label says "Holotype (?)". The type does not appear to have been disarticulated, according to the original description, and is located in TM (E 196/7537) thus the SAM specimen is most likely a paratype.

Ischnochiton mawsoni Cotton, 1937
BANZARE Rep. Ser. B. **4**(1): 9, figs 1-9.
Holotype: D14457, disarticulated valves stuck on glass and radula and girdle mounted on slide, from BANZARE Stn. 83 (54°42′30″S, 158°54′30″E), off Lusitania Bay, Macquarie Island, depth 69 m, collected by BANZARE, 5.xii.1930.
Paratypes: D15160, about 300 specimens with animals, with same collection data as holotype. D15161 disarticulated valves of one specimen stuck on glass with holotype and radula and girdle mounted on slide, with same collection data as holotype. D16014, 55 entire specimens with animals, in spirit, with same collection data as holotype.

Ischnochiton (Haploplax) mayi var. *viridis* Ashby, 1920
Trans. R. Soc. S. Aust. **44**: 264.
=*Ischnochiton (Haploplax) mayi* Pilsbry, 1895.
Holotype: D11972, entire specimen with animal, from Lunawanna, South Bruny Island, D'Entrecasteaux Channel, Tas., collected by E. Ashby, 22.iii.1920.

Ischnochiton (Haploplax) misimaensis Ashby, 1923
Trans. R. Soc. S. Aust. **47**: 228, pl. 16, figs 6, 6a-c.
=*Ischnochiton (Haploplax) adelaidensis* (Reeve, 1847).
Holotype: D12498, disarticulated specimen and fragments of girdle, from Misima, Papua New Guinea, collected by R. Andrew, date of collection unknown.
Paratype: D16552, entire specimen with animal, with same collection data as holotype.

Ischnochiton (Stenochiton) pallens Ashby, 1900
Trans. R. Soc. S. Aust. **24**: 86, pl. 1, fig. 1a-e, g.
=*Stenochiton pallens* (Ashby, 1900).
Holotype: D978, 5 disarticulated median valves and the anterior valve, from Gulf St Vincent, S.A., dredged by J. C. Verco, date of collection unknown.
Paratype: D11728, entire specimen with animal, with same collection data as holotype (labelled "cotype").
Note: Rest of type presumed lost.

Ischnochiton (Stenochiton) pilsbryanus Bednall, 1897
Proc. Malac. Soc. Lond. **2**(4): 142.
=*Stenochiton pilsbryanus* (Bednall, 1897).
Neotype: D11729, posterior and 3 median valves articulated with remains of girdle and disarticulated anterior and median valve, from Tapley Shoal, Gulf St Vincent, S.A., on *Zostera* bed, collected by R. Tate, date of collection unknown. Selected by Ashby (1919: 67, pl. 11, figs 2, 2a-c).
Paraneotype: D11727, entire specimen from Marino, near Adelaide, S.A., collected by E. Ashby, 19.ii.1910.
Note: The above specimens are the "holotype" and "paratype" respectively of Ashby's (1919) description of *Stenochiton (Zostericola) pilsbryanus* (Bednall, 1897). According to Davis *et al.* (1979) there are at least 3 syntypes of this species in ANSP (Shell Cat. No. 69142) however, Ashby (1919) refers to this material and says "I easily identified in the material shown to me the three species *S. juloides*, Ad. and Ang.; *S. cymodocealis*, Ashby; and *S. posidonialis*, Ashby, all very small and juvenile". Later, Ashby (1927) doubted the validity of his identification of the neotype and renamed it as a new species, *Stenochiton tatei*, also listed here.
Rest of neotype presumed lost.

Ischnochiton pilsbryi Bednall, 1897
Proc. Malac. Soc. Lond. **2**(4): 143, pl. 12, figs 2, 2a-e.
Neotype: D11766, entire specimen, from Sultana Bay, Yorke Peninsula, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 491, fig. 477).
Note: From Matthews and Bednall collection. According to Davis *et al.* (1979) there are 3 syntypes in ANSP (Shell Cat. No. 67369); we therefore consider the selection of a neotype invalid. Davis *et al.* (1979) also erroneously list the type locality as Cape Yorke Peninsula, Qld.
Since the above specimen came from the Matthews and Bednall collection and is from the type locality we consider it likely to be a syntype.

Ischnochiton (Heterozona) properensis Ashby, 1920
Trans. R. Soc. S. Aust. **44**: 278, pl. 12, fig. 7a-b.
Holotype: D11896, entire specimen, from Proper Bay, Port Lincoln, S.A., collected by E. Ashby, January, 1917

Ischnochiton resplendens Bednall & Matthews, 1906
Proc. Malac. Soc. Lond. 7(2): 91, pl. 9, figs 4, 4a-f.
Ischnochiton (Haploplax) smaragdinus resplendens Bednall & Matthews, 1906.
Neotype: D13739, entire specimen with animal, from Marino, near Adelaide, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 503, fig. 491).
Note: Listed and figured by Cotton and Godfrey (1940) as neotype without discussion and considered, by us, as invalid.

Ischnochiton (Haploplax) smaragdinus resplendens var. *westernensis* Ashby, 1923
Trans. R. Soc. S. Aust. **47**: 226.
Holotype: D13722, entire specimen, from Yallingup, W.A., collected by E. Ashby, date of collection unknown.

Ischnochiton (Haploplax) smaragdinus var. *funereus* Ashby, 1924
Trans. R. Soc. S. Aust. **48**: 315.
Holotype: D11237, entire specimen, with animal, from Long Reef, N.S.W., collected by W. H. Hatcher, date of collection unknown.

Ischnochiton strömfelti Bergenhayn, 1931
Arkiv. Zool. **23A**(13): 11, pl. 1, figs 14-16; pl. 2, figs 52-56.
=*Lepidochitona stroemfelti* (Bergenhayn, 1931).
Syntype: D16186, entire specimen with animal, from Fuertaventura, Puerto Cabras, Canary Islands, on rocks at low tide, collected by N. Odhner, 1930.
Note: From Ashby collection.

Ischnochiton tateanus Bednall, 1897.
Proc. Malac. Soc. Lond. **2**(4): 147, pl. 12, fig. 3a-d.
Neotype: D13738, entire specimen with animal, from Sultana Bay, Yorke Peninsula, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 493).
Note: Listed by Cotton and Godfrey (1940) without

discussion, also Davis *et al.* (1979) list 7 syntypes in ANSP (Shell Cat. No. 69143) and we therefore consider the selection of a neotype invalid.

Ischnochiton thomasi Bednall, 1897.
Proc. Malac. Soc. Lond. 2(4): 149, pl. 12, figs 4a-d, 5a-d.
=*Ischnochiton (Haploplax) thomasi* Bednall, 1897.
Neotype: D13737, entire specimen with animal, from Marino, near Adelaide, S.A., collector and date of collection unknown. Selected by Cotton and Godfrey (1940: 504).
Note: Listed by Cotton and Godfrey (1940) without discussion, also Davis *et al.* (1979) list 8 syntypes in ANSP (Shell Cat. No. 69144) and we therefore consider the selection of a neotype invalid.

Ischnochiton tindalei Ashby, 1924.
Trans. R. Soc. S. Aust. **48**: 323, pl. 31, fig. 4a-c.
Holotype: D4656, disarticulated specimen with pieces of girdle, from Groote Eylandt, Gulf of Carpentaria, N.T., on a block of dead coral in deep water, collected by N. B. Tindale, date of collection unknown.
Note: Type unique.

Lepidopleurus variegatus Adams & Angas, 1864.
=*Ischnochiton variegatus* (Adams & Angas, 1864).
see LEPIDOPLEURIDAE.

Ischnochiton veronis Torr, 1911.
Trans. R. Soc. S. Aust. **35**: 102, pl. 24, fig. 1a-f.
Holotype: D12868, entire specimen, from Ellenbrook, south of Cape Naturaliste, W.A., in rockpool on inside reef, collected by W. G. Torr, Christmas, 1910-11.
Note: Type unique.

Genus *Ischnoradsia* Shuttleworth, 1853

Ischnoradsia papuaensis Ashby, 1923.
Trans. R. Soc. S. Aust. **47**: 227, pl. 17, fig. 2a-c.
=*Ischnochiton (Ischnoradsia) papuaensis* (Ashby, 1923).
Holotype: D14316, posterior and 2 median valves articulated with girdle, rest of specimen disarticulated, from Normanby Island, Papua New Guinea, collected by R. Andrew, date of collection unknown.
Note: Type unique.

Genus *Stenochiton* Adams & Angas, 1864

Stenochiton cymodocealis Ashby, 1918.
Trans. R. Soc. S. Aust. **42**: 70, pl. 13, figs 1, 4, 5; pl. 14, figs 11, 12a-c.
Holotype: D981, entire specimen with animal, from Marino, near Adelaide, S.A., on *Cymodocea antarctica* stems, collected by E. Ashby, date of collection unknown.
Paratypes: D980, 2 entire specimens with animals, with same collection data as holotype. D16545, disarticulated specimen with posterior valve presumed lost, with same collection data as holotype.
Note: D16545 is labelled "type" but was obviously disarticulated for fig. 12. According to Ashby (1918) the type is the specimen illustrated in fig. 5 which corresponds to the above.

Stenochiton posidonialis Ashby, 1918.
Trans. R. Soc. S. Aust. **42**: 72, pl. 13, figs 2, 6, pl. 14, fig. 13a-d.
=*Stenochiton pilsbryanus* (Bednall, 1897).
Holotype: D11714, entire specimen with animal, from Marino, near Adelaide, S.A., collected by E. Ashby, date of collection unknown.
Paratypes: D11718, 5 entire specimens stuck on one card; 2 from Cape Jervis, S.A., collected by E. Ashby 14.iii.1918; 1 from Outer Harbour, S.A., and one from Marino collected by E. Ashby, date of collection unknown and 1 from Largs Bay, S.A., collected by E. H. Matthews, date of collection unknown. D16544, disarticulated specimen with same collection data as holotype.
Note: D16544 is labelled "type" but was obviously disarticulated for fig. 13. According to Ashby (1918) the type is the specimen illustrated in fig. 6 which corresponds to the above.

Stenochiton tatei Ashby, 1927.
Pap. Proc. R. Soc. Tas. 1926: 113.
=*Stenochiton pilsbryanus* (Bednall, 1897).
Holotype: D11729, based on the same specimen as the neotype of *Ischnochiton pilsbryanus* Bednall, 1897, selected by Ashby, (1919) and also listed here.
Note: A new name for the shell described as *I. pilsbryanus* (Ashby, 1919) as the identification of the specimen selected as neotype was in doubt.

Genus *Tonicella* Carpenter, 1873

Chiton marmoreus var., *caeruleus* Winkley, 1894.
=*Tonicella marmoreus* (Fabricus, 1780).
see CHITONIDAE

Genus *Trachydermon* Carpenter, 1864

Trachydermon lowei Pilsbry, 1918.
Nautilus **31**(4): 127.
=*Lepidochitona lowei* (Pilsbry, 1918).
Paratype: D11275, entire specimen, from San Pedro, California, U.S.A., collected by H. N. Lowe, date of collection unknown.
Note: From Ashby collection. Type in ANSP (Shell Cat. No. 117955).

Trachydermon (Craspedochilus) turtoni Ashby, 1928.
Proc. Malac. Soc. Lond. **18**(2): 80, pl. 6, figs 5-8.

=*Lepidochitona turtoni* (Ashby, 1928)
Holotype: D10982, 2 median valves, valve fragments and fragment of girdle, from Port Alfred, South Africa, collected by W. H. Turton, date of collection unknown.
Note: A label with the valves says "valves not photographed". Rest of type presumed lost. Type unique.

Family **LEPIDOPLEURIDAE**

Genus *Lepidopleurus* Risso, 1826

Lepidopleurus badius Hedley & Hull 1909.
Rec. Aust. Mus. 7: 260, pl. 73, figs 1 & 2.
=*Leptochiton badius* (Hedley & Hull, 1909).
Paratypes: D10668, 5 entire specimens with animals, from Long Reef, near Narrabeen, N.S.W., collector and date of collection unknown. D12532, one entire specimen with animal, with same collection data as D10668.
Note: The localities "Port Stephens" and "Kangaroo Island S.A." have been added to D10668 (in pencil) and there is therefore some doubt regarding the type status of these specimens. Type in AM (C30459).

Lepidopleurus columnarius Hedley & May, 1908.
Rec. Aust. Mus. 7(2): 123, pl. 24, figs 27 & 28.
=*Leptochiton columnarius* (Hedley & May, 1908).
Paratypes: D10667, 2 median valves, from 7 miles east of Cape Pillar, Tas., dredged with holotype in 100 fathoms, collected by W. L. May, 18.xii.1907. D15679, posterior and 4 median valves, with same collection data as D10667.
Note: D15679 from May collection (No. 226). Type in AM (C29060).

Lepidopleurus finlayi Ashby, 1929.
Trans. Proc. N.Z. Inst. 60: 372, pl. 32, figs 5-7.
=*Leptochiton finlayi* (Ashby, 1909).
Holotype: D11061, 5 disarticulated median valves and dried radula, from off Otago Heads, N.Z., dredged in 60 fathoms by H. J. Finlay, date of collection unknown.
Paratype: D16188, entire specimen with animal but posterior valve absent, with same collection data as holotype.
Note: Rest of type in AM (C95165).

Lepidopleurus glauerti Ashby, 1929.
J. R. Soc. W. Aust. 15: 50, fig. 16.
=*Leptochiton glauerti* (Ashby, 1929).
Paratype: D16152, 5 median valves articulated with animal and remains of girdle, anterior valve and other median valve disarticulated, from Bathurst Point, Rottnest Island, W.A., collected by L. Glauert, date of collection unknown.
Note: Posterior valve presumed lost. Type in WAM (12876).

Lepidopleurus iredalei Ashby, 1921.
Proc. R. Soc. Vic. (NS) 33: 157, pl. 8, fig. 3a-b.
=*Leptochiton inquinatus* (Reeve, 1847).
Holotype: D11240, entire specimen with animal, from Doubtless Bay, N.Z., collected by A. E. Brookes, date of collection unknown.

Lepidopleurus liratus Adams & Angas, 1864.
Proc. Zool. Soc. Lond. 13: 192.
=*Leptochiton liratus* (Adams & Angas, 1864).
Neotype: D13735, entire specimen with animal, from Sultana Bay, Yorke Peninsula, S.A., collected by Matthews and Bednall, date of collection unknown.
Note: A neotype for *L. liratus* was selected by Iredale and Hull (1925a: 343) and this specimen is in the AM (C10410). The above specimen was presumably selected by Cotton and Godfrey (1940: 477, fig. 458) as yet another neotype for *L. liratus*; however, the specimen does not match fig. 458. The type status of the above specimen is therefore extremely doubtful and is invalid in any case as Iredale and Hull (1925a) had already selected a neotype.

Lepidopleurus matthewsianus Bednall, 1906.
Proc. Malac. Soc. Lond. 7: 92, pl. 9, fig. 1a-f.
=*Leptochiton matthewsianus* (Bednall, 1906).
Neotype: D13734, entire specimen with remains of animal, from Marino, near Adelaide, S.A., collected by E. Ashby, 1919. Selected by Cotton and Godfrey (1940: 476, fig. 455).
Note: Listed and figured by Cotton and Godfrey (1940) as neotype without discussion and considered, by us, as invalid.

Lepidopleurus niger Torr, 1911.
Trans. R. Soc. S. Aust. 35: 105, pl. 25, fig. 5a-f.
=*Leptochiton niger* (Torr, 1911).
Holotype: D11686, entire specimen with animal but with anterior valve missing, from Hopetoun, W.A., under stones in shallow pools, collected by W. G. Torr, Christmas, 1910-11.
Note: Anterior valve presumed lost. Type unique.

Lepidopleurus pelagicus Torr, 1912.
Trans. R. Soc. S. Aust. 36: 165, pl. 5, fig. 2a-f.
=*Leptochiton columnaris* (Hedley & May, 1908).
Holotype: D11688, anterior, posterior and one median valve, dredged in 130 fathoms, off Cape Jaffa, S.A., collected by J. C. Verco, 25.xii.1905.
Note: Rest of type presumed lost.

Lepidopleurus profundus May, 1923.
Illust. Index Tas. Shells, pl. 14, fig. 2, Appendix
=*Leptochiton profundus* (May, 1923).
Holotype: D12533, entire specimen, dredged in 10 fathoms, off Pilot Station, Derwent River, Tas., collected by W. L. May, date of collection unknown.
Paratype: D16189, entire specimen with animal, with

anterior valve disarticulated, with same collection data as holotype.
Note: May (1923) illustrated *L. inquinatus* Sykes, 1896 but in an appendix says "An examination of the type in the British Museum shows that this is not *inquinatus*, which is the N.Z. species. Our shell is now to be known as *profundus* Ashby". Unfortunately Ashby's description of *profundus* was published after May's and in any case is a different species.

Lepidopleurus profundus Ashby, 1923.
Trans. R. Soc. S. Aust. **47**: 221, pl. 16, figs 2, 2a.
=*Leptochiton collusor* (Iredale & Hull, 1925).
Holotype: D11288, entire specimen with animal, from Gulf St Vincent, S.A., dredged by J. C. Verco, date of collection unknown.
Paratypes: D11691, 2 specimens, one entire, the other with animal but with anterior, posterior and one median valve disarticulated, from Port Phillip Bay, Vic., dredged by Bracebridge Wilson (No. 881), date of collection unknown.
Note: Renamed *Parachiton collusor* by Iredale and Hull (1925a), also listed here, as *L. profundus* was preoccupied.

Lepidopleurus variegatus Adams & Angas, 1864.
Proc. Zool. Soc. Lond. **13**: 192.
=*Ischnochiton variegatus* (Adams & Angas, 1864) (ISCHNOCHITONIDAE).
Neotype: D13736, entire specimen with animal, from Minlacowie, Hardwicke Bay, Yorke Peninsula, S.A., collected by E. H. Matthews, date of collection unknown. Selected by Iredale and Hull (1927: 13).

Genus *Parachiton* Thiele, 1909

Parachiton collusor Iredale & Hull, 1925.
Aust. Zool. **3**(8): 346, pl. 39, fig. 22.
=*Leptochiton collusor* (Iredale & Hull, 1925).
Holotype: D11288, based on the same specimen as the holotype of *Lepidopleurus profundus* Ashby, 1923, also listed here.
Note: There is some doubt that this specimen was the one selected as type by Iredale and Hull (1925a) as Iredale and Hull (1927) list the type of *P. cullusor* in SAM and the type of *L. profundus* in the Ashby collection. However, later labels with the specimen say that it is the type of *P. collusor* and Cotton and Godfrey (1940) also list and figure it as the type.

Parachiton verconis Cotton & Weeding, 1939.
Trans. R. Soc. S. Aust. **63**(2): 183, pl. 7, fig. 2.
=*Leptochiton verconis* (Cotton & Weeding, 1939).
Holotype: D11689, posterior valve only, from near St Francis Island, Nuyts Archipelago, S.A., dredged in 15-20 fathoms by J. C. Verco, date of collection unknown.
Note: Type description was based on this single valve.

Genus *Terenochiton* Iredale, 1914

Terenochiton iscus Cotton & Weeding, 1939.
Trans. R. Soc. S. Aust. **63**(2): 182, pl. 7, fig. 1.
=*Leptochiton iscus* (Cotton & Weeding, 1939).
Holotype: D1232, entire specimen with animal, from Cape Jervis, S.A., collected by F. L. Saunders, 1917.

Family **MOPALIIDAE**

Genus *Kopionella* Ashby, 1919

Kopionella matthewsi var. *intermedia* Ashby, 1927.
Pap. Proc. R. Soc. Tas. 1926: 101.
=*Plaxiphora (Fremblya) matthewsi* (Iredale, 1910).
Syntypes: D12115, 3 entire specimens with animal remains, from Penguin, north-western Tas., collected by E. Ashby, November, 1924.

Kopionella tasmanica Ashby, 1920.
Trans. R. Soc. S. Aust. **44**: 268, pl. 11, fig. 1a-d.
=*Plaxiphora (Fremblya) matthewsi* (Iredale, 1910).
Holotype: D12156, disarticulated specimen, from Lunawanna, South Bruny Island, D'Entrecasteaux Channel, Tas., collected by E. Ashby, March, 1920.
Note: Smith and Robertson (1970) list the holotype as lost as it could not be located at the time.

Genus *Plaxiphora* Gray, 1847

Plaxiphora hedleyi Torr, 1911.
Trans. R. Soc. S. Aust. **35**: 103, pl. 24, fig. 2a-f.
=*Plaxiphora (Fremblya) matthewsi* (Iredale, 1910).
Holotype: D12871, entire specimen with anterior and posterior valve disarticulated, from Rabbit Island, near Albany, W.A., collected by W. G. Torr, Christmas, 1910-11.

Plaxiphora pustulosa Torr, 1911.
Trans. R. Soc. S. Aust. **35**: 107, pl. 25, fig. 7.
=*Liolophura (Clavarizona) hirtosa* (Blainville, 1825) (CHITONIDAE).
Holotype: D13719, one median valve only, from Albany, W.A., collected by W. G. Torr, Christmas, 1910-11.
Note: Type description was based on this single valve.

Plaxiphora zebra Torr, 1911
Trans. R. Soc. S. Aust. **35**: 106, pl. 25, fig. 6.
=*Plaxiphora (Fremblya) matthewsi* (Iredale, 1910).
Holotype: D12869, one median valve only, from Port Esperance, W.A., collected by W. G. Torr, Christmas, 1910-11.
Note: Type description was based on this single valve.

Family **SCHIZOCHITONIDAE**

Genus *Lorica* H & A Adams, 1852

Lorica elliottae Cotton & Weeding, 1939.
Trans. R. Soc. S. Aust. **63**(2): 189, pl. 7, fig. 9.
Holotype: D11658, entire specimen, from Rottnest Island, W.A., collected by L. A. Elliott, January, 1933.
Note: Type unique.

Lorica haurakiensis Mestayer, 1921.
Trans. Proc. N.Z. Inst. **53**: 177, pl. 38, figs 1-3.
Paratype: D11089, entire specimen, dredged in 20 fathoms, off Kauwau and Tiritiri Islands, Hauraki Gulf, near Auckland, N.Z., collected by A. E. Brookes, date of collection unknown.
Note: Type in NMNZ (M1121).

Genus *Loricella* Pilsbry, 1893

Loricella torri Ashby, 1919.
Trans. R. Soc. S. Aust. **43**: 62, pl. 10, fig. 16.
=*Loricella angasi* (H. Adams in H. Adams & Angas, 1864).
Holotype: D12440, entire specimen, from Quarantine Station, Port Jackson, N.S.W., in shallow water at low tide, collected by E. Ashby, November, 1918.

Family **SUBTERENOCHITONIDAE**

Genus *Subterenochiton* Iredale & Hull, 1924

Ischnochiton bednalli Torr, 1912.
=*Subterenochiton bednalli* (Torr, 1912).
see ISCHNOCHITONIDAE.

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APPENDIX

List of Chiton "types" from the Dupuis collection given to Ashby by Dupuis. All are labelled "TYPE" or "CO-TYPE" usually with a Dupuis label with the word "TYPE" in red print, glued to the label and the prefix "co-" added by hand. The specimens are listed in alphabetical order according to the original name at the time of description.

Acanthopleura balansae Rochebrune, 1882.
Bull. Soc. Philom. Paris, Ser. 7, 6: 197.
=*Acanthopleura haddoni* Winkworth, 1927 (CHITONIDAE).
Syntype: D10231, entire specimen with animal, from Timor, collector and date of collection unknown.
Note: Specimen with label "co-TYPE de *A. balansae* Roch." and reidentified as *A. spinigera* Sowerby. The locality given by Rocheburne (1882) is "Australie (Péron et Lesueur). Nouvelle Caledonie (Balansa; Germain)". The type status of the above specimen is therefore very doubtful.

Chiton elongatus Blainville, 1825.
Dict. Sci. Nat. **36**: 352.
=*Ischnochiton elongatus* (Blainville, 1825) (ISCHNOCHITONIDAE).
Syntype: D10237, entire specimen, from King Island, Bass Strait, collected by Péron and Lesueur, 1802.
Note: The shell is marked on the inside "ile King"

presumably in the handwriting of Péron or Lesueur and is a historically significant shell (Macphail & Zeidler, 1978). It was sent to Ashby by Dupuis as "co-types" of *I. lineolatus* (Ashby, 1922) and a Dupuis label says the same. Ashby (1922) determined it as *I. crispus* (Reeve, 1847) which is now considered a synonym of *I. elongatus*. The above specimen matches the original description of *C. elongatus* and considering that it was collected by Péron and Lesueur it was most likely part of the series of specimens originally seen by Blainville.
Syntypes: D10238, 3 entire specimens with same collection data as D10237.
Note: =*I. subviridus* (Iredale & May, 1916) but would have been considered *I. elongatus* in the past. There is no original label with the specimen but a label presumably written by Ashby says "col. by Péron and Lesueur, Is. King 1802 (with Blainville's type of *lineolatus*)". If the information with the specimens is correct then they could also have been part of the original material seen by Blainville.

Chiton lamyi Dupuis, 1917.
Bull. Mus. Natn. Hist. nat. Paris 23: 538.
=*Chiton peregrinus* Thiele, 1910 (CHITONIDAE).
Syntypes: D10211, 10 entire specimens, only one with animal, from Aden, Red Sea, collected by Dr Jousseume, date of collection unknown. D10252, one disarticulated specimen with piece of dried girdle, from the Red Sea, collected by Dr Jousseume, date of collection unknown. D10255, one disarticulated specimen with piece of dried girdle with same collection data as D10252. D11200, one entire specimen from the Red Sea, collector and date of collection unknown.
Note: All of the above are labelled "TYPE" except for D11200 which is labelled "co-type". As Dupuis did not clearly designate a type and since the above specimens were given to Ashby by him, it is likely that they are all syntypes.

Chiton tehuelchus D'Orbigny, 1841.
Voy. Amer. merid., Moll. 3(3): 488, pl. 65, figs 7-13.
=*Chaetopleura angulata* (Spengler, 1797) (ISCHNOCHITONIDAE).
Syntype: D10293, entire specimen, from Bay of San Blas, Patagonia, collector and date of collection unknown.
Note: The above specimen is from the type locality but in the absence of original labels the type status must be very doubtful.

Chiton undulatus Quoy & Gaimard, 1835.
Voy. de l'Astrolabe, Zool. 3: 393, pl. 75, figs 19-24.
=*Onithochiton neglectus* Rochebrune, 1881 (CHITONIDAE).
Syntypes: D10223, 2 entire specimens, from N.Z., collector and date of collection unknown.
Note: Specimens of very doubtful type status. The type is in MNHN and was seen by Ashby (1922). However, Quoy and Gaimard recorded several specimens but apparently did not designate a type so the above specimens could have been part of the type series.

Chiton violaceus Quoy & Gaimard, 1835.
Voy. de l'Astrolabe, Zool. 3: 403, pl. 73, figs 15-20.
=*Notoplax violaceus* (Quoy & Gaimard, 1835) (ACANTHOCHITONIDAE).
Syntype: D11054, disarticulated specimen, from N.Z., collector and date of collection unknown.
Note: A specimen of doubtful type status. The Dupuis label with the specimen has "Tasman Bay nr. Nelson" added in pencil, which is the type locality.

Cryptoplax caledonicus Rochebrune, 1882.
Bull. Soc. Philom. Paris, Ser. 7, 6: 196.
=*Cryptoplax larvaeformis* (Burrows, 1815) (CRYPTOPLACIDAE).
Paratypes: D10330, 3 entire specimens with animals, from New Caledonia, collector and date of collection unknown.
Note: A Dupuis label with the specimens designates them as "co-types" but a later Ashby collection label has the words "with TYPE" on it thus indicating that the above specimens could be paratypes.

Cryptoconchus stewartianus Rochebrune, 1882.
Bull. Soc. Philom. Paris, Ser. 7, 6: 194.
=*Cryptoconchus porosus* (Burrows, 1815) (ACANTHOCHITONIDAE).
Paratype: D11053, disarticulated specimen, from Cook Strait, N.Z., collector and date of collection unknown.
Note: The above specimen is most likely a paratype as Ashby (1926) described and illustrated it and referred to it as "one of Rochebrune's cotypes". The type, a spirit specimen, is in MNHN (Ashby 1922).

Gymnoplax spiciferus Rochebrune, 1884.
Bull. Soc. Philom. Paris, Ser. 7, 8: 36.
=*Ischnochiton (Ischnoplax) pectinatus* (Sowerby, 1840) (ISCHNOCHITONIDAE).
Syntype: D10297, 1½ median valves, from Cochino Island, Guadeloupe, collector and date of collection unknown.
Note: The above material is from the type locality and was probably part of the type series.

Lepidopleurus campbelli Filhol, 1880.
Comptes Rendus hebd. Séanc. Acad. Sci. Paris, 91: 1095.
= *Ischnochiton circumvallatus* (Reeve, 1847) (ISCHNOCHITONIDAE).
Syntype: D11022, animal and disarticulated valves, from Campbell Island, N.Z., collector and date of collection unknown.
Note: There is some doubt that this is one of Filhol's types; however, it matches the description given by Dupuis (1917) for specimen "B" of two specimens that

he regarded as type material of *L. campbelli*. There is also a radula slide with D11022 but it does not belong to the above specimen; however, the SAM register refers to two specimens one of which may have been used for the radula preparation.

Lepidopleurus cessaci Rochebrune, 1881.
Bull. Soc. Philom. Paris, Ser. 7, **5**: 118.
=*Ischnochiton cessaci* (Rochebrune, 1881) (ISCHNOCHITONIDAE).
Syntype: D10324, disarticulated specimen, from Cape Verde Island, collector and date of collection unknown.
Note: SAM records indicate that there were another 5 specimens which Ashby kept and were presumably lost in the fire at Ashby's house. The above specimen is from the type locality and was probably part of the type series.

Lepidopleurus fodiatus Rochebrune, 1881.
Bull. Soc. Philom. Paris, Ser. 7, **5**: 119.
=*Ischnochiton textilis* (Gray, 1828) (ISCHNOCHITONIDAE).
Syntype: D10286, entire specimen, from Natal, South Africa, collected by M. Verreaux, date of collection unknown.
Note: The type status of this specimen is in doubt. The label with the specimen reads "*Ischnochiton tigrinus* Krauss (co-TYPE de *Lepidopleurus fodiatus* Rocheb. Australia!!) Verreaux *Natal*?". Obviously there is some confusion regarding the locality data.

Ashby (1922) says that he has never seen this species in Australia and is confident that New Holland, the type locality, is erroneous.

Lepidopleurus melanterus Rochebrune, 1884.
Bull. Soc. Philom. Paris, Ser. 7, **8**: 37.
=*Ischnochiton circumvallatus* (Reeve, 1847) (ISCHNOCHITONIDAE).
Syntypes: D10292, 7 entire specimens with animals, from Campbell Island, N.Z., collector and date of collection unknown. D10319, one entire specimen with animal, with same collection data as D10292. D13061, one entire specimen with animal, with same collection data as D10292.
Note: The above material is from the type locality and at least D10292 could have been part of the type series. D10319 and D13061 are without the usual Dupuis label and may have been extracted from D10292.

Lepidopleurus rochebruni Jousseaume, 1893
Bull. Soc. Philom. Paris, Ser. 8, **6**: 102.
=*Callistochiton adenensis* (E. A. Smith, 1891) (CALLISTOPLACIDAE).
Syntype: D10326, one entire specimen, from Djibouti, Gulf of Aden, collector and date of collection unknown. D10342, 2 disarticulated specimens, one from Djibouti, the other from Aden, Gulf of Aden, collector and date of collection unknown.
Note: D10326 is clearly marked "cotype du Dr Jousseaume" and the specimen matches the description and the largest measurement given by Jousseaume. It is therefore most probably a syntype. The type status of D10342 is rather more doubtful.

Notochiton mirandus Thiele, 1906
Wiss. Ergebn. d. Tiefsee Exp. **9**(2): 332, pl. 29, figs 11-16.
=*Nuttallochiton mirandus* (Thiele, 1906) (ISCHNOCHITONIDAE).
Syntype: D10213, 5 median valves articulated with girdle and disarticulated anterior, posterior and median valve 2, from Antarctica, collector and date of collection unknown.
Note: Despite the fact that D10213 is clearly labelled "cotype" it cannot be Thiele's type of *N. mirandus* as Thiele mentions only one specimen and an anterior valve from east of Bouvet Island (Valdivia Stn. 127) and this specimen was several times larger than D10213.

Onithochiton filholi Rochebrune, 1881
Bull. Soc. Philom. Paris, Ser. 7, **5**: 120.
=*Onithochiton neglectus* Rochebrune, 1881 (CHITONIDAE)
Syntype: D10215, disarticulated specimen, from Cook Strait, N.Z., collector and date of collection unknown.
Note: Clearly labelled "co-TYPE de *O. filholi* Roch".

Onithochiton neglectus Rochebrune, 1881 (CHITONIDAE)
Bull. Soc. Philom. Paris, Ser. 7, **5**: 120.
Syntypes: D10221, two entire specimens with animals, without collection data.
Note: In the absence of original labels and good locality data it is difficult to ascertain the type status of the above specimens.

Schizochiton hyadesi Rochebrune, 1889
Miss. Sci. Cap. Horn **4** *Zool.*, : 132, pl. 9, fig. 1.
=*Nuttallochiton hyadesi* (Rocheburne, 1889) (ISCHNOCHITONIDAE)
Syntype: D10189, entire specimen with animal, from Terra del Fuego, collector and date of collection unknown.
Note: The type status of this specimen is very doubtful. The original label does not indicate the type status but the words "cotype-paratype" have been added in pencil on the back of the label.

Schizochiton jousseaumei Dupuis, 1917 (SCHIZOCHITONIDAE)
Bull. Mus. Natn. Hist. natr. Paris, **23**: 536, figs 1-4.
Syntypes: D10233, 2 entire specimens with animals plus one anterior valve, from the Red Sea, collected by Jousseaume, date of collection unknown. D10235, one entire specimen with animal with same collection data as D10233

Note: Although the above specimens are labelled "TYPE" it is unlikely that any of them are types as the species was based on a unique specimen which is in MNHN. The single anterior valve of D10233 is labelled "Perim", the type locality.

Tonica fontainei Rochebrune, 1882
Bull. Soc. Philom. Paris, Ser. 7, **6**: 193.
–*Ischnochiton punctulatissimus* (Sowerby, 1832) (ISCHNOCHITONIDAE)
Syntypes: D10291, 4 entire specimens with animals, 2 disarticulated specimens plus 3 end valves and 4 median valves from at least 2 specimens, from Chile, collector and date of collection unknown.
Note: The specimens are clearly marked "co-TYPE" and are probably types.

Tonicia lebruni Rochebrune, 1884
Bull. Soc. Philom. Paris, Ser. 7, **8**: 35.
Syntype: D10196, entire specimen with animal, from Patagonia, collector and date of collection unknown.
Note: The specimen is labelled "TYPE" and in the absence of evidence to the contrary it must be considered possible type material.

ACKNOWLEDGMENTS

We wish to thank the following for supplying us with information regarding types held by their respective institutions: Dr W. O. Cernohorsky, AIM; Mr I. Loch, AM; Dr B. A. Marshall, NMNZ; Mr J. Stanisic, QM; Dr A. M. Testud, MNHN and Dr F. E. Wells, WAM.

We are especially grateful to Dr M. K. Macphail who initially curated the mollusc type collection under a State Unemployment Relief Scheme. We also wish to acknowledge Mrs Jan Forrest, SAM, who took the photographs and prepared Figure 1 and Miss J. Connor who typed the manuscript.

A REVISION OF THE SOUTHERN AUSTRALIAN STARFISH GENUS NECTRIA (ASTEROIDEA: OREASTERIDAE) WITH THE DESCRIPTION OF A NEW SPECIES

BY W. ZEIDLER AND F. W. E. ROWE

Summary

The status of the genus Nectria is discussed and the genus transferred from the family Goniasteridae to the family Oreasteridae. A previously closely allied genus, Nectriaster, is also transferred to the Oreasteridae. The status of the subfamily Nectriinae is discussed and maintained for the unique genus Nectria. A new subfamily, Oreasterinae, is erected for the remaining genera of the family Oreasteridae including Nectriaster. Problems relating to Gray's (1840, 1847a, b) misunderstanding of N. ocellifera which he based on Oudart's (1827) figure of Lamarck's species are discussed and Oudart's figure is reproduced for the first time. Eight species are currently recognised including a new species from Tasmania. Each of the eight species is diagnosed and geographic ranges detailed. A lectotype is selected for N. ocellata Perrier. N. pedicelligera Mortensen is recognised as a valid species restricted to the southern Australian coast. The species potential of the genus is considered not yet to have been reached. Nectria is recognised as an endemic southern Australian genus.

A REVISION OF THE SOUTHERN AUSTRALIAN STARFISH GENUS *NECTRIA* (ASTEROIDEA: OREASTERIDAE), WITH THE DESCRIPTION OF A NEW SPECIES

by

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(Manuscript accepted 5 March 1985)

ABSTRACT

ZEIDLER, W., and ROWE, F. W. E. 1986. A revision of the southern Australian starfish genus *Nectria* (Asteroidea: Oreasteridae), with the description of a new species. *Rec. S. Aust. Mus.* 19(9): 117-138.

The status of the genus *Nectria* is discussed and the genus transferred from the family Goniasteridae to the family Oreasteridae. A previously closely allied genus, *Nectriaster*, is also transferred to the Oreasteridae. The status of the subfamily Nectriinae is discussed and maintained for the unique genus *Nectria*. A new subfamily, Oreasterinae, is erected for the remaining genera of the family Oreasteridae including *Nectriaster*. Problems relating to Gray's (1840, 1847a, b) misunderstanding of *N. ocellifera* which he based on Oudart's (1827) figure of Lamarck's species are discussed and Oudart's figure is reproduced for the first time. Eight species are currently recognised including a new species from Tasmania. Each of the eight species is diagnosed and geographic ranges detailed. A lectotype is selected for *N. ocellata* Perrier. *N. pedicelligera* Mortensen is recognised as a valid species restricted to the southern Australian coast. The species potential of the genus is considered not yet to have been reached. *Nectria* is recognised as an endemic southern Australian genus.

INTRODUCTION

Although *Nectria* is a well established southern Australian genus and is easily recognisable, there has been some confusion regarding the type species and the identity of a number of the species despite the reviews of Clark (1966) and Shepherd (1967).

We have examined all available type material for each of the species together with the collections held in the Australian Museum Sydney (AM); Museum of Victoria, Melbourne (MV) (specimens not measured); South Australian Museum, Adelaide (SAM); Western Australian Museum, Perth (WAM); Tasmanian Museum and Art Gallery, Hobart (TM); Queen Victoria Museum and Art Gallery, Launceston (QVM) (specimens not measured) and Museum of Comparative Zoology, Harvard, U.S.A. (MCZ). Following our examination of this material it is apparent that Clark (1966) and Shepherd (1967) did not appreciate the limits of the species.

We have also obtained a copy of Oudart's (1827) figure of *Asterias ocellifera* Lamarck 1816 (there is no accompanying text) which was used by Gray to identify his specimens when he established the genus *Nectria*. This figure has apparently not been sighted since Perrier (1875) and we reproduce it here (Fig. 1) in order to clarify the confused situation created by Gray's (1840, 1847a, b) use of this figure.

We are now able to recognise eight species of *Nectria* one of which is new to science. We are further able to detail the distribution of these eight species.

Nectria is transferred to the family Oreasteridae but the status of the subfamily Nectriinae is maintained.

The following additional abbreviations are used in the text.

BMNH = British Museum (Natural History)
MNHN = Museum National D'Histoire Naturelle, Paris
NSW = New South Wales
SA = South Australia
Tas = Tasmania
Vic = Victoria
WA = Western Australia

SYSTEMATICS

Family **OREASTERIDAE** Fisher, 1911

Subfamily **Nectriinae** Perrier, 1894

Genus *Nectria* Gray, 1840

Nectria Gray, 1840 (1841): 287; 1866: 15; Dujardin & Hupé, 1862: 406; Perrier, 1875: 185; 1876: 1; 1894: 333; Viguier, 1878: 187; H. L. Clark, 1946: 85; A. M. Clark, 1966: 309.

Diagnosis: An oreasterid genus with 5 tapering arms (R up to 125 mm) and relatively large disc (r up to 45 mm). Abactinal surface convex, actinal surface flat. Abactinal skeleton comprises distinctive raised tabulae each supported by 6 radiating ossicles at the base forming a network. Disc tabulae crowned with peripheral ring of usually prominant granules encircling central granules, remainder with granules of varying shape and size. Tabulae distinguished on disc, decreasing in size along arm to about ½ R after which they become unrecognisable as tabulae. Marginal plates obvious, flat, squarish, infero- and supero-marginals of similar size and number decreasing regularly in size to arm tip, covered with even-sized granules. Actinal plates up to 6-8 rows at base of rays, decreasing distally, covered with coarse granules. Adambulacral plates with furrow spines being little larger than adjacent granules on actinal plates. Papulae in discrete groups between radiating ossicles of dorsal skeleton sometimes occurring between marginal plates but rarely on actinal surface immediately below inferomarginal plates. Interradial septae partially calcified. Pedicellariae often present (Fig. 2). Superambulacral plates present.

Nectria is an endemic Australian genus occurring from the mid-west coast of Western Australia (Houtman Abrolhos) along the southern coast to Broughton I. off Port Stephens, N.S.W. in the east (Fig. 3). Records of specimens from Fiji (Sladen 1889), New Zealand (Mortensen 1925) and Mauritius (MV specimen) are erroneous. Species occur from the shoreline down to 550 m and are recorded from habitats associated with rocky reefs.

Remarks: The genus was established by Gray (1840) based on a specimen or specimens without locality data which he identified as *Asterias ocellifera* Lamarck, 1816 (as "*oculifera*" lapsus cal.) using Oudart's (1827) figure (Fig. 1) of Lamarck's species. However we have determined that of the few dried specimens of *Nectria* in the BMNH from the mid-19th century likely to have been seen by Gray (1840), none are *N. ocellifera*. One specimen in particular (BMNH: 1953: 4.27.24) (Fig. 6b) which was certainly seen by Gray "as its oldest label has '*Nectria oculifera*' stuck on the back of the board with '=*Asterias ocellifera* Lamarck' below and 'Gray' pencilled after *oculifera*" (A. M. Clark, pers. comm.) is clearly *N. ocellata*.

Thus like Perrier (1875) we conclude that Gray (1840) mistook one species for the other. Clearly Gray never saw a specimen of *N. ocellifera* for later (1847a, b) he identified a specimen as *Patiria ocellifera*, noting that he may have mis-identified the BMNH *Nectria* since he says "this species [*P. ocellifera*] more nearly resembles Oudart's figure than the species I have described under the name *Nectria oculifera*". In shape, but not structure, *N. ocellifera* resembles *P. ocellifera* more so than does *N. ocellata*. We regard Gray's (1847a) *Patiria ocellifera* another mis-identification based on Oudart's figure and not a description of a new species. However, Clark (1963) has redescribed and figured Gray's specimen of *P. ocellifera* as the holotype of that species since she does not consider Gray mis-identified the specimen.

The above confusion raises the problem of whether *ocellifera* or *ocellata* should now be the type species of the genus. Although H. L. Clark (1946) has stated "*Asterias ocellifera* is the type species of *Nectria* we concur with A. M. Clark (1966) in that "strictly speaking, *N. ocellata* Perrier might be considered as the type species since that is the one that Gray had before him when he diagnosed the genus *Nectria*, though he mistakenly identified it with Lamarck's species." According to Article 70a of the International Code of Zoological Nomenclature (ICZN) a decision on such a matter should be left to the Commission.

Nectria was first placed in the family Pentacerotidae by Gray (1840); subsequently Perrier (1875) included the genus in the Goniasteridae, dropping all reference to the Pentacerotidae. Later (1894) Perrier placed the genus in its own subfamily the Nectriinae on the basis of the distinctive tabulae. Following the examination of two specimens Fisher (1911) maintained the subfamilial status in the family Goniasteridae on the basis of the presence of intermarginal papulae which he considered a most important character; he also described the occurrences of superambulacral plates in a number of goniasterid genera including *Nectria*. Spencer and Wright (1966) uphold Nectriinae on the same basis as Fisher (1911). They include within the subfamily one other genus, *Nectriaster* H. L. Clark, 1946. However, we transfer both of these genera to the family Oreasteridae, since, like such genera as *Oreaster* and *Pentaceraster*, *Nectria* has a substantially complete calcareous interbrachial septum, and *Nectriaster* possesses a complete, calcareous interbrachial septum. The interbrachial septum of goniasterids is typically membranous. Also, in both *Nectria* and *Nectriaster*, the alignment of marginal plates, their granulose covering, and the arrangement of abactinal plates in particular, are similar to other oreasterids.

The relationship between *Nectria* and *Nectriaster* does not appear as close as that suggested by H. L. Clark (1946) and subsequent authors. Indeed the dorsal armament of *Nectriaster* is not unlike that of *Oreaster* and *Pentaceraster*, to which it may be considered more closely aligned. However, the distinctive abactinal tabulae of *Nectria* stands it apart from all other oreasterids and for this reason we prefer to retain the subfamily Nectriinae, as did Perrier, but within the family Oreasteridae. With the recognition of this subfamily for the type-genus *Nectria*, the remaining genera within the Oreasteridae should be referred (until otherwise revised) to the nominative subfamily **Oreasterinae sub.fam.nov.** which is diagnosed herein as a subfamily of Oreasteridae which lacks tabulae and for which *Oreaster* is nominated as the type-genus.

Clearly, however, the family Oreasteridae is in need of critical reappraisal.

KEY TO THE SPECIES OF *NECTRIA*

1 Intermarginal papulae present, when absent many distal arm plates enlarged 2

— Intermarginal papulae absent, distal arm plates never enlarged 5

2 Tabulae with concave aspect, with central granules lower in profile and smaller than periphals .... *N. macrobrachia*

— Tabulae with convex aspect, with central granules higher in profile and larger than peripherals 3

3 Dorsal arm plates decrease regularly in size towards arm tip; pedicellariae with slender valves .... *N. pedicelligera*

— Dorsal arm plates of mixed sizes towards arm tip, some almost as large as disc plates; pedicellariae with slender or broad valves 4

4 Furrow spines 4-6 (rarely 3 or 7); pedicellariae common with broad valves; intermarginal papulae always present .... *N. multispina*

— Furrow spines 3-4 (rarely 2) pedicellariae rare with slender valves; intermarginal papulae sometimes absent .... *N. saoria*

5 Tabulae low about 1 mm high ... *N. humilis* sp.nov.

— Tabulae well developed more than 1 mm high 6

6 Marginal plates with granules distinctly smaller than on actinal surface; tabulae with very low, flat central granules and radiating scale-like peripheral granules R/r=2.65±0.06 (±95% c.l.) .... *N. ocellifera*

— Marginal plates with coarse granules or granules similar to actinal surface; tabulae with central granules rarely flat, peripheral granules wedge-shaped sometimes radiating. If marginal plates with fine granulation and tabulae with low flat central granules, then peripherals not radiating and R/r=3.11±0.12 (±95% c.l.) .. 7

7 Tabulae with peripheral and central granules few in number (usually each <20), irregular in size and shape, round in cross-section, peripherals radiating; dorsal arm plates always indistinct distally with enlarged central granules .... *N. wilsoni*

— Tabulae with numerous peripheral and central granules (usually >20, often >30), usually regular in size and shape, peripherals forming compact ring around centrals, rarely radiating; central granules convex, usually crowded, larger than peripherals, dorsal arm plates with more or less distinct limits distally and with central granules not prominent (FORM 1); central granules irregular in size, dorsal arm plates indistinct distally with central granule or granules prominent (as in *wilsoni*) (FORM 2); central granules lower than peripherals, becoming flat in extreme cases (as in *ocellifera*), dorsal arm plates with distinct limits distally and with even granulation (FORM 3) . *N. ocellata*

Nectria ocellifera (Lamarck)
(Figs 1 & 4a)

Asterias ocellifera Lamarck, 1816: 553; 1840: 239 (part); Oudart, 1827: plate 1.

Goniodiscus ocelliferus: Müller & Troschel, 1842: 60.

Nectria ocellifera: Dujardin & Hupé, 1862: 406; Perrier, 1869: 283; 1875: 187; 1876: 3; H. L. Clark, 1914: 139; 1916: 35; 1928: 379 (key); 1946: 86; Shepherd, 1967: 464, fig. 3 (part); Marsh, 1976: 217 (table).

Nectria ocellata: Shepherd, 1967: 467 (part).

Material examined: Holotype, MNHN; ECAS 670 (R/r=55/20 mm), mers australes?, Péron et Lesueur, 1803 (Shepherd (1967) has suggested that the type probably came from Geographe Bay, W.A.).

In addition 65 specimens from WAM, 3 specimens from AM and one specimen from MCZ.

Diagnosis: R up to 75 mm, r up to 30 mm. R/r=2.65±0.06 (±95% c.l.). Tabulae with central granules irregular in size and shape, flat, very low in profile (approx. 0.2 mm above tabula), slightly spaced, angular in cross-section. Peripheral granules radiating, about twice as long as wide, up to 1 mm high, thin, scale-like, tapering to rounded tip. Tabulae more or less confined to disc. Dorsal arm plates slightly convex, decreasing in size towards arm tip, with low granules giving smooth covering, peripheral granules reduced not distinctive, centrals larger than peripherals, limits of plates distinct to naked eye. Marginal plates distinct, granules of similar size to each other, close but not compact, distinctly smaller than those on actinal or abactinal surfaces. Actinal plates up to 6 rows proximally. Furrow spines 2-4. Subambulacral spines 3-4 on first row and 2-3 on second row. Papulae numerous dorsally extending almost to arm tips, absent intermarginally and actinally. Pedicellariae absent. Colour red or orange according to Clark (1946), or pale pink to pale orange-pink (L. M. Marsh, pers. comm.).

Remarks: The form and granulation of the tabulae (Fig. 4a), the distribution of the papulae, the fine granulation of the marginal plates and the relationship of R/r gives this species a particularly characteristic appearance. The relationship of this species with extreme forms of *N. ocellata* from the Great Australian Bight are discussed under that species.

On the basis of a poorly preserved specimen (WAM; 9676, R/r=35/14 mm) from Bald I., near Albany, W.A. in 51.2-64 m, which we recognise as *ocellifera*, we extend the range of the species to the south coast of W.A., otherwise all known specimens have been collected between Geraldton and Cape Naturaliste, W.A., in depths of 45-180 m. The specimen from Bald I. was identified by Shepherd (1967) as *N. ocellata*.

Distribution: Geraldton to Bald I., near Albany, W.A.; 45-180 m (Fig. 3a).

Nectria ocellata Perrier
(Figs 2a & 4b-8a)

Asterias ocellifera Lamarck, 1816: 553 (part); 1840: 239 (part).

Nectria oculifera (lapsus cal. for *ocellifera*): Gray, 1840: 287.

Nectria ocellifera: Gray, 1866: 15; Sladen, 1889: 319, pl. 55, figs 1-7; H. L. Clark, 1909: 529.

Nectria ocellata: Perrier, 1875: 188; 1876: 4; H. L. Clark, 1916: 34; 1928: 378 (part), 379 (key); 1938: 78; 1946: 85; Cotton & Godfrey, 1942: 197 (part); A. M. Clark, 1966: 313, 315 (table-part), pl. 2, fig. 3; Shepherd, 1967: 468 (part), fig. 4; 1968: 738 (part); Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 406 (part); fig. 10.4a.

Nectria multispina: Shepherd 1967: 468 (part).

Material Examined: Lectotype (designated herein), BMNH; 1958: 7.30.20 (R/r=68/23 mm), Tasmania, purchased E. Gerrard jun. One specimen BMNH, 1953: 4.27.24 (R/r=53-56/16 mm), without data.

In addition 98 specimens from AM, 38 specimens from MV, 36 specimens from TM, 18 specimens from

SAM, 15 specimens from MCZ, 7 specimens from QVM and 4 specimens from WAM.

Diagnosis: R up to 125 mm, r up to 45 mm. R/r=2.97±0.05 (±95% c.l.). Tabulae with central granules of similar size and shape, close but usually not compact, rounded to angular in cross-section, rarely lower than peripherals. Peripheral granules of similar size to each other, usually smaller than centrals, wedge-shaped, forming more or less compact ring around centrals, tending to radiate in some specimens. Tabulae varying from flat to convex, extending beyond disc to about ⅓ R. Dorsal arm plates usually convex sometimes flat, decreasing regularly in size towards arm tip, peripheral granules becoming indistinct, central granules often enlarged and prominent giving plates rough appearance, limits of plates varying from distinct to indistinct to naked eye. Marginal plates distinct, granules of similar size to each other, convex, close but not compact, similar to those on actinal surface. Actinal plates up to 8 rows proximally. Furrow spines 2-4 (rarely 5). Subambulacral spines 1-3 on first and second row. Papulae numerous dorsally extending almost to arm tips, absent intermarginally and actinally. Pedicellariae with 3-4 (rarely 2 or 5) usually elongate valves (Fig. 2a), common on all surfaces, frequently replacing subambulacral spines. Colour uniformly brick red to orange, sometimes mottled with lighter and darker coloured tabulae.

Remarks: This is the most variable and frequently mis-identified species of *Nectria*. This has been so since Gray (1840) originally mis-identified the species as *ocellifera* Lamarck. Perrier (1875) examined a number of specimens in the BMNH, all apparently from northern Tas. and concluded that Gray mis-identified *ocellifera* of Lamarck and proposed the name *ocellata*. We have examined 3 historical specimens each of which was possibly examined by Gray and subsequently Perrier (A. M. Clark, pers. comm.), of these one specimen (BMNH; 1846.8.3.14) we identify as *N. pedicelligera* (Fig. 9a) (see p. 000), of the other two, one (BMNH; 1958.7.30.20) has tabulae and tabular granulation conforming closely to Perrier's description and this specimen we nominate as a lectotype for the species *ocellata* (Fig. 4b). We have rejected the second specimen (BMNH; 1953.4.27.24) (Fig. 6b) as a possible lectotype or paralectotype, even though Perrier probably saw it, as the tabulae and tabular granulation does not conform to Perrier's description of *N. ocellata*, and we are therefore uncertain that it qualifies as a type specimen. Perrier (1875) also refers to a poor specimen in the MNHN which he was unable to determine. This specimen (ECAS 668) which may have been seen by Lamarck and identified as *ocellifera* has been labelled as a type of *ocellata* which it clearly is not as the species description of *ocellata* was based on the material in the BMNH.

Following our examination of 218 specimens from southern and south-eastern Australia we have recognised 3 more or less intergrading forms within the species *ocellata*.

The first form conforms most closely with the lectotype in that the tabulae are slightly convex and covered with even sized granules (Figs 5a, b). This form has its centre of distribution at the eastern and north coast of Tas. extending north to Port Jackson, N.S.W. and west to Phillip I. Vic. and is found in very shallow water from the shoreline down to 20 m (Fig. 3b).

Along the east coast of Australia we recognise a second form with tabulae with central granules which become shorter than the peripheral granules, the latter radiating giving the tabula a flatter appearance and with dorsal arm plates which frequently possess enlarged central granules giving the arms a rough texture (Figs 5c, 6a) similar to that of *wilsoni* from W.A. This form is distributed between Broughton I., off Port Stephens, N.S.W. and Erith I., Bass Strait, but has a greater depth range than form 1 occurring in 0-90 m (Fig. 3b).

The third form (Figs 6b-d; 7a) has tabulae with central granules distinctly shorter than the radiating peripherals, becoming flattened and *ocellifera*-like at the extreme western end of their range (Figs 7b; 8a). The dorsal arm plates have an even covering of granules and the limits of the plates are relatively distinct. We do not identify the specimens from the Great Australian Bight with *ocellifera* because of the elongate arms and the smaller size and distribution of the tabulae despite the fact that the marginal granulation is finer than the actinal granulation. These extreme variants may point to a relationship between *ocellata* and *ocellifera* which is not obvious when comparing *ocellifera* from W.A. (Fig. 4a) with typical *ocellata* from Tas. (Fig. 5a). The relationship between *ocellata* and *ocellifera* can only be resolved satisfactorily when more specimens from the Great Australian Bight become available.

Form 3 extends from south-eastern Tas. west to the Great Australian Bight (125°30'E) occurring in depths of 5-230 m (Fig. 3b).

Although form 1 clearly intergrades with form 2 along the east coast and with form 3 along the south coast, forms 2 and 3 are easily separable and may have originated as a result of the Pleistocene land bridge between Vic. and Tas. separating the two populations which then developed their different characteristics.

Along the NSW coast, at least as far south as Eden, *N. ocellata* is the only known species of *Nectria* so that its identity has not been confused. However, along the south coast the species most often confused with *ocellata* is *pedicelligera* (Figs 9b; 10a) which most resembles our form 3 and can most easily be distinguished from it by the presence of intermarginal papulae.

Of the first 13 records of *ocellata* listed by Clark (1966, table 3) at least two (BMNH; 1862.7.9.51 and -52) from W.A. and Dirk Hartog I. (Shark Bay, W.A.)

respectively are unlikely to be *ocellata*. Further we doubt the likelihood of Dirk Hartog I. as a locality from which *Nectria* would have been collected.

Shepherd (1967) records a juvenile specimen from Caloundra, Queensland; we have examined this specimen and confirm its identity but consider the locality data to be erroneous.

Distribution: Western end of the Great Australian Bight (125°30′E) through Bass Strait south along the eastern coast of Tas. and north along the N.S.W. coast to Broughton I.; intertidal to 230 m (Fig. 3b).

Nectria macrobrachia H. L. Clark
(Figs 2b & 8b, c)

Nectria macrobrachia H. L. Clark, 1923: 236, pl. 13, figs 5-6; 1928: 379 (key); 1946: 86; A. M. Clark, 1966: 311, pl. 3, figs 2-3, text fig. 2; Shepherd, 1967: 474, fig. 2 (part); 1968: 738; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 406, fig. 10.4e.

Material Examined: Holotype, BMNH, 1929.6.12.1 (R/r=60/17 mm), Pelsart Group, Houtman Abrolhos, shore, Prof. Dakin.

In addition 32 specimens from WAM, 23 specimens from SAM and 20 specimens from A.M.

Diagnosis: R up to 75 mm, r up to 21 mm. R/r=3.47±0.08 (±95% c.l.). Tabulae with central granules irregular in size and shape, flat, low in profile, close but not compact, angular in cross-section. Peripheral granules of similar size to each other, conspicuously larger than centrals, sometimes radiating particularly in deep-water specimens (Fig. 8c), generally wedge-shaped, raised well above centrals to form concave tabulae. Tabulae low, crowded extending beyond disc to about ⅓ R. Dorsal arm plates flat, decreasing regularly in size towards arm tips, peripheral granules becoming indistinct from centrals, limits of plates indistinct to naked eye. Marginal plates relatively indistinct due to close, even covering of granules, similar to those on actinal surface. Actinal plates up to 3 (rarely 4) rows proximally. Furrow spines 2-3. Subambulacral spines 2-3 in first and second row. Papulae numerous dorsally extending to arm tips also present intermarginally and actinally. Pedicellariae with 3-4 broad valves (Fig. 2b) resembling those of *N. multispina*, rarely present, occurring at least on actinal and abactinal surface. Colour light yellow to orange, brown or even pink with peripheral granules on tabulae lighter and arm tips darker than rest of body (Shepherd 1967).

Remarks: The form and granulation of the tabulae (Figs 8b, c) and the distribution of the papulae easily separates this species from others in the genus.

Distribution: Houtman Abrolhos, W.A. to Wilson's Promontory, Vic. and Erith I., Bass Strait, but has not been recorded from Tas.; intertial to 180 m (Fig. 3c). We have been unable to substantiate the depth record of 350 m given by Shepherd (1967) which we consider to be a misprint.

Nectria pedicelligera Mortensen
(Figs 2c, 9 & 10a, b)

?*Chaetaster munitus*, Möbius, 1859: 3, pl. 1, figs 1-2.
Nectria sp. Fisher, 1911: 163; H. L. Clark, 1914: 140.
Nectria pedicelligera Mortensen, 1925: 291, pl. 13, figs 5-6, text fig. 9; H. L. Clark, 1928: 370 (key); A. M. Clark, 1966: 315 (table); Shepherd, 1967: 478.
Nectria ocellata: H. L. Clark, 1928: 378, 379 (key); A. M. Clark, 1966: 315 (table-part), pl. 2, fig. 4; Shepherd, 1967: 465 (part); Zeidler & Shepherd; 1982: 406 (part); fig. 10.4b.
Nectria multispina: Cotton & Godfrey, 1942: 197; A. M. Clark, 1966: 314 (part); Shepherd, 1967: 468 (part), fig. 3 (part).

Material Examined: Holotype, Otago Museum; A 53-47 (R/r=53/18 mm), Gisborne, east coast North I., New Zealand, H. Suter? (see remarks). One specimen, BMNH; 1846; 8.3.14 (R/r=55/18 mm), Flinders I., Tasmania, Lord Stanley.

In addition 146 specimens from SAM, 26 specimens from MV, 25 specimens from AM, 11 specimens from WAM, 4 specimens from MCZ and 2 specimens from TM and QVM.

Diagnosis: R up to 120 mm, r up to 36 mm. R/r=3.16±0.04 (±95% c.l.). Tabulae with central granules of similar size and shape, close or compact, angular in cross-section, larger than peripherals. Peripheral granules of similar size to each other, wedge-shaped, forming a more or less compact ring around centrals, rarely radiating. Tabulae slightly convex, rarely flat, extending beyond disc for up to ½ R. Dorsal arm plates more or less flat, decreasing regularly in size towards arm tip, peripheral granules becoming indistinct, central granules similar to peripherals or enlarged and prominent giving plates rough appearance, limits of plates indistinct to naked eye. Marginal plates distinct, granules of similar size to each other, convex, close but not compact, coarse, similar to those on actinal surface. Actinal plates up to 7 rows proximally, coarsely granulated. Furrow spines 3-4 (sometimes 5, rarely 6). Subambulacral spines 2-3 on first row and 3-4 (rarely up to 6) on second row. Papulae numerous dorsally extending almost to arm tips, also present intermarginally but rarely actinally. Pedicellariae with 3-5 (rarely 6) very slender valves (Fig. 2c), valves particularly slender on actinal surface, usually common on all surfaces and often replacing a subambulacral spine on the adambulacral plates. Colour uniformly brick red to orange, often mottled with lighter coloured tabulae, especially at the base of the arms.

Remarks: This is the first time that this species has been fully recognised since Mortensen (1925) described it, from Gisborne, New Zealand. However, according to A. N. Baker (pers. comm.), despite extensive collecting efforts in New Zealand particularly off Gisborne, no species of *Nectria* have ever been recovered. We therefore believe the New Zealand record to be an error and we recognise it as an endemic southern Australian species. This species is now known to range from Denmark, W.A. to Eden, N.S.W. including the north coast of Tas. and is a shallow-water species occurring in 0-20 m.

This species has been confused most frequently with *ocellata* and *multispina*. This confusion has probably arisen because previous authors have not examined the type of *pedicelligera* thus not appreciating it as a southern Australian species believing it to be endemic to New Zealand. *N. pedicelligera* is distinguished from *ocellata* by the intermarginal papulae, often the presence of a rosette of 6 prominent tabulae at the base of the arms and the more regular form of the granulation (Figs 9a, c; 10a). Superficially it resembles some specimens of *multispina* (Fig. 10b) however, *multispina* differs in the form of its granulation, the enlarged plates extending along the arm, the consistently higher number of furrow spines and the much broader valved pedicellariae.

We have examined the specimen from Westernport, Vic. (MCZ, 1932), described by Fisher (1911) and examined by Clark (1914) and have identified it as *pedicelligera*. The holotype of *Chaetaster munitus* Möbius 1859 is presumed lost as it is not in the Kiel museum (Shepherd 1967) and was not found by one of us (F.W.E.R.) in the Hamburg museum. However, the figure given by Möbius (1859) is most like *pedicelligera*, particularly in the arrangement of the tabulae and their granulation. The apparent absence of pedicellariae with large valves on the actinal surface also excludes it from *multispina* with which Clark (1966) and Shepherd (1967) thought it was conspecific. In order to maintain stability and due to the inadequate description given by Möbius and the loss of type material we agree with Clark (1966) that the name *Chaetaster munitus* be treated as a nomen oblitum, such action however requires a case to be put to the ICZN (article 23b).

The three specimens (BMNH; 1862.1.8.10 & 11; 1846.8.3.14) recorded by A. M. Clark from Tas. (1966, table 3) as "intermediate between *ocellata* and *multispina*" we identify as *pedicelligera*.

Distribution: Denmark, W.A. to Eden, N.S.W. including Bass Strait and the north-west of Tas.; intertidal to 20 m (Fig. 3d).

Nectria multispina H. L. Clark
(Figs 2d, 10c & 11a)

Nectria multispina H. L. Clark, 1928: 375, figs 111a-b; 1938: 77, 1946: 86; Cotton & Godfrey, 1942: 197 (part); A. M. Clark, 1966: 314, 315 (table-part), pl. 2, figs 1-2; Shepherd, 1967: 468 (part); 1968: 739; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 406, figs 10.4c, d.

Material Examined: Holotype, SAM; K50 (R/r = 80-85/30-32 mm)? S.A., probably Spencer Gulf or Gulf St Vincent, H. L. Clark (1928); 2 paratypes, SAM; K52 (R/r = 56/19, 51/17 mm) without locality data, J. C. Verco Feb 1891; paratype, MCZ 2904 (R/r = 60/19 mm) with same data as K52.

In addition 22 specimens from SAM, 7 specimens from AM, 4 specimens from WAM and one specimen from MV.

Diagnosis: R up to 102 mm, r up to 34 mm. R/r = 3.01 ± 0.08 (±95% c.l.). Tabulae with central granules irregular in size with central ones being larger than those at periphery, very compact giving central tabulae smooth convex appearance, angular in cross-section, all larger than peripherals. Peripheral granules of similar size to each other forming distinct compact ring around centrals. Tabulae appear to extend to arm tips but from ⅓ R become indistinguishable from convex plates, interspersed with smaller, flatter plates. Dorsal arm plates with granules maintaining their relative sizes but peripherals becoming less distinct than on disc, limits of plates distinct to naked eye. Marginal plates distinct, granules often similar in size, sometimes the peripherals are noticeably smaller, close, sometimes compact, similar in size to those on actinal surface. Actinal plates up to 6 rows proximally. Furrow spines 4-6 (rarely 3 or 7). Subambulacral spines 3 (rarely 4) in first row, 3-8 in second row. Papulae numerous dorsally, extending to arm tips, also present intermarginally, absent actinally. Pedicellaraie with 3-4 (rarely 2) distinctive broad valves (Fig. 2d), common on all surfaces but particularly characteristic of first actinal row of plates. Colour orange to brick red, mottled with darker tabulae, often only some of the central granules of the tabulae are darker.

Remarks: This is a clearly defined species easily distinguished by the form of the tabulae, the distinctive pedicellariae and the consistently high number of furrow spines (Figs 10c; 11a). Although *multispina* has not been confused with other species it is clear that other species have been confused with *multispina* due to a lack of understanding of the limits of each of the species of *Nectria*. *N. ocellata* and *N. pedicelligera* have been the species most frequently confused with *multispina* and this is discussed under those species.

Of the 9 lots of specimens referred to *multispina* by Clark (1966, table 3) only the type specimens and specimens under the number BMNH; 1962.4.97 are *multispina*.

The species which most resembles and appears most closely related to *multispina* is *saoria*, particularly in the arrangement of the tabulae and dorsal arm plates. However it is clearly distinguished by its smaller disc, the consistently fewer furrow spines and the absence of the characteristically large pedicellariae found in *multispina*.

Distribution: Shoalwater Bay, near Cape Peron, south of Fremantle, W.A. to Wilson's Promontory, Vic.

but not from Bass Strait or Tas., intertidal to 20 m (Fig. 3a).

Nectria wilsoni Shepherd & Hodgkin
(Figs 2e, 11b & 12)

Nectria wilsoni Shepherd & Hodgkin, 1965: 119, fig. 1; Shepherd, 1967: 474; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 408, fig. 10.4e.

Nectria ocellata: A. M. Clark, 1966: 315 (table-part), pl. 1, figs 4-6; Shepherd, 1967: 465 (part).

Material Examined: Holotype, WAM; 3-65 (R/r = 77/26 mm), Sorrento Beach, W.A. 1.8 m, B. R. Wilson, 27. I.1963; paratype, WAM; 18-59 (R/r=63/20 mm), Eagle Bay, Cape Naturaliste, W.A., 9.2 m, B. R. Wilson & L. Marsh, 27.XII.1958; paratype, WAM; 19-59 (R/r=75/25 mm), Dunsborough, W.A., 9.2 m, B. R. Wilson & L. Marsh, 25.XII.1958; paratype, WAM; 2-62 (R/r=88/31 mm), Hamelin Bay near Cape Leeuwin, W.A., on jetty piles, B. R. Wilson & R. Slack-Smith, 30.XII.1961; paratype, WAM, 1-65 (R/r=56/19 mm), Dunsborough, W.A., 16.9 m on rock, B. R. Wilson, 15.IV.1963; paratype, WAM; 2-65 (R/r=90/34 mm) Sorrento Reef near Fremantle, W.A., on sea grass, B. R. Wilson; paratype, WAM; 4-65 (R/r=90/30 mm) Sorrento Reef, W.A., B. R. Wilson, 21.XII. 1963; paratype, WAM; 5-65 (R/r=83/27 mm) Sorrento beach, W.A., 5.5 m on sea grass near limestone, B. R. Wilson, 23.XI. 1963; paratype, WAM; 3-62 (R/r=120/45 mm), off Beagle Island (29°50'S), W.A., Poole Brothers, Mar. 1961; paratype, SAM; K613 (R/r=69/22 mm) Hall Bank near Fremantle, W.A., B. R. Wilson, 1.II.1963.

In addition 40 specimens from WAM, 9 specimens from SAM and 7 specimens from AM.

Diagnosis: R up to 120 mm, r up to 40 mm. R/r=3.08±0.06 (±95% c.l.). Tabulae with central granules irregular in size and shape, a mixture of granules larger and smaller than peripherals, markedly convex, raised well above tabula, well spaced (rarely crowded), round in cross-section. Peripheral granules radiating, irregular in size and shape, but forming distinct peripheral ring. Tabulae more or less confined to disc. Dorsal arm plates, flat decreasing in size towards arm tip, with very coarse granulation. 1 or 2 central granules on each plate often enlarged and prominent, limits of plates indistinct to naked eye. Marginal plates distinct, granules coarse, spaced, some central ones very large similar to dorsal arm plates. Actinal plates up to 7-8 rows proximally. Furrow spines 3-4 (rarely 2). Subambulacral spines 2-3 on first and second row. Papulae numerous dorsally extending rarely beyond ½ R, absent intermarginally and actinally. Pedicellariae with 4-5 (rarely 3, 6 or 7) slender valves (Fig. 2e), usually present on all surfaces, some specimens without.

Colour deep orange to magenta, papular area lighter (Shepherd and Hodgkin 1965).

Remarks: Despite some confusion between this species and *ocellata* the large and irregular granules of the tabulae, marginals and arm plates particularly make *wilsoni* a very distinctive species (Fig. 11b). The granulation of this species is very variable (Fig. 12). It is interesting to note that some N.S.W. specimens of *ocellata* (Fig. 6a) resemble *wilsoni* in that the granules become irregular. However, the tabular granulation is much finer and the granules are more numerous in the N.S.W. specimens so that these two widely geographically separated species are not confused. We agree with Shepherd (1967) that the three specimens (WAM: 18.59; 19.59 & 2.62) recorded by Clark (1966, table 3) as being "affiliated to *ocellata*" are *wilsoni*. The species is now extended in range eastward across the Great Australian Bight to Cape Jervis, S.A.

Distribution: Beagle I., W.A. to Cape Jervis, S.A.; intertidal to 44 m (Fig. 3f).

Nectria saoria Shepherd
(Figs 2f & 13a)

Nectria saoria Shepherd, 1967: 475, fig. 2 (part); 1968: 739; Marsh, 1976: 217 (table); Zeidler & Shepherd, 1982: 408, fig. 10.4.f.

Nectria multispina: A. M. Clark, 1966: 315 (table-part).

Material Examined: Holotype, SAM; K670 (R/r=56/15 mm), submerged limestone reef between Wright I. and The Bluff, Encounter Bay, S.A., 10 m, S. A. Shepherd, 8.VI.1963; 4 paratypes, SAM; K628 (R/r=56/15, 53/16, 50/13, 47/14 mm), collected with type; 3 paratypes, SAM; K627 (R/r=61/16, 52/15, 40/13 mm), West I., Encounter Bay, S.A., 10 m, S. A. Shepherd, 23.VIII.1964; paratype, SAM; K656 (R/r=65/17 mm) collected with type; paratype, SAM; K658 (R/r=64/20 mm), limestone reef between Thistle and Hopkins I., Spencer Gulf, S.A., 10 m., S. A. Shepherd, Jan. 1964; paratype, WAM 8-64 (R/r=60/17 mm), Hamelin Bay near Cape Leeuwin, W.A., B. R. Wilson and R. Slack-Smith, 30.XII.61.

In addition 24 specimens from SAM, 23 specimens from WAM, 7 specimens from MV and 6 specimens from AM.

Diagnosis: R up to 83 mm, r up to 28 mm. R/r=3.49±0.09 (±95% c.l.). Tabulae with central granules similar in size, sometimes 1-2 very large granules but these usually mixed with smaller ones, compact giving tabulae convex appearance, angular in cross-section, all larger than peripherals. Peripheral granules slightly irregular in size forming an irregular peripheral ring. Tabulae appear to extend to arm tips but from about ⅔ R become indistinguishable from convex plates; interspersed with smaller plates. Dorsal arm plates with granulation similar to disc but more compact giving the larger distal plates a smoother aspect, limits of plates distinct to naked eye. Marginal plates distinct, granules often similar in size to each other, close, sometimes compact, similar in size to those on actinal surface. Actinal plates up to 2-3 rows proximally. Furrow spines 3-4 (rarely 2). Subambulacral spines 2-3 in first row, 2-4 in second row. Papulae numerous dorsally, extending to arm tips, less common and sometimes absent intermarginally, absent actinally. Pedicellariae with 3-5 (rarely 2 or 6) elongate valves (Fig. 2f), common abactinally, less common or absent marginally and actinally. Colour bright red, papulae black (Shepherd 1967).

Remarks: This distinctive species (Fig. 13a) has been adequately described by Shepherd (1967) and its relationship to *multispina* has been discussed under that species. Prior to Shepherd's description of this species it has been identified with *multispina*.

Of the 9 lots of specimens referred to *multispina* by Clark (1966, table 3) those from Rottnest I., Albany and Recherche Archipelago are *saoria* as suggested by Shepherd (1967).

Distribution: Off Perth and Rottnest I., W.A. to Encounter Bay, S.A. intertidal to 25 m (Fig. 3g).

Nectria humilis sp.nov.

(Figs 2g; 13b & 14)

Material Examined: Holotype, TM; H 1476, 80 km west of Woolnorth, north-west Tas., 550 m, A. McGifford ("Sea Fisheries"), 28.II.1979; paratype, TM; H 1844, collected with holotype; 7 paratypes, AM; J 18467, labelled "80/130 off Storm Bay near Tamar River 25-30 fms" (approx. 45-55 m), no other data.

Description: The holotype (Fig. 13b) measures R/r=53-58/17.5 mm; br=22 mm. Arms taper regularly to narrow tip. Abactinal tabulae low not more than 1 mm high, very slightly convex, longitudinally ovate up to 3.5×2.9 mm, spaced, arranged in a carinal row with two dorsal lateral rows to about ½ R, a third dorsal row of plates also extends to about ½ R, beyond ½ R the tabulae become indistinguishable from arm plates, tabulae/arm plates decrease regularly in size distally. Tabulae with central granules of even size, convex, low, angular in cross-section, peripheral granules marginally smaller than centrals forming compact ring around centrals. Marginal plates distinct, 22-23 supero- and infero-marginal plates with an even covering of small granules (approx. 7 granules/2 mm), finer than those on actinal plates. Actinal plates of 6 rows proximally, the first row extends almost to arm tip (to 17th infero-marginal plate) the second, third and fourth row extend to the 5th, 3rd and 2nd inferomarginal plates respectively, the fifth and sixth row do not extend beyond the 1st inferomarginal plate. Actinal plates covered with coarse, spaced granules (approx. 5 granules/2 mm). Adambulacral plates with 3-4 furrow spines, where there are 4 the first one is smallest otherwise the other 3 are similar in size to each other. Subambulacral spines, 3 on first row, about half-length of furrow spines; 3 on second row, barely indistinguishable in size from adjacent actinal granulation. Oral plates with 8 furrow-spines, 4 subambulacral spines and 7-8 low spines/granules on actinal surface of plate. Papulae abundant dorsally in discrete groups of 8-10, confined by the skeletal reticulum, absent intermarginally and actinally. Pedicellariae absent. Colour unknown (white in alcohol).

The paratype (Fig. 14) (TM: H 1844) measures R/r=46-51/17-19 mm; br=23 mm. Essentially similar to holotype differing only in having stouter arms.

The seven paratypes (AM; J 18467) range in size from R/r=66/18 mm to R/r=48/25.5 mm and differ from the type only in the presence of pedicellariae which occur on the dorsal and actinal surfaces, but are most common on the adambulacral plates. Pedicellariae with 3-4 valves, triangular in shape, about twice as long as wide (Fig. 2g).

Etymology

From the Latin *Humilis*=low, referring to the very low tabulae.

Remarks: This species stands apart from other species of *Nectria* by the granulation and form and arrangement of the dorsal tabulae. The only other species with such low tabulae is *macrobrachia*, but in this species the tabulae are close-packed and transversely hexagonal or ovate, the granulation is quite distinctive and the distribution of papulae immediately separates the two species. Amongst the species in which the papulae are restricted to the dorsal surface, *humilis* is most closely related to *ocellata*. However, the tabulae of *ocellata* never become as low, or the granulation covering the tabulae as even, as in *humilis*.

It is unfortunate that the data with the 7 paratypes is ambiguous as the Tamar River is in the mid-north of Tas. and the only known Storm Bay is that near the mouth of the Derwent in south-eastern Tasmania (Fig. 3h).

CONCLUDING REMARKS

In the most recent revision of the Asteroidea, *Nectria* has been allied with *Nectriaster* in the subfamily Nectriinae of the family Gonasteridae. However, we have concluded that skeletal features, including particularly the calcified form of the interbrachial septum, show that these genera are better placed in the family Oreasteridae. We have further concluded that *Nectria*, by virtue of its abactinal tabulae, stands apart from all other genera in that family. We prefer to recognise this isolation by maintaining the status of the subfamily Nectriinae from which *Nectriaster* is excluded. All other genera within the family Oreasteridae are referred to the new subfamily Oreasterinae.

Within the genus *Nectria* we have found the presence or absence of intermarginal papulae to be a very useful and consistent character for all of the species except *saoria*. This character in combination with the form of abactinal and marginal granulation and the form of the pedicellariae have enabled us to determine the limits of the species.

We have determined that *Nectria* is an endemic southern Australian genus and that records from Fiji (Sladen 1889), New Zealand (Mortensen 1925) and Mauritius (MV specimen) are erroneous.

Regarding the origin of the genus *Nectria* in Australia, lack of fossil material prevents us from determining its evolutionary or temporal origin. From our knowledge of the species distributions we would infer that the genus arose in south-western Australia and distributed along the south coast; this is consistent with our present knowledge of major ocean currents in southern Australia. However, only one species, *N. ocellata,* has been successful in reaching the N.S.W. coast. Considering our interpretation of the complexity of this species we conclude that the full potential for speciation in the genus *Nectria* has not yet been realised.

ACKNOWLEDGMENTS

We would like to thank Miss A. M. Clark, British Museum (Natural History), London; Miss A. Green and Mrs E. Turner, the Tasmanian Museum and Art Gallery, Hobart; Dr A. Guille, Museum National d'Histoire Naturelle, Paris; Dr A. C. Harris, Otago Museum, Dunedin, New Zealand; Mrs L. M. Marsh, Western Australian Museum, Perth and Dr R. Woollacott, Museum of Comparative Zoology, Harvard, U.S.A. for the loan of material. Collections have also been examined in the Museum of Victoria and the Queen Victoria Museum and Art Gallery, Launceston by the authors access to which was given by Sue Boyd and Bob Green who are respectively thanked.

Miss A. M. Clark and Mrs L. M. Marsh also kindly reviewed the manuscript and made helpful suggestions.

The photographs were taken by Miss H. McClelland of The Australian Museum, who is duly acknowledged. Ms J. M. Thurmer of the South Australian Museum prepared Fig. 3. We are especially grateful to Dr D. Kuhlmann, Museum fur Naturkunde der Humboldt—Universitat, Berlin, DDR, for supplying us with copies of Oudart's figure.

The Mark Mitchell Research Foundation is acknowledged for granting financial assistance to one of us (W.Z.) for travel to Sydney to complete the study.

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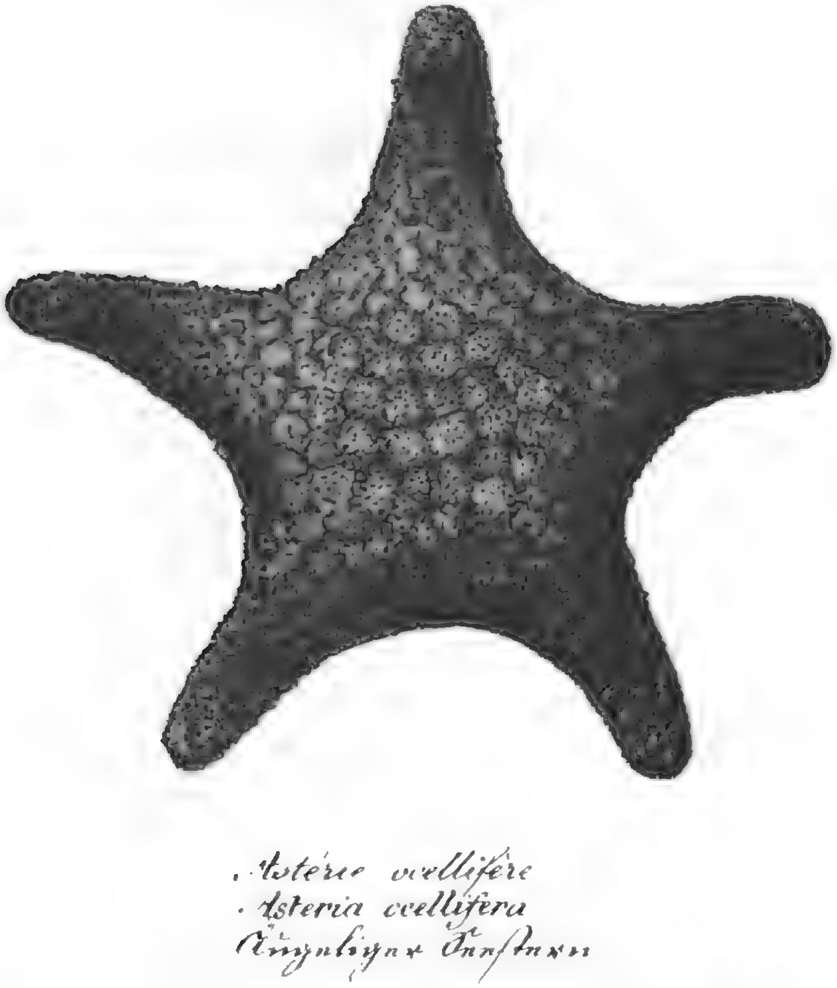

FIG. 1. Oudart's (1827) figure of *N. ocellifera* Lamarck.

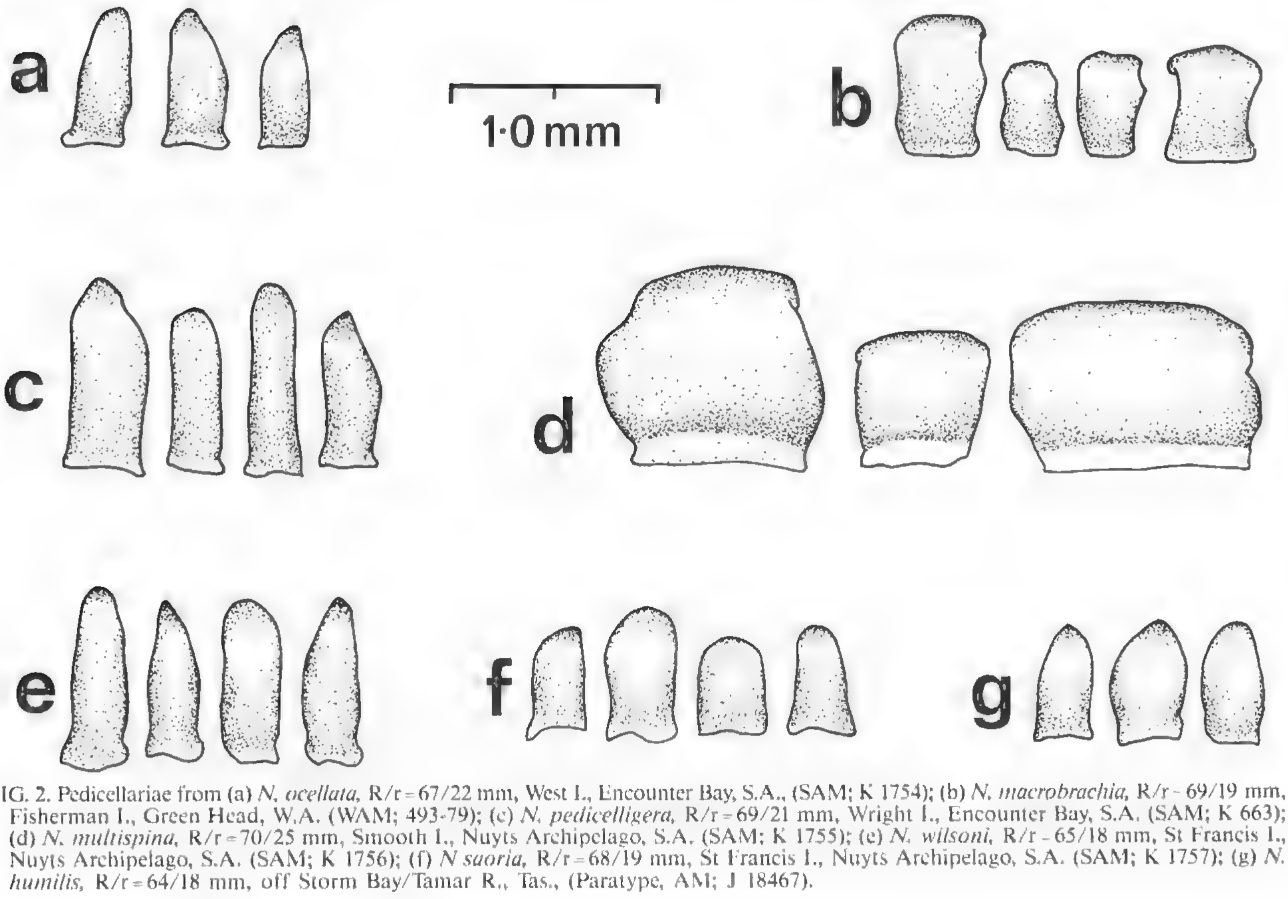

FIG. 2. Pedicellariae from (a) *N. ocellata*, R/r = 67/22 mm, West I., Encounter Bay, S.A., (SAM; K 1754); (b) *N. macrobrachia*, R/r - 69/19 mm, Fisherman I., Green Head, W.A. (WAM; 493-79); (c) *N. pedicelligera*, R/r = 69/21 mm, Wright I., Encounter Bay, S.A. (SAM; K 663); (d) *N. multispina*, R/r = 70/25 mm, Smooth I., Nuyts Archipelago, S.A. (SAM; K 1755); (e) *N. wilsoni*, R/r - 65/18 mm, St Francis I., Nuyts Archipelago, S.A. (SAM; K 1756); (f) *N saoria*, R/r = 68/19 mm, St Francis I., Nuyts Archipelago, S.A. (SAM; K 1757); (g) *N. humilis*, R/r = 64/18 mm, off Storm Bay/Tamar R., Tas., (Paratype, AM; J 18467).

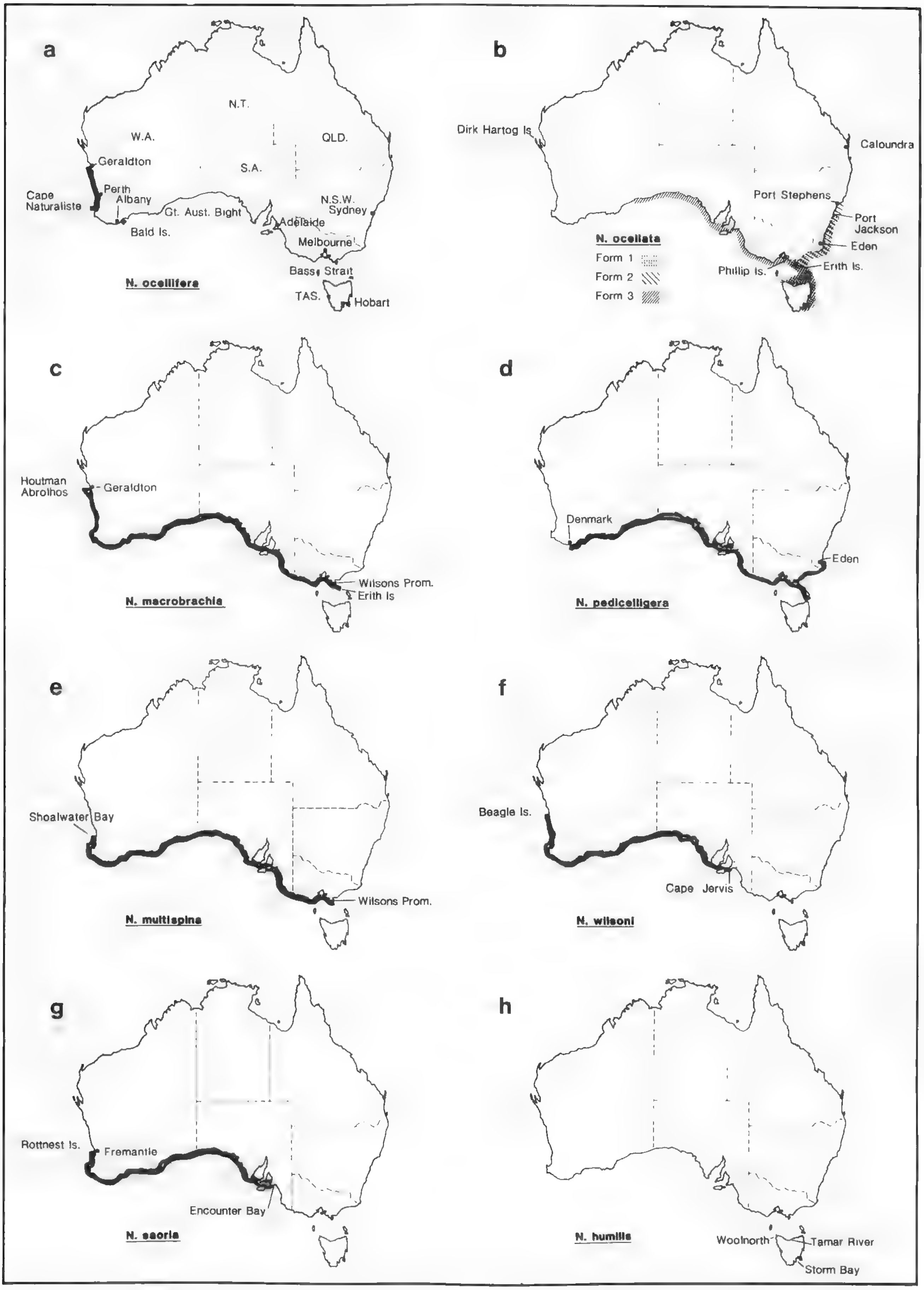

FIG. 3. Maps showing distribution of *Nectria* species.

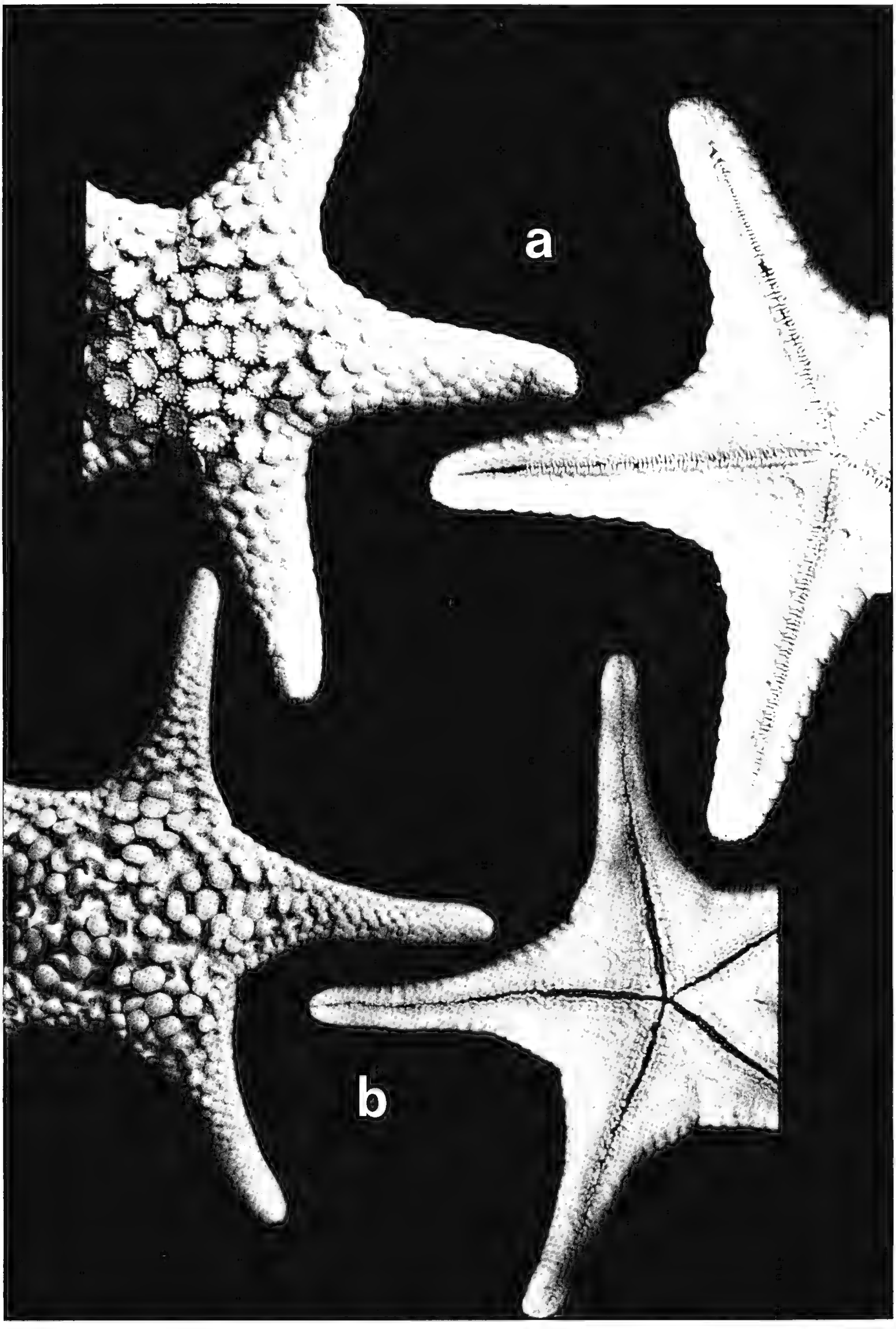

FIG. 4. (a) *N. ocellifera*, R/r=40/15 mm, "Diamantina" Stn. 68 (30°37'S; 114°44'E), 139-146 m. (WAM; 1375-74); (b) *N. ocellata*, R/r=68/23 mm, Tas. (Lectotype, BMNH; 1958: 7.30.20).

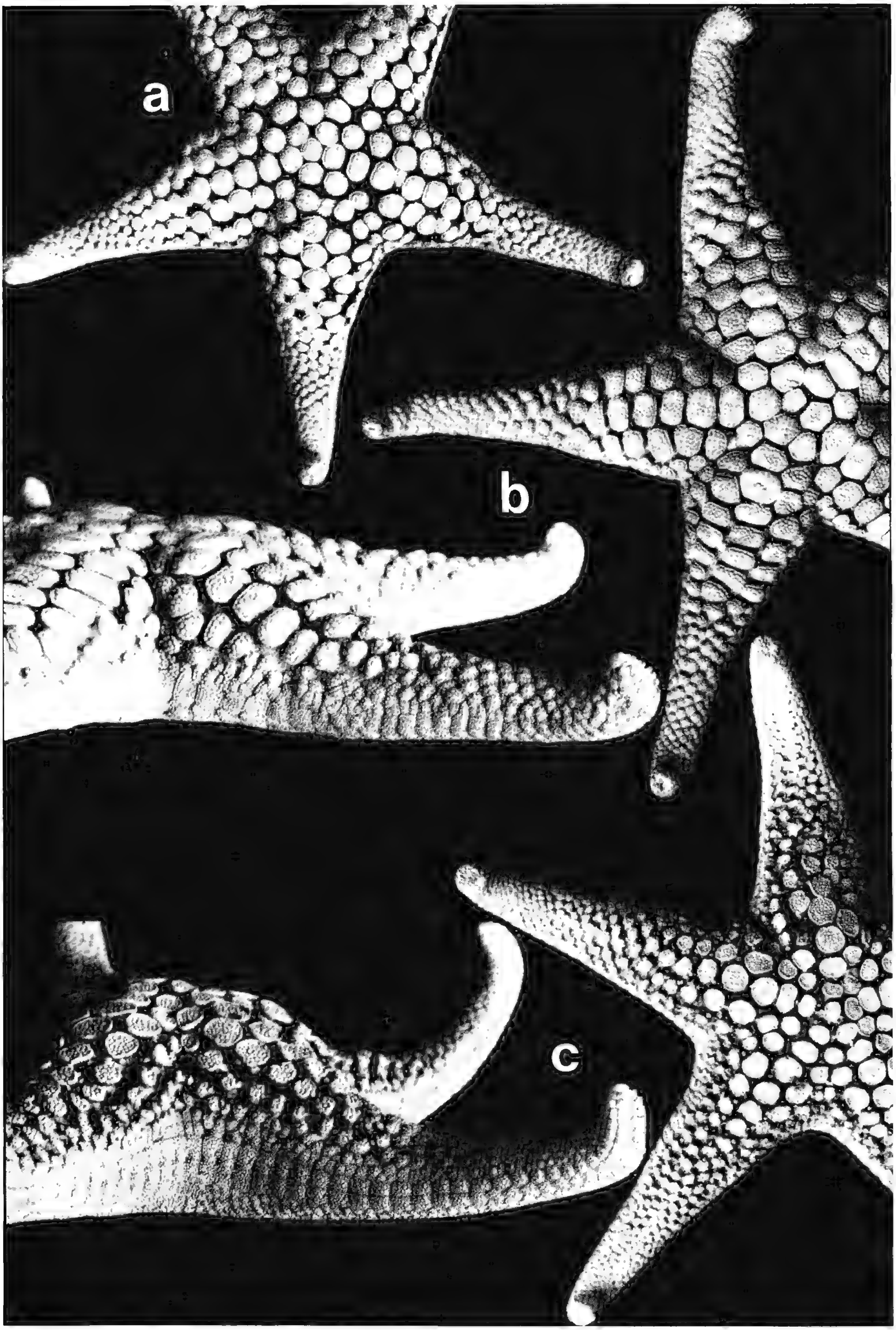

FIG. 5. *N. ocellata* (a) Form 1, R/r = 123/40 mm, off Maria I., Tas. (TM; H 1293); (b) Form 1, R/r = 76/22, Cape Woolamai, Phillip I., Vic., 10-15 mm (AM; J12499); (c) Form 2, R/r = 88/29 mm, Broughton I. near Port Stephens, N.S.W., 25 m (AM; J 13003).

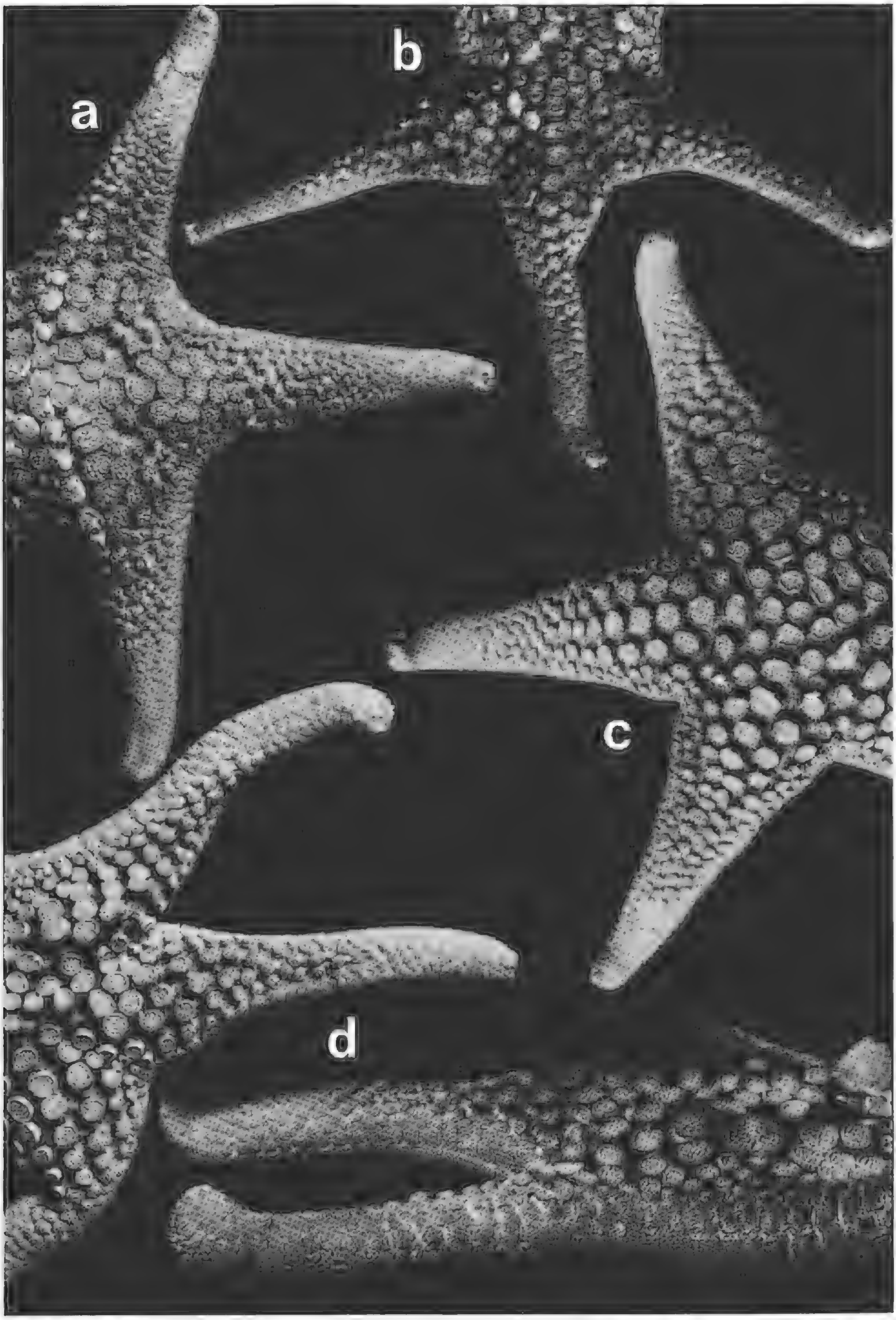

FIG. 6. *N. ocellata* (a) Form 2, R/r = 97/31 mm, off Norah Head, N.S.W., 50-70 m (AM; J 3466); (b) Form 3, R/r = 56/16 mm, without data (BMNH; 1953: 4.27.24); (c) Form 3, R/r = 87/29 mm, Westernport, North Arm Channel, Vic. (AM; J 9920); (d) Form 3, R/r = 80/27 mm, Great Taylors Bay, Bruny I., Tas. (TM; H 450).

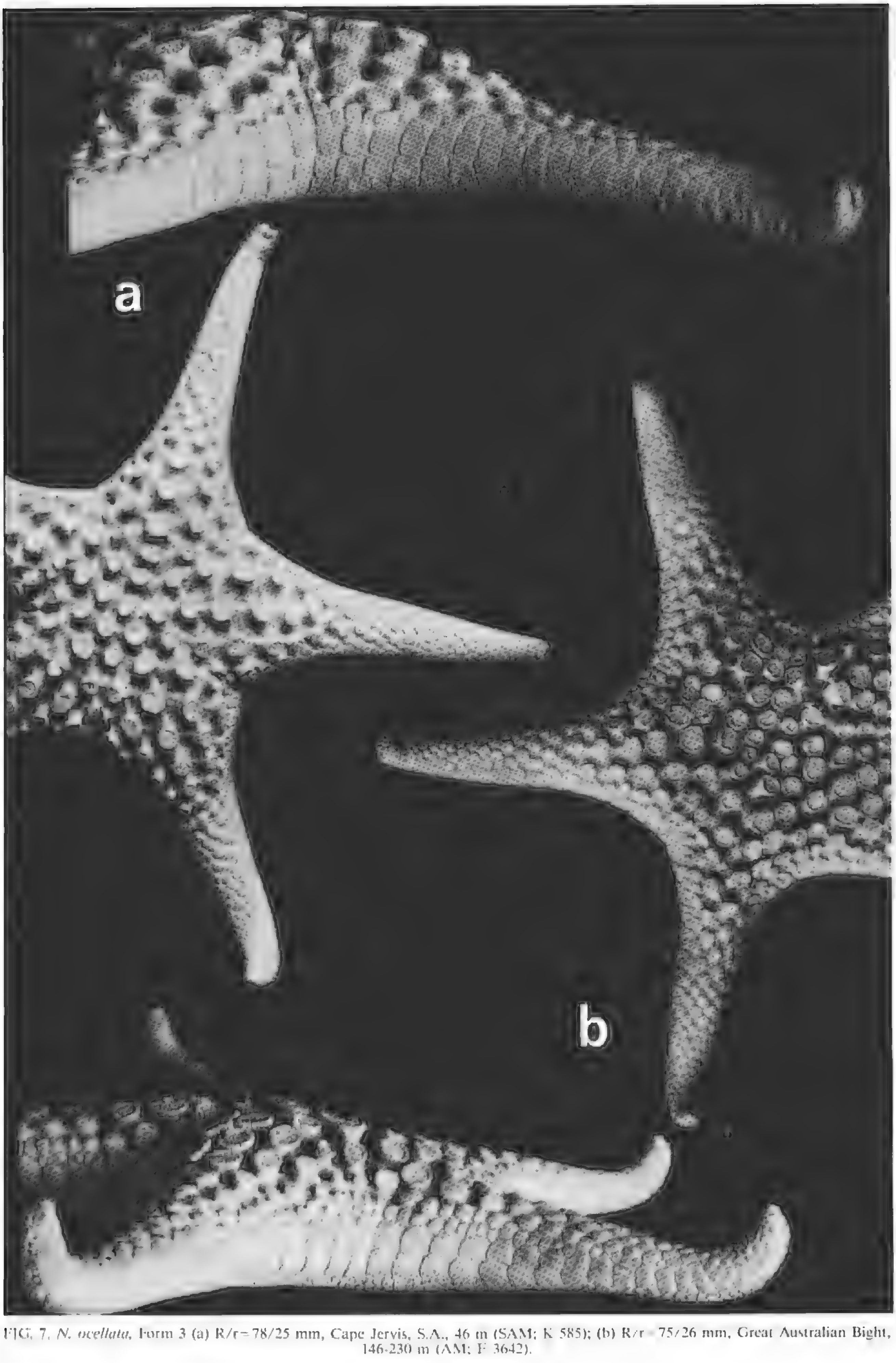

FIG. 7. *N. ocellata*, Form 3 (a) R/r=78/25 mm, Cape Jervis, S.A., 46 m (SAM: K 585); (b) R/r=75/26 mm, Great Australian Bight, 146-230 m (AM: F 3642).

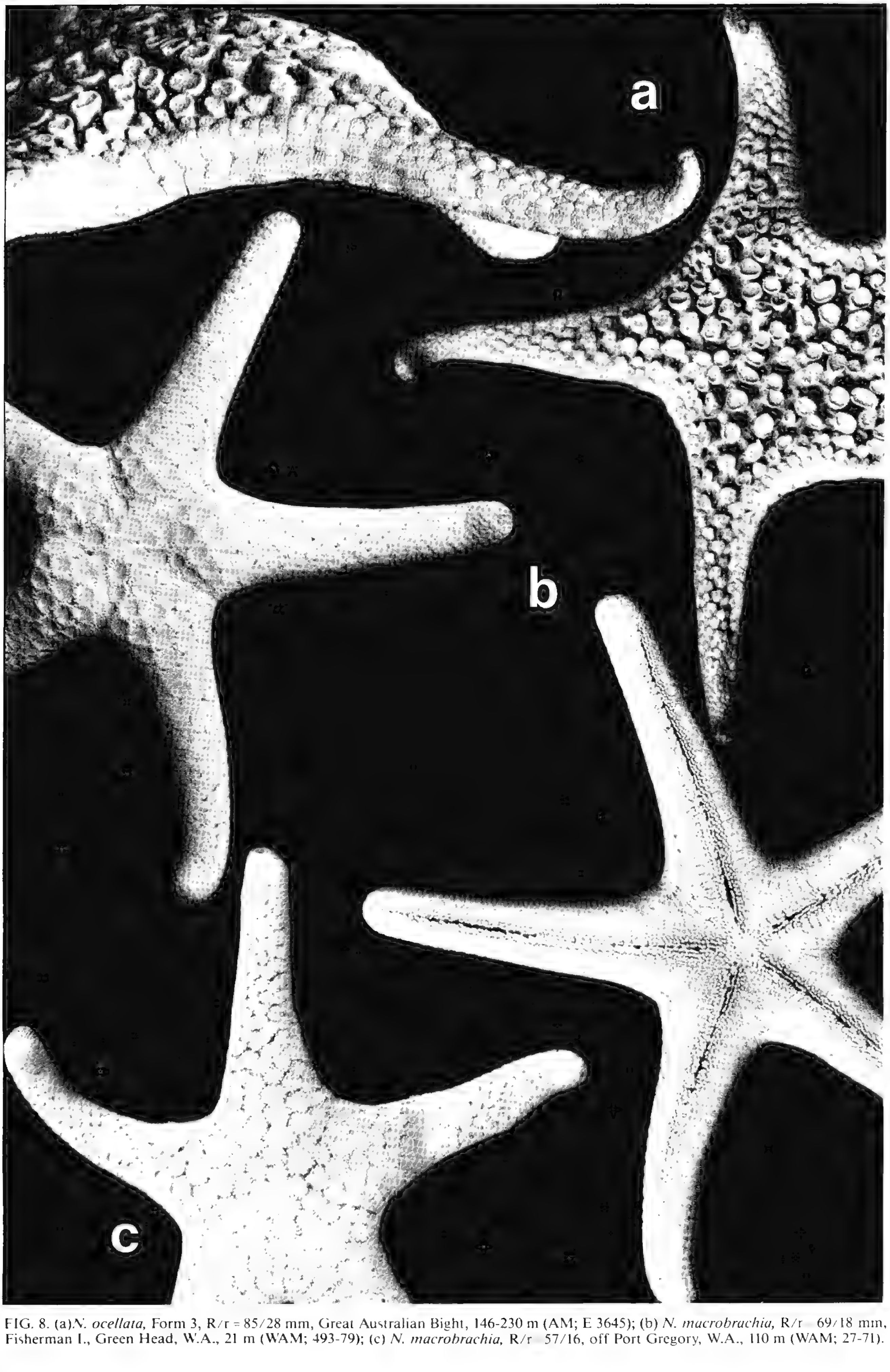

FIG. 8. (a) *N. ocellata,* Form 3, R/r = 85/28 mm, Great Australian Bight, 146-230 m (AM; E 3645); (b) *N. macrobrachia,* R/r 69/18 mm, Fisherman I., Green Head, W.A., 21 m (WAM; 493-79); (c) *N. macrobrachia,* R/r 57/16, off Port Gregory, W.A., 110 m (WAM; 27-71).

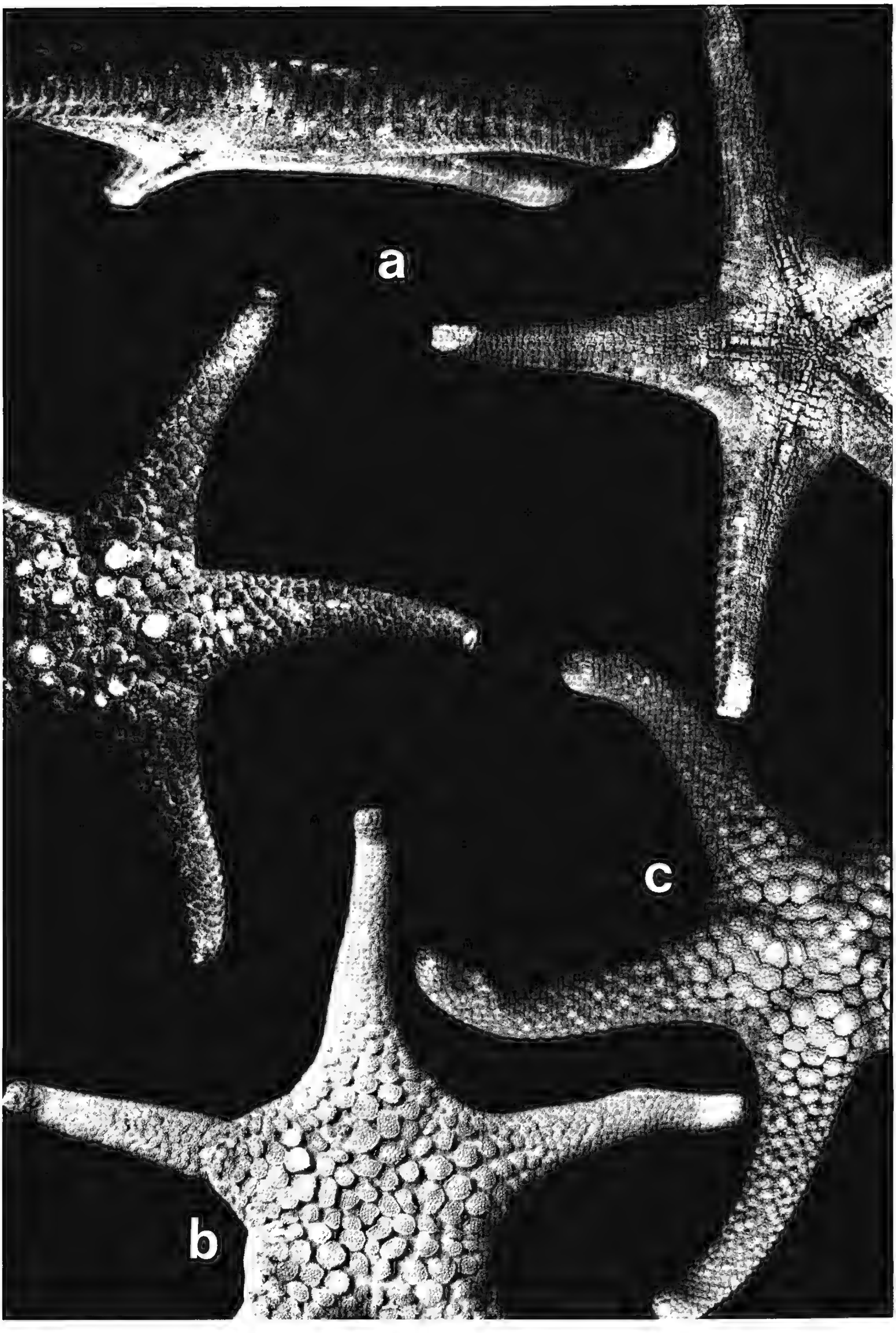

FIG. 9. *N. pedicelligera* (a) R/r = 55/18 mm, Flinders I., Tas. (BMNH; 1846: 8.3.14); (b) R/r = 85/28 mm, Cape Jervis, S.A., 10 m (SAM; K 596); (c) R/r = 85/25 mm, Doubtful Islands Bay, W.A., 1-2 m (WAM; 367-75).

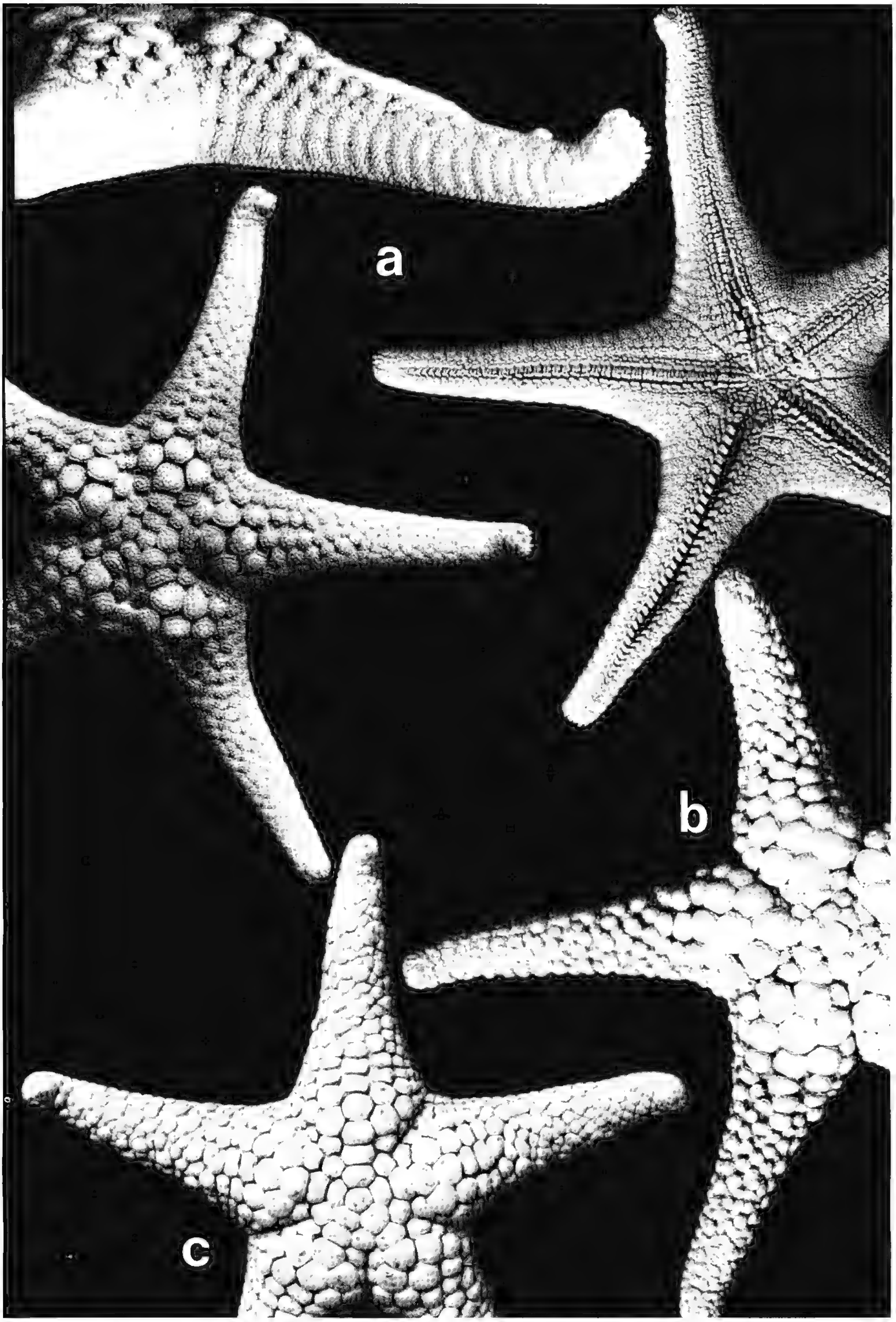

FIG. 10. (a) *N. pedicelligera,* R/r = 49/15, West I., Encounter Bay, S.A., 4·5 m (AM; J 7554); (b) *N. pedicelligera,* R/r = 72/22 mm, Stanley I., Denmark, W.A., 12-23 m (AM; J 12709); (c) *N. multispina,* R/r = 80/28 mm, Shoreham near Melbourne, Vic. (WAM; 1399-74).

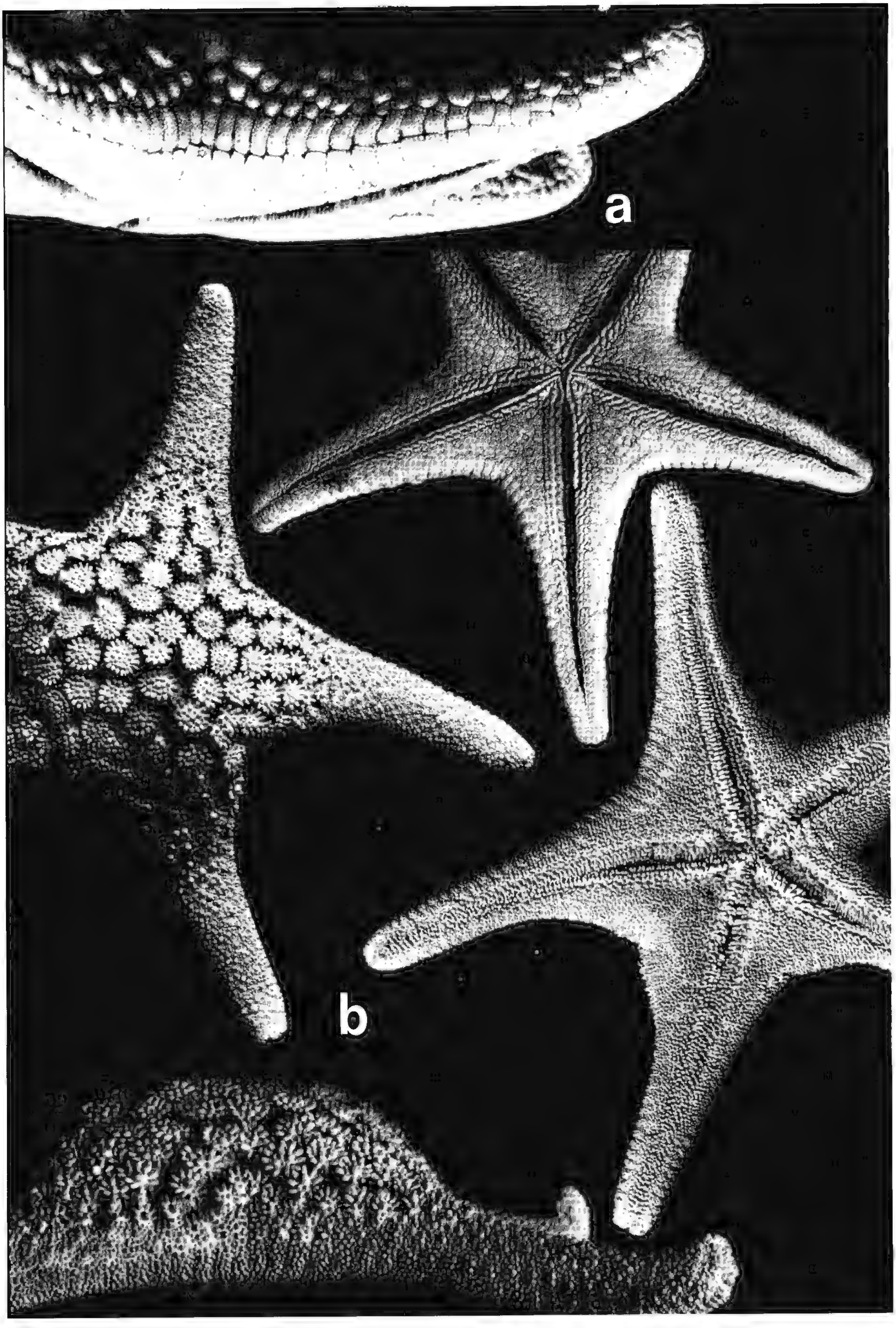

FIG. 11. (a) *N. multispina*, same specimen as 10 (e); (b) *N. wilsoni*, R/r 94/33 mm, Sorrento Reef, Perth, W.A., 4·5 m (AM; J 7834).

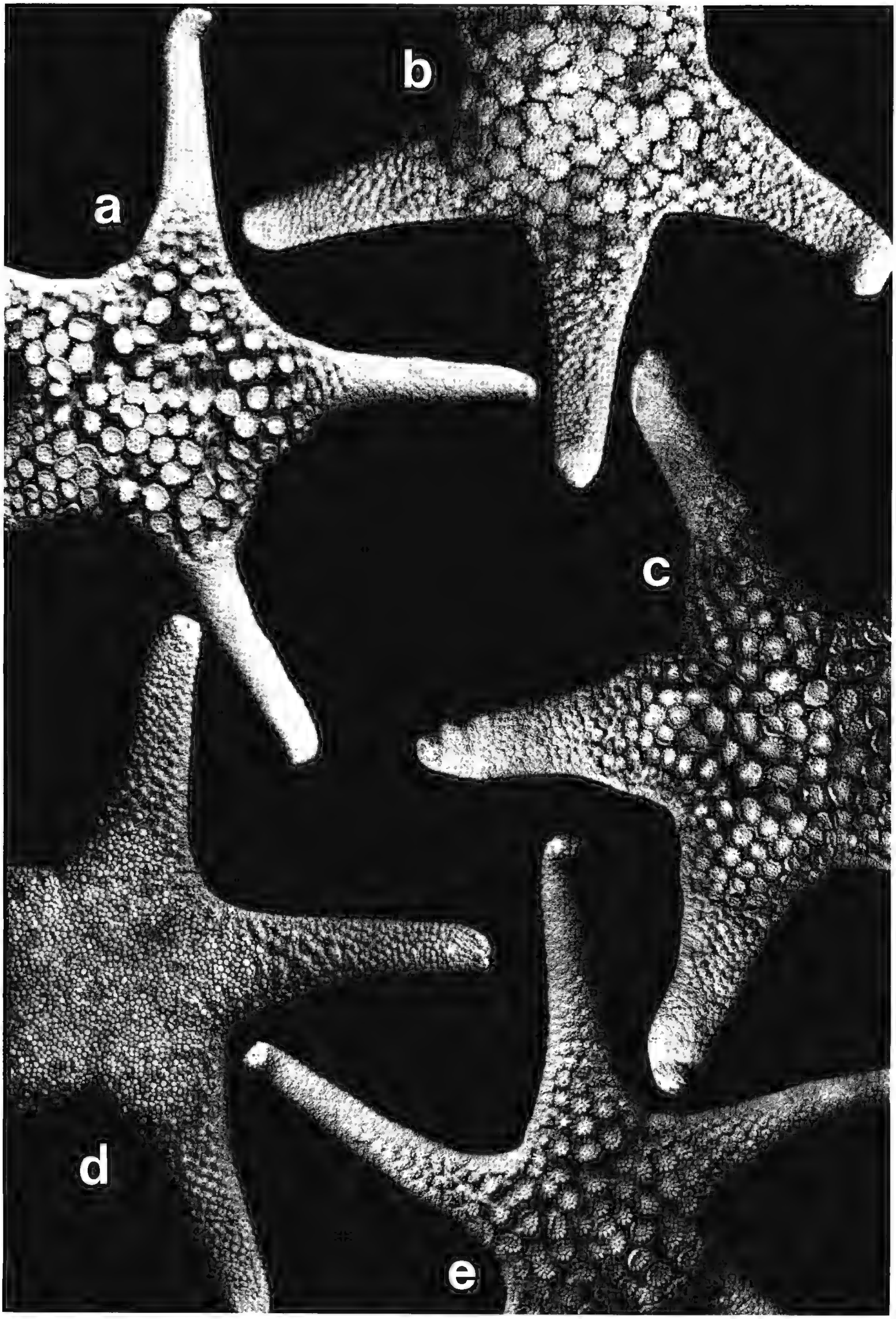

FIG. 12. *N. wilsoni* (a) R/r 68/24 mm, Cape Jervis, S.A., 10 m (SAM; K 1758); (b) R/r 94/32 mm, Sorrento Reef, Perth, W.A. 4·5 m (Paratype, WAM, 1395-74); (c) R/r 120/42 mm, off Beagle I., W.A. (Paratype, WAM; 3-62); (d) R/r 90/33 mm, Sorrento Reef, Perth, W.A. (Paratype, WAM; 2-65); (e) R/r = 64/18, off Dunsborough, Geographe Bay, W.A., 20-30 m (WAM; 746-76).

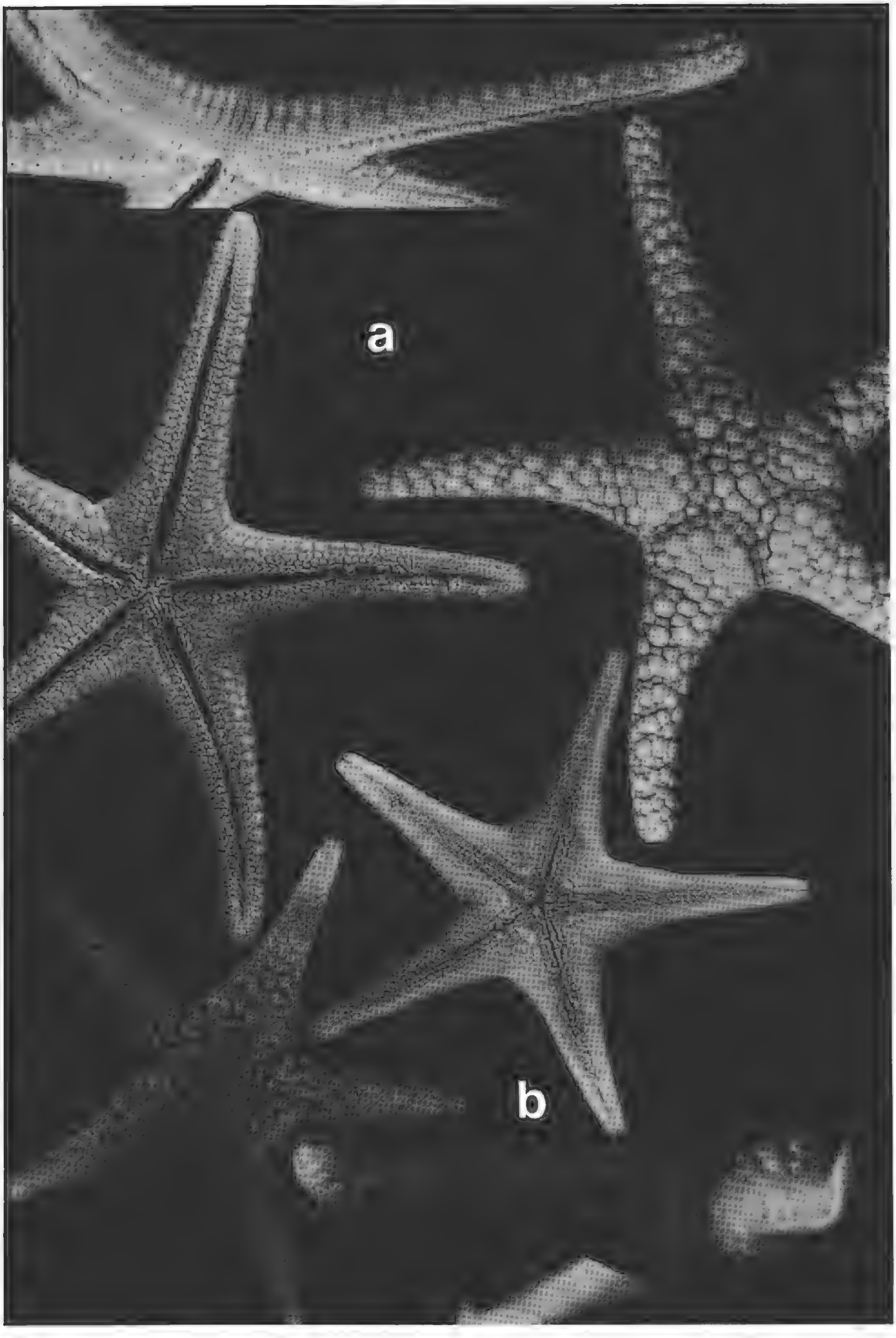

FIG. 13. (a) *N. saoria*, R/r = 74/21 mm, off Rottnest I., W.A., 25 m (WAM; 33-71); (b) *N. humilis*, R/r = 53-58/17·5 mm, 80 km W. of Woolnorth, Tas., 550 m (Holotype, TM; H 1476).

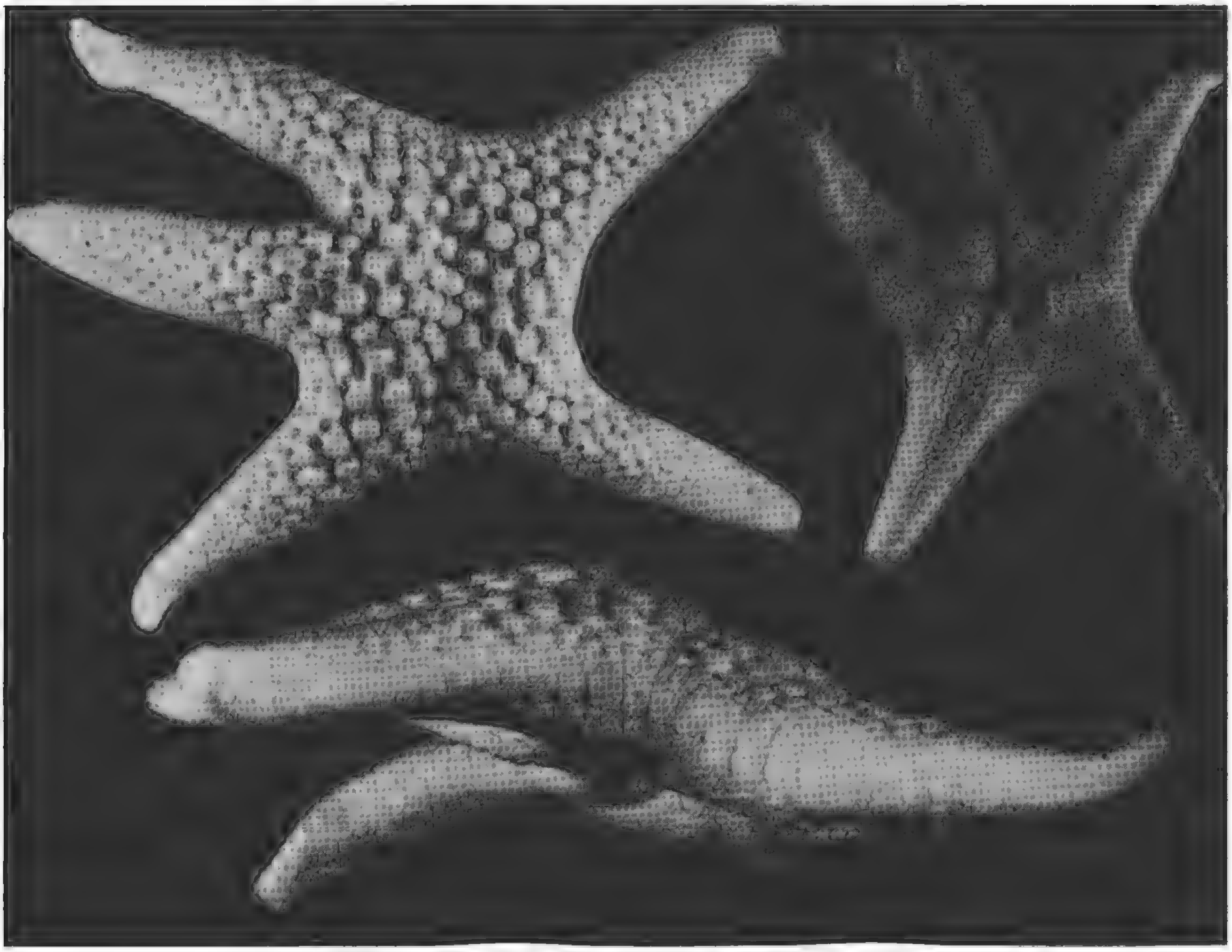

FIG. 14. *N. humilis,* R/r=46-51/17-19 mm, collected with holotype (Paratype, TM; 1844).

REDESCRIPTION OF THE MYSID CRUSTACEAN, NOTOMYSIS AUSTRALIENSIS (TATTERSALL) COMB. NOV.: REPRESENTATIVE OF A NEW GENUS

BY KARL J. WITTMANN

Summary

Distinctive features of the mouth-parts and ventral setae on the telson necessitate the establishment of a new genus, Notomysis, for Leptomysis australiensis Tattersall.

REDESCRIPTION OF THE MYSID CRUSTACEAN, *NOTOMYSIS AUSTRALIENSIS* (TATTERSALL) COMB. NOV.: REPRESENTATIVE OF A NEW GENUS

by

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(*Manuscript accepted 30 April 1985*)

ABSTRACT

WITTMANN, K. J. 1986. Redescription of the mysid crustacean, *Notomysis australiensis* (Tattersall) comb. nov.: representative of a new genus. *Rec. S. Aust. Mus.* **19**(10): 139-143.

Distinctive features of the mouth-parts and ventral setae on the telson necessitate the establishment of a new genus, *Notomysis*, for *Leptomysis australiensis* Tattersall.

INTRODUCTION

While preparing a revision of the genus *Leptomysis* it became obvious that *L. australiensis* Tattersall has several characters which are not found in any other known species. Tattersall's (1927) description was based on material collected by H. M. Hale in late 1926 in Gulf St Vincent, South Australia. No other *Leptomysis* species has been found in Australian waters since then. In his description Tattersall states: "This is a characteristic species of the genus . . ."; however, he gives no description of the mandibles and maxillae which are crucial taxonomic characters at the species and genus level.

The doubtful status of the species made it necessary to examine the type material which is kept at the South Australian Museum (Reg. No. C. 1617). The material, labelled as syntypes, comprises five adult and three subadult females, seven adult males, and several parts of animals. A male with a body length of 9 mm was chosen as lectotype, dissected completely, and mounted in Swan medium on slides. Seven further specimens collected by H. M. Hale in 1925 at the same location, not labelled as syntypes, are in the Tattersall collection, British Museum (Natural History) (Reg. Nos 1964.1.21: 2257-2275). The examination revealed that the description given by Tattersall (1927) is somewhat incomplete; also there are several conflicting points concerning features common to all specimens studied: the eyes are much smaller; the exopod of the fourth male pleopod has four instead of five large modified setae; the dactylus of the third to eighth thoracic endopods is much smaller than described; and the telson bears setae and has a minute apical incision. These findings show that a redescription is necessary. From the following description of mouth-parts and telson it becomes clear that the species cannot remain in the genus *Leptomysis* but should be placed in a new genus.

Notomysis nov. gen.

Diagnosis: Mysidae, Leptomysini with eyes normal. In addition to the usual sexual dimorphism of the antennula the males are characterized by a hairy rounded organ located dorsally at the distal segment of the sympod. Antennal scale setose all around, with small terminal joint. Labrum normal, without spiniform process. Mandible with processus molaris reduced, palpus normal. Maxillula with endite small, distal joint slender. Maxilla with exopod normal, endopod without spines, proximal endite as broad as other 2 endites combined. First thoracic endopod without endites, ischium distinct but very short. Third to eighth thoracic endopod with carpopropodus 3-segmented by transverse articulations. Female with 3 pairs of oostegites. Pleopods of female represented by simple setose plates. Pleopods of male all biramous, well segmented except first endopod; fourth exopod with a total of 4 large modified setae on distal 3 segments. Endopod of uropod with spines on inner margin. Exopod without distal joint and without spines. Telson with numerous setae ventrally, minute apical incision, and spines on lateral margins.

Type-species: Leptomysis australiensis Tattersall.

Etymology: From the Greek term '*nōtos*' (= south).

Relationships: The genus *Notomysis* is closely allied to the genus *Promysis, sensu* Ii (1964), with which it shares features of the antennae, mouth-parts, thoracopods, and pleopods. Maxilla, maxillula, mandible, and first maxilliped are unlike *Leptomysis* but clearly belong to the type represented by the genera *Promysis* and *Prionomysis*. The new genus is distinguished from these and all other genera of the family Mysidae by the unique structure of the telson.

Notomysis australiensis (Tattersall) comb. nov.
(Figs 1-26)

Diagnosis: Middle segment of antennular peduncle with strong modified seta directed laterad. Inner margin of endopod of uropod with 16-28 spines increasing in length distally; 11-22 of these spines irregularly arranged on statocyst; 5-7 spines linearly arranged distal to statocyst. Telson with about 45-60 closely set spines on each lateral margin; apex with minute narrow incision about 1/41 length of telson. Ventrally telson bears 8-12 plumose setae on longitudinal ridge running half-way between centre and tip.

Description: General body proportions slender, closely similar to *Prionomysis aspera* Ii. A further coincidence with this species is that body and appendages are densely covered with small cuticle structures (Fig. 5). These are of about cylindrical shape on the carapace, body trunk, eye-stalks, and bases of appendages. Towards tips of appendages they tend to become acute and scale-like (Figs 3, 14, 19, 21, 23). Carapace with a transverse straight row of *ca* 13 pores in median position a short distance anterior to cervical sulcus; a further row of *ca* 27 pores at the cardial sulcus and a larger pore surrounded by 7 smaller ones a short distance anterior to the rounded posterior margin of carapace. Rostrum large, longer than distal segment of the antennular peduncle. Eyes as in Fig. 1. Last abdominal somite terminally produced into 2 strong spiniform projections on each lateral margin.

Mouth-parts: Frontal border of labrum bluntly rounded. Mandibles with processus molaris reduced to two lobes, masticatory lamellae completely lacking. Teeth of pars incisivus and lacinia mobilis larger on left than on right mandible. Left pars incisivus with 3 large and 3-4 smaller teeth, with the size decreasing proximally. Right pars incisivus distally with one large tooth flanked on each side, rostrally and caudally, by one masticatory plate carrying several small teeth. Left lacinia mobilis with 5-6, right one with about 4 teeth of varying size. Each pars centralis (= spine row) with 4-5 teeth of about equal size. Left mandible only densely covered with bristles on caudal face in region of lacinia mobilis and pars centralis. Palpus with unusually dense setation. Maxillula as is typical of *Mysidopsis* and *Promysis*; distal joint without array of pores found in *Leptomysis*. Maxilla essentially as figured by Ii (1964) for *Promysis orientalis* Dana.

Thoracopods: First exopod with 9 segments, second to seventh with 10, eighth with 9-10. Proximal segment flanked by large intersegmental joints; acutely pointed at laterodistal corner; small plumose seta usually present close to this corner. Epipodite 1 linguiform, without seta. First and second endopod like those in *Promysis*. Merus of first endopod without array of pores that occurs in *Leptomysis*; propodus and dactylus without spines except a strong nail at apex of dactylus. Carpopropodus of third to eighth endopod with 3 short joints; dactylus minute with slender nail. First pair of oostegites reduced, but larger than usual in Mysidae, with same basic setation pattern as in second pair (Figs 17, 18). Penis short, with about 11 smooth, curved setae around ejaculatory opening, and a series of plumose setae along outer margin.

Pleopods: In females all 5 pairs represented by simple setose rods increasing in length caudally. In sub-basal position each bears a more or less indistinct apophysis directed laterad. All features of male pleopods essentially as in *Promysis orientalis, sensu* Ii (1964). First to fifth endopod with 1, 9, 9, 9, and 8-9 joints, respectively. Basal joints each with a well-developed apophysis which is slender in first endopod, but rounded, plate-like in second to fifth. Basal segment of fifth endopod with small additional apophysis. First to fifth exopod with 8, 9, 10, 11-12, and 9-10 joints, respectively. Fourth exopod with large modified setae on last 3 joints. Antepenultimate and penultimate segment each with one large modified seta and an additional small smooth seta. Distal segment minute, with 2 less powerful modified setae.

Uropods: Exopod setose all around, 1.6 times as long as telson, or 1.5 times endopod. Endopod with spiniform projection dorsally at statocyst. Distance between apical spine at inner margin and tip is 25-30% length of endopod.

Nauplioid stage: Antennula distally with acute scales arranged in comb-like units. Antenna and mandible smooth. Abdomen covered with small hairs.

Length: Measured from rostrum to tip of telson excluding spines. Length is 8-13 mm in adult females (n = 8) and 7-11 mm in adult males (n = 9). Mean egg diameter is 0.49 mm (n = 4).

ACKNOWLEDGMENTS

I am greatly indebted to Dr Joan Ellis (London) and Mr Peter Aerfeldt (Adelaide) for the trouble they have taken to send the material to Vienna.

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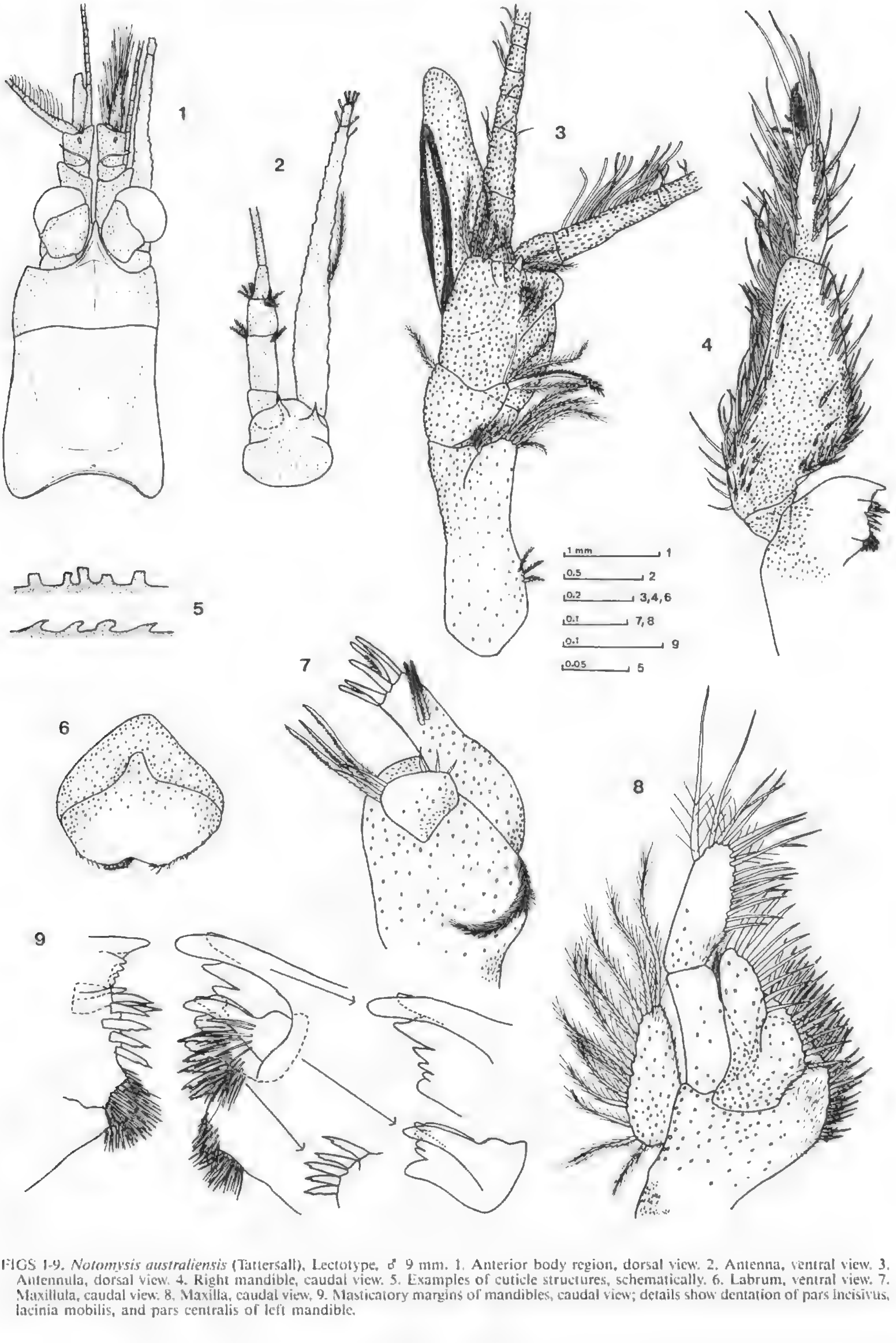
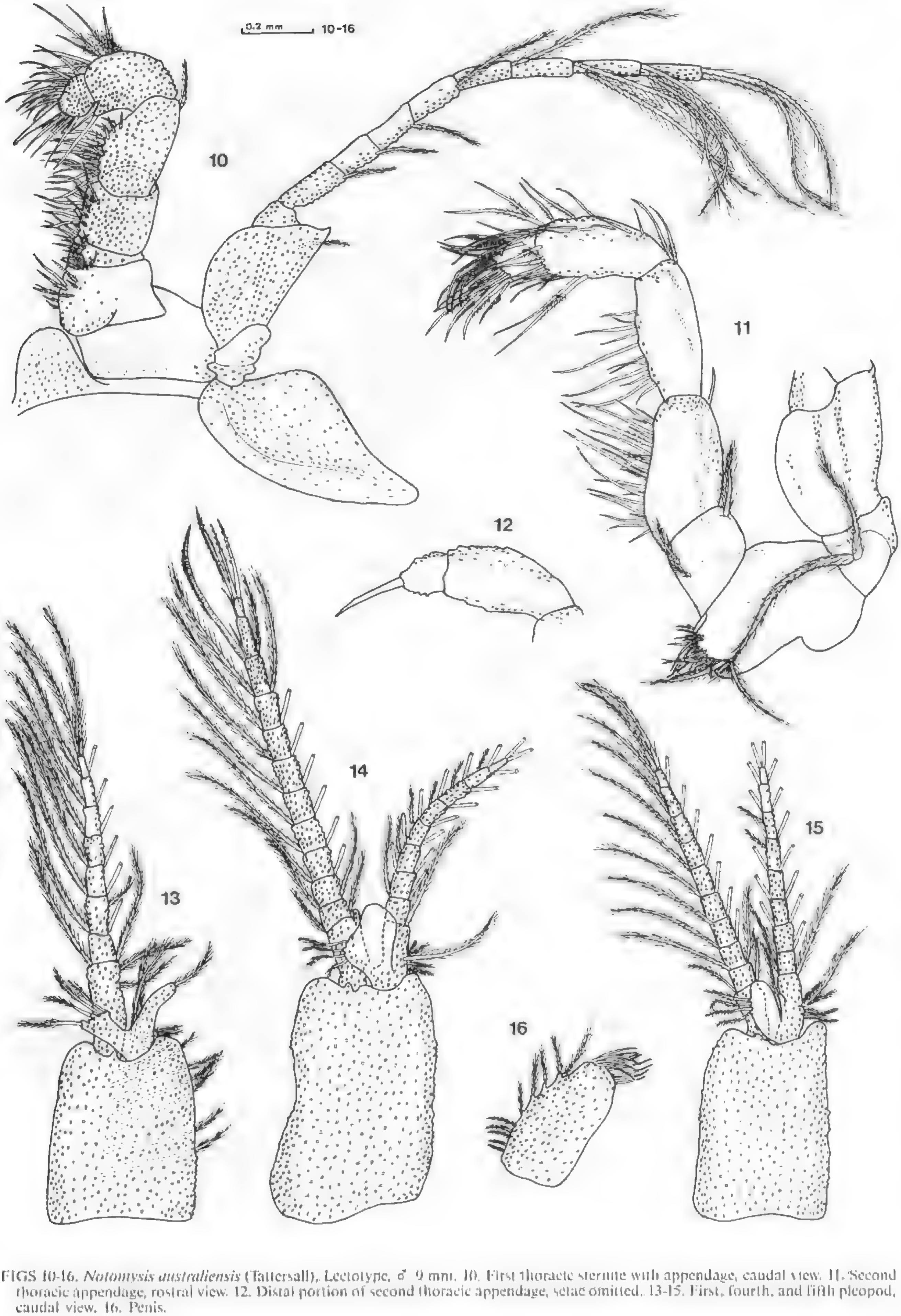
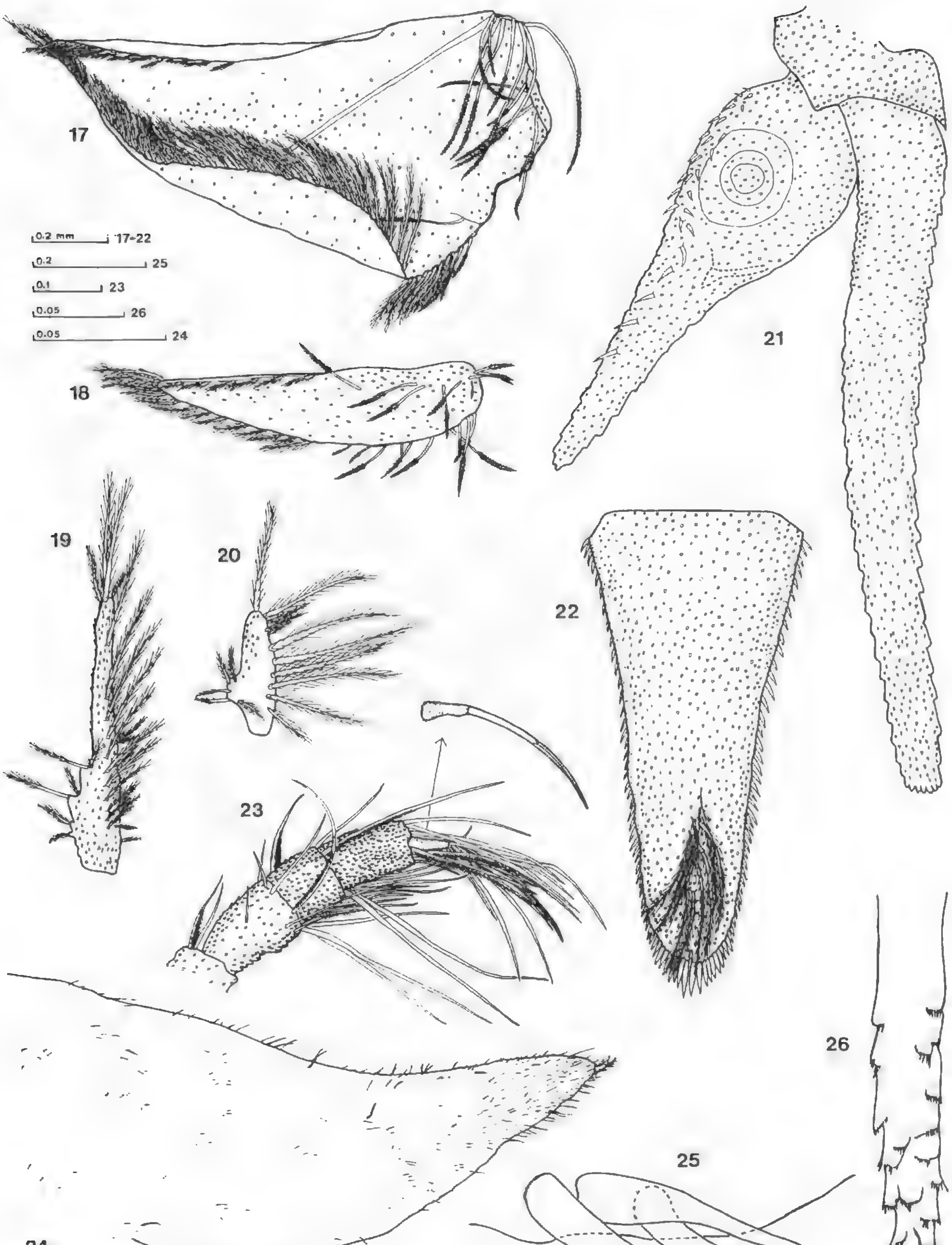


FIGS 1-9. *Notomysis australiensis* (Tattersall), Lectotype, ♂ 9 mm. 1. Anterior body region, dorsal view. 2. Antenna, ventral view. 3. Antennula, dorsal view. 4. Right mandible, caudal view. 5. Examples of cuticle structures, schematically. 6. Labrum, ventral view. 7. Maxillula, caudal view. 8. Maxilla, caudal view. 9. Masticatory margins of mandibles, caudal view; details show dentation of pars incisivus, lacinia mobilis, and pars centralis of left mandible.



FIGS 10-16. *Notomysis australiensis* (Tattersall). Lectotype, ♂ 9 mm. 10. First thoracic sternite with appendage, caudal view. 11. Second thoracic appendage, rostral view. 12. Distal portion of second thoracic appendage, setae omitted. 13-15. First, fourth, and fifth pleopod, caudal view. 16. Penis.



FIGS 17-26. *Notomysis australiensis* (Tattersall). 17-20. ♀ 9 mm. 17. Second oostegite, inner face. 18. First oostegite, inner face. 19. Fifth pleopod, rostral view. 20. First pleopod, rostral view. 21, 22. Lectotype, ♂ 9 mm. 21. Uropods, ventral view. 22. Telson, ventral view. 23. ♂ 8 mm, 'tarsus' of third thoracic endopod, detail shows dactylus with nail. 24-26. Nauplioid larva, lateral views. 24. Distal portion of abdomen. 25. Nauplius appendages. 26. Distal portion of antennula.

RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

VOLUME 19 NUMBERS 11–14 MAY 1986

SOUTH AUSTRALIAN MUSEUM
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ON TROMBELLA ALPHA N.SP. (ACARINA: TROMBELLIDAE) FROM AUSTRALIA: CORRELATION, DESCRIPTION, DEVELOPMENTAL ABNORMALITIES, SYSTEMATICS AND POSSIBLE AUDITORY STRUCTURES

BY R. V. SOUTHCOTT

Summary

A trombidoid mite (Acarina: Trombellidae) larva, parasitic upon field crickets Teleogryllus commodus (Walker) in northern New South Wales, has been reared experimentally to the active deutonymph. The larva, protonymph and deutonymph are described as Trombella alpha n.sp., and the deutonymph compared with previously known species of the genus, particularly T. warregensis Hirst and T. adelaideae Womersley from Australia.

ON *TROMBELLA ALPHA* N.SP. (ACARINA: TROMBELLIDAE) FROM AUSTRALIA: CORRELATION, DESCRIPTION, DEVELOPMENTAL ABNORMALITIES, SYSTEMATICS AND POSSIBLE AUDITORY STRUCTURES

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(Manuscript accepted 23 January 1985)

ABSTRACT

SOUTHCOTT, R. V. 1986. On *Trombella alpha* n.sp. (Acarina: Trombellidae): correlation, description, developmental abnormalities, systematics and possible auditory structures. *Rec. S. Aust. Mus.* 19(11): 145-168.

A trombidoid mite (Acarina: Trombellidae) larva, parasitic upon field crickets *Teleogryllus commodus* (Walker) in northern New South Wales, has been reared experimentally to the active deutonymph. The larva, protonymph and deutonymph are described as *Trombella alpha* n.sp., and the deutonymph compared with previously known species of the genus, particularly *T. warregensis* Hirst and *T. adelaideae* Womersley from Australia.

One reared nymph of *T. alpha* had gross developmental abnormalities of the legs, with shortening or even loss of segments, and non-development of setae, here termed brachymely. Similar occurrences in this and other mites are instanced.

A correlation and a principal component analysis was made of the larval dimensional variates, using various dorsal scutum, leg segmental, and body setae measurements. Three principal components were defined, each including one or more idiosomal variates and one or more leg variates.

A key is presented for the known adults and deutonymphs of *Trombella* of the world.

Leg chaetotaxy of *Trombella alpha*, the only described larva of *Trombella*, is discussed.

The family Trombellidae and its subfamilies Chyzeriinae and Trombellinae are redefined. Generic classification of the Trombellidae is revised. A new genus is erected for adults and nymphs: *Maiputrombella* n. gen., with type species *M. americanum* (Robaux, 1968) its only member, from South America. Keys are provided to the genera of both larvae and of adults and deutonymphs. *Womersleyia* Radford, 1946 is restored to full generic status.

The adult genus *Parachyzeria* Hirst is removed from the family and placed in the Johnstonianidae, as is also the larval genus *Ralphaudyna* Vercammen-Grandjean *et al.* (1974).

The possible functions of some of the structural peculiarities of *Trombella alpha* larva are discussed in relation to existing knowledge and suggestions that have been made for some other prostigmatic mites. The attenuation of the larval tarsi is believed to be related to its function as a sound receptor, serving as a sonar device for the location of the sound-emitting cricket hosts. This suggestion is supported by a significant bias (over 3:1) in the numbers of mites obtained from vocalizing male crickets as against the silent females and because this bias was not found in the sub-adult (i.e. non-stridulating) male instars.

INTRODUCTION

Berlese (1887) proposed the genus *Trombella* for *T. glandulosa* Berlese, 1887 from northern Italy; a species since recorded from Austria (Schuster, 1960). Originally Berlese gave a definition and description only of the type species, i.e. by referring to the sixteen dorsal depressions. In 1888 he added the South American *T. nothroides* Berl. 1888, which lacks the rounded dorsal opisthosomal depressions.

Womersley (1954b) reviewed the subfamily Trombellinae Thor, 1935 and erected the genus *Nothrotrombidium* for *Trombella otiorum* Berlese, 1902, from Europe (see Feider 1955, p. 68; 1958, p. 265), thereby restricting Berlese's genus; he placed in it also *T. nothroides* Berlese, and *T. lundbladi* Willmann, 1939 from Madeira (North Atlantic region). Additional species include *Nothrotrombidium bulbiferum* (Willmann, 1940) (*nom. emend.*), from Europe and *Nothrotrombidium brevitarsum* André, 1960 (nom. emend.) (1960a) from Tonkin, Indochina. *Trombella s. str.* has currently five described species: *T. glandulosa* Berlese (type), *T. warregensis* Hirst, 1929 (Australia), *T. adelaideae* Womersley, 1939 (Australia), *T. favosa* André, 1936 (1936a) (Africa) and *T. lusitanica* André, 1944 (Europe).

Genera now placed in the family Trombellidae include *Trombella* Berlese, *Parachyzeria* Hirst, 1926 (however, see further below), *Parathrombella* André, 1958, *Neonothrothrombidium* Robaux, 1968, based purely on the adult forms, *Chyzeria* Canestrini, 1897 and *Nothrotrombidium* Womersley, 1954, known from the adult and the larva, *Audyana* Womersley, 1954 (1954a) and *Durenia* Vercammen-Grandjean, 1955, known from the larva and deutonymph, and *Womersleyia* Radford, 1946, *Ralphaudyna* Vercammen-Grandjean *et al.*, 1974, and *Nothrotrombicula* Dumbleton, 1947, known only from the larva.

I reported that larval trombidioid mites, parasitic upon field crickets, *Teleogryllus commodus* (Walker), in northern New South Wales, and classifiable to *Womersleyia* Radford, had been reared experimentally to the nymphal stage, and that these nymphs were classifiable as *Trombella* (Southcott, 1982). It was thus proposed that *Womersleyia* Radford is a junior synonym of *Trombella* Berlese. Previously it was known only from its type species, *W. minuta* Radford, 1946, a larva taken either free-living from mud, or parasitic under the wings of grasshoppers (Acridoidea: Tetrigidae and Tettigoniidae) on the Island of Gan, Addu Attoll, Maldive Islands; original specimens taken on 20.xii.1944. (A paratype slide in the South Australian Museum collection is labelled (in the writing of one of Womersley's technical assistants) "ex Grasshopper/ Maldive Is/13. Jan 1945 C.D.R." This slide bears also a label in pencil showing that it was used by Vercammen-Grandjean in 1970 in his revision (1972) of the species. I have added an identifying number ACB731 to each label.)

This paper describes the larva, protonymph and deutonymph instars of the New South Wales species of *Trombella*, details of the experimental correlation and its taxonomic significance.

The reared deutonymphs appeared to be morphologically similar to the adult *Trombella adelaideae* Womersley, 1939, known from a single specimen collected "from under a stone at Burnside", in the Adelaide district, South Australia, in August. However, there are differences. One other Australian species is known, based also on a single specimen; this is *T. warregensis* Hirst, 1929, found "under a log on the bank" of the River Warrego, 4 miles west of Barringun, New South Wales, in August 1928 by Hirst. The total number of species of *Trombella* in Australia is conjectural, as these mites have been collected and surveyed very inadequately. I have seen several as yet undescribed species of larvae referable to *Trombella s. str.* parasitic upon grasshoppers, whilst surveying the mite ectoparasites of grasshoppers in the Australian National Insect Collection, CSIRO Division of Entomology, Canberra. In view of the uncertainties of attempting to correlate deutonymphal and adult trombidioid (and other prostigmatic) mites on morphological features, it is considered wisest to erect a new taxon, *Trombella alpha* n. sp., for this species.

After again studying the characters of *Trombella alpha* and other larvae known in the family, *Womersleyia* is restored to full generic status (see further below).

All measurements are given in micrometres (μm) unless otherwise stated.

Genus *Trombella* Berlese

Synonymy

Note: I have not attempted in the synonymic list for *Trombella* below to define where it covered also *Nothrotrombidium* Womersley, 1954. All authors used the genus name of *Trombella* for all species here considered until Womersley's action. It may therefore be taken that from 1887 to 28 May 1954 (the date of publication of Womersley, 1954b) all usages of *Trombella* included, or implied the inclusion of, *Nothrotrombidium*. Subsequently, the great majority of authors used this separation, exceptions being Feider (1955, 1959a), Daniel (1959) and Krantz (1978), who still included *T. otiorum* Berlese, 1902. These remarks apply also to the incorrect spelling as *Thrombella* by some authors. Feider subsequently (1958) became aware of, and accepted, the use of *Nothrotrombidium*.

Trombella Berlese 1887, fasc. 40. no. 2; 1888, p. 180; 1893, pp. 91-92, 96, 138, 149; 1894, fasc. 72, no. 6; 1902, p. 127; 1912, pp. 2, 4, 8, 9, 11, 14-16, 18, 22-30. Hirst, 1929, p. 168; Vitzthum, 1929, pp. vii, 63; 1931, 3(II), p. 146; 1940, pp. 144, 145; 1941, pp. 506, 826. Womersley 1934, pp. 181, 185; 1937, pp. 75, 76; 1939, p. 149; 1954b, p. 125. Thor 1935, p. 108. Willmann 1939, p. 15; 1940, p. 215; 1941, p. 59. Thor and Willmann 1947, p. 199. Baker and Wharton 1952, p. 250. Feider, 1950, p. 4; 1955, pp. 26, 41, 68; 1958, p. 265; 1959b, p. 541. Vercammen-Grandjean 1955, pp. 253, 260; 1973, p. 109. Vercammen-Grandjean and Kolebinova 1968, p. 250. Schuster 1960, p. 5. Krantz 1978, pp. 278, 351. Southcott 1982, pp. 286, 290.

Thrombella André 1934, p. 472; 1936a, p. 9; 1936b, p. 325; 1938a, p. 215; 1944, p. 230; 1958, pp. 14, 15; 1962, p. 63. Robaux 1967, pp. 3, 4, 7, 109; 1968, p. 453 (incorrect spelling).

Trombella alpha n. sp.

Description of holotype larva (specimen ACB713A; also supplemented from other specimens) (Figs. 1A, B, 2, 3, 4A, C, 5A, B).

Colour in life orange. Length of idiosoma (partially engorged specimen, slide-mounted) 355, width 215; total length of animal from tip of chelicerae to posterior pole of idiosoma 445.

Dorsal scutum trapezoidal, with a broad projecting anterior "nasus"; anterolateral angles ("shoulders") rounded, obtuse-angled; posterolateral angles evenly rounded. Anterolateral margins indented, lateral and posterior margins concave. Scutal sensilla placed towards rear of scutum, well separated, and closer to level of PLs than ALs with only a faint indication of setules (branches, see Goff *et al.* 1982) with phase-contrast oil immersion microscopy.

Scutal scobalae (non-sensillary setae) six in number, with two AM setae at about middle of "nasus", the ALs and PLs towards their respective angles; these setae ciliate, slender, tapering, a little blunted, with a single large terminal setule in many instances.

Standard data of the holotype and a series of other larvae are summarized in Table 1. Raw data are held on file at the South Australian Museum.

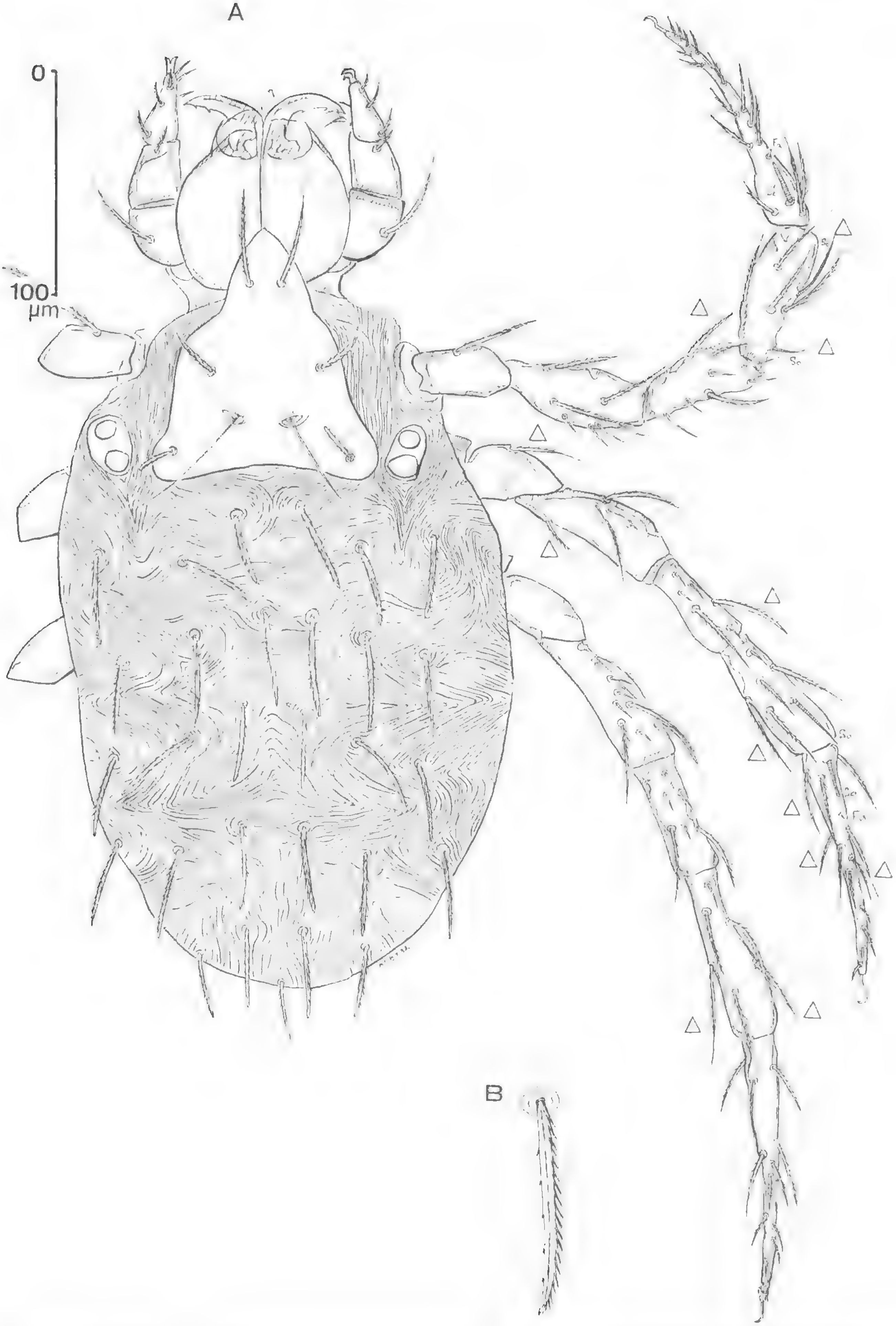


FIG. 1. *Trombella alpha* sp. nov. Holotype larva. A Dorsal view, to scale on left. (Legs on left side omitted beyond trochanters.) B. Dorsal idiosomal seta, further enlarged (not to scale). In this and in subsequent figures the Δ sign indicates the seta is shown in both the dorsal and ventral figures

TABLE 1. STANDARD DATA AND OTHER MORPHOMETRIC DATA OF A SERIES OF LARVAE OF *TROMBELLA ALPHA* N. SP.

(All measurements in micrometres, µm)

Character	Holotype	Range	Mean	S.D.	n
AW	55	55-64	56.67	2.84	12
PW	84	76-90	84.50	4.19	12
SB	25	22-28	24.25	1.60	12
ASB	81	58-81	72.11	9.02	9
PSB	34	25-40	35.42	4.60	12
L	120	87-120	108.33	11.27	9
W	109	100-118	105.67	5.14	12
A-P	43	34-44	39.00	3.44	11
AM	46	36-ca49	44.78	4.09	9
AL	27	20 • -34	28.55	3.96	11
PL	21	ca18-27	21.30	2.58	10
AMB	22	18-22	19.10	1.66	10
Sens	—	40-51	43.67		3
DS	39-46	(31-42)-(35-49)	45.64*	2.16*	11
mid-DS	40-46	(33-42)-(44-49)		—	11
PDS	39-42	(31-37)-(36-48)	—		10
GeI	55	51-60	54.83	2.98	12
TiI	73	62-73	66.33	3.47	12
GeII	51	47-55	51.00	2.13	12
TiII	67	57-69	62.50	3.37	12
GeIII	60	51-60	55.42	2.23	12
TiIII	87	73-87	79.83	4.39	12

* For maximum values of DS.

At times setae are broken in the specimens. As Table 1 indicates, it is unusual to find the scutal sensillary setae intact in a mounted specimen. During the moulting process, scutal scobalae commonly fracture. A number of specimens measured here have been allowed to moult. This often results in disruption of the skin, or its crumpling and folding and usually increases the difficulties of measuring. In some cases, however, e.g. in the cast dorsal scutum, it may result in a flattening and better display of the more anterior parts of the scutum, as well as better estimates of the rectilinear length. In fully or partially fed specimens of the larvae the shield is often, in its anterior part, too curved and obscured for accurate measurements on the slide, and in such cases estimates of L and ASB tend to be unreliable.

Eyes 2+2, sessile, each lateral pair on a distinct ocular plate near PL angle of scutum. Corneae oval, anterior with longest diameter 13, posterior with longest diameter 17.

Dorsal idiosomalae slender, ciliate, blunt-ended, arising from the usual small plates or annuli set in the epicuticle; in rows arranged 6, 6, 6, 6, 4, 1; total 29.

Venter of idiosoma with a pair of scobalae in area between coxae II and III, slender, tapering, pointed, ciliate, 41 long. Behind the level of coxae III and about 38 setae, tapering, ciliate, pointed or slightly blunted, in irregular transverse rows across the opisthosoma, 25-35 long. Anus (uroporus *auct.*), of two longitudinal valves (obscured in holotype; 36 long in ACB712E).

Coxalae 2, 1, 1, normal, pointed, with long setules. Medial coxala I placed over about the mid-point of the anterior coxal border, or a little medial to it, 54 long; lateral coxala I placed well laterally, over the heavily chitinized anterolateral rim of the coxa, 51 long. Coxala II placed towards outer part of coxa, about 1/3 back from the anterior border, 47 long. Coxala III placed over anterior border, about 1/5 back from its heavily chitinized and projecting lateral part; 46 long.

Leg segmental formula 6, 6, 6. Legs slender, segments from femur to tibia more or less cylindrical; tarsi tapering, attenuated. Leg I 430 long, II 415, III 455 (each including coxa and claw). Pedocoxal supracoxalae not identified, presumably absent.

Tarsus I 116 long, by 18 high at its thickest part, near its origin, TiI/GeI = 1.33. Tarsus II 118 by 18; TiII/GeII = 1.31. Tarsus III 124 by 18; TiIII/GeIII = 1.45. (Tarsal measurements exclude claw and pedicle.) For other leg metric data, see Table 1. One falciform, slender claw to each tarsus.

Leg scobalae (i.e. branched, barbed setae) slender, tapering, pointed, the setules (barbs) moderately outstanding. Leg scobalar formula: trochanters I, II, III 1(1), 1(1), 1(1), femora 6-7(5-7), 7(6-7), 6(6), genua 4(4), 4(4-5), 4(4), tibiae 7(6-9), 6(6-7), 7(7) (figures given for holotype, followed by the range observed in at least six specimens, in brackets).

Femora, genua, tibiae and tarsi with specialized setae (see Figs 1A, 2). Large striate solenoidalae are present on leg segments as figured. In addition to these easily identifiable setae, the femora, genua and tibiae carry small, slender, pointed, smooth i.e. unbranched setae, not optically active. In previous papers I have identified these setae by the name of "spinalae". These setae will be referred to here as spinofemoralae, spinogenualae etc., according to my previous system of nomenclature (Southcott 1961a, 1961b, 1963; see also the further comments below). Solenotarsalae 1, 1, 0. Solenotibialae 2(?1), 2(?1), 1(?0) (there is some difficulty in differentiating the more slender of these setae from spinalae). (A previous statement (Southcott 1982, p. 317) that the formula for the solenotibialae in *Chyzeria* is 0, 0, 0 was wrong, it should be 2, 2, 1 as shown in the figures to that article.) Vestigiotibialae 1, 0, 0. Vestigiogenualae 1, 1, 0.

Gnathosoma small, compact, the combined chelae bases from above almost hemispherical; gnathosoma 95 long to front of cheliceral blades, by 82 wide. Cheliceral blades large, transverse, each with three (range 0-3) retrorse teeth along posterior edge. Anterior hypostomala pointed, ciliate, 22 long. Palpal coxala present, tapering, pointed, ciliate, 36 long. Palpal formula 1, 0, 2, 1, 3, 8 or 9. Dorsal palpfemorala tapering, ciliate, 35 long, ventral similar but more slender, 35 long. Palpgenuala tapering, ciliate, placed dorsolaterally, 31 long (from ACB71JC; broken in Holotype). Palpal tibialae and tarsalae as figured. Palpal tibial claw bifid, with the tines short, curved, pointed, a little separated, slightly unequal. Palpal supracoxala not identified. Galeala absent.

Analysis of the Larval Variates

In an analysis of the data in Table 1, I have eliminated the Sens figures, since only three are recorded. Also, as the data for the various estimates

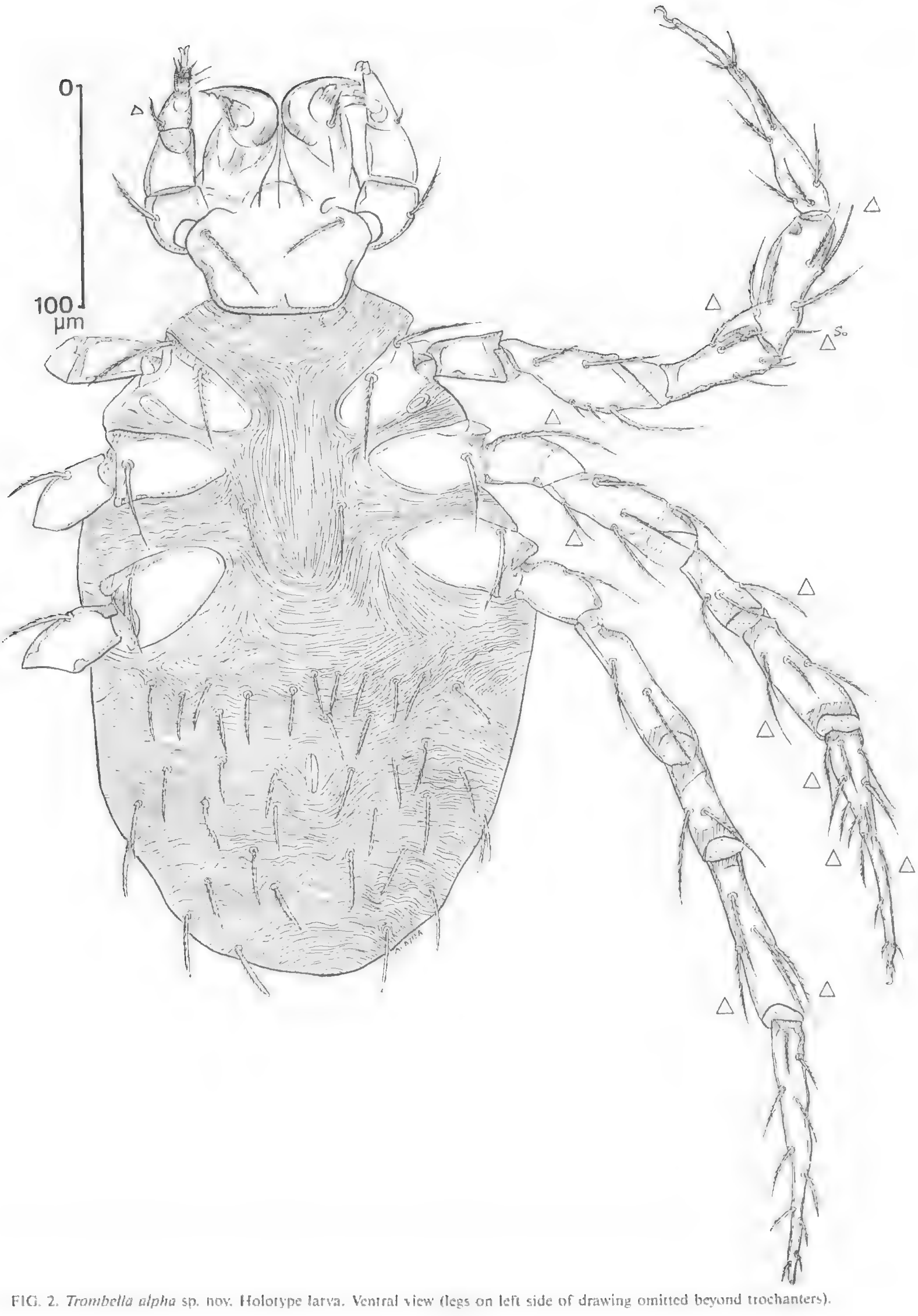


FIG. 2. *Trombella alpha* sp. nov. Holotype larva. Ventral view (legs on left side of drawing omitted beyond trochanters).

for DS are to some extent redundant, these figures have been restricted to the maximum of the DS. The data are thus reduced to a 19 × 12 table of variates.

A correlation matrix was first calculated from these figures, followed by a principal component analysis (Hotelling 1933). In view of the small number of mites only the first three (independent) patterns are considered.

Pattern 1: The variates ASB, L, A-P and TiIII (and to a less extent TiII and GeIII) varied in the same way, and accounted for about 40% of the patterning. These variates refer mainly to estimates of shield length, together with that for Tibia III.

Pattern 2: The variates AW, PW, PSB, AM and GeI vary together and account for about 30% of the patterning. These refer mainly to shield width estimates, plus GeI.

Pattern 3: The variates DS and TiI vary together and make up about 20% of the patterning. This pattern refers only to estimates of the maximum length of the dorsal idiosomal setae and of Tibia I, and has no shield variate component.

It is interesting that there is in each component a representation of a leg variate. It may be commented that these findings appear to differ from results commonly obtained from morphometric studies upon, for example, vertebrates, where the first pattern is usually of a size variable. If such were the case here one would expect that all shield measurements would tend to be represented in Pattern 1. The results could be, to some extent, an indication of the uniformity of the parasite samples available for study.

Description of Protonymph

(see pp. 160-161)

Description of Deutonymph

(Figs 6, 7A, B, 8A, B; see also Figs 4C, D, 7C, D)

Description based mainly on reared specimen ACB712B.

Colour in life orange. Idiosoma slender, cordate, flattened dorsally, with prominent division between propodosoma and metapodosoma. Propodosoma more or less conical, with base considerably narrower at junction with metapodosoma. Anterior edge of metapodosoma more or less straight, terminating laterally in slightly obtuse but rounded shoulders, continuing into the posterolateral and posterior margins. (In the unfed and unmounted newly emerged nymph the posterolateral borders are somewhat concave; see Fig. 4D). Length of idiosoma from tip of "nasus" to posterior pole 840, greatest width 425, length of propodosoma 200, of metapodosoma 640.

Propodosoma with a pair of dorsal sensillary areas, each sensillum being mounted in a small boss carrying chitinous projections with pointed tips, the whole appearance burr-like. Each boss laterally with a pair of short, blunted, ciliate setae, 12, 15 long; each of these setae projecting from individual papillae. Anteriorly, propodosoma produced into a short blunted point overlying cheliceral fangs; from this point the border runs back posterolaterally and almost transversely to an obtuse shoulder, and then more posteriorad.

FIG. 3. *Tiombella alpha* sp. nov. Larva *in situ*, parasitic on a cricket (SEM by courtesy of Mr S. J. Davidson.)

Anterior and peripheral part of dorsal surface of propodosoma with almost smooth "tear drop" setae, each mounted on an individual papilla, an enlarged and heightened annulus of the seta. Long axis of scobillum of each seta lies more or less transversely upon seta shaft, pointing slightly upwards. The more anterior of these on propodosoma point more or less medially; those on anterolateral parts of dorsum of propodosoma point more or less anteriorly (Fig. 7A).

The more central and posterior part of propodosoma rugose and devoid of setae, the anterior portion, lying between the sensilla, being level, the posterior portion formed into two large projecting bosses, with burr-like projections of epicuticle; propodosoma bordered by "tear drop" scobalae, and, more laterally, more attenuated setae.

Eyes 2+2, sessile, lateral upon propodosoma, lateral and somewhat posterior to sensilla. Each pair consists of an anterolateral and a posterolateral eye, with a thick cornea, each about 16 across.

A single filiform sensillary seta, 96 long, emerges from each sensillary boss.

Hysterosoma dorsally with 16 oval or circular shallow pits in two lateral lines, each of six depressions, and a median longitudinal row of four. Depressions fairly close to each other, and collectively occupy a considerable proportion of dorsum of hysterosoma. Anteromost pit of median row elliptical, somewhat posterior to two anteromost pits of lateral rows; behind it are two circular pits, then an elliptical pit, set among the six most posterior of the lateral pits of the dorsum.

Each pit of lateral row somewhat elliptical or ovoid, second the largest, posteriorad they become progressively smaller.

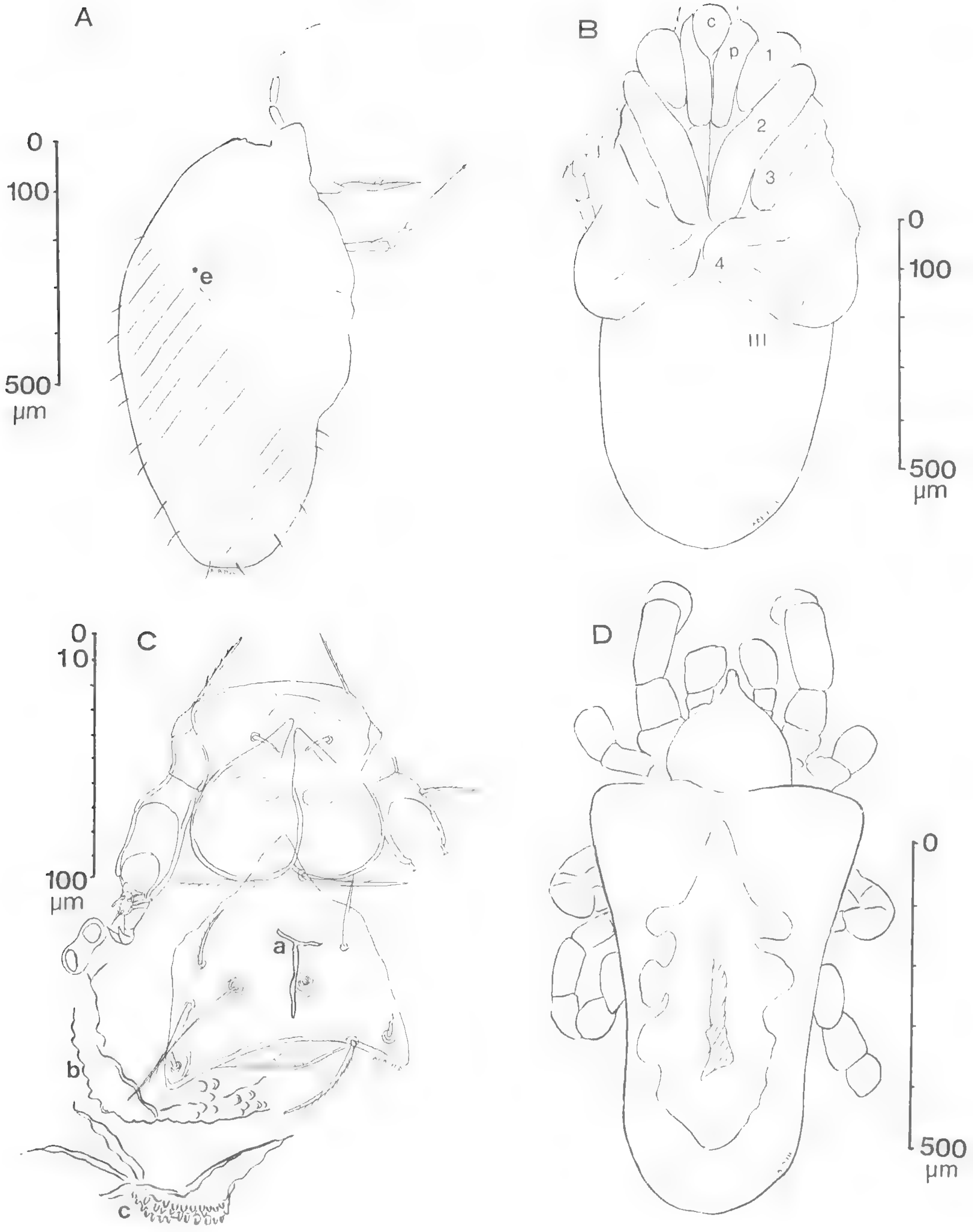


FIG. 4. *Trombella alpha* sp. nov. A Larva in oblique lateral view, undergoing transformation to nymph, specimen ACB712C on 9.iv.1980. *e* eyespot. B Later stage in the larva to nymph transformation, from below, from specimen ACB712B on 9.iv.1980. The nymph is developing within the uncast larval skin, two of the larval legs being shown; III indicates larval leg III. In the nymph *c* indicates the developing chelicerae, *p* the palpi, and 1, 2, 3, 4 indicate the developing nymphal legs. C Cast larval skin and some of the protonymphal skin (latter drawn in heavier line) (specimen ACB712D). The palpi and basis of the gnathosoma are laid back and these parts of the mouthparts are seen in ventral view. *a* the "Y"- or "T"-structure of the deutonymphal skin. *b* another part of the deutonymphal skin. *c* the "mateola" or studded boss of the deutonymphal skin. D Deutonymph (ACB712C) seen in transparency. (All to nearest scale).

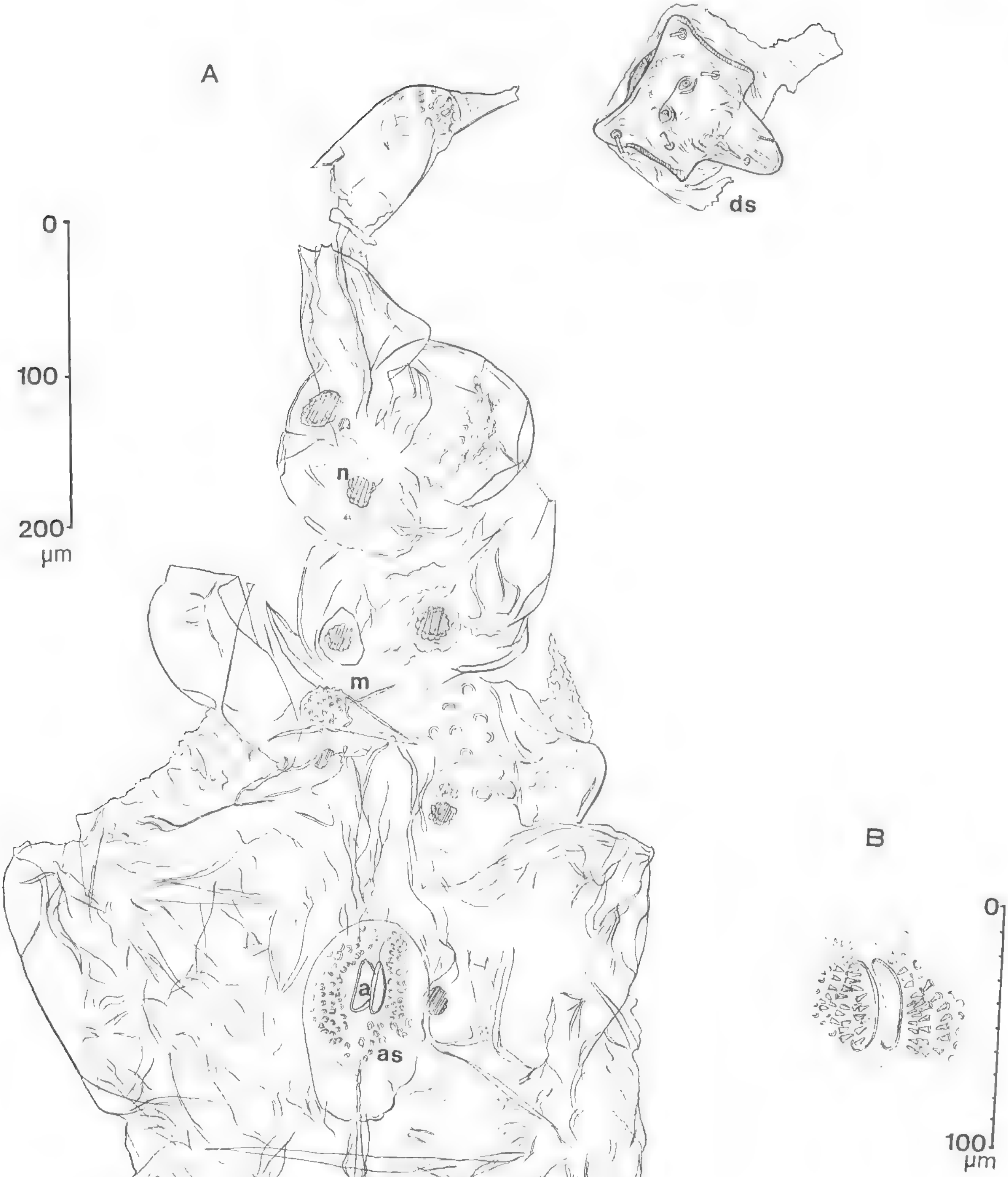


FIG. 5. *Trombella alpha* sp. nov., protonymph. A An almost intact protonymphal skin, from specimen ACB712A. *a* anal valves from the larva, *as* area setosa, *m* mateola or studded boss, *n* one of the nodular bodies inside the skin (shown cross-hatched), *ls* attached piece of idiosomal skin of larva, *ds* dorsal scutum of larva in a fragment of larval skin (to scale on left). B Anal valves and area setosa of another specimen (ACB714B) (to scale on right).

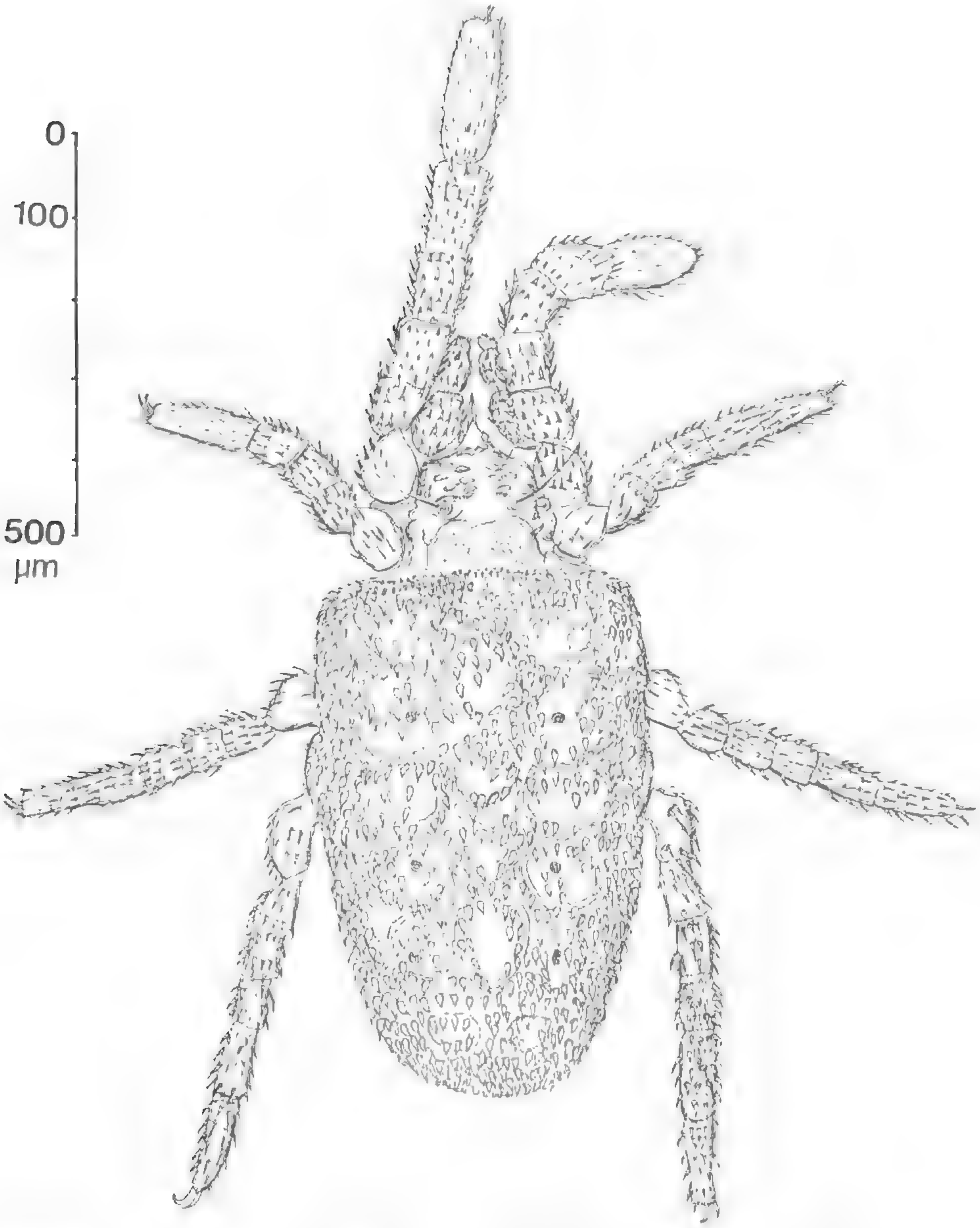


FIG. 6. *Trombella alpha* sp. nov. Active nymph (deutonymph), specimen ACB712B, dorsal view, entire.

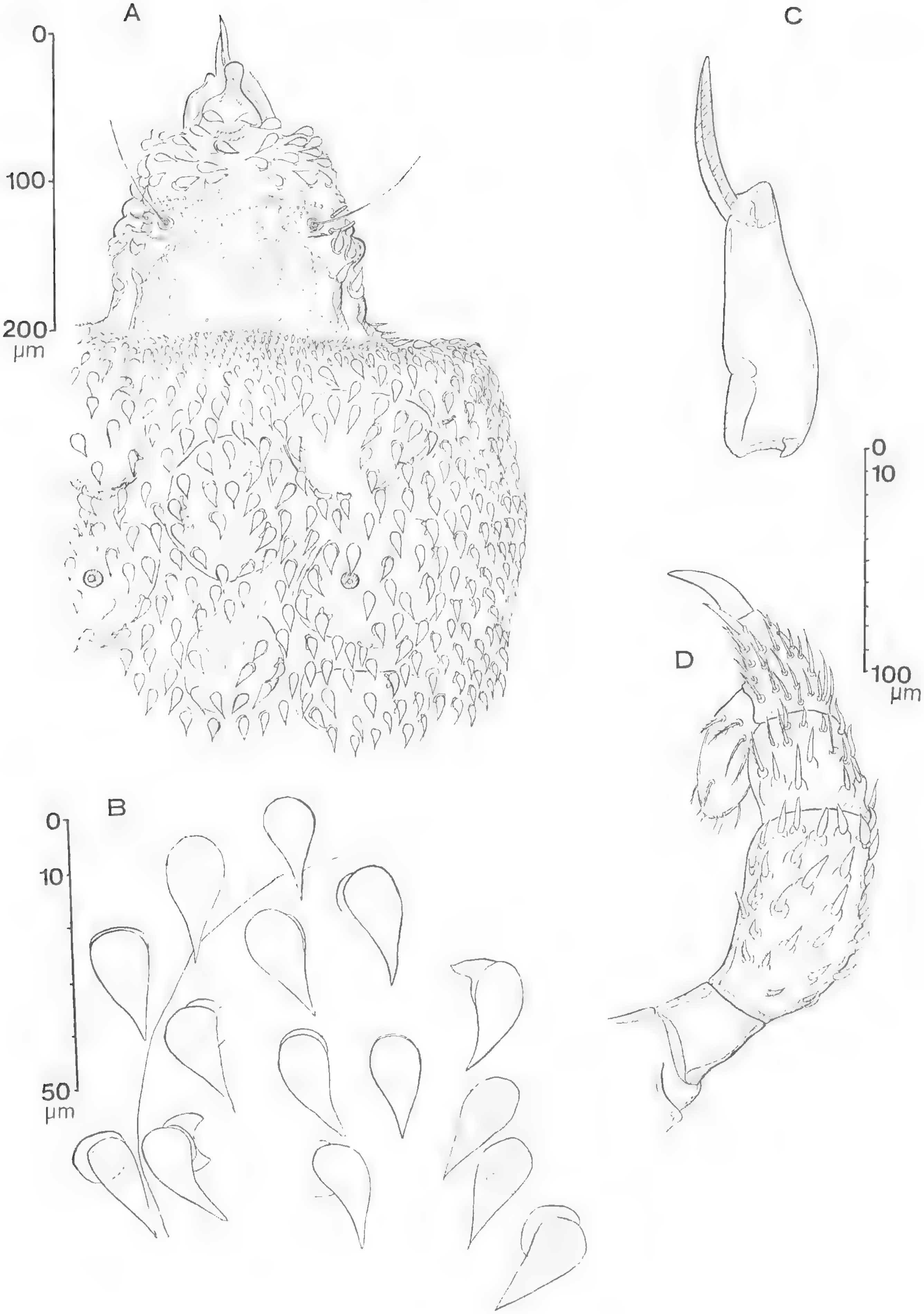
Most of dorsum of hysterosoma densely covered with robust setae, with tear-drop shaped scobillum perched transversely on chitinized "papilla" (seta annulus). Surface of scobillum with faint more or less oblique pattern, visible at high magnification, but scobillar surface smooth in lateral view. These setae occur over most of dorsum, including pits, but are sparser in inner parts of pits. Setae smaller in anterior part of dorsum of metapodosoma, and surfaces tend to project, thus resembling small burrs; laterally setae tend to elongate and be ciliate.

The second, fourth and fifth of lateral row of pits contain, more or less centrally, ring of chitin (appears as "C" in pit 5) set lower than bases of setae; it possibly functions as a respiratory aperture, but could function as muscle insertion; presumably derived from seta base (annulus).

Ventral surface: not clearly seen in ACB712B, but appears to be normal for *Trombella*. Genital aperture and anus appear to be normal for deutonymphs (somewhat obscured in mounts).

Legs (Figs 6, 8A, B) short, fairly robust for a trombidioid mite, segments beyond trochanters more or less cylindrical. Leg I 620 long, II 415, III 445, IV 520 (including trochanters to tips of tarsi, without claws). Each tarsus bearing two claws. All segments of legs with irregular surface due to leg setae (scobalae) originating from small papillae. These leg setae generally robust, and tend to resemble body setae but are much more slender, tapering and blunt-pointed. In more proximal and more distal parts of legs these scobalae tapering, more slender and flexible, more like usual setation of trombidioid mites. Leg segments carrying small spiniform sensory hairs (spinalae) interspersed among scobalae, from telofemora to tibiae.

In leg I (Figs 6, 8A) tarsus from above more or less parallel-sided, 198 long by 67 wide. In leg IV (Fig. 6)


A
0
100
200
μm
B
0
10
50
μm
C
0
10
100
μm
D

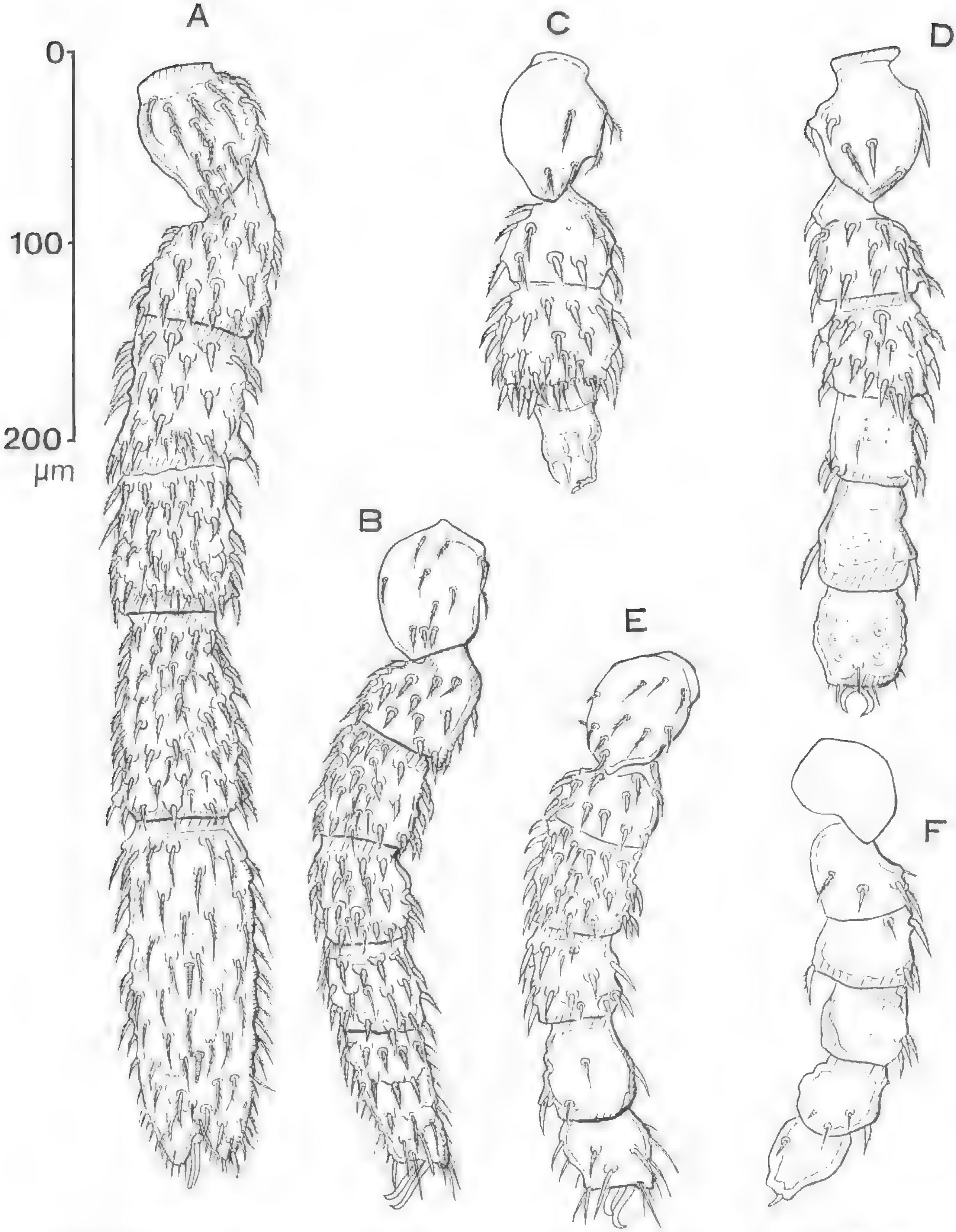


FIG. 8. *Trombella alpha* sp. nov. Deutonymph. A, B Normal specimen ACB712B, A left leg I, B left leg II. C-F Abnormal legs of specimen ACB712A (see text), C left leg I, showing extensive deformity, with almost complete loss of all segments beyond the telofemur, but all segments somewhat abnormal. D Right leg I, showing a generalized deformity with progressive shortening of segments; note also loss of setae. E Left leg II, similarly affected. F Right leg II, with considerable deformity, including shortening of all segments and gross reduction of setation, and reduction of the paired claws to a single short peg. (All to scale shown.)

FIG. 7. *Trombella alpha* sp. nov. Deutonymph. A Dorsal view of anterior part of idiosoma and tips of chelicerae, specimen ACB712B. B Further enlargement of the setae of the anterior of the median column of depressions. The surface patterning of three of these setae is shown at the lower right. C Chelicera of specimen ACB712C. D Medial aspect of R palp of ACB712C. (All to nearest scale.)

TABLE 2. MEASUREMENTS OF LENGTHS (µm) OF LEG SEGMENTS OF A SERIES OF NYMPHS OF *TROMBELLA ALPHA* N. SP.; AND SIMILAR DATA FROM THE HOLOTYPES OF *TROMBELLA ADELAIDEAE* WOM. AND *T. WARREGENSIS* HIRST; TOGETHER WITH RATIOS OF LEG SEGMENTS AS A PROPORTION OF TARSAL LENGTH

	Nymphs of *Trombella alpha*										Adult of *T. adelaideae*		Adult of *T. warregensis*	
Specimen number	ACB712B		ACB712A*		ACB712C		ACB712D		ACB714B†		ACB729		ACB730	
Segment	µm	ratio	µm	ratio	µm	ratio	µm	ratio	µm	ratio	µm	ratio	µm	ratio
Tarsus I	198	1.00	62	1.00	183	1.00	191	1.00	170	1.00	280	1.00	390	1.00
Tibia I	120	.60	61	.98	106	.58	120	.63	98	.58	180	.64	320	.82
Genu I	80	.40	49	.79	—‡	—	90	.47	—‡	—	148	.53	230	.59
Tarsus IV	126	1.00	122	1.00	135	1.00	133	1.00	125	1.00	214	1.00	311	1.00
Tibia IV	114	.90	113	.93	117	.87	111	.83	105	.84	192	.90	328	1.05
Genu IV	72	.57	73	.60	75	.56	78	.59	72	.58	128	.60	197	.63

* Teratological specimen. The measurements are taken from the less deformed right side (see text). Legs II and III also show the same deformity (brachymely).

† This specimen has a brachymelic right leg III. However legs I and IV appear normal (see text).

‡ Specimen flexed, not measurable in mount.

tarsus tapering, 126 long by 36 wide. For other leg dimensions see Table 2.

Palpi fairly stout, provided with robust scobalae over femur and genu, more distally setae more slender, and some are barbed (see Fig. 7D, from ACB712C). Palpal tibia with strong curved claw, and accessory claw-like seta on medial side. Palpal tarsus with sparse setation of slender pointed hairs, some barbed.

Cheliceral fang robust, curved, pointed, 71 long, arising from a basis chelicerae about twice as long (Fig. 7C, from ACB712C).

Origin of the Specimens of Trombella alpha

This study of *Trombella alpha* is based upon larvae which have been obtained parasitic upon field crickets, *Teleogryllus commodus* (Walker), in the New England District of New South Wales, by Mr S. J. Davidson, who commented (pers. comm., 5.xi.1979) on ". . . a red-orange coloured mite which appears to be parasitic on gryllids. Up to 50 per cricket have been recorded, with mouthparts attached to the hosts' pleural regions, especially on the metathorax" (see Fig. 3). In a further note (pers. comm., 1982) Mr Davidson has summarized his observations on the parasitisation of the crickets by this mite species as follows: The mite "attaches principally to the soft pleural regions of the host . . . Numbers of this mite were monitored by examination of most of the *T. commodus* trapped in pitfalls from 1979 to 1980. A higher percentage of crickets was parasitised in 1979 than in 1980, with respective means of 61% and 20% . . . Similarly, there was a higher mean parasite burden per cricket in 1979 than in 1980. The mite was most prevalent on crickets in about February, and both percentage parasitism and parasite burdens declined in late autumn . . ." [Table 3]

TABLE 3. PERCENTAGE OF *T. COMMODUS* PARASITISED [BY *T. ALPHA*] AND THE MEAN PARASITE BURDEN PER CRICKET, OVER TWO SUCCESSIVE SEASONS OF PITFALL TRAPPING AT KIRBY STATION.

Collection date	Number of crickets examined	Percentage of crickets with mite parasites	Mean number of mites per cricket
30.i.79	31	42	0.71
9.ii.79	55	91	7.22
26.ii.79	18	83	8.50
26.iii.79	79	84	2.80
9.iv.79	46	50	0.80
24.iv.79	33	18	0.18
Mean (1979)	44	61	3.4
11.i.80	119	24	0.34
8.ii.80	14	21	0.36
7.iii.80	39	18	0.23
4.iv.80	75	15	0.19
Mean (1980)	62	20	0.3

Note: These data refer to all instars of the cricket in which the sex can be distinguished, i.e. the last three instars (see also Table 7, and text thereto).

Material examined

ACB711: 4 specimens, collected from paddock number K2, Kirby Rural Research Station, near Armidale, N.S.W., 12.iii.1979. Preserved in alcohol, decolorized.

ACB712: 5 specimens, live, crickets collected 12.iii.1980; mites removed 19.iii.1980. (Transformed to nymphs in Adelaide.)

ACB713: Several larvae collected 19.iii.1980; preserved in alcohol.

ACB714: 3 specimens, live, collected 19.iii.1980.

ACB712, ACB713 and ACB714 were all collected 10 km N of Armidale, N.S.W.

Type and paratypes to be deposited in the South Australian Museum.

Rearing Experiments: Larvae to Nymphs of T. alpha

Deutonymphs were reared from two batches of larvae forwarded to my laboratory, on strips of wet blotting paper in sealed tubes. Experimental details are as follows:

(1) Experiment ACB712. The cricket was collected on 12.iii.1980 and the mites removed on 19.iii.1980. The five larvae sent were received by me on 21.iii.1980. On receipt the mites were immobile, i.e. they were possibly in a pre-pupal condition. One mite was rather swollen, on its back in a film of water on the site of the tube. The legs looked decolorized. One larva was waving its legs about, stuck to glass. The three other larvae immobile, not swollen. Later in the day two mites became immobile and were considered swollen, while two were waving their legs about. All five were stuck in a film of water and the tube was wet.

23.iii.80. All larvae immobile, plump.

24.iii.80. All immobile, not shrivelled, not mouldy. One or more were considered to be in a pre-pupal stage.

25-29.iii.80. All mites observed daily, and recorded as immobile.

30.iii.80. In two specimens "frosting" under the skin of the mite was detected. This was interpreted as representing the development of nymphal setae within the exuviae.

31.iii.80. 3.00-3.15 p.m. One larva appeared to be sitting upon a pupa larger than itself. Skin of larva appeared transversely wrinkled. The other larvae were smooth, swollen, not mouldy, and were considered to be in a pupal state.

3.30 p.m. The legs of the nymph were clearly visible. Anterior part of the larval skin had gradually become whiter and more opaque, as though filling with air. A clear gap was visible, most noticeable in the right rear leg.

The legs of the nymph gradually extended away from the body of the animal.

Other larvae also had air under the skin.

1.iv.80. Nymphs had not as yet emerged. Two larvae in the tube had prominent protuberances.

8.iv.80. Nymphs had still not emerged, despite nymphal palpi and legs being clearly visible within the larval skin.

9.iv.80. Camera lucida sketches were made of the transforming larvae (see Figs 4A, B).

15.iv.80. Two nymphs had emerged, these being labelled ACB712C and ACB712D. These were not the specimens mainly described above. The cast larval skins of these two mites, also a dead larva (ACB712E), were mounted.

16.iv.80. One more nymph (ACB712A) emerged in the morning, and one (ACB712B) at night. The cast skins of these two specimens were mounted.

18.iv.80. One nymph (ACB712D) was immobile, possibly dead; mounted. I attempted to feed the nymphs with pieces of apple, culicine mosquito eggs, and squashed adults of *Aedes notoscriptus*, also a sample of bird dung, and the juice of a squashed grasshopper (*Phaulacridium vittatum*), etc. One nymph appeared to feed upon the piece of apple, and possibly feeding could have occurred with the other materials. One nymph (ACB712D) was seen moving slowly as late as 17.v.80; the others had died earlier. Eventually all nymphs were mounted in gum chloral mountant for study; none had transformed to any later instar.

(2) Experiment ACB714. Three plump larvae were received in wet preparation on 21.iii.80, having been collected on 19.iii.80. All remained immobile, and unaffected by mould filaments spreading slowly across the inner surface of the glass tube, which began to produce spores on 27.iii.80.

On 28.iii.80 one mite was observed to have decolorized legs and mouthparts.

On 31.iii.80 nymphal legs developing in one larva, in its unchanged larval skin, were detected.

On 8.iv.80 one specimen (ACB714A) became mouldy. Another specimen (ACB714C) eventually shrivelled to a more or less spherical object without recognizable features. One larva (ACB714B) was seen to have protruding limb masses by 8.iv.80, and a nymph emerged on 20.iv.80. Food was offered to it in the form of a mass of culicine eggs, pieces of grass, a squashed dipteran, a squashed small weevil, a squashed *Phaulacridium vittatum* etc., and the mite possibly fed. It was not seen moving after 13.v.1980. The mite and its cast skin, and the other larvae used in the experiments, were eventually mounted on slides for study.

From these observations a confident correlation of the larva with the nymph of this species can be made.

Table 4 summarizes the details of the successful larva-nymph transformations.

Remarks on the Larva to Nymph Transformation

The active nymphal stage of the Parasitengona is currently recognized as the deutonymph. Between the larva and the deutonymph is the protonymph, which, as with most prostigmatic mites in the Parasitengona, is calyptostatic and takes place within the larval skin. In the Erythraeoidea the skin tends to retain its shape when shed by the protonymph, and can commonly be retrieved in one piece after such ecdysis (Frauenfeld 1868; Womersley and Southcott 1941; Southcott 1946a, 1946c, 1961a). In the case of the smaller Trombidioidea the protonymphal skin is thinner and more fragile, so that although there have been many studies on larva to nymphal transformations in the Trombiculidae and other families, rarely is there an attempt to describe the protonymphal stage between the larva and the deutonymph. However, modern exceptions to this statement can be found in the works of Jones (1951,

TABLE 4. DETAILS OF SUCCESSFUL TRANSFORMATIONS OF LARVA TO ACTIVE NYMPH IN *TROMBELLA ALPHA* N.SP.

Experiment and specimen number	Date collected	Date received	Date became immobile	Date Active nymph emerged	Duration of the immobile phase*
ACB712A	12.iii.80	21.iii.80	19-23.iii.80	16.iv.80	24-28 days
ACB712B	12.iii.80	21.iii.80	19-23.iii.80	16.iv.80	24-28
ACB712C	12.iii.80	21.iii.80	19-23.iii.80	15.iv.80	23-27
ACB712D	12.iii.80	21.iii.80	19-23.iii.80	15.iv.80	23-27
ACB714B	19.iii.80	21.iii.80	19-21.iii.80	20.iv.80	30-32

* By subtraction. The figures given express a range of possible dates from the data available. Since there is no precise indication of the time of commencement of the protonymphal stage it is not possible to give any estimate of the duration of that period.

1954), Neal and Barnett (1961), Johnston and Wacker (1967) and Robaux (1974).

An intermediate membrane seen within the investing integuments of the prelarva, or later stages, was named the "Zwischenhaut" by Claparède (1868) in his study of the development of the water mite *Atax bonzi* Claparède, the "apoderma" by Henking (1882) in his study of *Trombidium fuliginosum* Hermann, or the "intermediate skin" by Jones (1951, 1954), in his study on *Neotrombicula autumnalis* (Shaw). Since deutonymphal development takes place entirely within the expanding larval skin, there appears no need for the protonymph of the Trombidioidea to develop the distinct pupal setation as in the Erythraeoidea, and which presumably has a defensive and possibly substrate-anchoring function.

In the case of the developing *Trombella alpha* deutonymph, some of the successive stages of the gradual transformation from immobile larva through the protonymph to the active deutonymph are shown in Fig. 4A, B. Initially the legs and palpi lose their orange coloration, as the living substance of the animal is withdrawn to a more compact mass. The ventral part of the larva enlarges, so that after several days the appearances are of a larva riding upon a larger rounded structure, a flattened prolate spheroid. The nymphal leg prominences gradually appear, and project increasingly from the main mass. The larval skin appears to separate from the developing nymph, so that the dorsal surface at least appears as whitish and more opaque. The emerging nymph may or may not leave behind a more or less intact larval skin. Generally the "intermediate skin", i.e. the protonymphal skin, remains inside the cast larval skin, so that it is not easy to recognize. Occasionally parts of the protonymphal skin separate from the larval skin, and rarely, the protonymphal skin may appear as a more or less intact structure. Even within the cast larval skin, however, distinct structures may be seen in the exuviae discarded by the nymph. Thus in Fig. 4C there is visible a Y- or T-shaped thickening of the integument ("*a*"), shown underneath the larval scutum. More posteriorly is a distinct structure, near the midline, which appears as a studded boss or "mateola", with folds of thin skin running up to it ("*c*" in Fig. 4C). Other less clearly recognizable structures can also be seen, with vague outlines suggesting that they may have been investments of the developing limbs, and sometimes with numerous small elevations (e.g., as shown in Fig. 4C, "*b*").

One distinct structure is made up of two elongate-oval or kidney-shaped valves, surrounded by a large number of small conical elevations in an "area setosa" ('*as*' in Fig. 5A; see also Fig. 5B). These valves are the same structure as the larval anus or "uroporus", having the same appearance of two apposed valves, but surrounded by a highly modified area of skin. Comparison of the cast larval and protonymphal skins shows that between them they possess only one pair of valves or valve-like structures, which are of the same dimensions as those of the larvae, i.e. these are of larval origin. the area setosa, however, is purely of protonymphal origin. The more or less concentrically arranged elevations are short cones with blunted tips. They are setiform in shape, and either represent precursors to setae, or possibly serve as investing structures for the developing setae of this area of the deutonymph. These protonymphal setae are similar in appearance to the projections of the "studded boss" ("mateola", or small mace) mentioned above.

Although it is not at present possible to allocate anatomical positions or functions to all of the structures of the protonymphal skin, at least some of the main structures can be postulated.

In Fig. 5A is shown a more or less intact protonymphal integument, after slide-mounting through lactophenol and gum chloral media (specimen ACB712A). This is described briefly in the following section.

Description of Cast Protonymphal Skin (Fig. 5A, B)

This skin (ACB712B) is more or less in one piece, transparent and colourless. Overall length 875, to tip of projecting anterior pointed structure; width 445. General outline oval, with broad rounded posterior end and crumpled but narrower anterior end. Whole of skin with crumpled appearance; only some of the many minor folds are shown in Fig. 5A. The appearance of the skin matches roughly the shape of developing nymph (see Fig. 4B), with widest part and lateral bulges corresponding to legs IV of nymph. The position of anal valves and surrounds corresponds to position of these structures in larva and deutonymph. The anterior part of cast skin is more difficult to assign to corresponding structures, but presumably the various parts are investing integuments to chelicerae, palpi, and the more anterior legs.

The mateola appears in the skin, projecting anteriorly, about midway between the anal area and the front of the skin with folds of integument leading to the base. The "Y-structure" was not certainly identified, but possibly was contained in the folds drawn around the mateola ("*m*" in Fig. 5A).

Rounded markings present over various parts of cast skin, recognizable as rounded elevations on protonymphal skin. There is no evidence of seta formation in them (such skin elevations are a well-marked feature of the few developing protonymphs of trombidioid mites that have been described; e.g. Johnston and Wacker, 1967, Fig. 5, p. 307, for *Eutrombicula splendens*).

Several thickened, almost nodular deposits appear within the skin, shown cross-hatched in Fig. 5A, one being labelled "*n*". Whether these are mere accidental inclusions, or are representative of some consistent process is not known, because only one reasonably intact protonymphal skin was available.

Anal valves (from larva) and area setosa as described above.

Associated with the protonymphal skin in this preparation are only two other pieces of larval skin. One (*"ds"* in Fig. 5A) consists of the larval dorsal scutum and a small amount of its surrounding skin, detached from the protonymphal skin. The setae of scutum are severely damaged from the processes of transformation, and possibly by the mounting procedure and no seta is intact. The other small larval skin piece is at the posterolateral aspect of the protonymphal skin (*'ls'* in Fig. 5A).

Variations in the Leg Structure of the Deutonymph, and the Developmental Abnormality "Brachymely"

Since dimensions of leg segments are commonly used as species-differentiating characteristics in these and other mites, it is instructive to examine the intraspecific variation of a batch of mites which have been collected from the same area, and handled in the laboratory as uniformly as possible.

Table 2 lists tarsus, tibia and genu lengths of legs I and IV of the reared *Trombella* alpha nymphs (also those of holotypes of *T. adelaideae* and *T. warregensis*)).

There is some similarity between ratios of the segmental lengths in the three nymphs ACB712B, ACB712C and ACB714B. However, ACB712A shows gross shortening of the three measured segments of Leg I, but no abnormality in leg IV. This occurs in greater degree distally; and is accompanied by other structural abnormalities. It occurs in legs other than those shown in Table 2, and may vary between the two sides of the animal. This developmental abnormality will be termed "brachymely".

Brachymely in Trombella alpha *and in some other Prostigmatic Mites*

Fig. 8C-F shows the deformed legs I and II of ACB712A, compared with the normally developed legs I and II of ACB712B (Fig. 8A, B).

TABLE 5. COMPARISONS OF ABSOLUTE LENGTHS (μm) OF LEG SEGMENTS OF LEGS I AND IV OF REARED *TROMBELLA ALPHA* NYMPHS AND RATIOS

	ACB712A* x	ACB712B y	ACB712C z	ACB714B w	m $\frac{y+z+w}{3}$†	x/m
Segment						
TaI	64	198	183	170	183.7	.35
TiI	61	120	106	98	108	.56
GeI	49	80	—	—	80	.61
TaIV	122	126	135	125	128.7	.95
TiIV	113	114	117	105	112	1.01
GeIV	73	72	75	72	73	1.00

* Measuring the less deformed R leg, for purposes of comparison. In the left leg the segments beyond the femur are unrecognizable from the gross shortening and fusion.

† or 1, in the case of GeI.

Table 5 shows normal variation for leg IV in specimen ACB712A; deformities in this specimen are restricted to legs I-III. In the right leg I the tarsus, tibia and genu are considerably shortened, and the setae much reduced (Fig. 8D). The trochanters, basifemora and telofemora appear more or less normal, with a minor degree of shortening and some loss of setae in these segments also. The degree of shortening is greater distally. In legs II (Figs. 8E, F) and III there is a reduction of setae throughout the legs, including the two parts of each femur. In right leg II (Fig. 8F) and right leg III there is only one tarsal claw to each tarsus. The most extensive deformity occurs in left leg I, where there is some thickening of the femur, and beyond the femur the remainder of the leg is reduced to a single fused segment (Fig. 8C). In this segment there is no recognizable tarsal claw or claws, with only a rudimentary indication of setae, without any seta basis or other part being distinctly recognizable. (In specimen ACB714B there appears to be a minor degree of shortening of right leg III, apparently without other abnormalities in the body or other legs. The measurements of the lengths are: Tarsus III 66, tibia III 76, genu III 57. In tarsus III and tibia III there is a reduction of setation, and possibly also in genu III. For left leg III of the same specimen: tarsus III 93 long, tibia III 73, genu III 58.

There was nothing that occurred in the experimental handling of specimen ACB712A to suggest a reason for the remarkable degree of deformity observed. All of the larvae in experiment ACB712 underwent transformations at about the same time intervals. The abnormalities cannot be attributed to a failure of the production of moulting fluid, as such would simply fail to allow release, but would not be expected to affect limb development. Abnormalities other than in the limb segments were not detected. The cast skin of the larva and protonymph appear normal. The lengths of the leg segments of the larva, also the shield data (see Table 1), are normal. The larval tibiae and tarsi, for example, are normal in structure. The cast protonymphal skin (see Fig. 5A) appears normal. It is the most intact of the protonymphal skins available for study, at least of those that have separated from the larval skin. It would be inappropriate to attempt to connect some of the parts of the ACB712A protonymphal skin with structural abnormalities of the nymphal legs at the present time, because of the lack of knowledge of the correspondence of nymphal and protonymphal structures.

It is not uncommon for minor abnormalities in leg claw structure to be seen in larval erythraeid mites captured in the field. This has been referred to as "twisted claws" or TC abnormality (Southcott, 1961a, p. 481; 1966, p. 732; 1972, p. 29). More severe deformities are also seen in the legs of larvae caught in the field. Thus in one batch of larvae caught at Inman Valley, South Australia in 1952 many larvae of

Erythrites urrbrae (Wom.) and *E. reginae* (Hirst) showed a mild tarsal deformity, and one specimen of *E. reginae* showed an extreme deformity of all pedotarsi, which were grossly contracted and distorted (Southcott, 1955).

The cause of these deformities is unknown. An attempt to reproduce them in larval erythraeid mites by chilling batches of eggs resulted in scutal deformities but not leg deformities (Southcott, 1955).

Although it is not unusual for minor abnormalities of scutal structure to occur among prostigmatic mites, involving supernumerary setae or loss of setae (see Southcott, 1966, pp. 756-758), it appears that the limbs of developing mites are more at risk of structural abnormalities (in the form of shortening of segments and loss of setational pattern) than the structures associated with the idiosoma. The claws may suffer a minor deformity, may be grossly distorted, or virtually absent.

Various other developmental abnormalities have been recorded among the Acarina and in other arthropods. Among prostigmatic mites there may be complete absence of a leg, e.g. in the water mite *Sperchon glandulosus thienemanni* Koenike (Szalay, 1932), or in *Eutrombidium otorheiense* Feider (Feider, 1946). Simple shortening of a leg, but without other abnormality, has been recorded by Feider (1946) in *E. otorheiense*, and termed micromely. Schizomely (complete or incomplete duplication of a leg) has been recorded by André (1949, 1960b) in the trombidioid mites *Microtrombidium sucidum* (L. Koch) and *Carpothrombium carduigerum* (Berlese). Various leg and other abnormalities in Hydrachnellae and other mites were recorded and discussed by Thor (1926).

Exposure of the developing eggs of other arachnids to supraoptimal temperatures has produced limb, eye and other deformities. Among the limb deformities are brachymely and schizomely (opilionids: Juberthie, 1968; spiders: Jacuński, 1971, Mikulska and Jacuński, 1971, Mikulska, 1973).

The observations reported here indicate that developing limbs of Acarina are sensitive to teratogenic agents, as yet unknown.

Classification of Post-larval Trombella

Known post-larval forms of *Trombella* s. str. comprise six closely related species, characterized by the lack of a crista metopica and the presence of large idiosomal depressions, allotted a glandular function by some authors. The genus and species were founded on a single specimen of *T. glandulosa*, found deeply buried in soil, Adria, northern Italy (Berlese, 1887). This specimen, which has not been restudied by any later author, had several unusual morphological features, not recorded for any other species since placed in *Trombella* s. str.: (1) the presence of a chitinized pore in *each* of the idiosomal pits, whether dorsal, lateral or ventral; (2) the dorsal idiosomal pits not contiguous, in fact well separated and occupying only a small proportion of the surface; (3) the posteromost median dorsal pit being set in a group of four of the lateral pits, instead of being set in the midst of a group of six pits; (4) the presence of a long sinuous idiosomal seta arising from a small prominence on the lateral side of each propodosomal sensillum. These features of Berlese's original drawing were reproduced in Thor and Willmann (1947), and the sole further specimen of *T. glandulosa* recorded, from Austria, by Schuster (1960), is stated to correspond accurately in all morphological features they give, apart from being somewhat smaller. One may therefore accept Berlese's drawings as accurate.

The African *T. favosa* appears to be the species most separate from *T. glandulosa*. Dorsally it carries large idiosomal depressions, all lacking a central pore, but surrounded by a prominent ring of chitin. The dorsal idiosomal setae are also markedly different, being in the form of large flattened scales, the scobillum ending in a long central point and being provided with large projections along its lateral edges (André 1936a, 1958). In *T. glandulosa* the dorsal idiosomal setae are spinelike, simple, and bent near the base of the shaft so that the main part of the shaft is parallel to the surface. In *T. lusitanica* the general idiosomal setae are spiniform, simple, curved, sharp, on short tubercles (papillae), only the more peripheral ones of the propodosoma bearing fine setules. In *T. warregensis* the dorsal idiosomal seta is papillate, elongate, curved near its base, and ornamented with prominent broad setules in the form of scales or long barbs; in both *T. adelaideae* and *T. alpha* the seta presents as a tear-drop perched transversely upon a papilla. In *T. adelaideae* the scobillum is ornamented with prominent broad scales, while in *T. alpha* only a reticular pattern is visible (see Figs 7B, 9A-D).

The other hitherto recorded species of adults of *Trombella*—*T. lusitanica* André, *T. warregensis* Hirst (which appear to be close to each other) and *T. adelaideae* Wom.—differ in having different members of the idiosomal pits with central pores, in setal and leg characters, etc. (One feature used by André in proposing *T. lusitanica* and separating it from *T. glandulosa* and *T. warregensis*, was stated to be its possession of a punctate seta-less area on the propodosoma. However in *T. warregensis* re-examination of the holotype under oil immersion shows minute puncta in this glabrous area. The same glabrous area in *T. adelaideae* and *T. alpha* has small rounded tubercles.)

Thus in *T. adelaideae* and *T. alpha* the dorsal pits carry these chitinous pores or rings more or less centrally in lateral depressions 2, 4 and 5; in *T. warregensis* they are present in lateral depressions 2, 3, 4, 5 and 6; in *T. lusitanica* they are present in lateral depressions 2, 3, 4 and 5 (André, 1944).

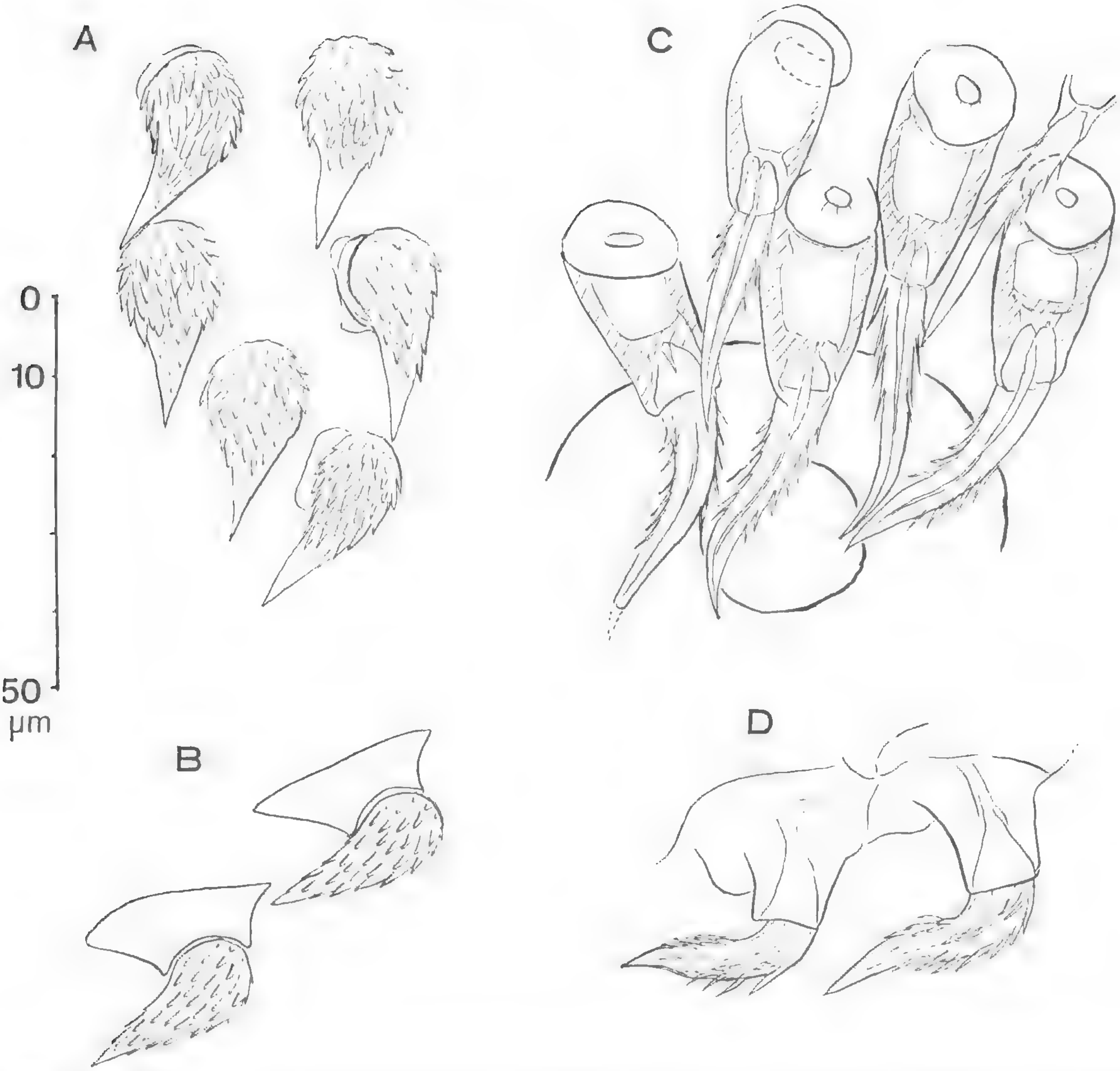


FIG. 9. Dorsal idiosoma setae in adult *Trombella*. A, B *Trombella adelaideae* Wom., Holotype, A setae from the anterior median dorsal depression; B setae from the posterolateral edge of the dorsum. C, D *T. warregensis* Hirst, Holotype. C Group of setae from posterolateral part of dorsal idiosoma; D Two setae in lateral view at the posterolateral edge of the dorsum. (All to scale shown.)

The arrangement of the setae of the dorsal idiosomal pits has been used by authors (e.g. Womersley, 1954b) as taxonomic criteria. Thus the central areas of these pits in *T. favosa* bear slender papilla-less spiniform setae (André, 1936a), while in *T. lusitanica* the pits bear spiniform, conical setae arising from a short tubercle (André, 1944); in *T. glandulosa* they are short, conical and curved (figured by Berlese, 1887). In the three Australian species recorded here the setae of the pits do not differ essentially from the general dorsal idiosomal setae. In both *T. adelaideae* and *T. alpha* the peripheral setae of the dorsal pits may form a single vague row, but in *T. warregensis* the central part of the dorsal depressions is nude, with peripherally the setae in one or two fairly regular concentric rows (in *T. glandulosa* Berlese figures one row of setae near the centre, and one row at the rim).

Some use has been made of the relative shapes of leg segments and the rations of various segmental lengths as taxonomic characters of trombidioid and other mites, although with soft-bodied mites such as the trombidioids too much reliance should not be placed upon the shape characteristics of the tarsi. For the three Australian species of *Trombella* the ratios of tarsus I length/tibia I length and tarsus I length/tarsus I width, are given in Table 6.

The data in Table 6 indicate that *T. adelaideae* and *T. alpha* resemble each other more than either resembles *T. warregensis*, which agrees with the idiosomal seta characteristics.

The data presented or previously published appear adequate to separate species of *Trombella* on a world basis, even though we do not have any species recorded

TABLE 6. COMPARISON OF LEG-SHAPE RATIOS IN *TROMBELLA* FROM AUSTRALIA, USING TARSUS I/TIBIA I, AND LENGTH OF TARSUS I/WIDTH OF TARSUS I, IN NYMPHS OF *T. ALPHA* AND ADULTS OF *T. ADELAIDEAE* AND *T. WARREGENSIS* (See also Table 5 for figures to lengths)

	Trombella alpha nymphs*				*T. adelaideae*†		*T. warregensis*†	
	ACB712B	ACB712C	ACB712D	ACB714B	ACB729		ACB730	
Tarsus I / Tibia I	1.65	1.73	1.59	1.73	1.56		1.22	
Tarsal width	67	67	75	65	100μm(L), 102μm(R)		176μm(L), 164μm(R)	
					(L)	(R)	(L)	(R)
Length TaI / Width TaI	2.96	2.73	2.55	2.62	280 / 100	282 / 102	390 / 176	ca380 / 164
					2.80‡	2.76‡	2.22§	2.32§

* omitting brachymelic specimen ACB712A. See data in Table 2.

† Re-measured from holotype. See data in Table 2. In both leg I is seen in lateral view.

‡ Womersley (1954b, pp. 127, 128) gives these figures as 270 and 90, and the ratio as 3:1. The specimen has not been remounted. (In 1939, p. 149, he gave these figures as 260 and 90.)

§ Womersley (1954b, pp. 126, 128) (who had remounted the specimen) gives these figures as 375 and 135, and the ratio as 2.75:1. Hirst (1929, p. 170) gave 370 and 140, i.e. a ratio of 2.64:1.

in which both adults and deutonymphs have been described. The following key is therefore presented.

KEY TO THE KNOWN WORLD SPECIES OF POST-LARVAL STAGES OF *TROMBELLA S. STR*

1\. All dorsal pits of idiosoma lack a central chitinized pore-structure. Dorsal idiosomal setae flattened, with long median end and 3-5 strong lateral projections. Central areas of dorsal pits with long spiniform setae, not mounted on papillae .... *T. favosa* André

At least some of the dorsal pits of the idiosoma with a central chitinized pore-structure 2

2(1) All dorsal idiosomal pits with a central chitinized pore-structure. Dorsal idiosomal setae spiniform, bent near base so that the shaft lies parallel to body surface. Ratio of length tarsus I/tibia I about 2.0 .... *T. glandulosa* Berlese

At least the anteromost of the lateral row of dorsal idiosomal pits lacking a central chitinized pore-structure 3

3(2) Dorsal idiosomal setae long and pointed, the seta scobillum not wider than its basal papilla. Third lateral dorsal depression with central pore-structure 4

Dorsal idiosomal setae tear-drop shaped, the scobillum wider than the basal papilla. Third lateral dorsal depression without central pore-structure 5

4(3) Dorsal idiosomal setae with numerous prominent setules. Chitinized pores present in lateral row pits of dorsum numbers 2, 3, 4, 5 and 6. Tarsus I/tibia I about 1.2 .... *T. warregensis* Hirst

Dorsal idiosomal setae either spiniform or with slender setules. Chitinized pores present to lateral row pits of dorsum numbers 2, 3, 4 and 5. Tarsus I/tibia I about 1.35 .... *T. lusitanica* André

5(3) Scobillum of dorsal idiosomal setae with distinct ciliate-barbed surface .... *T. adelaideae* Womersley

Scobillum of dorsal idiosomal setae with smooth surface, not presenting as a ciliate-barbed structure .... *T. alpha* n. sp. (deutonymph)

Leg Chaetotaxy of Trombella alpha *Larva*

Specialized sensory setae upon the legs of larval prostigmatic mites have been of interest to taxonomists for many years, particularly in classification. Although they function as physical and chemical receptors, there have been few functional studies upon them, efforts having been mainly in description and classification, with their functions only rarely being postulated. Classification of these setae has been contentious, with two main systems being used in the terrestrial Parasitengona, which I have designated the "trombiculid system" and the "Grandjean system" (Southcott, 1961a). Despite these differing classificatory systems, there are no doubts that setal patterns differ, not only between families, but between genera. Within the genera allotted to the family Trombellidae considerable differences in leg setational patterns occur (Southcott, 1982).

Although the presence of modified "normal setae" or scobalae—"mastisetae"—is well-known on the femora of trombiculid mites (Audy, 1954; Southcott, 1961b), the presence of simple sensory setae upon the femora is more restricted. In the Trombellidae, in addition to being present on femur I, II and III of *Trombella alpha*, they were recorded earlier on the telofemora I and III in *Ralphaudyna* (as nude femoralae) by Vercammen-Grandjean *et al.* (1974). However, they occur more widely, being also present upon the femur of larval *Neotrombidium* (Southcott 1954; Borland, 1956) and *Monunguis* (Lindquist and Vercammen-Grandjean, 1971) (Neotrombidiidae or Neotrombidiinae), in *Durenia* (Vercammen-Grandjean 1955; Vercammen-Grandjean and Audy, 1959) (Trombellidae) and *Hannemania* (Hyland, 1956) (Leeuwenhoekiidae or Leeuwenhoekiinae) and more widely in the Trombidioidea, such as in *Megophthrombium* (Mullen and Vercammen-Grandjean, 1978) (Microtrombidiinae or Microtrombidiidae), and in various genera of the Johnstonianidae (Newell, 1957; Robaux 1978). It would thus be unwise to place too much stress on the presence of these setae on the femora of the larval instars as a taxonomic character.

Similar smooth sensory setae occur also on the adults and nymphs of *Trombella* (Fig. 8A-F). They also occur more widely in the Prostigmata e.g. *Smaris cooperi* Southcott (Smarididae), referred to as spinalae, spinofemoralae, etc. (Southcott, 1961b), and on genua I-III of the nymph of *Microtrombidium hirsutum* Wom. (Southcott, 1946b).

Another resemblance between *Trombella* and *Ralphaudyna* larvae lies in each possessing two palpal femoralae. In *Trombella*, however, there are no vestigialae; in *Ralphaudyna* these are present as distinct "mushroom-like microspurs" (Vercammen-Grandjean, *et al.*, 1974, pp. 248-9).

Generic Classification of the Trombellidae

1. Adults and nymphs

Thor (1935) defined the Trombellinae as those Trombidiidae which lacked a crista, with eyes 2 + 2, sessile, setae short and sharp, with two sensory setae on the propodosoma at the level of the eyes, and some lesser characters, to include only *Trombella* Berlese. In 1937 Womersley added *Chyzeria* Canestrini 1897 to be subfamily, as well as *Parachyzeria* Hirst 1926 (syn. *Thaumatothrombium* André 1938) (1938b)); this was accepted by Thor and Willmann (1947). However, both *Parachyzeria indica* Hirst and *P. poecilotrichum* (André) have two pairs of prosomal sensilla, and therefore should be placed in the family Johnstonianidae Thor 1935, subfamily Johnstonianinae as defined by Newell (1957). Womersley (1954b) described the reared eyeless deutonymphs of *Audyana* Wom., dividing the subfamily into the tribe Chyzeriini for *Chyzeria* and *Parachyzeria*, and Trombellini for *Trombella*, *Audyana* and *Nothrotrombidium* Wom., 1954 (erected for the European *T. otiorum* Berl.), but did not redefine the subfamily. Vercammen-Grandjean (1955) described the reared nymphs of *Durenia*, and provided a revised key for the tribes and genera of the post-larval Trombellinae. Feider (1955) elevated the Trombellinae to the family Trombellidae, a status which most later authors have accepted (see Southcott 1982). Within this family (or subfamily) two further genera have been proposed for adults or adults and nymphs): *Parathrombella* André, 1958 and *Neonothrothrombidium* Robaux, 1968.

In defining these two last-named genera each author stated that a crista metopica is present. In *Parathrombella nasuta* André, the type species of its genus, the propodosoma bears dorsally 1 + 1 eyes laterally, and in the central part there is a thickened chitinous plaque, roughly in the shape of a trapezium, with prominent anterolateral angles, each bearing a sensillary seta, which are thus well separated. There is no anterior linear projection of chitin from this plaque or shield. The hysterosoma bears 10 (or 11) contiguous plates, which resemble those of *Trombella*, there being four in each lateral row and two or three median. André therefore redefined the Trombellinae, saying that the crista was limited to a more or less developed transverse band, with "rarement un vestige, très réduit, médian". The use of the term crista etc. seems to be largely a matter of terminology. There is no doubt that the two species André classified in *Parathrombella* belong to the Trombellidae. However the other two species that he placed in *Parathrombella* differ from *P. nasuta* in having the following three characters: (1) eyes 2 + 2, (2) no large dorsal hysterosomal depressions but instead a hexagonal network connecting the bases of the seta papillae, (3) two small circular pits anterolaterally on dorsum of hysterosoma. André (1962) recognized that the two latter species come within *Durenia*.

Robaux (1968) erected *Neonothrothrombidium*, with type species *N. franzi* Robaux, 1968 from South America, stating that in this genus the crista is well developed, but did not discuss any consequent revision of the definition of the Trombellinae. As earlier (1966) he had referred to a crista in *Nothrotrombidium otiorum* (Berl.) as consisting of no more than the two prosomal sensillary bosses, he was clearly using the term crista in a wider sense than the majority of authors. Even so, he later (1968) figured in *N. franzi* a broad chitinous thickening of the dorsum of the propodosoma extending from its rear border, anteriorly enclosing the sensillary bosses and with an anterior gutter-like seta-less delimited extension running into the nasus. In the second species he placed in this genus, *N. americanum* Robaux, 1968, the propodosoma bears dorsally an oblong plaque, extending only as far forwards as to enclose the sensillary bosses (which are anterior to the eyes), and without any further anterior extension.

In my opinion these large thickened areas on the dorsum of the propodosoma correspond to the dorsal shields of other prostigmatic mites, and could well be termed a scutum rather than a crista. The same situation occurs in *Chyzeria*, where there is evidence of a dorsal propodosomal scutum and also of a rudimentary crista (Southcott, 1982). The crista may be considered as absent in *N. americanum*, and rudimentary in *N. franzi*.

The differences enumerated between *N. franzi* and *N. americanum* justify their generic separation, and for *N. americanum* the genus *Maïputrombella* n. gen. is proposed.

Although the definition of the Trombellinae given by Thor (1935) and Thor and Willmann (1947) included 2 + 2 eyes, yet eyes are absent in *Audyana*, present as 1 + 1 in *Parathrombella*, and as 2 + 2 in *Trombella* and other genera. For *Nothrotrombidium* Wom. the status of the eyes is unclear, as Robaux (1966, Fig. 1D) shows only 1 + 1 for *N. otiorum*, the type species (but does not comment on this in the text), while André (1960a) records that *N. brevitarsum* André, 1960, has 2 + 2 eyes.

From the foregoing, a revised definition of the Trombellidae may be offered, with also subfamilies, and a definition of a new genus.

Family Trombellidae Thor
(Originally as Trombellinae Thor, 1935)

Definition: Trombidioidea with absent or rudimentary crista metopica. Eyes absent, or present as 1 + 1 or 2 + 2; if present, sessile. Propodosoma dorsally with a pair of sensilla (trichobothria), set in a fossa which may have an elevated rim, or be present as a papilla with a central hole. Dorsum of propodosoma commonly with a thickened scutum, which may be poorly defined at its borders. Idiosoma commonly highly modified, with pits or depressions with a possible glandular function, and bearing modified setae. Body and leg scobalae borne singly, or in groups upon small cuticular plates.

Type genus *Trombella* Berlese, 1887.

KEY TO THE SUBFAMILIES AND GENERA OF ADULTS AND DEUTONYMPHS OF TROMBELLIDAE

1. Dorsum of hysterosoma with prominent seta-bearing projections .... Chyzeriinae, new status
Sole genus .... *Chyzeria* Canestrini, 1897
Dorsum of hysterosoma without prominent seta-bearing projections, but may bear depressions of possible glandular function (Trombellinae, s. str.)........ 2
2(1) Dorsum of hysterosoma with pits or depressions .. 3
Dorsum of hysterosoma without pits or depressions5
3(2) Dorsum of hysterosoma with two small anterolateral pits. Propodosoma may bear a chitinized plaque dorsally, adjoining or enclosing the propodosomal sensilla. Eyes 2 + 2, about level with sensilla .... *Durenia* Vercammen-Grandjean, 1955
Dorsum of hysterosoma with three longitudinal rows of circular, oval or oblong depressions 4
4(3) Six depressions in lateral dorsal hysterosomal row. Eyes 2 + 2 .... *Trombella* Berlese, 1887
Four depressions in lateral dorsal opisthosomal row. Eyes 1 + 1 .... *Parathrombella* André, 1958
5(2) Dorsal idiosomal setae on papillae, in groups of 2-12 in small cuticular plaques. Sensilla well separated. Eyes absent.................... *Audyana* Womersley, 1954
Dorsal idiosomal setae on papillae, arising individually from cuticle 6
6(5) Dorsum of propodosoma without significant thickening to a scutum or plaque-like structure. Propodosomal sensilla close together, somewhat posterior to level of eyes (for *N. otiorum* (Berl.), from Robaux, 1966) .... *Nothrotrombidium* Womersley, 1954
Dorsum of propodosoma with a well-developed scutum or chitinized plaque in its posteriormedial part. Eyes 2 + 2 7
7(6) Propodosomal sensilla approximated, level with eyes, on an elongate propodosomal scutum which extends forward on to nasus, there forming a median furrow .... *Neonothrothrombidium* Robaux, 1968
Propodosomal sensilla well separated, anterior to level of eyes. Propodosoma bears dorsally a large transverse oblong scutum or plaque, enclosing sensillary bosses; there is no anterior extension of this scutum. Palpal genu bears distally on its lateral face a row of broadened, spatulate setae .... *Maiputrombella* n. gen.

Definition of a New Genus of Trombellidae

Maiputrombella n. gen.

Definition: Trombellidae with 2 + 2 eyes, posterior to level of propodosomal sensilla. Propodosoma bears dorsally a large transverse oblong scutum or plaque, enclosing the sensillary bosses; anterior chitinized extension of propodosomal scutum absent. Body setae short, blunt-ended, on short papillae. Palpal genu bears distally upon its lateral face a row of broadened, spatulate setae.

Type species *Neonothrothrombidium americanum* Robaux, 1968.

This genus is known only from its type species. The generic name is derived from Maipu, Chile, the place of collection, and *Trombella*.

(2) Larvae

Southcott (1982) discussed the characters of larval Trombellidae, concluding that it was not possible to give a formal definition of a larval trombellid. Of the two subfamilies into which the Trombellidae is here divided, the reared larvae, except *Chyzeria*, belong to the Trombellinae.

A review of the characters of the larval Trombellidae shows that *Womersleyia* Radford has a number of features in common with *Durenia*, so that I have decided to restore the former to full generic status (see key below.)

The following is a revised key to the larvae at present allotted to Trombellidae. (*Ralphaudyna* Vercammen-Grandjean *et al.*, 1974, has been included, although a review of its characters, with two pairs of scutal sensilla, shows that its affinities lie with the family Johnstonianidae, near the subfamily Lasseniinae Newell, 1957, where it is provisionally placed.)

KEY TO THE LARVAE OF TROMBELLIDAE

1. Leg segmental formula 7, 7, 7.................... 2
Leg segmental formula 7, 6, 6 or 6, 6, 6 4
2(1) Dorsal scutum lacking anteromedian projection ("nasus")............. *Chyzeria* Canestrini, 1897
Dorsal scutum with anteromedian projection ("nasus")3
3(2) Dorsal scutum with 8 setae .... *Ralphaudyna* Vercammen-Grandjean *et al.*, 1974
Dorsal scutum with 6 setae .... *Nothotrombicula* Dumbleton, 1947
4(1) Leg segmental formula 7, 6, 6. AM and AL (latter close to Sens) setae short, clavate. Two claws to each pedotarsus. Palpal tibial claw with four prongs (Vercammen-Grandjean, 1972)............... .... *Audyana* Womersley, 1954 (1954a)
Leg segmental formula 6, 6, 6.................. 5
5(4) Tarsus of each leg with a single claw............. 6
Tarsus of legs I and II with a single apically trifurcate claw, tarsus of leg III with two claws 7
6(5) Scutal sensilla well behind level of AL scutalae, about midway between levels of AL and PL. Chelicerae compact, the combined chelae bases not more than twice as long as wide............ *Trombella* Berlese, 1887
Scutal sensilla only a little behind level of AL scutalae. Chelicerae elongate, the combined chelae bases more than twice as long as wide (for *N. otiorum* (Berl.), from Feider, 1958) .... *Nothrotrombidium* Womersley, 1954 (1954b)
7(5) Nasus of scutum small, largely occupied by the bases of the AM scutalae, and with a deep constriction behind Leg tibia III with a large solenoidala .... *Womersleyia* Radford, 1946
Nasus of scutum large, triangular, its lateral borders continuous with anterolateral borders of scutum, with at most only minor constriction. Leg tibia III without a large solenoidala.......................... .... *Durenia* Vercammen-Grandjean, 1955.

AUDITORY FUNCTION IN ACARINA

(a) Function of Tarsi in Trombella alpha *Larva*

The attenuated tarsi of larval *Trombella alpha* represent an unusual shape among larval prostigmatic mites, suggesting that they might serve as sound-receptor organs. If so, they could possibly be useful in locating males of the host cricket. At my request, Mr Davidson, the collector of the specimens and data, has provided information on the numbers of mites parasitic upon male and females of *Teleogryllus commodus*, as well as for sub-adults (A1 and A2 instars). As only the adult males stridulate, for the hypothesis to be valid there should be a greater tendency for parasitization of the adult males. In Table 7 data are provided on the numbers of mites on the various instars of the crickets, by date of collection.

Examination of the data in Table 7 shows that there is a greater number of larval mites attached to the adult male crickets than to adult females, the proportion being 3.70/1.15 overall, or greater than 3:1. Submitting the data to a test of the null hypothesis, i.e. that the proportions of the mites on the crickets are independent of sex, we find that $\chi^2 = 83.52$ on 1 d. f., i.e., $P < .001$***.

A significantly greater degree of parasitization of the adult male crickets occurs than in the females. It should be pointed out also that as the crickets were captured in pitfall traps (using Vacola jars as traps), there could have been some transfers of mites between the crickets, since these traps functioned over several days and the conditions in the traps the crickets were extremely crowded when many were caught. Although only a proportion of the mites were studied, among the samples submitted there was only this one species of larva.

This finding therefore is consistent with the hypothesis that the mites may find their hosts, at least in part, by the use of a sound-detection mechanism.

Since only the adult male crickets stridulate, the hypothesis may be examined further by comparing the figures of parasitization for the sub-adult crickets; the first and second instar sub-adults are the only sub-adult instars in which the sex is readily determinable. (Mr Davidson advises (pers. comm., 1983) that difficulties in sexing account for some differences between the totals in the tables.)

Table 7 shows that in the sub-adult instars the mites appear to have a preference for the female crickets, with a mean of 1.57 mites per female against a mean of 1.25 mites per male. If however we compare these figures by the same null hypothesis as above, we calculate that $\chi^2 = 2.90$ on 1 d. f., not significant, i.e. the null hypothesis is not disproved.

There is thus no evidence of a sexual preference by the mites in parasitizing the sub-adult crickets.

These results thus are consistent with the hypothesis that the mites make some use of sound-detection in their searches for their cricket hosts.

(b) Possible Auditory Organs in Acarina

It has been suggested above that the larvae of *Trombella alpha* use the leg tarsi as sound-receptor organs for locating the sound-emitting adult males of the crickets, which is supported by the greater incidence of parasitization in adult males than in adult females. Other instars of the crickets are also utilized by the mites (compare Tables 3, 7).

Earlier suggestions have been made that there are structural adaptations in ectoparasitic mites which serve an auditory function in host location. Newell and Vercammen-Grandjean (1964) described two species of mites from Africa in the family Johnstonianidae (Trombidioidea) as *Pteridopus auditor* Newell and Vercammen-Grandjean, 1964, and *P. pseudohannemania* Newell and Vercammen-Grandjean, 1964. *P. auditor* had been collected parasitic upon crickets, while *P. pseudohannemania* was described from a single specimen collected free on the forest floor.

In both of these species there is an unusual morphological arrangement and modification of setae: tarsus III and tibia III carry a dorsal row of long feathered setae, each of which has a preformed fracture line near its base, corresponding to an interruption of the actinochitin. They proposed that these setae

TABLE 7 INCIDENCE OF *TROMBELLA ALPHA* ON THE CRICKET *TELOGRYLLUS COMMODUS*
(Only live crickets examined)

Cricket Category	Adult Males			Adult Females			Sub-Adult* Males			Sub-Adult* Females		
Date of Collection	No. of Crickets N_c	No. of Mites N_m	Nm/Nc	No of Crickets N_c	No. of Mites N_m	Nm/Nc	No. of Crickets N_c	No. of Mites N_m	Nm/Nc	Crickets N_c	Mites N_m	Nm/Nc
30.i.79	6	3	0.5	1	0	0.0	15	7	0.47	9	12	1.33
9.ii.79	10	133	13.3	8	62	7.75	16	87	5.44	20	69	3.45
26.ii.79	14	127	9.07	4	26	6.50	0	0	—	0	0	—
26.iii.79	37	149	4.03	42	72	1.71	0	0	—	0	0	—
9.iv.79	18	15	0.83	28	23	0.82	0	0	—	0	0	-
24.iv.79	5	1	0.2	25	5	0.20	1	0	0.0	1	0	0.0
11.i.80	0	0	—	0	0	—	38	9	0.24	22	13	0.59
8.ii.80	2	0	0.0	1	0	0.0	7	1	0.14	4	4	1.0
7.iii.80	16	8	0.50	11	2	0.18	6	0	0.0	4	1	0.25
4.iv.80	10	1	0.1	57	13	0.23	1	0	0.0	3	0	0.0
Totals	118	437	3.70	177	203	1.15	84	104	1.24	63	99	1.57

* Adult-1 and adult 2 instars.

subserve an auditory function, allowing the larvae to locate their hosts by a sonar technique. These setae are generally broken off in the older (i.e. fed) larvae. These authors proposed that this row of setae served no further useful function after attachment to the host. (This would be consistent with the general finding that such larvae feed fully on a single host.) Additionally, the tarsi of *P. pseudohunnemania* (but only tarsus III in *P. auditor*) are highly attenuated, each tarsus ending in a short pedicellus and three claws.

The arrangement of the setae was considered suggestive "of the setae of the antennae of male Culicidae, which are known auditory organs".

In a later paper Vercammen-Grandjean *et al.* (1965) discussed another form of setal modification in the North American leeuwenhoekiid mite, *Whartonia glenni* Brennan, 1962, which is an ectoparasite of two species of bats of two families: Phyllostomatidae and Emballuronidae. In this species of mite there are greatly elongated setae ("mastisetae") on the larval tarsus III. These anisotropic setae, identified as mastitarsalae, have two conspicuous bends and points of weakness. Most specimens of setae from mites taken in the field are broken (92.1% of 341 setae), a situation analogous to that seen in the genus *Pteridopus*. These authors speculate that such setae assist in locating sound-emitting vertebrates, such as bats which emit their high-pitched sounds even when roosting, when almost all of the opportunities of attachment of these mites can be conceived to occur.

Although these authors do not mention it, some other prostigmatic mites have highly modified setae which might conceivably serve as sound-detecting organs. Thus in the family Erythracidae the genera *Eatoniana* Cambridge, 1898 and *Ptilophus* Berlese, 1916 have such upon the tibia IV of the adults (and possibly also on genu IV). With regard to the possible function of these setae, there termed "plumalae", the author (Southcott, 1961a, p. 486) accepted the views of previous students that these setae were used as sails as a means of progression. It is now apparent that a more detailed study of their function is warranted.

In the case of *Trombella alpha* larvae, the setational pattern does not suggest that the setae have any possible specialized auditory function. However, the attenuation of all tarsi does suggest that they could function as sound receptor organs in host detection. Such a function might be enhanced by the possession of a single tarsal claw to each leg. The use by this larva of a cricket as its host species is possibly of significance. Since many animals emit sounds for a variety of purposes, such as territory-establishment, echo-location of surroundings and prey, sexual attraction and other functions, it would appear that the development of host-locating organs by their potential parasites is worthy of a wider study.

ACKNOWLEDGMENTS

I am indebted to Mr Steve J. Davidson, Zoology Department, University of New England, Armidale, New South Wales, for collecting and forwarding both preserved and live larval mites and data for the present study. The South Australian Museum has made available the holotypes of *Trombella warregensis* Hirst and *T. adelaideae* Wom., and a paratype of *Womersleyia minuta* Radford, for study. I thank Mr L. G. Veitch, Principal Research Scientist, CSIRO Division of Mathematics and Statistics, Glen Osmond, South Australia, for aid and advice in statistical matters.

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THE GENUS ODONTACARUS (ACARINA: TROMBICULIDAE). II. OBSERVATIONS ON THE LIFE HISTORY AND MORPHOLOGY OF ODONTACARUS SWANI N. SP., AND RELATED FORMS

BY R. V. SOUTHCOTT

Summary

The ovum, larva and adult of Odontacarus swani n. sp. are described, being the first recorded correlation between adults and larvae in Odontacarus. However, as is customary in this group, a larva has been selected as the type.

A key is given for all species described as larvae from Australia, New Guinea and South East Asia.

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(Manuscript accepted 23 January 1985)

ABSTRACT

SOUTHCOTT, R. V. 1986. The genus *Odontacarus* (Acarina: Trombiculidae) II. Observations on the life history and morphology of *Odontacarus swani* n. sp. and related forms. *Rec. S. Aust. Mus.* 19(12): 169-200.

The ovum, larva and adult of *Odontacarus swani* n. sp. are described, being the first recorded correlation between adults and larvae in *Odontacarus*. However, as is customary in this group, a larva has been selected as the type.

A key is given for all species described as larvae from Australia, New Guinea and South East Asia.

A correlation analysis is made of the dimensions of the chitinized parts (scutum, setae and leg segments) of the type series of *O. swani*. A principal component analysis defined two components, both of which include variates derived from the dorsal scutum and the leg segments.

A similar analysis is made for the larvae of two other species of *Odontacarus: O. athertonensis* (Womersley, 1945) from north Queensland, and *O. mccullochi* (Womersley, 1944) recorded from north Queensland (and Papua New Guinea). In each of these species two principal components of correlation are defined which are not completely duplicated in the other two species. All four of these components include variates based upon scutal dimensions, three of them include variates based on leg segmental lengths, and two of them (each of these latter being the second principal components) include variates based on lengths of idiosomal (body) setae. Some components contain also variates derived from body hair dimensions.

It is concluded that no standard components can be defined and in general there is not a high degree of correlation between the various standard (and other) variates customarily used in the classification of the larvae of the genus *Odontacarus* (family Trombiculidae), in agreement with my earlier study of *Trombella* where another group of correlated variates was defined. This contrasts with similar analyses of hard structures (such as bone) of vertebrates.

Additional morphological details are given for the Australian species of *Odontocarus, O. cooki* (Southcott, 1957), *O. langani* (Southcott, 1957), *O. mathewi* (Southcott, 1957), and *O. southcotti* (Womersley, 1944) to help construct the key of the larvae and for *O. barrinensis* (Womersley, 1945). Amended collection data are provided for *O. southcotti.*

A key is given for the adults of *Odontacarus* (all known adults are Australian) and the adult *O. swani* is described.

Acomatacarus retentus (Banks, 1916), known from only the original material from Victoria, is made the type of *Scopitrombium* n. gen., in the Leeuwenhoekiinae. A lectotype is designated, and the species redescribed.

Revised keys are given for the subfamilies of Trombiculidae, and for the genera of the subfamily Leeuwenhoekiinae for both adults and nymphs.

INTRODUCTION

The genus *Odontacarus* was founded by Ewing (1929b, pp. 22, 188) with the following definition:

"Each chelicera with a row of backwardly directed teeth on the upper margin of chela, and some upturned teeth on the lower margin (Fig. 16). Palpal claw bifurcate, the two divisions unequal. Dorsal plate without median anterior process and with only five setae in addition to the pseudostigmatic organs, which are flagelliform and pectinate.

Type: *Trombicula dentata* Ewing".

Ewing's species was based upon two larvae: "Described from two specimens; one, the holotype, from Sonora, Texas (Bish. No. 10681), taken by O. G. Babcock, December 17, 1922 on a white-tailed deer and the other from Balboa, Panama on a cotton rat by L. H. Dunn". He figured (1925a, p. 258) only the right chelicera of the holotype (Cat. No. 888, U.S.N.M.).

In founding *Odontacarus* Ewing (1929b, p. 188) compared it with the larvae then attributed to *Trombicula* Berlese 1905 (described originally from the adult) and to the larvae of *Schöngastia* Oudemans 1910, and saying "only the type species included", i.e. *T. dentata* Ewing, 1925. He made no reference to the larval genus *Leeuwenhoekia* Oudemans, 1911.

In 1942 Ewing revised the taxonomy of some of the American mites ('chiggers') then placed in the subfamily Trombiculinae Ewing, 1929 (1929b, p. 22). He (1942, p. 489) decided to divide the genus *Leeuwenhoekia*, and erected two new genera, *Comatacarus* and *Acomatacarus*. The latter he founded for the larval *A. arizonensis* Ewing, 1942, defining it as:

"Most nearly related to *Comatacarus* [Ewing, *loc. cit.*, p. 489] but differing from it as follows: Chelicera with a row of teeth on upper margin instead of a single tooth and both the first [palpal femorala] and second [palpal genuala] palpal setae simple instead of one or both being plumose or barbed".

The principal distinguishing characters of *Comatacarus* (from *Leeuwenhoekia*) were (Ewing, 1942, p. 489) "in having the posterolateral setae of the dorsal plate of the usual form and similar to the anterolateral, instead of being clavate, and in having a large number of sessile setae on the dorsum of the abdomen, instead of a small number situated on the tubercles".

Ewing (1946, p. 436), in a further revision of the trombiculid mites (raised to the family Trombiculidae by Ewing in 1944), redefined *Odontacarus* and stated:

"*Odontacarus* is related to *Acomatacarus* Ewing, 1942, from which it differs in having a single median seta on the dorsal plate instead of two submedian setae. It is also related to *Endotrombicula* Ewing, 1931 [See Wharton and Fuller (1952, p. 72) and Audy (1954, p. 160) for opinions on the present status of this genus.]. . ."; he included in *Odontacarus* also *O. australis* (Ewing, 1929), which was described (1929a, p. 10) from several specimens collected on the lizard *Tropiduras peruvianus* at Verrugas Cañon, Lima, Peru, 15.iv.1928, R. C. Shannon, Cat. No. 987, U.S.N.M.

Brennan (1959) stated that *Trombicula dentata* Ewing, 1925 was based on a single teratological specimen, possessing a single anteromedian scutal seta instead of the normal two, commenting that this holotype specimen is in a distorted and damaged condition, with most diagnostic features hard to determine. Nevertheless he stated that "The AM [seta] is slightly to the right of center", and declared that "there is no doubt whatsoever as to its generic status", even though its "specific identity . . . is in question".

With regard to the second larval specimen assigned by Ewing originally to *T. dentata*, Brennan (1959, p. 2) has commented that it is "damaged beyond recognition and reclaim . . . It seems incomprehensible, however, that this specimen could possibly have been regarded as conspecific with the holotype".

As far as *O. australis* (Ewing) is concerned, Brennan (1959) redescribed the holotype briefly, without figures, stating that this specimen also had a teratological dorsal scutum—"In each [of the two holotypes], the left AM is lost; thus the specimens are freaks". Two other specimens, each labelled by Ewing as a "cotype", were identified by Brennan (*loc. cit*) as *Eutrombicula alfreddugesi* (Oudemans, 1910).

However, eventually *O. dentatus* holotype was found not to be teratological after all; Goff *et al.* (1972) were able to see two AM seta bases, using phase microscopy, although the setae were not attached (Goff and Loomis, 1977).

Wharton and Fuller had earlier (1952, p. 103) realized the probable synonymy of *Odontacarus* and *Acomatacarus*, but had commented, with reference to *Odontacarus*: "Specimens in existence are too badly damaged to study satisfactorily". These remarks applied to both *O. dentatus* and *O. australis*.

It appears strange that Ewing had not at this stage seen the characteristic feature of the leeuwenhoekiinae shield, an anteromedian tongue-like projection to the dorsal scutum, in fact stating specifically that it was absent (see his definition of *Odontacarus* above). Although Oudemans had described this feature in *Leeuwenhoekia verduni* (Oudemans, 1910) as early as 1910 and 1911, and again in his 1912 monograph, apparently it was not observed by Ewing and published until his 1942 paper for *Acomatacarus* and *Comatacarus*. However, in his key to the larval Trombiculinae, Ewing (1938, p. 291) showed that he was aware of the anteromedian process in *Leeuwenhoekia* Oudemans, but again failed to record it for *Odontacarus*.

Comatacarus Ewing was reduced to subgeneric status (in *Leeuwenhoekia*) by Wharton *et al.* (1951), followed by Wharton and Fuller (1952, p. 96), Gould (1956), Loomis (1956), and Finley (1958), but restored to full generic status by Reed (1973) and Goff and Loomis (1974).

Acomatacarus Ewing, 1942, was resurrected by Vercammen-Grandjean (1968, p. 122), and in its new generic status was divided into subgenera by the same author—*Acomatacarus* subgen., and *Orochlorus* subgen. (Vercammen-Grandjean, *loc. cit.*).

Odontacarus has been divided into the subgenera *Tarsalacarus* and *Leogonius* by Vercammen-Grandjean (1968, pp. 120-121). *Acomatacarus* Ewing, 1942 includes several subgenera: *Xenodontacarus* Loomis and Goff (1973) (a new name for *Xenacarus* Greenberg, 1951, on grounds of pre-occupation by *Xenacarus* Kishida, 1925), *Metacarus* Vercammen-Grandjean, 1956 and *Orochlorus* Vercammen-Grandjean (1968, p. 122. The last has been synonymized with *Tarsalacarus* by Goff and Loomis (1977), since the type species, *Acomatacarus micheneri* Greenberg, 1952, actually belonged to *Odontacarus*, with the characters of *Tarsalacarus*, which had page priority.

The genera *Austracarus* Lawrence, 1949 and *Hyracarus* Lawrence, 1949, which were placed as subgenera of *Acomatacarus* by Vercammen-Grandjean (1957), are now considered by the same author (1973a), without giving any explanation, to be full genera in the Leewenhoekiinae.

With the restriction of the genus *Odontacarus* and its separation from *Acomatacarus*, the only subgenus of immediate concern here is *Leogonius*, in which the Australia-New Guinea species considered here and *O. audyi* (Radford, 1946) are placed (see Vercammen-Grandjean, 1968; Goff, 1979a, b).

The genus *Odontacarus* as at present accepted is a widespread one, with species in North and South America, Asia, New Guinea and Australia. In the present paper the term will be used in the sense of Goff (1979a, b).

Most studies of *Odontacarus* species have been based on larvae, as in that instar they are readily collectable as parasites upon vertebrates, including, in some instances, man. At times they are captured from a free-living state, e.g. upon cards, boots, fence posts, etc. In a few Australasian species rearings have been achieved from larvae to nymphs. These were *O. australiensis* (Hirst), from Hollandia, former Dutch New Guinea (now Dyayapura, West Irian), reared by C. B. Philip, and *O. longipes* (Womersley, 1945) (synonymized with *O. novaguinea* by Goff (1979a, p. 149)) from the Dobadura area of New Guinea, and *O. nova-guinea* (Wom., 1944), from "New Guinea", these last two having been reared by G. M. Kohls. These rearings were recorded by Womersley (1945), and allowed him to define the post-larval characters of the genus (then *Acomatacarus*). Later larva to nymph rearings have been achieved by Domrow (1956) for *O. australiensis* in Queensland, and by Nadchatram (1963) for *O. audyi* (Radford, 1946) in Malaysia. The experimental rearings reported in Womersley (1945) allowed him to assign four species of adult trombidioid mites to the genus, these being *O. attolus* (Banks, 1916) from Sydney, New South Wales, *O. dromus* (s. str.) (Womersley, 1939), from Long Gully, South Australia, *O. patrius* (Wom., 1945), from Murray Bridge and Burra, South Australia, and *O. retentus* (Banks, 1916), from Lal Lal, Sea Lake and Ocean Grove in Victoria. Despite the widespread geographical distribution of the genus, and the fact that the larvae may be at times locally numerous, so far all adults that have been recognized as belonging to the genus are of Australian origin. Hitherto there has been no record of a correlation by rearing between an adult of this genus and a larva.

In 1944 I was able to make records of oviposition by adults of *O. swani* n. sp., collected in north Queensland, and to rear larvae from these eggs. The present paper describes these experiments and also the adult, larva and ovum.

Since the great majority of taxa among the Leeuwenhoekiinae and other chigger mites of the family Trombiculidae have been based on the larvae, one of the reared larvae is selected as the type of the species.

I have taken the opportunity to examine the taxonomic status of some species of the genus from Queensland and New Guinea, and to give a key to the larvae of *Odontacarus* known from New Guinea and South-East Asia. However it should be pointed out that this paper does not undertake a general taxonomic review of the larvae of *Odontacarus*, subgenus *Leogonius*, but considers only what is required to establish the new taxon proposed, and for the majority of the species considered in the key it relies on the data of previous authors.

One species of adult allotted to this genus by Womersley (1945) is markedly distinct from the others, this being *O. retentus* (Banks, 1916), and for it a new genus *Scopitrombium* is proposed.

Revised keys are given for the classification, for adults and nymphs, of the subfamilies of the Trombiculidae, and the genera of the Leeuwenkoekiinae.

All measurements are given in micrometres (μm) unless otherwise stated.

SYSTEMATICS

Odontacarus Ewing

Synonymy

(Note: Only a partial synonymy is given here. For earlier and more complete lists of synonymies, see Wharton and Fuller (1952), Audy (1954), Goff and colleagues (1974-1979)).

Odontacarus Ewing, 1929b, p. 188; 1931, p. 6; 1946, p. 436. Fuller, 1952, p. 228. Wharton and Fuller, 1952, p. 103 (ad part.). Vercammen-Grandjean, 1968, p. 120. Loomis and Crossley, 1963, p. 381. Nadchatram, 1963, p. 535. Southcott, 1973, p. 46; 1976, p. 139; 1978, p. 16. Reed and Brennan, 1975, p. 6. Goff and Loomis, 1977, p. 370. Goff and Brennan, 1978, p. 50. Goff, 1979a, p. 143; 1979b, p. 140.

Leeuwenhoekia (Oudemans, 1911) Hirst, 1925, p. 150. Womersley, 1934, p. 217; 1944, p. 103. Womersley and Heaslip, 1943, p. 141. Taylor, 1946, p. 227 ff.

Acomatacarus Ewing, 1942, p. 490. Womersley, 1945, p. 98. Taylor, 1946, p. 225. Greenberg 1951, p. 525; 1952, p. 473. Fuller, 1952, p. 229. Gunther, 1952, p. 39. Wharton and Fuller, 1952, p. 96. Audy, 1954, p. 164. Baker *et al.*, 1956, p. 104. Domrow, 1956, p. 150. Southcott, 1957, p. 146; 1973, p. 103; non Vercammen-Grandjean, 1968.

Odontacarus swani n. sp.

Description of adult female (principally from specimen ACB240A, slide-mounted, somewhat compressed; but supplemented by other specimens) (Figs. 1A-E; 2).

Colour in life red. Idiosoma (Fig. 1A) of normal ovoid shape for a trombidioid mite, without waist, and without division between prosoma and opisthosoma; length on slide about 1400 μm (all measurements in micrometres), width about 900.

Prosoma carries dorsally a well-chitinized crista, with an enlarged posterior end, carrying two sensillary setae (Fig. 1B). The crista tapers anteriorly, to a blunt-pointed rod, embedded in an arrow-shaped area of chitinization (here named the "sagitta" since the term "tectum" used by Crossley (1960) for this part of the scutum is considered less appropriate.). The crista is surrounded by the normal dorsal setation, sparser around anterior end. The sagitta carries two long, thin, ciliate setae (Figs. 1B, 1E). Crista 343 long from its blunted anterior point to rear edge of the posterior sensillary boss; 423 long to tip of sagitta. Behind posterior sensillary boss the crista continues for a further 70, to end in a blunted point. Sensillary boss 94 across, distance between centres of sensillary setae bases (i.e. "SB") 57. Sensillary setae slender, long,

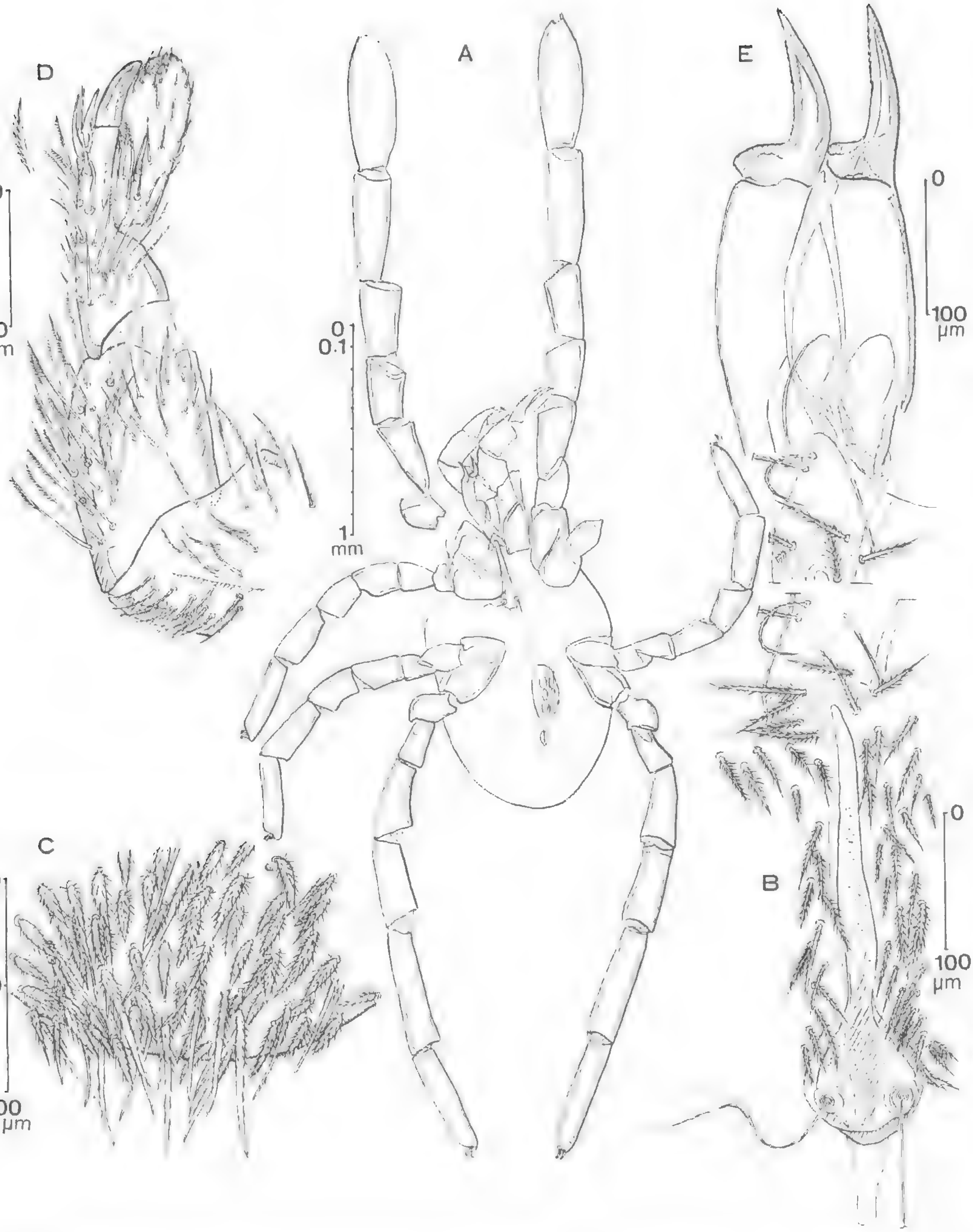

FIG. 1. *Odontacarus swani* sp. nov. Adult female, specimen ACB240, parent of the holotype. A Entire specimen, slide-mounted, seen in transparency. B Crista and adjacent area. C Dorsal setae at posterior pole of idiosoma. D Left palp, medial aspect. E Chelicerae. (All to nearest scale.)

filiform, 290 long. The chitin of crista, including that of the area between the sensillary sockets, punctate.

The whole of dorsum of idiosoma is densely covered with setae mounted on short papillae. The setae tend to be separable into two distinct types—a shorter burr-like, spindle-shaped, pointed, heavily ciliate group, mostly 27-31 long, and interspersed among these are longer, swordlike setae, in which the proximal part of the scobillum is somewhat expanded and ciliate; but the distal half is curved, swordlike, curved and pointed, with adnate cilia along the edges: a batch of these setae at the posterior pole of the idiosoma is illustrated in

Fig. 1C. There is, however, some intergrading between these two main types of dorsal idiosomalae; at the posterior pole the longer swordlike setae are 64-73 µm long, the shorter spindle-shaped setae 25-42 long. At the centre of the dorsum the longer setae are 56-95 long, the shorter setae 27-44 long.

Eyes are not visible in any of the specimens of adults available, and it must be concluded that they are absent (despite being present and normal in the larvae).

Ventral surface of idiosoma is covered with a dense setation of spindle-shaped, tapering, heavily ciliate setae. These tend to be uniform, similar to the shorter dorsal idiosomalae, except towards the posterior pole, where they are interspersed with swordlike setae similar to those of the adjacent dorsum.

Genital aperture in usual position, about 390 long by 255 across, with three oval suckers along each side.

Anus normal, 91 long by 46 across.

Legs long, but robust for a trombidioid mite, moderately chitinized; trochanters generally rounded, basifemoral, telofemoral and genual segments presenting as truncate cones, tibiae and tarsi approximately cylindrical. Leg lengths (including coxae and claws): I 2660, II 1760, III 1770, IV 2640. Each tarsus bears two claws. Legs well covered with numerous fine, pointed, lightly ciliate setae (scobalae), these being interspersed in the distal segments with pointed, specialized sensory setae (spinalae, or eupathidalae).

Tarsus I an elongate oval, 634 long by 214 across, wider than tibia I, which is 534 long by 178 across; tarsus II 397 long by 93 high; tibia II 313 long by 121 high; tarsus III 399 long by 85 high; tibia III 352×128 similarly; tarsus IV 523×114 similarly; tibia IV 627×157 similarly. For other leg morphometric data, see Table I.

TABLE I. MEASUREMENTS (µm) OF SOME CHITINIZED PARTS OF EIGHT ADULTS OF *ODONTACARUS SWANI* N. SP.

Character	*Range*	*n*	*Mean*	*S.D.*
Crista length[1]	277-343	8	321,75	57,42
SB	34-63	8	52,87	23,89
TaI[2]	585-634	7	603.14	48.36
TiI	499-548	7	517.29	46.17
GeI	332-368	7	344,14	32.45
TaIV[2]	435-523	7	488,71	72,91
TiIV	506-627	7	574,00	94,95
GeIV	370-427	7	390,29	53.27

[1] Measured from anterior end of chitinous rod to posterior pole of sensillary boss.

[2] Omitting claws and pedicle

Palpi comparatively slender, well covered with ciliate setae (see Fig. 1D). Many of these scobalae along the dorsal (i.e. extensor) margins of the palpal genu and tibia are ciliate along their distal and outer aspects, the cilia broad and flattened, curved, uniform and almost apposed, as though capable of being touch receptors utilizing a mechanism akin to stridulation; for these setae the term *pectinala* is proposed (plural: pectinalae). Palpal tibial claw stout, blunted, with four accessory claws (thickened scobalae) on the medial to dorsal aspects.

Palpal tarsus an elongate ovoid, with numerous ciliate setae (scobalae); these setae tend to resemble the palpal tibial and genual pectinalae, but are shorter. Among them are also nude setae (spinalae) and pectinalae. A cluster of short sensory setae is present at the tip of the palpal tarsus.

Chelicerae robust; fangs curved, pointed, about 135 long, with a row of about 10 fine retrorse teeth along distal flexor edge; extensor edge smooth. Chelicera basis about twice as long as fang. Rostrum (cone) of mouthparts with numerous ciliated, tapering setae.

Taxonomic placing: In the key of Womersley (1945, p. 110) this adult keys to the caption for *O. dromus* (Wom., 1939). From that species *O. swani* may readily be separated as follows:

Colour of adult mite red. Longer dorsal idiosomal setae with long cilia in the basal half, and with adnate cilia, scarcely detectable, in the distal half of the seta. Shorter dorsal idiosomal setae strongly ciliate, spindle-shaped, tapering .... *O. swani* n. sp.

Colour of adult mite white in life. Longer dorsal idiosomal setae ciliate throughout length. Shorter dorsal idiosomal setae slender, uniformly ciliate ....
.... *O. dromus* (Wom.)

Further comments on the taxonomy of adult leeuwenhoekiine mites are made later in this article.

Description of Ovum

(Fig. 2, 3A-D) (from mounted material)

Colour in life not observed. Ovum nearly spherical to somewhat spheroidal, about 250-350 long in longest diameter. Ovum has the usual lightly pigmented outer layer (chorion), which is smooth, lacking any striate markings in the available material. Minute tuberculations occur on the parts of the mounted material, but these could be, at least to some extent, results of compression in eclosion, or rupture by other means.

The sole embryo available (Fig. 3D) is about 280 long in its greatest diameter, by about 220 wide in its shortest diameter. It contains a large number of rounded granules, presumably of yolk, mainly concentrated in the region opposite to that in which the limbs are developing. Two annuli (seta bases) are present in the specimen, and two tooth-like structures, possibly shell-piercers in eclosion ("t" Fig. 3D). From one annulus there is a vague indication of a developing seta shaft. On the developing limb segments are smooth, rounded, low tubercles, similar to those recorded for *Trombella alpha* developing nymph (Southcott 1986a, Fig. 5A).

One chorion (Fig. 3C) is unusual in being covered randomly with small circular or oval lacunae. In rupturing, presumably from eclosion, some of these lacunae have been cut across transversely; it is clear that they were present before rupture, and presumably in life. No evidence of mould filaments or other possible chitinolytic agents can be seen near them, and their origin is unknown. Under polarized light a few of them

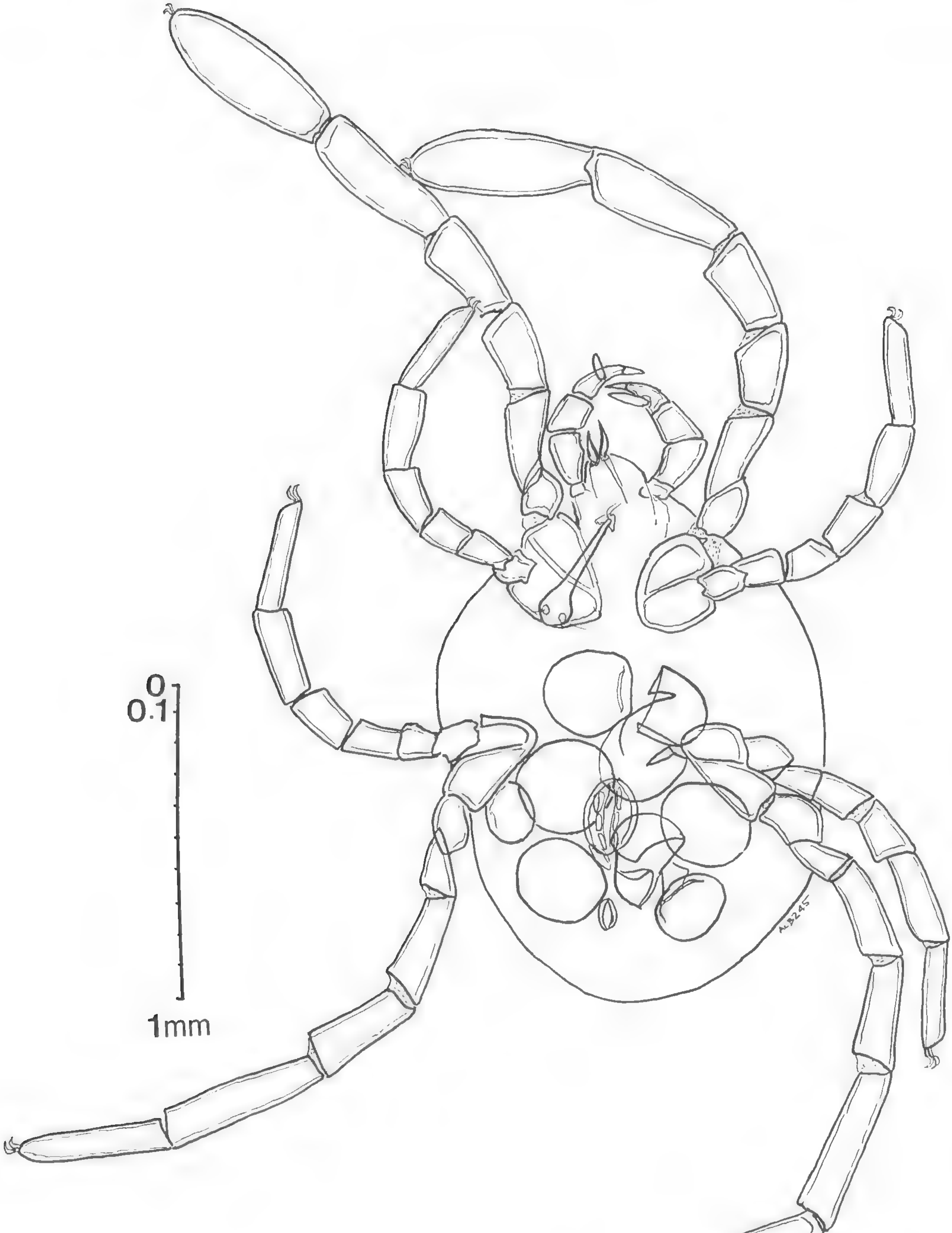

FIG. 2. *Odontacarus swani* sp. nov. Adult female, specimen ACB245, seen in transparency. The idiosoma contains nine eggs, of varying sizes, some having been disrupted by the mounting process.

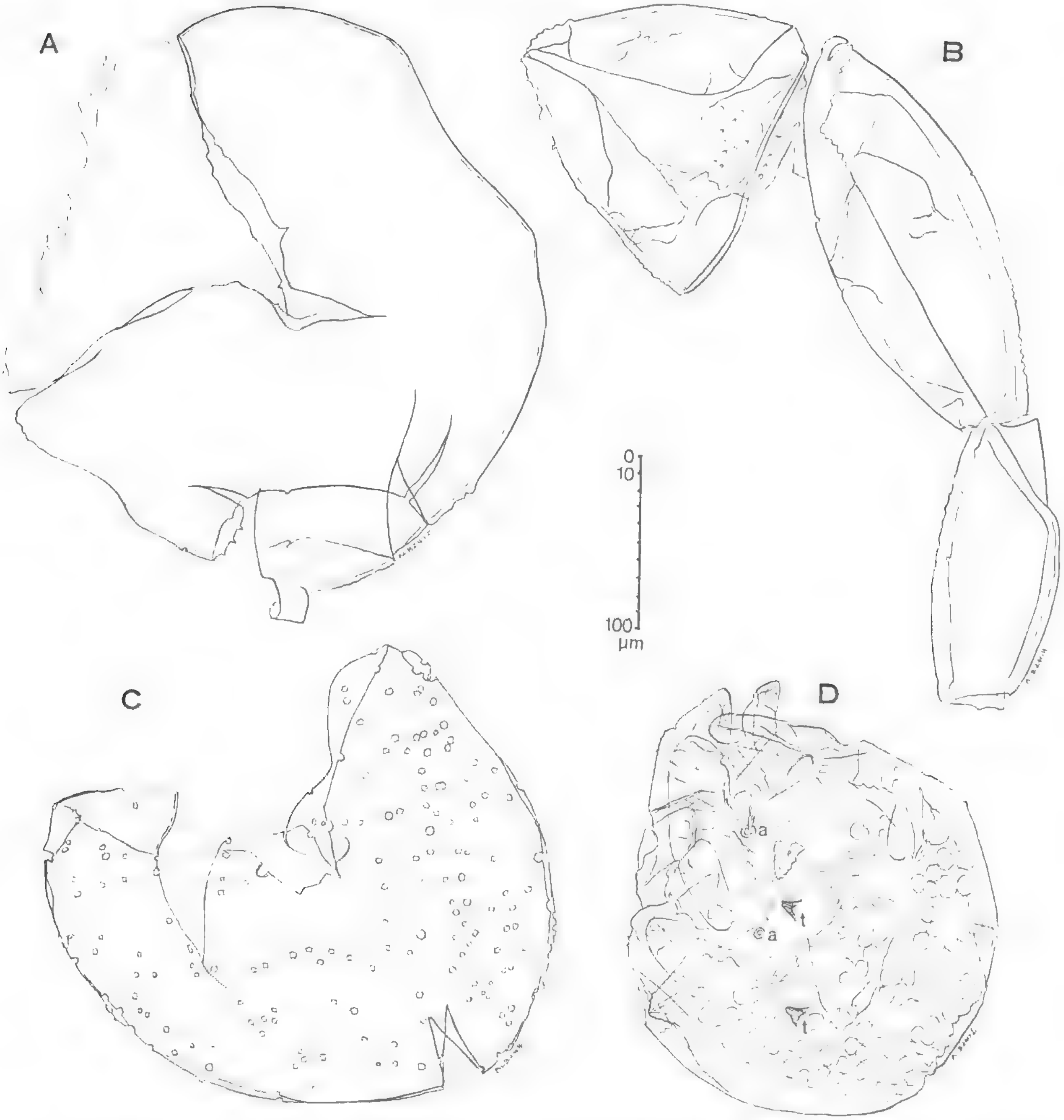

FIG. 3. *Odontacarus swani* sp. nov. Ova, slide-mounted specimens. A Ruptured ovum, showing chorion. B Chorion of another ovum split into three pieces, and possibly some of the developing embryo. C A ruptured chorion with multiple lacunae (see text). D Developing embryo, shed from its chorion, with early development of limbs and other structures: a annulus or seta base, t tooth-like projection (see text). All specimens shown in transparency. (All to scale shown.)

show a typical Maltese-cross figure, indicating that there is possibly a layer of optically active material at the base of the lacuna, perhaps an artefact of the mounting. The chorion shows only weak evidence of optical activity under crossed polarizers.

Description of Larva (from reared specimen ACB240B, holotype, and supplemented by other specimens) (Figs. 5A-D, 6A-C).

Colour in life red. Length of idiosoma (mounted on slide) 207, width 197; total length of animal from tip of cheliceral fangs to posterior pole of idiosoma 293.

Dorsal scutum slightly wider than long (including nasus). Although most authors measure the length of the dorsal scutum ("S.D." or shield depth) of *Odontacarus* larvae (and other genera of the Leeuwenhoekiinae in which there is a distinct beak-like "nasus" to the scutum) excluding this "nasus", a comparative study of allied forms, e.g. *Neotrombidium* larvae, as well as larval *Trombella* (see Southcott, 1986a), shows that the "nasus" may range from a broad continuation of the scutum, without clear point of differentiation, to a distinct and sharply demarcated beak. The length

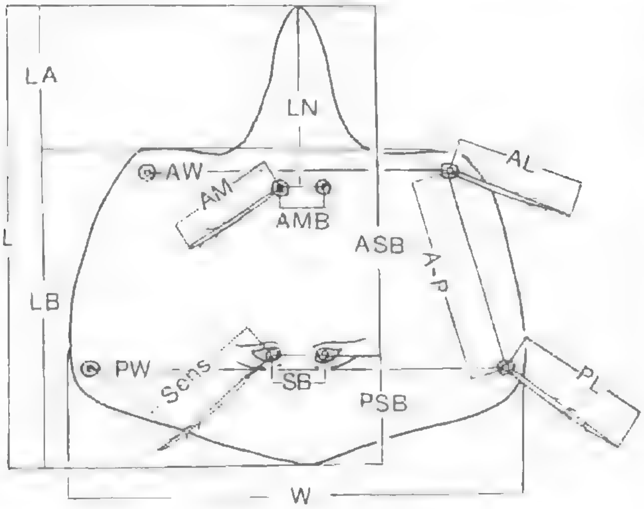

FIG. 4. Conventions of measurements of dorsal scutum of a leeuwenhoekiinae larva, as used in the present article (see text).

(L) is taken here as including the "nasus". However, in order to make the measurements comparable between different workers, measurements are offered here of the shield length including "nasus" (L) and without "nasus" (LB) (see Fig. 4 for explanation).

Nasus well-developed, running into more or less straight (slightly sinuous) anterior margin; lateral borders slightly convex; posterolateral convex, of varying curvature; AM setae tapering, pointed, lightly ciliate; AL and PL similar. Sensillary setae normal, ciliate in distal half or third. Sensillary sockets about level with PL bases, sloping obliquely anterolaterally, and with well-marked margins ("lids").

The standard (and other) data for this specimen, as well as other reared material, and the Type series and other identified material in the South Australian Museum Collection are given in Table 2.

Eyes 2+2, sessile, near PL angles of dorsal scutum, oval. Anterior eye with maximum diameter of cornea 16, posterior 14.

Dorsal idiosomal setae long, moderately ciliate with lightly projecting barbs; setae arranged 6, 12, ..., in vague transverse rows, total in ACB240B, 57.

Venter with a pair of pointed setae between coxae III, ciliate, 33 long. On opisthosoma ventrally about 37 further setae, pointed, well ciliate, 27-42 long, the posterior setae longer and tending to be blunted at the tip, resembling the posterior dorsal idiosomalae.

Coxalae 2, 1, 1. All coxalae long, pointed, ciliate; lateral coxala I 51 long, medial 46, coxala II 44, III — (missing in holotype; 58 long in ACB240C).

Legs normal, I 379 long, II 322, III 380 (all lengths include coxae and claws). Chaetotaxy of legs as figured. Leg scobalae normal, pointed, ciliate. Trochanteral formula 1, 1, 1; femoral 6, 5, 4. Leg specialized setae as follows: VsGeI.70pd ("microseta"), VsTiI.87pd ("microseta"), SoGeI.36pd, SoTiI.90d (i.e. slightly distal to Vs), VsGeII.70d, SoGeII.30d, SoTiII.45d, SoTiII.91d, SoGeIII.29pd. Tarsus I and II have each a large dorsal solenoidala. FaTaII present (see figure). Normal SoTaIII present. Tibia III with two mastisetae (=mastalae): MaTiIII.73d, MaTiIII.76pd. Tarsus III with one mastiseta: MaTiIII.33pd. (In these estimates tarsal length excludes claws and pedicle.) Tarsus I 86 long by 32 across. Tarsus III 85×24. Other specialized leg setae as figured. Other leg measurements as in Table 2.

TABLE 2. MEASUREMENTS (μm) OF REARED *ODONTACARUS SWANI* N. SP. LARVAE

Character	*Holotype*	*Range*	*n*	*Mean*	*S.D.*
AW	65	65-73	8	69.13	3.271
PW	78	77-83	8	80.88	3.271
SB	27	25-30	8	26.75	1.669
ASB	49	49-57	8	53.13	2.949
PSB	33	22-33	8	30.25	3.536
L	82	77-87	8	83.38	3.462
LA	18	17-22	8	19.13	1.727
LB	64	55-69	8	64.25	4.432
LN	25	27-35	8	30.25	3.495
W	85	85-97	8	91.63	3.739
A-P	25	24-29	8	26.13	1.552
AM	41	35-43	8	38.88	2.900
AL	47	46-55	8	48.63	3.159
PL	55	55-62	8	59.50	2.507
AMB	11	11-13	8	12.00	0.926
Sens	51	48-55	—	—	—
PW/LB[1]	1.22	1.20-1.51	—	—	—
DS	36-47	(36-44)-(47-51)	—	—	—
mid-DS	36-44	(36-44)-(44-51)	8	46.25[2]	2.188[2]
PDS	38-47	(38-46)-(47-51)	8	49.13[2]	1.727[2]
GeI	46	41-51	8	47.25	3.012
TiI	55	54-57	8	55.25	0.886
GeII	38	38-45	8	40.63	2.264
TiII	46	44-54	8	47.50	2.264
GeIII	43	43-48	8	46.25	1.581
TiIII	57	57-63	8	59.63	2.066

[1] This is the PW/SD of Womersley (1944, 1945) and the PW/L of Greenberg (1951) (see Fig. 4, and text explanation).

[2] For the maximum values of each variate.

Tarsal claws normal, falciform, slender, with strong cilia (onychotrichs) on anterior and posterior; middle claw longer and more slender than the neolaterals, with weak cilia.

Gnathosoma normal. Combined chelicerae bases 84 across, chelicerae 89 long from tips of fangs to posterior pole of chelicerae bases. Cheliceral fang stout, curved, pointed, with three of four retrorse teeth along (concave) flexor (dorsal) edge, and 4-5 tuberculations or blunted teeth on (convex) extensor (ventral) edge. Galeala nude, 22 long. Gnathobasal setae (palpal coxalae) curved, pointed, well ciliate, about 24 long.

Palpi compact. Palpal formula 1, 1, 3, 8, with palpal formula B(b), N(?b), BNN, So+7 (B or N), as figured. Palpal tibial claw trifurcate. No supracoxala to legs or palpi.

Origin of Adult Material Studied

I collected ten adults in damp soil in rainforest at Mt Hypipamee, Atherton Tableland, Queensland on 26.x.1944.

Each was placed in a small tube with some damp soil from the capture area, and observed periodically (albeit somewhat irregularly, as I was engaged in military duties). Living larvae were observed in two of the tubes from 20-24.xii.1944 using a 28× Zeiss microscope ocular reversed as a hand lens; in a third

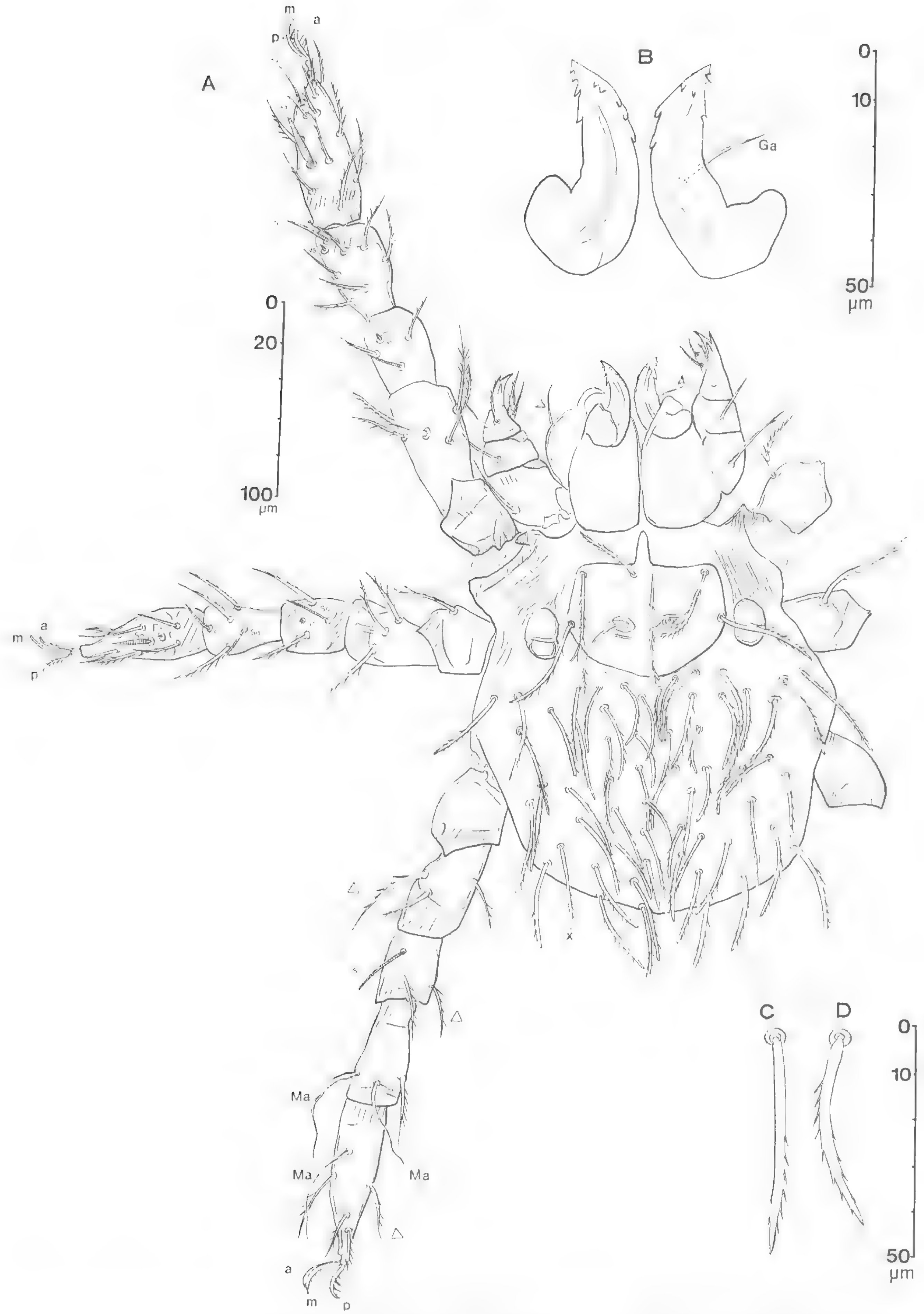

FIG. 5. *Odontacarus swani* sp. nov., larva, holotype, ACB240B. A Dorsal aspect, legs on right hand side omitted beyond trochanters. B Cheliceral fangs and galeala from above (distal half of cheliceral fangs shown in transparency). C Posterior dorsal seta (x in A). D Posterior ventral seta (y in Fig. 6A). (All to nearest scale.) In this and in subsequent figures the Δ sign indicates the seta is shown in both dorsal and ventral figures.

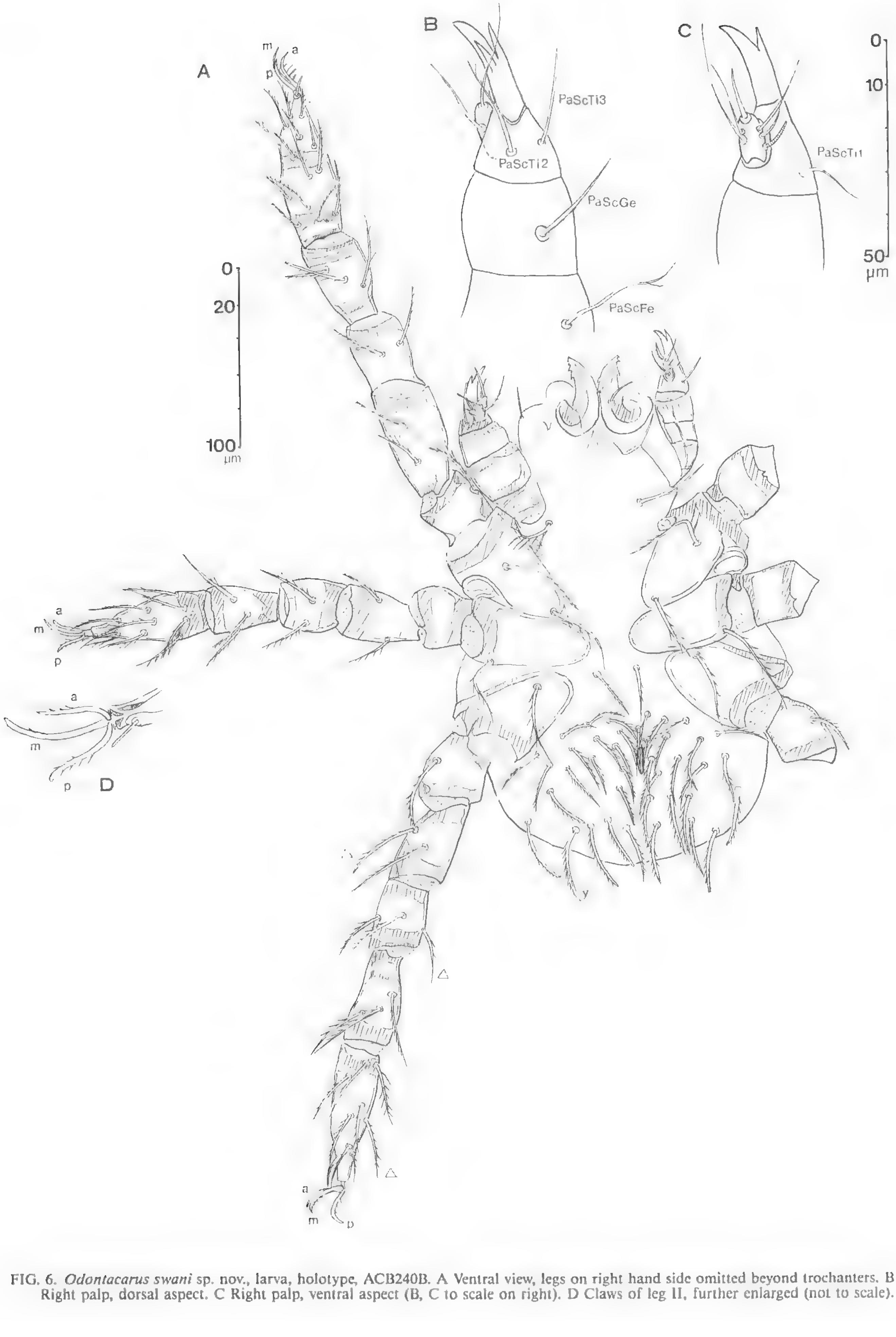

FIG. 6. *Odontacarus swani* sp. nov., larva, holotype, ACB240B. A Ventral view, legs on right hand side omitted beyond trochanters. B Right palp, dorsal aspect. C Right palp, ventral aspect (B, C to scale on right). D Claws of leg II, further enlarged (not to scale).

TABLE 3. DETAILS OF REARING EXPERIMENTS COMMENCING WITH A BATCH OF ADULTS OF *ODONTACARUS SWANI* N. SP. FROM MT HYPIPAMEE, QUEENSLAND, CAPTURED 26 OCTOBER, 1944

Serial No. ACB	*Sex*	*Eggs observed*	*Larvae observed*	*Larvae dead*	*Adult dead*	*Remarks*
238		—	—	—	22.xi.44-20.xii.44	
239	F	(8.vii.45)*	20-23.xii.44	24-30.xii.44	22.xi.44-20.xii.44	
240	F	(8.vii.45)*	20-23.xii.44	24-30.xii.44	22.xi.44-20.xii.44	
241		—	—	—	2-6.xi.44	
242		—	—	—	22.xi.44-20.xii.44	
243	F	—	—	—	17.xi.44-22.xi.44	Gravid, laid no eggs, but body contains about 50 eggs
244	F	(21.v.48)*	(21.v.48)*	—	22.xi.44-20.xii.44	
245	F	—	—	—	ca 6.xi.44	Gravid (9 eggs), laid none
246		—	—	—	22.xi.44-20.xii.44	
247		—	—	—	22.xi.44-20.xii.44	

* These eggs or larvae were found in the dried tubes, months or years after the attempted rearings had been concluded

tube examined some years later (long after all the tubes had been allowed to dry out), larvae were also found, dead and dry. Although living eggs were not observed in these tubes, egg remnants were eventually found when the opportunity to examine the tubes in detail with a microscope occurred. Two female adults, on being slide-mounted, were also found to contain eggs, although no eggs or larvae were recovered from their tubes. The details of these experimental animals are summarized in Table 3.

Taxonomic Placing of Odontacarus swani *n. sp.*

The larva of this species is distinguished from others of the genus by the following combination of characters: (1) palpal tibial claw three-pronged, (2) galeala nude, and (3) about 57 dorsal body setae present, (4) two mastitibialae III present, (5) one mastitarsala III present, palpal genuala (PaScGe) and the two palpal tibialae (PaScTi1 and PaScTi3) almost nude, with only faint indications of barbs, cheliceral fangs with a row of 3-4 dorsal and 4-5 ventral denticles.

Characters (1), (2) and (3) alone are sufficient to distinguish this species from all others of the Australasian to South-East Asian region (subgenus *Leogonius*).

The diagnostic characters of the adult have been given above.

Nomenclature

This species is dedicated to Duncan Campbell Swan (28.xi.1907-26.xii.1960), entomologist, who made field observations on the distribution of chigger mites in South Australia (see Southcott, 1982).

Classification of the Larvae of the Australian, New Guinean and South-East Asian Species of Odontacarus

About 20 species of *Odontacarus* have been described from Australia and New Guinea (including West Irian and Papua New Guinea). A single further species, *O. audyi* (Radford, 1946) has been described from South-East Asia, one, *O. gymnodactyli* (Ewing, 1925) (1925b) from India, and one, *O. lygosomae* (Dumbleton, 1947), from New Zealand. Since only limited keys to the classification of these species have been offered since Womersley's (1944, 1945) papers, an attempt to key the species of this region is offered here.

The most detailed studies of recent years for this region have been done by Goff and Loomis (see references), who unfortunately deal only with the species from New Guinea, and incidentally with a few north Queensland species, where these occur also in New Guinea.

In attempting to classify the larvae here allotted to *O. swani* n. sp., as well as various other species from northern Queensland and New Guinea, I have experienced difficulty in using one of the main characters used by Goff (1979a, b) in classification, this being deciding on the number of setae on the dorsum of the abdomen in the "first post-humeral row", i.e. the row of setae immediately behind the dorsal scutum, but excluding the two (or four) long "humeral" or "scapular" setae. These remarks apply not only to the specimens of *O. swani* described here, but also members of the type series of *O. athertonensis* (Womersley, 1945), and of *O. mccullochi* (Wom., 1944), which were used by Goff (1979a) in drawing up his key to the species which occur in New Guinea.

For this reason, it has been decided not to use the number of the setae in this row as a key character. It should also be noted that students of the larvae of the Trombidioidea and Erythraeoidea usually experience difficulty in deciding which setae to allot to different rows, as the arrangement is commonly irregular, and the allotment of the setae is largely a matter of guesswork. On the other hand, the total number of dorsal or ventral idiosomal setae appears to be free from these defects, even if the counting of them is at times tedious.

The following key to the larvae of *Odontacarus* for this region is therefore proposed, based to a large extent upon already published descriptions, but supplemented with some new data.

KEY TO THE LARVAE OF *ODONTACARUS* (SUBGENUS *LEOGONIUS*) OF AUSTRALIA, NEW GUINEA AND SOUTH-EAST ASIA

1. Palpal tibial claw with more than three prongs .. 2
Palpal tibial claws with three prongs .... [illegible]

2\. Palpal tibial claw with seven prongs .... *O. riannae* Goff, 1979
Palpal tibial claw with four prongs 3
3\. AL setae longer than PL .... *O. nadchatrami* Goff, 1979
AL setae shorter than PL 4
4\. Mastitibialae III absent. Two mastitarsalae III present. Dorsal idiosomal setae about 110 .... *O. mitchelli* Goff, 1981
One or more mastitibialae III present 5
5\. One mastitibiala III present. Dorsal idiosomal setae about 230 .... *O. unisetosus* Goff, 1979
Two mastitibialae III present to tibial III 6
6\. Galeala nude. Palpal setal formula B/B/BNN/So + 7B. About 120 dorsal idiosomal setae present .... *O. trisetosus* Goff, 1979
Galeala barbed 7
7\. Dorsal idiosomal setae number about 54. Ventral idiosomal setae about 78. Palpal setal formula B/B/BBB/So + 7B. Cheliceral denticles 4-5d/4-7v .... *O. ziegleri* Goff, 1979
Dorsal idiosomal setae number about 52-90. Ventral idiosomal setae number about 46-56. Palpal setal formula B/B/Bbb/So + 7B. Cheliceral denticles 7d/6-8v .... *O. audyi* (Radford, 1946) (Occasional specimens of *O. audyi* have only three palpal tibial prongs (see Nadchatram, 1963).)
8\. Mastitibialae III lacking 9
Mastitibialae III present 11
9\. Mastitarsalae III lacking. About 42 dorsal idiosomal setae present. Cheliceral denticles 3-4d/3-4v. AM seta short and thickened, reaching about 2/3 across to the AL seta base (Fig. 7A, B) .... *O. southcotti* (Womersley, 1944)
Mastitarsalae III present 10
10\. Cheliceral denticles 4-5d/1v (Fig. 7C). DS to 22 μm long .... *O. langani* (Southcott, 1957)
Cheliceral denticles 3-4d/4-5d (Fig. 7D). DS 29-32 μm long .... *O. mathewi* (Southcott, 1957)
11\. Tibia III with three mastitibialae. Palpal setal formula B/B/BBB/So + 7B. Cheliceral denticles 3d/3v. One mastitarsala III present .... *O. mcculochi* (Womersley, 1944)
Tibia III with two mastitibialae 12
12\. About 30 opisthosomal ventral setae present .... *O. adelaideae* (Womersley, 1944)
More than 30 opisthosomal ventral setae present 13
13\. PL/AL less than 1.20 .... *O. nova-guinea* Womersley, 1944) and *O. longipes* (Womersley, 1945)
PL/AL greater than 1.20 14
14\. Over 75 dorsal idiosomal setae present .... *O. australiensis* (Hirst, 1925) and *O. hirsti* (Womersley, 1944)
Less than 70 dorsal idiosomal setae present 15
15\. More than 58 ventral opisthosomal setae present. Cheliceral denticles 3d/4v (Fig. 7E) .... *O. cooki* (Southcott, 1957)
Less than 58 ventral opisthosomal setae present . 16
16\. PSB/SB <1.00[1]. PW 87 μm ± 1 μm (Womersley, 1945) .... *O. barrinensis* (Womersley, 1945)
PSB/SB ≥ 1.00[1]. PW mostly less than 85 μm 17
17\. PL/AL >1.3. Ventral opisthosomal setae 48-54 in number. Palpal setal formula B/B/BBB/So + 7B. .... *O. athertonensis* (Womersley, 1945)
PL/AL <1.3. Ventral opisthosomal setae in range of 35-45 in number 18
18\. AW 54-61. PW/(A-P) <2.75[2] .... *O. echidnus* (Womersley, 1945)
AW 65-73. PW/(A-P) >2.75. Palpal setal formula B(b)/N(?b)/BNN/So + 7(B or N). Galeala nude .... *O. swani* n. sp.

The following two species have been omitted from the above key:

(1) *Odontacarus gymnodactyli* (Ewing, 1925) (1925b), described from India. This species was doubtfully referred to *Acomatacarus (Acomatacarus)* by Wharton and Fuller (1952, p. 98), who list the previous synonymy. The descriptive details are insufficient to place this species in the above key.

(2) *Odontacarus lygosomae* (Dumbleton, 1947), from New Zealand. The descriptive details are insufficient for the placing of this species in the above key. Nevertheless it is quite a distinct species, with a wide dorsal scutum, and flattened, broad, lanceolate scutalae and dorsal idiosomal setae, the latter numbering about 100.

Analysis of Morphometric Data of O. swani *Larvae*

In previous papers I have attempted to determine correlations and other relationships between variates that are used by taxonomists for classificatory purposes, to see if they may be a useful basis for more general studies such as whether the mechanisms controlling size are interrelated in some way, e.g. genetic. Southcott (1966, pp. 736-738) reported on the correlation of the standard data for the erythraeoid larval mite, *Charletonia swaziana* (Lawrence, 1940). In a later paper (Southcott, 1986a) a correlation study by principal component analysis (Hotelling, 1933) was presented for both scutal and leg variates for a trombidioid larval mite, *Trombella alpha* Southcott. In the present paper a series of larval *O. swani* is similarly analysed. Some of the same remarks made about utilizing the data of Southcott (1986a) apply also to the present paper. In attempting to elucidate relationships we have here a group of larvae reared from conspecific adults, collected over a few square metres of soil, near the surface, on a single day. Additionally, the batches of larvae were reared with damp soil in sealed tubes in my baggage, so that all the larvae of each batch may be said to have experienced at least similar conditions in their life-spans. Such conditions could therefore possibly eliminate sources of variation from dissimilar conditions of rearing.

In making statistical analyses, as was done with the study of the larvae of *Trombella alpha*, we may restrict the data for the dorsal setae to a single variate, in view of the partial redundancy in using the variates DS, mid-DS and PDS. We may also omit the data for Sens, since these sensillary setae are slender, flexible and difficult to measure accurately; also these setae are commonly absent in microscopic mounts, whether from the

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[1] For *O. barrinensis* and *O. echidnus* this statistic is based on Womersley's (1945) Figs. 5F and 5D respectively.

[2] From Womersley (1945).

TABLE 4. CORRELATION MATRIX FOR VARIATES OF LARVAE OF *ODONTACARUS SWANI*, ON 6D, F.

P=.05* |r| ≥ .7067

.01** .[illegible]

.001*** .9249

AW	1	1.0000											
PW	2	0.5398	1.0000										
SB	3	-0.0196	0.4631	1.0000									
ASB	4	0.7239*	0.7337*	0.0073	1.0000								
PSB	5	0.1575	-0.4072	-0.0605	-0.4419	1.0000							
L	6	0.7776*	0.2517	-0.0556	0.4006	0.6449	1.0000						
LA	7	0.1486	0.1443	-0.3346	0.4734	-0.7780*	-0.3913	1.0000					
LB	8	0.5434	0.1402	0.0369	0.1284	0.8068*	0.9335**	-0.6953	1.0000				
[illegible]	9	0.4843	0.7155*	0.1347	0.8693**	-0.4914	0.2391	0.3965	0.0323	1.0000			
W	10	0.7987*	0.3830	-0.0172	0.6397	0.1270	0.6746	0.0747	0.4978	0.6750	1.0000		
[illegible]	11	0.4747	-0.2234	-0.3721	0.3081	0.1496	0.4153	0.3130	0.2024	0.3620	0.7228*	1.0000	
[illegible]	12	-0.1337	0.0183	0.1332	-0.4155	0.6304	0.2333	-0.8522**	0.5585	-0.4757	-0.3079	0.6306	1.0000
AL	13	[illegible]	0.1347	0.1693	0.0271	0.1531	0.6156	0.0884	0.4463	0.5013	0.7603*	0.7681	-0.4424
PL	14	0.5140	0.6407	0.2390	0.6853	-0.4135	0.0905	0.4734	-0.1157	0.8473*	0.6933	0.3853	-0.5403
AMB	15	0.4246	0.5238	0.5472	0.3563	0.3055	0.0000	0.1737	-0.0696	0.2649	0.3301	0.3000	-0.2660
MDS	16	0.3544	0.5057	0.3324	0.5924	0.1933	0.3066	0.2174	0.1547	0.6633	0.3373	0.1157	-0.0169
PDS	17	0.3064	0.7767*	0.4089	0.3332	-0.4035	-0.0907	0.1856	-0.1353	0.4201	0.1632	-0.3796	0.0891
G1	18	0.6200	0.8705**	0.2934	0.8002*	-0.1677	0.5104	0.0755	0.3692	0.6446	0.3520	-0.0993	0.0859
T1	19	0.2341	0.0355	0.7242*	-0.1776	0.3419	0.1979	-0.3966	0.3091	-0.1153	0.2309	0.0778	0.1250
G2	20	0.2957	0.4184	0.0035	0.5302	-0.0530	0.3669	-0.2055	0.3665	0.3747	0.3692	0.0254	0.1224
T2	21	0.0937	-0.2306	-0.4529	0.2505	-0.2673	0.0341	0.4788	-0.1599	0.4056	0.3854	0.7455*	-0.7575*
G3	22	0.4627	0.6614	0.2436	0.4519	-0.0333	0.3453	-0.2224	0.3568	0.5041	0.5980	-0.0727	0.2259
T3	23	0.6634	0.5465	0.5075	0.5950	-0.0636	0.4420	0.0951	0.3081	0.6876	0.8114*	0.5066	-0.3566
		1	2	3	4	5	6	7	8	9	10	11	12

AL	13	1.0000										
PL	14	0.4238	1.0000									
AMB	15	0.3907	0.4924	1.0000								
MDS	16	-0.0258	0.4949	-0.3527	1.0000							
PDS	17	-0.2258	0.6434	0.4468	0.4443	1.0000						
G1	18	0.3415	0.4162	0.2562	0.5529	0.4875	1.0000					
T1	19	0.3953	0.1928	0.6963	-0.5525	0.1633	-0.0803	1.0000				
G2	20	0.2372	0.0378	0.2045	0.1659	-0.0594	0.3719	-0.0890	1.0000			
T2	21	0.5458	0.1834	-0.1021	0.0648	-0.5609	-0.1255	-0.3198	0.2817	1.0000		
G3	22	0.0786	0.5406	0.3904	0.4337	0.6148	0.3750	0.2548	0.5987	-0.2092	1.0000	
T3	23	0.8071	0.7361	0.6722	0.1185	0.3354	0.4534	0.6046	0.1795	0.1944	0.4701	1.0000
		13	14	15	16	17	18	19	20	21	22	23

[illegible] for [illegible] read [illegible], thus G2 means GeII, etc. (This applies also [illegible] correlation tables of these variables.)

capture, mounting or preservation procedures themselves or possibly earlier traumas of life. Omitting also PW/LB, which is a statistic derived from two of the listed variates, we may therefore construct a 8×23 table of variates from these data.

A correlation matrix of 23×23 values (including L, which is the sum of LA+LB, or ASB+PSB) was then calculated. There are only 21 independent measures in the table of r, on 6 degrees of freedom (Table 4).

The table of the correlation matrix shows a total of 25 significant correlations (at P=.05 or at greater significance).

From this we may calculate a principal component analysis (Table 5). As there were only eight specimens in the series, it was considered the principal component analysis should be restricted to only two (first and second) components.

Table 5 for the principal components for the variates selected for study in *O. swani* shows that the first principal components includes all 23 variates with the exception of SB, PSB, LA, LB, A-P, AM, PDS, TiI, GeII and TiII, indicating that this component may represent a size variable affecting the majority of the variates; and the second principal component includes PSB, L, LB, and AM (also LA and TiII, of opposite sign of the direction cosines), thus indicating that these measures are correlated, and that after allowing for size, where one group is relatively large, the other is relatively small.

Further Studies on the Relationships of Variables Used in Classification of Trombiculid Mite Larvae

Statistical analyses of chitinized parts of various trombidioid, erythraeoid and other mites have been increasingly used as an aid to classification. My use of correlation analyses to determine the interrelationships of these variates has been outlined above. In my 1986 (1986a) study I showed that there is a correlation between a variate dependent upon a body character (scutum) and of a leg character, in some cases. Above it was found that in *O. swani* larvae both principal components (first and second) include both scutal and leg dimension variates, these being positively correlated in the case of the first, and both positively and negatively (for the different variates) in the case of the second.

In order to decide whether such interrelationships are an expression of some more general phenomenon or phenomena, it was decided to do similar studies on some other species of related trombiculid mites. According to keys in existence before the present study was commenced, it was thought that the larvae described above as *Odontacarus swani* were classified close to *O. athertonensis* and *O. mccullochi*, and initially were classified as *O. athertonensis*. Both of these species are included in the same couplet in the key of Goff (1979a, p. 154). These two species of larvae were therefore selected as being suitable for similar correlation studies, with the additional hope that if difficulties in classification were to appear, the correlation study might provide some guidance as to the relationships between these species. Accordingly careful measurements were made on the available series of these two species also. Ultimately, with further study, it was found that the larvae described here as *O. swani* differed in several characters from both *O. athertonensis* and *O. mccullochi*, so that only *O. athertonensis* and *O. swani* appear close together in the key above.

In the case of *O. athertonensis* a long series of larvae was available (28 specimens), and in the case of *O. mccullochi*, 10 specimens. These were measured for the same structures as in *O. swani*. Nevertheless, it is clearly as valuable to test for species widely separated from each other as for closely related species, in a search for such interrelationships.

Odontacarus athertonensis (Womersley)

Synonymy

Acomatacarus athertonensis Womersley, 1945, p. 104; Taylor, 1946, p. 226; Fuller, 1952, p. 230; Gunther, 1952, p. 40; Wharton and Fuller, 1952, p. 97; Audy, 1954, p. 164.

Odontacarus athertonensis Goff, 1979a, p. 144.

Source of the Larvae of Odontacarus athertonensis *Used in the Present Study*

The larvae of *O. athertonensis* studied for the present paper came from the following sources:

(1) The type series of 19 larvae, identification numbers ACB732A-S, Wongabel, Q., October, 1944, R. N. McC[ulloch], also two further larvae, identification numbers ACB732T, U, with same locality, date and collector information; South Australian Museum collection. Specimen ACB732A slide is notated "Syntype"; specimens ACB732B-S are notated as

TABLE 5. PRINCIPAL COMPONENT ANALYSIS OF THE VARIATES OF *ODONTACARUS SWANI* LARVAE

	1	*2*
AW	−0.2846	0.1073
PW	−0.2688	0.0357
SB	−0.0810	0.1797
ASB	−0.3111	−0.1144
PSB	0.0774	0.3769
L	−0.1860	0.2875
LA	−0.0884	−0.4182
LB	−0.1108	0.3875
LN	−0.3032	−0.1458
W	−0.2984	0.0569
A-P	−0.1496	−0.1097
AM	0.1187	0.3843
AL	−0.2384	0.0396
PL	−0.2891	−0.1461
AMB	−0.1852	0.0307
MDS	−0.1713	−0.0782
PDS	−0.1625	0.0058
G1	−0.2475	0.0756
T1	−0.0745	0.2512
G2	−0.1476	0.0949
T2	−0.0850	−0.2692
G3	−0.2199	0.1564
T3	−0.3011	0.548

Paratypes; specimens ACB732T, U are without type notation.

Womersley stated (1944, p. 105) that the species was "described from 16 syntypes". Specimen ACB732A, which bears also a number N1981384, and was presumably the one examined by Goff (1979a), is hereby formally designated the lectotype.

(2) Six larvae, mounted individually on slides, identification numbers ACB733A-F, Mt. Jukes, Q[ueensland] [21°00'S, 148°57'E], 6.ix.1951, E. H. Derrick (South Australian Museum collection). These six slides were also examined by Goff (1979a), and bear the notations G192, G193, G197, G196, G206, G197 respectively, also numbers G1981385-G1981390, respectively. Each slide also bears the comment "Was marked paratype" (this marking has been removed). These slides were clearly never part of the type series. Specimen ACB733C is a poor mount, unsuitable for detailed measurement.

Omitting specimen ACB733C, three of the five larvae key directly to *O. athertonensis* by the key given above, while for two others (ACB733 E & F) *O. athertonensis* is the nearest fit, there being a mismatch in each of PL/AL=1.225. Further studies of these larvae have been presented elsewhere (Veitch and Southcott, 1984; Southcott, 1986b).

(3) ACB734, one larva, Lae Test Area, Papua New Guinea, 24.iv.1944, R. N. McCulloch (S.A. Mus.). The slide has the notation: *Leeuwenhoekia (Acomatacarus)* nr. *athertonensis* Wom. Lae Test Area. 24.4.44. R. N. McC. Det. H. Womersley. AW and PW Standard Data longer. AW=75.6, PW=84.0. (This is a poor mount, the dorsal scutum being damaged.)

By the key given above this specimen comes to caption 18, but then does not fit the criteria of either *O. echidnus* or *O. swani*. A further analysis of the statistical data of this specimen has been made elsewhere (Veitch and Southcott, 1984; Southcott, 1986b).

In response to my request for locality data, Dr. R. N. McCulloch has replied (pers. comm., 1983): "Lae test area was jungle just off the main road and where I did stopping-time tests [see McCulloch 1944, 1946, 1947] probably a mile towards the big air strip from 2/7 A. G. H." (2nd/7th Australian General Hospital).

(4) ACB735, one larva, Lae Scrub, 24.iii.44, A. S. D. (South Aust. Mus.). The slide is additionally notated: "*Leeuwenhoekia (Acomatacarus)* nr. *athertonensis* Wom. AW and PW Standard Data longer. AW=70.0, PW=84.0. Det. H. Womersley." This is another poor mount.

By the key above this specimen is not identifiable, owing to both legs III being damaged.

As no mite student or collector with the initials A. S. D. was known to me, I have written to Dr. R. N. McCulloch asking for further locality and other information. He has replied (pers. comm., 1983) "ASD means, I guess, Advanced Stores Depot and was on the old disused civilian air strip which was between the new [i.e. 1944] active air strip and 2/7 A. G. H.".

TABLE 6. MORPHOMETRIC DATA (μm) OF *ODONTACARUS ATHERTONENSIS* (WOMERSLEY) LARVAE

Character	*Lectotype ACB732A*	*Conspecificity Queried*		*Range for Type series*	*n*	*Mean*[1]	*S.D.*[1]
		ACB734	*ACB735*				
AW	71	79	85	61-71	21	65.90	2.700
PW	80	91	90	75-87	21	77.62	2.655
SB	25	31	27	22-30	21	25.10	1.413
ASB	47	55	54(52)[4]	47-56	21	53.00	2.490
PSB	35	34(31)[4]	28(36)[4]	25-35	21	28.90	2.719
L	82	89(86)[4]	82(88)[4]	76-87	21	81.90	3.113
LA	16	20(25)[4]	18	16-23	21	19.81	2.040
LB	66	69(61)[4]	64(70)[4]	55-67	21	62.10	2.897
LN	25	30	29	25-32	21	29.05	2.202
W	94	96	97	81-96	21	87.14	4.246
A-P	25	32	27	25-32	21	28.24	1.814
AM	37	39	37	35-42	21	38.38	2.459
AL	41	46	46	37-46	21	40.71	2.101
PL	55	58	66	50-58	21	55.24	1.700
AMB	13	15	11	10-13	21	11.43	1.028
Sens	50	—	45	45-55	?	—	—
PW/LB	1.21	1.32	1.41	1.17-1.45	21	—	—
DS	29-42	33-64	36-67	(29-35)-(42-56)	21	—	—
mid-DS	29-40	33-38	34-44	(29-35)-(35-42)	21	37.76[3]	2.385[3]
PDS	36-40	42-46	33-42(-51)[4]	(35-38)-(38-46)	21	41.57[3]	1.964[3]
GeI	45	45	56	42-49	21	45.76	1.670
TiI	60	55	67	53-60	20	55.19	1.662
GeII	40	37	51	36-42	21	39.19	1.662
TiII	47	42	56	41-49	21	45.43	1.886
GeIII	49	42(44)[4]	56(58)[4]	44-50	21	45.71	1.875
TiIII	65	57	69(75)[4]	57-65	21	59.86	2.197

[1] The mean and the s.d. are calculated for the type series only with n=21 (see text).

[2] In subsequent calculations of correlation the three missing values indicated by (a), (b) and (c) were replaced as follows: (a) AL for ACB732B: 41, (b) AM for ACB732S: 35, (c) TiI for ACB732B: 53, after a study of the data. This refers to the table of variates for the type series held on file in the South Australian Museum.

[3] Figures calculated from the maximal values only of that variate.

[4] Figures in brackets are a set of variant estimates made subsequently and which differed by 2 μm or more from the earlier ones, and used in calculations presented in Veitch and Southcott (1984) as a check on the reliability of analytical procedures. The specimens were the most separated from the others using the variables selected. Specimens ACB734 and ACB735 were poor mounts, presenting difficulties in microscopic measurement.

TABLE 7. CORRELATION MATRIX FOR VARIATES OF *ODONTACARUS ATHERTONENSIS* LARVAE, ON 19 D. F.

P=.05* |r| ≥ .4329
.01** .5487
.001*** .6652

		1	2	3	4	5	6	7	8	9	10	11	12
AW	1	1.0000											
PW	2	0.5248*	1.0000										
SB	3	0.5529**	0.7437***	1.0000									
ASB	4	-0.4834*	-0.0832	0.0133	1.0000								
PSB	5	0.2371	0.0709	0.0266	-0.2881	1.0000							
L	6	-0.1796	-0.0046	0.0339	0.5483*	0.6429**	1.0000						
LA	7	-0.3575	-0.0325	0.1033	0.7874***	0.2288	0.4300	1.0000					
LB	8	0.0588	0.0180	-0.0364	0.0347	0.8520***	0.7718***	-0.2422	1.0000				
LN	9	-0.2095	0.0974	0.1936	0.7752***	-0.3083	0.3509	0.7813***	-0.1732	1.0000			
W	10	0.6903***	0.6438**	0.5113*	-0.1561	0.4517*	0.2697	-0.0544	0.3281	0.0206	1.0000		
A-P	11	-0.2197	-0.2190	-0.3001	0.0886	-0.5731**	-0.4297	-0.0277	-0.4423*	-0.0531	-0.2448	1.0000	
AM	12	-0.0018	0.1076	0.2719	0.2940	-0.2187	0.0442	0.0451	0.0157	0.0057	-0.1012	0.3597	1.0000
AL	13	0.2153	0.0781	0.1033	-0.0669	-0.0488	-0.0961	-0.2816	0.0951	-0.2996	0.0945	0.3861	0.4576*
PL	14	0.1686	0.1651	0.2628	-0.2480	-0.1247	-0.3073	-0.0151	-0.3196	-0.0433	-0.0604	-0.2463	-0.1185
AMB	15	0.1415	0.1178	-0.1561	-0.1562	0.3373	0.1696	-0.0068	0.1871	-0.1641	0.4205	-0.0306	-0.2260
MDS	16	-0.0115	0.0086	-0.1457	-0.1515	0.0117	-0.1109	-0.1331	-0.0255	-0.1405	-0.1594	-0.0902	-0.1542
PDS	17	0.0108	-0.0904	0.0481	0.1227	0.1886	0.2629	-0.0713	0.3327	0.1900	0.1216	-0.2927	-0.3372
G1	18	-0.0607	-0.0778	0.1281	0.1082	-0.1484	-0.0430	0.2061	-0.1914	0.1528	-0.2769	0.2177	0.3883
T1	19	0.3385	0.0059	-0.0871	-0.3142	0.4248	0.1197	-0.3427	0.3700	-0.1393	0.0810	-0.3309	-0.0920
G2	20	0.1714	0.0059	0.0719	-0.2175	0.4690*	0.2356	-0.3575	0.5050*	-0.4125	-0.1032	-0.1319	0.2750
T2	21	-0.0309	0.0442	0.0200	-0.1704	0.5447*	0.3394	0.0613	0.3216	-0.2099	0.1668	-0.3675	-0.2526
G3	22	0.3796	-0.0632	0.0277	-0.5677**	0.4261	-0.0820	-0.4202	0.2078	-0.4690*	0.0619	-0.5524**	-0.3765
T3	23	0.3347	-0.0869	-0.1009	-0.5392*	0.4914*	-0.0021	-0.2518	0.1751	-0.3396	0.0934	-0.5430*	-0.3780

		13	14	15	16	17	18	19	20	21	22	23
AL	13	1.0000										
PL	14	0.1320	1.0000									
AMB	15	-0.0099	-0.0899	1.0000								
MDS	16	0.0755	0.0886	0.1252	1.0000							
PDS	17	-0.2856	-0.3572	0.0460	0.0305	1.0000						
G1	18	0.1791	-0.1551	-0.1123	-0.0902	-0.2155	1.0000					
T1	19	0.0736	-0.2823	0.1839	0.3525	0.1488	0.3233	1.0000				
G2	20	0.1739	-0.1938	-0.0502	0.0625	0.0569	0.3233	0.4388*	1.0000			
T2	21	-0.2199	0.1381	0.2873	0.0572	0.0116	0.0023	0.0365	0.1641	1.0000		
G3	22	-0.3137	0.0381	0.0926	0.1629	0.2774	0.0411	0.4356*	0.3714	0.4465*	1.0000	
T3	23	-0.3558	0.1568	0.4047	0.2317	0.1125	-0.1732	0.5007*	0.2543	0.3413	0.6693***	1.0000

A further statistical study of the data of this specimen has been made elsewhere (Veitch and Southcott, 1984; Southcott, 1986b).

(5) ACB736, one larva, collection data as for ACB734. The slide bears the notation: "*Leeuwenhoekia (Acomatacarus)* nr. *athertonensis* Wom. Lae Test Area. 24.4.44. R. N. McC. AW and PW Standard Data longer. AW=68.6, PW=84.0. Det. H. Womersley."

Remeasuring gives AW about 65, PW about 75. From obscurity in the mount the specimen is not identifiable by the foregoing key, various key characters not being visible. (The data of this specimen have been omitted from the table given below (Table 4), as too many values are unavailable for it to be capable of being included in a correlation analysis.)

These three are the only specimens in the South Australian Museum collection placed as or near *O. athertonensis,* from Papua New Guinea. Although Goff (1979a, p. 146) states that the three specimens examined were from "Morobe Distr[.], Lae, 24.iv.1944, collected in scrub", only two slides bear the date 24.iv.1944, and the term "scrub" occurs on only one slide; none of these slides carry any loan number designations, apart from that implied by my identification numbers.

Data

The measurements of the standard data and other variates selected for study are shown in Table 6.

Results of the Correlation Analysis of the Variates of Odontacarus athertonensis *Larvae*

In Table 6 the means and standard deviations of the variates have been calculated from the type series only (ACB732A-U). The reason for this is that a preliminary discriminant analysis of the data given indicate that the specimens previously considered as conspecific, as well as those under the heading "Conspecificity queried" differ significantly in various statistical measures from the type series. This subject will be analysed further in another paper.* Accordingly, correlation analyses here will be confined to the data of the type series.

Proceeding as before, a correlation matrix of 23×23 values is calculated; this is shown in Table 7.

There are 32 correlations between variates shown in Table 7 at the 5% (or more significant) levels of probability. These are marked in the table by asterisks, as shown.

Examining the principal components as before, we may select the first and second principal components (in view of the sample size of 21 specimens). These are shown in Table 8.

From Table 8 we see that there are two significant groups of correlations. Component 1, of AW, PSB, LB, TiI, GeII, TiII, GeIII, TiIII, together with (of opposite sign) ASB, LA, LN and A-P. This component thus represents a mixture of size and shape variables. Component 2, of ASB, PSB, L, LA, LB, LN and PDS, and (of opposite sign) A-P, which is thus seen to include mainly variables based upon the dorsal scutum. This component again is a mixture of size and shape variables.

TABLE 8. PRINCIPAL COMPONENT ANALYSIS OF THE VARIATES OF *ODONTACARUS ATHERTONENSIS* LARVAE

	1	*2*
AW	−0.2232	0.1410
PW	−0.0750	−0.0299
SB	−0.0399	0.0587
ASB	0.2704	−0.3856
PSB	−0.3569	−0.2042
L	−0.0954	0.4868
LA	0.2266	0.3494
LB	−0.2621	−0.2770
LN	0.2255	0.3471
W	−0.1864	0.1381
A-P	0.2743	0.2177
AM	0.1562	0.0371
AL	0.0486	0.1865
PL	0.0007	0.1760
AMB	−0.1648	0.0630
MDS	−0.0869	0.1064
PDS	−0.1153	−0.2161
G1	0.0827	0.0341
T1	−0.2558	0.0222
G2	−0.2074	0.0255
T2	−0.2151	−0.1362
G3	−0.3325	0.0961
T3	−0.3248	0.0585

Odontacarus mccullochi (Womersley)

Synonymy

Leeuwenhoekia mccullochi Womersley, 1944, p. 108.

Acomatacarus mccullochi Womersley, 1945, p. 111. Taylor, 1946, p. 226. Gunther, 1952, p. 40.

Acomatacarus (Acomatacarus) mccullochi Wharton and Fuller, 1952, p. 99. Audy, 1954, p. 164

Odontacarus (Leogonius) mccullochi Goff, 1979a, pp. 147, 154.

Material Examined

(All specimens in South Australian Museum collection)

QUEENSLAND

Trinity Beach Area [Trinity Bay] 10.vii.1943, R. N. McC[ulloch], on boots, edge of scrub, four specimens, identification numbers ACB752A-D, A labelled Type, B-D Paratypes.

Trinity Beach, Cairns, Q[ld.], edge of scrub, 8.vii.1943, name of collector not stated, identification numbers ACB753A-D. (These slides are labelled Paratypes, although according to Womersley's account (1944, p. 109) they were not mentioned in the original description.)

Emerald, C[entral] Q[ueensland], Nov. 1948, ex *Pomatostomus temporalis,* H. W[omersley], two specimens, identification numbers ACB754A, B.

Data

The measurements of the standard data and other variates selected for study are shown in Table 9.

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* Note added in proof: This has now been done; see Veitch and Southcott (1984).

TABLE 9. MORPHOMETRIC DATE (μm) FOR *ODONTACARUS MCCULLOCHI* LARVAE

Character	Type *(ACB752A)*	*Range*	*n*	*Mean*	*S.D.*
AW	62	56-66	10	62.50	3.206
PW	77	74-83	10	78.20	3.084
SB	24	23-27	10	24.20	1.229
ASB	50	46-59	10	51.00	3.916
PSB	24	24-28	10	26.10	1.370
L	74	73-87	10	77.10	4.358
LA	18	15-21	10	17.70	2.163
LB	56	56-66	10	59.20	3.360
LN	27	22-31	10	26.30	4.138
W	86	78-93	10	86.80	4.492
A-P	32	24-35	10	30.90	3.315
AM	33	33-40	9	35.50	2.369
AL	41	34-41	10	37.80	2.394
PL	53	47-58	10	52.70	3.621
AMB	11	9-14	10	10.90	1.287
Sens	56	46-56	—	—	—
PW/LB	1.38	1.20-1.38	—	—	—
DS	31-56	(25-31)-(47-62)	—	—	—
mid-DS	31-36	(25-31)-(31-36)	10	34.70[1]	1.567[1]
PDS	36-40	(31-36)-(33-40)	10	38.70[1]	2.406[1]
GeI	54	46-54	9	49.70	2.584
TiI	56	55-62	9	57.70	2.751
GeII	38	38-46	10	42.20	2.741
TiII	46	43-52	10	47.20	2.741
GeIII	49	45-54	10	48.00	2.867
TiIII	62	57-63	10	61.00	2.211

1. Figures for the maximum values of the variate.

Analysis of Morphometric Data for Odontacarus mccullochi *Larvae*

The data in Table 9 were submitted to the previously described analysis, the variate Sens being omitted for the reasons as before. Likewise the variates involving the dorsal idiosomal setae were restricted to the maximum values of the mid-DS and PDS variates.

Proceeding as before we thus have a 23 × 23 table on 8 degrees of freedom (Table 10).

Table 10 shows 28 significant correlations between the variables, at the 5% or greater level of significance.

From these data we may perform a principal component analysis, as before. This is shown in Table 11.

From Table 11 it can be seen that there are two significant groups of correlations. Component 1, of AW, PW, SB, ASB, L, LA, BL, LN, W, A-P, AMB, GeI, TiI and TiII, i.e. indicating largely that this is a correlation induced by size factors. Component 2, of AW, TiI, TiII, GeIII and TiIII, and (of opposite sign) LA, LN, A-P, AL, AMB, MDS and PDS; it is thus a mixture of correlations of opposite signs, involving variables derived from scutum, body setae and leg dimensions.

Conclusions on Correlations Between Measurements of Chitinized Idiosomal and Leg Parts in Three Species of Larval Trombidioid Mites

My earlier study on *Trombella alpha* (Southcott, 1986a) and the present study of three species of trombiculids have defined in each species the first two (or three) principal components in a comparable series of variates from specified chitinized parts of the body and limbs of these mites. The findings are set out in Table 12.

It is apparent from the preceding analysis and Table 12 that the correlation patterns are different in each species of mite studied, for the variates that have been selected for study. For the first principal component, there appears to be a greater similarity between the patterns between *O. mccullochi* and *O. swani*, than between either of these species with *O. athertonensis*. The patterns of the first principal component in these three species of *Odontacarus* resemble each other more than they do that of *Trombella alpha*.

This result suggests that all of these measurements may be necessary to separate species of *Odontacarus* and, by an extension of this concept, species in other genera of mites.

There is thus not a compact set of correlations manifested in these data. This is due in part to the small sizes of the samples studied, although other causes of these variations and comparative paucity of correlations could be suggested, particularly nutritional or other environmental factors.

Odontacarus southcotti (Womersley)

(Fig. 7A, B)

Synonymy

Leeuwenhoekia southcotti Womersley, 1944, p. 109. Taylor, 1946, p. 232.

Acomatacarus southcotti Womersley, 1945, p. 111. Taylor, 1946, p. 226. Gunther, 1952, p. 40.

Acomatacarus (Acomatacarus) southcotti Wharton and Fuller, 1952, p. 100; Audy, 1954, p. 164.

Material Examined

NORTHERN TERRITORY: Type series ACB169A1-7, South Australian Museum collection, Adelaide River, 15.vi.1943, on skink. (These are the only specimens in the S.A.M. collection; originally I had submitted 10 specimens, on two slides, labelled ACB169A (8 specimens) and ACB169B (2 specimens).

Remarks on Collection Data

On 15.vi.1943 I collected 10 or more red larval mites from the external auditory meati of a small skink, specimen R45 (my number), in the Adelaide River area, about 12 km (8 miles) east of the 57 mile point (i.e. 57 miles (91 km) southwards along the main road from Darwin; this being the current military nomenclature). This is about lat. 13°06'S, long. 131°14'E. There were 5 or more larval mites in each ear of the skink; but none in the axillae or elsewhere on the external surface of the skink. The skink was later identified as *Leiolepisma ?pectoralis* by Mr F. J. Mitchell, South Australian Museum, but not kept. Another specimen caught at the same time and place (my R46) was identified by Mr Mitchell as *L. pectoralis*, and is preserved in the South Australian Museum collection as R2703.

These notes supersede the collection data given by Womersley (1944, p. 110), which are partly wrong.

TABLE 10. CORRELATION MATRIX FOR VARIATES OF *ODONTACARUS MCCULLOCHI* LARVAE, ON 8 D. F.

P=.05* $|r| \geqslant$ .6319
.01** .7646
.001*** .8721

		1	2	3	4	5	6	7	8	9	10	11	12
AW	1	1.0000											
PW	2	0.6968*	1.0000										
SB	3	0.3947	0.2521	1.0000									
ASB	4	0.3717	0.5612	0.4386	1.0000								
PSB	5	-0.4679	-0.1367	-0.1451	0.1657	1.0000							
L	6	0.1869	0.4613	0.3485	0.9507***	0.4633	1.0000						
LA	7	0.2644	0.2599	0.5684	0.8397**	-0.1387	0.7109*	1.0000					
LB	8	0.1032	0.5211	0.0430	0.7770**	0.6468*	0.9016***	0.3608	1.0000				
LN	9	0.4024	0.5729	0.3344	0.8488**	-0.1372	0.7195*	0.8674**	0.5128	1.0000			
W	10	0.7638*	0.8935***	0.1489	0.6064	-0.3033	0.4496	0.3934	0.4594	0.6971*	1.0000		
A-P	11	0.1621	0.5673	0.2236	0.7447*	-0.1688	0.6161	0.7082*	0.4808	0.7823**	0.6328*	1.0000	
AM	12	-0.6511*	-0.2129	-0.4961	-0.3953	0.3936	-0.2314	-0.4663	-0.0140	-0.3231	-0.3759	-0.1061	1.0000
AL	13	-0.2171	0.0211	-0.4379	0.0830	-0.3996	-0.0511	0.2017	-0.0912	0.2484	0.1405	0.5711	0.1763
PL	14	0.3733	0.3084	-0.3744	-0.3370	-0.4703	-0.4507	-0.3547	-0.2649	-0.0242	0.4782	-0.0463	-0.1295
AMB	15	0.1481	0.3136	0.5760	0.5293	-0.2458	0.3983	0.7466*	0.1336	0.6560*	0.3806	0.7268*	-0.3463
MDS	16	0.0111	0.4276	-0.2538	0.3622	-0.2432	0.2490	0.2656	0.3081	0.4995	0.5904	0.7850**	0.1048
PDS	17	-0.3673	-0.3953	-0.0526	0.3066	-0.0910	0.2469	0.6213	-0.0055	0.3980	-0.1398	0.4555	-0.0877
G1	18	0.6237	0.3569	0.5457	0.3294	-0.4613	0.1510	0.3400	-0.0307	0.2691	0.3389	0.0999	-0.8259**
T1	19	0.5229	0.6496*	0.5126	0.5261	0.2152	0.5404	0.1886	0.5723	0.3323	0.5162	0.1791	-0.2132
G2	20	0.1012	0.1656	0.3166	0.2485	0.3195	0.3238	0.1425	0.2848	0.2138	0.0397	-0.0465	0.3423
T2	21	0.4932	0.6652*	0.5475	0.4970	0.1420	0.4912	0.2549	0.4778	0.4372	0.4729	0.1737	-0.1883
G3	22	0.6043	0.6911*	0.2207	0.1583	-0.2262	0.0711	-0.1433	0.1615	-0.0458	0.4744	0.1636	-0.2617
T3	23	0.5800	0.2281	0.5723	0.3208	-0.3667	0.1730	0.3253	-0.0449	0.1978	0.2237	0.0455	-0.4031

		13	14	15	16	17	18	19	20	21	22	23
AL	13	1.0000										
PL	14	0.1025	1.0000									
AMB	15	0.2092	-0.0000	1.0000								
MDS	16	0.6633*	0.3525	0.3692	1.0000							
PDS	17	0.5863	-0.2806	0.4917	0.2977	1.0000						
G1	18	-0.1365	0.0237	0.1905	-0.0796	-0.1948	1.0000					
T1	19	-0.5499	-0.1116	0.0220	0.0541	-0.5691	0.4080	1.0000				
G2	20	-0.4504	-0.4255	-0.1828	-0.1915	-0.2932	-0.1475	0.6131	1.0000			
T2	21	-0.5012	-0.1120	0.1008	-0.0103	-0.5459	0.4801	0.9226***	0.6302	1.0000		
G3	22	-0.0162	0.1391	-0.0602	0.0495	-0.5959	0.4948	0.4508	-0.0848	0.3817	1.0000	
T3	23	-0.2099	-0.3192	-0.0781	-0.1603	-0.2089	0.6028	0.5481	0.4951	0.4951	0.3855	1.0000

TABLE 11. PRINCIPAL COMPONENT ANALYSIS OF THE VARIATES OF *ODONTACARUS MCCULLOCHI* LARVAE

	1	*2*
AW	−0.2326	0.1860
PW	−0.2784	0.0693
SB	−0.2094	0.1310
ASB	−0.3164	−0.1233
PSB	0.0359	0.0428
L	−0.2730	−0.0974
LA	−0.2598	−0.2159
LB	−0.2155	−0.0462
LN	−0.2920	0.1979
W	−0.2796	−0.0299
A-P	−0.2459	−0.2958
AM	0.1781	−0.0525
AL	0.0158	−0.3645
PL	0.0307	0.0012
AMB	0.1930	0.2467
MDS	−0.1259	−0.2859
PDS	0.0017	−0.4122
G1	−0.1934	0.1564
T1	−0.2514	0.2677
G2	−0.1009	0.1977
T2	−0.2511	0.2536
G3	−0.1443	0.2099
T3	0.1735	0.2212

Additional Notes on Morphology

This species has a broad, shallow dorsal scutum, with short, rather thickened, AM setae, which reach about two-thirds of the way across to the AL seta bases. The cheliceral fang has 3-4 dorsal, and 3-4 ventral, denticles. These features are illustrated in Figs. 7A, B.

Odontacarus barrinensis (Womersley)

Synonymy

Acomatacarus barrinensis Womersley, 1945, p. 106. Taylor, 1946, p. 226. Gunther, 1952, pp. 41, 48.

Acomatacarus (Acomatacarus) barrinensis Wharton and Fuller, 1952, p. 98. Audy, 1954, p. 164 (with query).

Remarks on Collection Data

Womersley recorded (1945, p. 106) "Described from five syn-types collected free, from Lake Barrine, Queensland, 16 Nov. 1943 (R.V.S.), and a single specimen from man, Atherton Tableland, Queensland, 8 March 1944 (R.V.S.)".

Reference to my field and other notes shows that the first group ("five syn-types") were my serial ACB188, recorded originally by me as "ACB188...5 larval...Running over a log. Lake Barrine shores. Qld. 16.11.43."

With respect to the sixth specimen, stated to have been collected "from man, Atherton Tableland, 8 March 1944", this is my specimen ACB210A. This was the sole specimen of *Odontacarus* among a batch of mites which included many larval trombiculids (ACB210B, C, D, etc.) and two small (larval) ticks (ACC358, ACC359), collected parasitic on three soldiers at Gilbey Creek, near Wondecla, Atherton Tableland, Queensland (Map Ref. Herberton (1:63360) 392023), on 8 March 1944. The actual collector of the specimens was Cpl. E. Grinham, A Company, 2nd/7th Australian Field Ambulance, as I was away in another area at the time. The other larval trombiculid mites collected were later identified as *Eutrombicula hirsti* (Sambon, 1927).

Remarks on the Subgeneric Classification of the Larvae of Odontacarus *Ewing*

The genus *Odontacarus* (as well as a number of others of the family Trombiculidae) was revised and divided by Vercammen-Grandjean (1968). Definitions were submitted not in the usual terminology of acarological or even trombiculid description, but in Vercammen-Grandjean's own code. Such extensive use of codes in the descriptions and definitions of trombiculid mites has in fact been subject to criticism (see Brennan and Goff, 1977).

The following is an account of the revision of *Odontacarus* made by Vercammen-Grandjean (1968, pp. 120-121).

Definitions	Remarks and interpretation
Odontacarus Ewing, 1929 GT/*Trombicula dentata* Ewing, 1925	Type species, "genotype"
Leeuwenhoekiini of medium to large size.	A new tribe introduced by Vercammen-Grandjean on the same page (p. 120); on p. 119 he retained the family Leeuwenhoekiidae Womersley, 1945, and subfamily Leeuwenhoekiinae Womersley, 1944.
Ip = 700-1400	Ip = Index pedibus, the sum of the lengths of legs I, II and III. Despite its use by Vercammen-Grandjean, it must be considered of little diagnostic value; e.g. *Acomatacarus* (p. 122) is stated to have an Ip of 800-1020 (μm).

TABLE 12. ELEMENTS OF THE FIRST TWO (OR THREE) PRINCIPAL COMPONENTS OF A PRINCIPAL COMPONENT ANALYSIS OF COMPARABLE SERIES OF VARIABLES OF CHITINIZED IDIOSOMAL AND LEG STRUCTURES FOR THREE SPECIES OF LARVAL TROMBIDIOID MITES

Species	*Component 1*	*Component 2*	*Component 3*
Trombella alpha	ASB, L, A-P, TiIII	AW, PW, PSB, AM, GeI	DS, TiI
Odontacarus athertonensis	AW, PSB, LB, TiI, GeII, TiII, GeIII, TiIII, -ASB, -LA, -LN, -(A-P)	ASB, PSB, L, LA, LB, PDS, -(A-P)	—
Odontacarus mccullochi	AW, PW, ASB, L, LA, LB, LN, W, A-P, AMB, GeI, TiI, TiII	AW, TiI, TiII, GeIII, TiIII, -LA, -LN, -(A-P), -AL, -AMB, -MBS, -PDS	—
Odontacarus swani	AW, PW, ASB, L, LN, W, AL, PL, AMB, MDS, GeI, GeIII, TiIII	PSB, L, LB, AM, -LA, -TiII	—

Note: ASB=ASBa in Southcott (1986a); PSB=ASBp likewise.

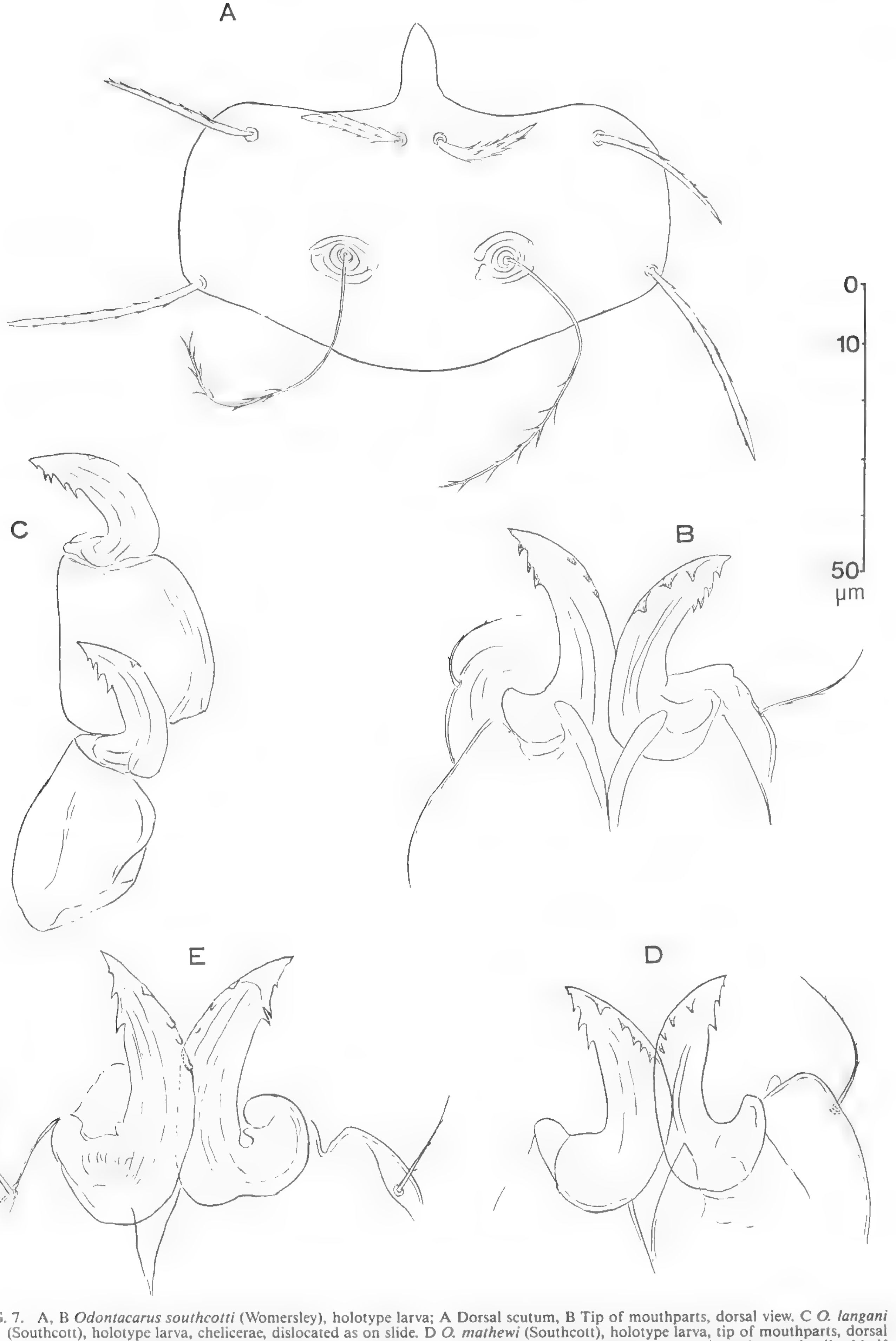

FIG. 7. A, B *Odontacarus southcotti* (Womersley), holotype larva; A Dorsal scutum, B Tip of mouthparts, dorsal view. C *O. langani* (Southcott), holotype larva, chelicerae, dislocated as on slide. D *O. mathewi* (Southcott), holotype larva, tip of mouthparts, dorsal view. E *O. cooki* (Southcott), holotype larva, tip of mouthparts, dorsal view. All to scale shown. (Note: in each case the distal half of the cheliceral fang is shown in transparency, so that the denticles on both the lateral and medial aspects are shown.)

Scutum roughly pentagonal with a nasus, 2 AM, 2 AL and 2 PL.	This means there are two anteromedian setae, two anterolaterals, and two posterolaterals to the scutum.
Eye lenses, 2p.	The term "2p" is not defined, but presumably means that two eyes are present on each side, each with a lens.
fT=7B	This is the code for the "palpotarsal pilous formula", meaning here that there are seven branched setae (plus a solenoidala, stated to be invariably present) on the palpal tarsus.
and palpotibial claw, Gr=2-4	This means there are 2-4 prongs to the palpal tibial claw
Subterminala or parasubterminala more often branched or absent than nude.	These are specialized setae of the pedal tarsi. As according to Vercammen-Grandjean's statement they may be absent or present, and if present, then branched or nude, they can clearly be allotted no diagnostic significance.
Always at least one mastitarsala or a solenidion (s) on leg 3. Stigmatae (sic) and tracheae present (S+T).	Vercammen-Grandjean, in the same work, also uses S and T with other meanings.
Ch = $\frac{d}{o}$, $\frac{o}{v}$, or $\frac{d}{o}$, never $\frac{o}{o}$.	The code Ch refers to the chelicerae. The notation $\frac{d}{o}$ etc., is not explained, but presumably refers to the presence or absence of dorsal (d) or ventral (v) teeth on the cheliceral fang. The second $\frac{d}{o}$ is presumably an error for $\frac{d}{v}$, as both dorsal and ventral denticles are often present to the fang in *Odontacarus*.

Vercammen-Grandjean (1968, p. 120) then proceeded to divide *Odontacarus* into *Odontacarus* s. str., and two new subgenera, *Taralacarus* and *Leogonius*. He offered no definition for *Odontacarus* s. str., commenting "The subgenus *Odontacarus* s. str. is of no concern in this study", doubtless on the (implied) grounds that it was not represented in the "Far East" (a term which was used to include Australia, Malaysia, and eastern Asia more generally). *Odontacarus* s. str. was also omitted from the diagnostic key given on p. 53 of the same work. Reference to that key shows that *Tarsalacarus* is separated by being a section of *Odontacarus* sens. lat. in which leg tarsus III has a dorsal solenidion (solenoidala), while in *Leogonius* tarsus III lacks such a seta "but there is 1 mastitarsala and 2 mastitibialae" to leg III of the larva. Additional characters are listed for *Tarsalacarus* and *Leogonius* by Vercammen-Grandjean in that work (pp. 53, 121). Perusal of the characters listed shows that many of these are shared in common, or are overlapping, e.g. "*Odontacarus* of median (sic) size" as against "*Odontacarus* of medium to large size", or "Gr 2-4" (i.e. 2-4 claws to palpal tibia). The only characters listed by Vercammen-Grandjean as being distinct between the two subgenera, apart from that listed above, is Ch=O/v for *Tarsalacarus*, and Ch=d/O for *Leogonius*, i.e. *Tarsalacarus* has ventral cheliceral denticles but lacks dorsal ones, while the reverse situation is stated to apply in *Leogonius*. Onychotrichs (cilia to the pedotarsal claws) are not mentioned.

The subgeneric classification has been clarified and corrected by Goff and Loomis (1977), who defined *Odontacarus* s. str. as "*Odontacarus* larvae lacking tarsala III [i.e. a solenoidala]; mastitarsala III present or absent", and *Tarsalacarus* as "*Odontacarus* larvae with tarsala III; mastitarsala III absent; onychotriches absent". *Leogonius* was redefined by Goff (1979a), the diagnosis including: onychotriches on both claws and empodia; cheliceral blade with dorsal and ventral teeth; 2-3 mastitibialae III present, with basal barbs; mastitarsala III present, with basal barbs.

By the above definitions therefore, the species (as larvae) considered in the present paper come within *Leogonius*, as in fact all Australian, New Guinea and South-East Asian species have been placed by previous authors, since the subgeneric division of Vercammen-Grandjean.

The characters of the subgenera of *Odontacarus* are shown in the following Table 13.

Classification of Adults and Nymphs of Odontacarus

As this is the first description of an adult *Odontacarus*, confirmed by experimental rearing, it is appropriate here to examine the status of other adults that have been placed in this genus on the basis of morphological similarity to nymphs reared from larvae. So far seven nymphs have been allotted to *Odontacarus* by such experimental rearing, these being:

(1) *O. arizonensis* (Ewing), from North America, reared by Crossley (1960, p. 196). This species has since been replaced in *Acomatacarus s. str.* by Vercammen-Grandjean (1968).

(2) *O. plumosus* (Greenberg, 1951). This binomen was used by Brennan and Jones (1959), Loomis and Crossley (1963) and Nadchatram (1963).

A separate genus name, *Xenacarus* Greenberg, 1951 (since replaced by *Xenodontacarus* by Loomis and

TABLE 13. DIFFERENTIATING CHARACTERS OF THE SUBGENERA OF *ODONTACARUS* (+PRESENT, −ABSENT) (SEE TEXT FOR FURTHER EXPLANATION)

Code	*Mastitibialae III (MaTiIII)*	*Mastitarsalae III (MaTaIII)*	*Solenotarsala III (SoTaIII)*	*Onychotrichs*	*Cheliceral denticles*
Subgenus					
Odontacarus	—	±	—	±	d/v
Tarsalacarus	—	—	—	—	O/v
Leogonius	±	+	—	+	d/v

Goff, 1973, on grounds of pre-occupation) has been allotted to this species, which was reared to a nymph by Grossley (1960, p. 197). Since Loomis and Goff (1973), as well as Vercammen-Grandjean (1973a) confer full generic status on this and related species, we may exclude it from immediate consideration.

There are thus five species of trombiculid mites which have been reared experimentally from the larval to the nymphal stage, which may be placed in the genus *Odontacarus* in the sense of Goff (1979a, b). These are:

(3) *O. (Leogonius) australiensis* (Hirst, 1925) from Australia and New Guinea, reared by C. B. Philip (in Womersley, 1945) from New Guinea material, and by Domrow (1956) from Australian material.

(4) *O. (L.) adelaideae* (Womersley, 1944), from southeastern Australia, reared by the present author (unpublished).

(5) *O. (L.) audyi* (Radford, 1946), from India, Thailand and Malaya, reared from Malayan material by Nadchatram (1963).

(6) *O. (L.) novaguinea* (Womersley, 1944) which was reared from larvae by G. M. Kohls in New Guinea in April, 1944 (in Womersley, 1945).

(7) *O. (L.) longipes* (Womersley, 1945), which was reared from larvae taken from *Podargus* sp. by G. M. Kohls, Dobadura area of Papua New Guinea, 25 July "1940" (probably 1944); recorded in Womersley (1945). (This species was synonymized with *O. (L.) novaguinea* by Goff (1979a, p. 149). Nevertheless the nymphs were stated by Womersley to differ significantly from those of the latter species, and this was not resolved by Goff (*loc. cit.*). It is therefore proposed to retain these two species as separate at present.)

Womersley thus in 1945 had sound grounds to define the post-larval characters of *Odontacarus* (as *Acomatacarus*), and to allot to it several species of adult mites whose previous taxonomic placings had been largely conjectural, these being, as Womersley stated (1945, p. 98) "...*Rhyncholophus attolus* Banks 1916, *R. retentus* Banks 1916, both considered [Womersley] (1934) as *Microtrombidium*, and *Dromeothrombium dromus* Wom. 1939, the last now being shown to be really two species" (Womersley, 1945, p. 109, erected *Acomatacarus patrius* to accommodate this second species).

It is very curious that, despite the widespread distribution of *Odontacarus* (*s.l.*, to include also *Acomatacarus*) in North America, Asia and Australia, adults of this genus have been recorded only from the Australian continent. This would suggest, *inter alia* (when combined with the small amount of information on their ecology), that the adults live obscure and presumably subterranean lives. Thus the adults of *O. swani* recorded here were found in soil in rain-forest, and the original specimen of *O. patrius* (Wom., 1945) was collected under a stone, in mallee country, about 7 miles west of Murray Bridge, South Australia, on 25.v.1938 by the present author, and was recorded as "white in life" which would suggest that that instar at least is spent in darkness. Four species, *O. attolus* (Banks, 1916), *O. dromus* (Womersley, 1939), *O. retentus* (Banks, 1916) and *O. patrius* have been recorded as being associated with ants, and in fact these are the only records of capture of these species apart from the above-mentioned record for *O. patrius*.

All known species of larvae in the genus have 2+2 eyes, which is consistent with their mode of life as ectoparasites upon terrestrial vertebrates. Goff (1979a) considers that the New Guinea larvae are principally ectoparasites of birds, although elsewhere there are records of these larval mites from mammals and lizards. In the case of the adults, eyes are stated to be absent in *O. swani* (see earlier), *O. dromus* (see Womersley, 1945, p. 110), and *O. patrius* (see Womersley, *loc. cit.*).

In the case of *O. attolus*, Banks (1916, p. 225) stated that this species had 1+1 eyes, but Womersley (1945, p. 108) stated that they "are not now visible"; he made a similar statement in 1934 after examining freshly mounted specimens. Careful reexamination of the type material using phase microscopy techniques (not available to Womersley) also fails to reveal evidence of eyes, nor was the writer able to see them in October, 1946, when the mite had been remounted by Womersley at some indeterminate time beforehand. It may therefore be concluded that this species lacks eyes.

The only adult species for which previous authors have agreed on the presence of eyes is *O. retentus* (Banks, 1916), for which Banks (1916, p. 116) recorded "one eye each side", whereas Womersley (1945, p. 106) recorded "Eyes present, 2+2, small, on distinct ocular shields...". Re-examination of the type material confirms Womersley's description.

This species differs also in having idiosomal setae which are terminally forked or branched. Its taxonomic placing has been even more uncertain than that of the other species mentioned by Womersley (see above). In fact Womersley placed it in *Microtrombidium* (subgenus *Enemothrombium*) in 1934, and in *Calothrombium* in 1937.

For this species, I therefore erect a genus *Scopitrombium* nov. (see further below) within the Trombiculidae, subfamily Leeuwenhoekiinae.

Genus *Scopitrombium* nov.

Type species (original designation) *Rhyncholophus retentus* Banks, 1916.

Definition: Adult of normal trombidioid shape, the idiosoma not constricted. Eyes 2+2, placed behind level of middle of crista. Crista broad posteriorly, narrowing anteriorly to end in a broad arrow-shaped expansion, the sagitta, provided with two normal setae. Crista with a pair of sensillary setae, filiform, at its posterior end. Palp slender. Palpal tibia with strong spine with several adjacent thickened setae. Dorsal body setae ciliate, terminally forked or branched. Legs rather long, longer than idiosoma.

Remarks: This species is known only from the type species. It is a typical leeuwenhoekiine post-larval mite, with a well-defined sagitta to the crista. As indicated in the key below, it comes nearest to *Hannemania,* but is easily distinguished by the character of the dorsal setae. Its larval stage is unknown.

Derivation of name: The name is derived from scopi-, the root of *scopae* (f. pl.), a broom or besom, an allusion to the branched and ciliate ends of the dorsal idiosomal setae, and trombi-, the root name of the family Trombidiidae.

Scopitrombium retentum (Banks, 1916)

(Figs 8A-C, 9A-F, 10)

Synonymy

Rhyncholophus retentus Banks, 1916, p. 225.

Microtrombidium (Enemthrombium—lapsus for

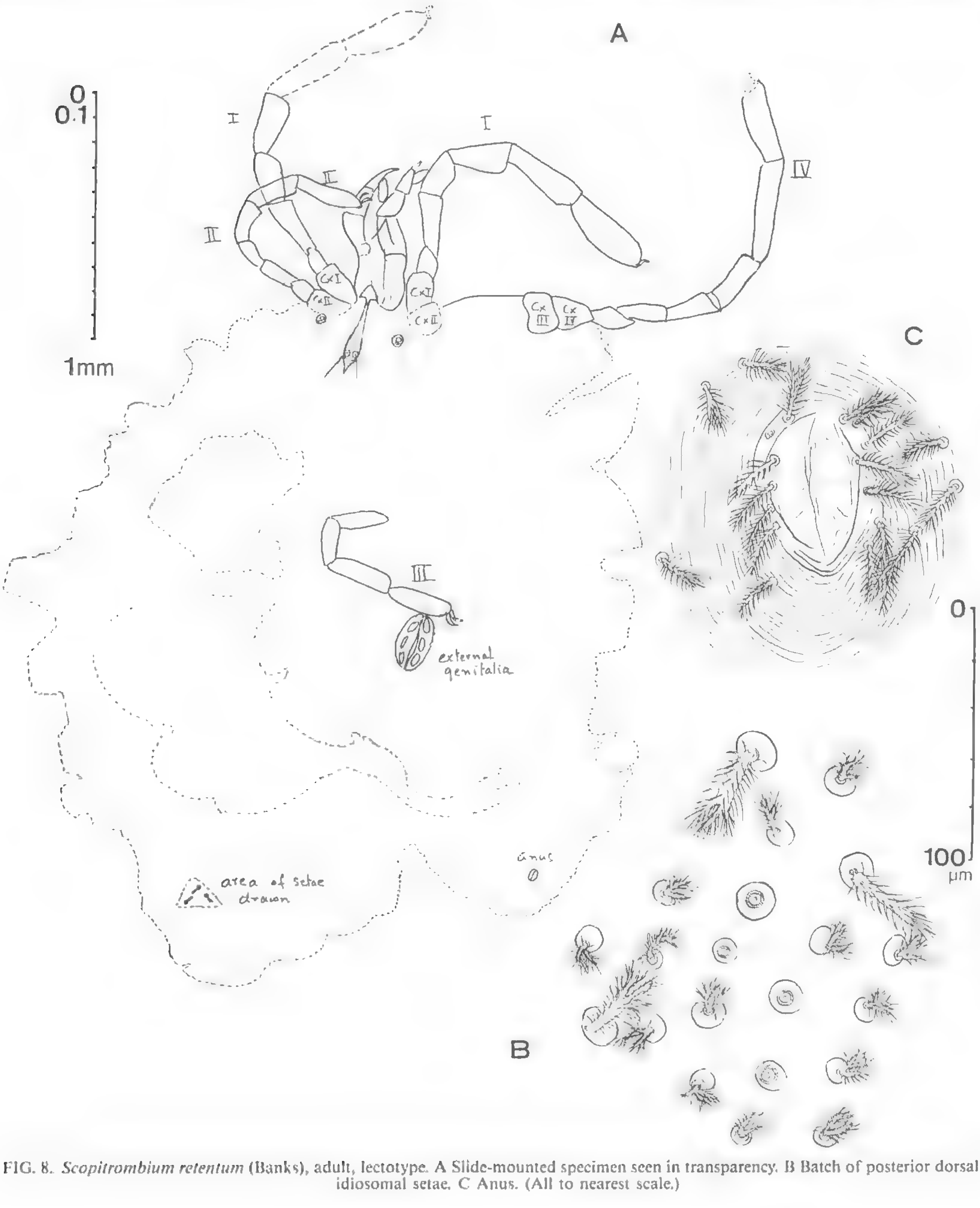

FIG. 8. *Scopitrombium retentum* (Banks), adult, lectotype. A Slide-mounted specimen seen in transparency. B Batch of posterior dorsal idiosomal setae. C Anus. (All to nearest scale.)

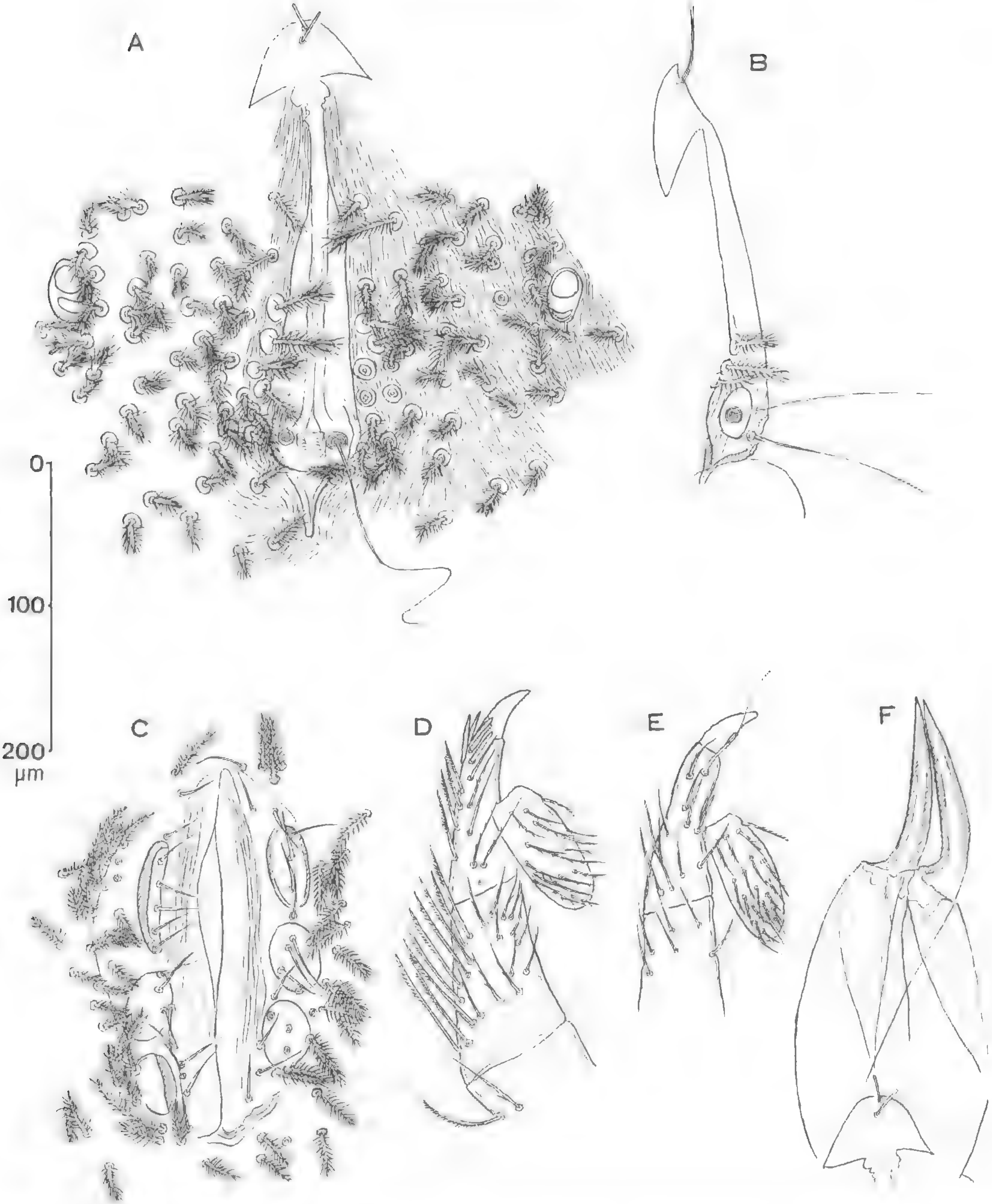

FIG. 9. *Scopitrombium retentum* (Banks). Adult. A Crista, eyes and adjacent part of dorsum. B Crista and sagitta in lateral view. C External genitalia. D Left palp, medial aspect. E Same, lateral aspect. F Chelicerae. (A, C-F from lectotype; B from ACB748). (All to scale shown.)

Enemothrombium) retentus Womersley, 1934, p. 193. *Calothrombium retentus* Womersley, 1937, p. 85. *Acomatacarus retentus* Womersley, 1945, p. 106. Gunther, 1952, p. 41. *Microtrombidium retentum* Thor and Willmann, 1947, p. 370.

Remarks: This species was described by Banks (1916) and Womersley (1934, 1945). It was recorded originally from three localities in Victoria, in each case with a species of ant.

Hirst (1928b) was the first to point out that this was a trombidiid (*sens. lat.*) mite, not an erythraaeid one as originally described by Banks, and he assigned it to *Microtrombidium* without formally giving it a binomen. He commented (p. 1027) "This species is closely related to *M. barringunense* [Hirst, 1928a], but the tarsus of the first leg is considerably shorter . . . . It is closely allied to *M. affine* [Hirst, 1928b] but has a short but distinct nasal process".

Of the three specimens, each labelled "Cotype", specimen ACB750 is the most suitable for further description, and is therefore designated the lectotype (see further below).

Redescription of Lectotype, Specimen ACB750 (Supplemented by the Two Paratypes)

The specimen in its present state is a squashed mass mounted on a 75×25 mm slide in a transparent, yellowish water-miscible medium, based on either gum chloral or polyvinyl alcohol, with picric acid used as a stain (Womersley favoured the use of picric-acid-containing media in the later 1940-1950s and possibly later). The squashed mass is the remains of the idiosoma, and is about 2.7 mm long by about 2.25 mm wide, indicating a considerably smaller original specimen (Banks recorded the specimen(s) he described as 1.3-1.5 mm long and "about one and a half times as long as broad", i.e. ca 0.9-1.0 mm broad.

Crista is a rod set in a narrow tapering scutum, widest posteriorly, and ending anteriorly in a broad sagitta; crista and sagitta with combined length of 306. Sagitta bell- or probability-curve-shaped anteriorly, borders smooth, posterior margin reflex-angled; sagitta 82 μm across by 52 deep. The corners of the sagitta are sharp (i.e. lateral angles). Sagitta bears two scobalae which are both broken off, at 21, 25 length; they are not broadened, but appear normal and almost smooth. From specimen ACB748 these can be seen to be tapered and pointed, 68 long. Sensilla bases normal, at posterior end of crista, set in a sensillary boss, centres 37 apart; sensillary setae filiform, about 180 long.

The crista and sensillary boss are invested by a narrow scutum, which tapers anteriorly, leaving the anterior third of the crista without this. The scutum is free of setae, but is set in the normal plicate idiosomal skin with its characteristic setae. Behind the sensillary boss is a conical continuation of the crista, probably subcuticular, about 50 long.

Eyes 2+2, each lateral pair set in a small oval plate about 38 long by 25 across. Anterior eye considerably the larger. Cornea 18×20, posterior eye more or less transverse, with cornea 16×9. Eyeshields set at the level of the junction of the middle and posterior thirds of the crista; centre of each eye shield about 171 distant from the midline of the crista.

Various dimensions of the type and paratypes are shown in the following Table 14.

Dorsal idiosomal setae arise from a small papilla set in a broad plate. They are heavily ciliate, more so distally, and vary considerably in length. A clear division between two distinct length-groups cannot be made. The setae tend to split or branch in about their distal third, and these branches may branch again. As all parts of the scobillum are heavily ciliate with coarse cilia, the end of the more branched setae appears commonly besom-like, these remarks applying particularly to the longer setae. In the anterior part of the dorsum there are comparatively few of the longer setae, except immediately around the sensillary area of the crista, but they are more numerous towards the posterior part of the dorsum of the idiosoma.

Ventral surface (partly from ACB749) provided with numerous but shorter ciliate setae, more uniform, and with only a slight tendency to branch terminally.

Genitalia oval, 235 long by 165 wide, with three oval suckers alongside the introitus on each side, anterior sucker 57 long by 29 wide, middle 48×34, posterior 49×36. Each valve of the external genitalia with a single row of tapering setae 32-45 long. No internal chitinization seen to genitalia, so the specimen ACB749 is possibly a female (damage to the specimen making this a little uncertain).

Anus oval, about 62 long by 51 wide, with two valves, each valve with 4-6 ciliate setae 31-35 long.

Legs moderately long and thin, appearing normal for a trombidioid mite, I 1670 long, II 1270, III incomplete, IV ca 1820 (lengths including coxae and claws). Legs with a normal degree of setation. Many of the ordinary setae (scobalae) are unilaterally and regularly ciliate, thus making them classifiable as pectinalae (see above). Dimensions of leg segments of

TABLE 14. DIMENSIONS (μm) OF SOME CHITINIZED STRUCTURES OF ADULTS OF *SCOPITROMBIUM RETENTUM* TYPE SERIES

	Identification Number			*Womersley*	
Structure	*ACB750*	*ACB748*	*ACB749*	*(1934)*	*(1945)*
Crista (including sagitta)	313	ca 285	ca 304	—	—
SB	37	—	38	—	43
TaI	362 × 128	347 × 105	—	360 × 90	360 × 110
TiI	339	334	—	315	330
GeI	245	248	—	—	—
TaIV	ca 300 × 97*	278 × 95	—	—	—
TiIV	402*	388	—	—	—
GeIV	274*	240	—	—	—
DS	16-55	20-57	18-46†	20-50	20-56

* This leg has been dislocated and damaged, but I presume that it has been correctly identified.

† Damaged specimen, and only a few of the longer setae are available

lectotype: tarsus I 362 long by 128 high, tibia I 339, genu I 245, tarsus II 252×70, tibia II 245, genu II 168, tarsus III 265×86, tibia III 286, genu III 195, tarsus IV 300×97, tibia IV 402, genu IV 274 (all tarsi measured without claws). (The preceding assumes I have identified legs III and IV correctly.)

Tarsal claws sickle-shaped, unciliate, slightly blunted, appearing of normal trombidioid facies.

Palpi rather slender, normally setose. Palpal tibial claw stout, somewhat blunted. A blunted large dorsomedial accessory claw (a thickened seta) alongside claw, and several smaller thickened peg-like setae behind it. One long whip-like seta present on lateral aspect of tibia terminally, over-reaching claw. Palpal tarsus an elongate oval, with usual setation of ciliate and sensory setae.

Cheliceral fangs slender with about 12 indistinct teeth along the flexor (upper) border.

Material Examined

The only material available is the three individually mounted specimens of the original type series. Womersley stated (1934, p. 193) "As the specimens have been remounted for further examination . . . ", but only two of the specimens have been remounted from the original balsam to water-miscible medium or media. I suspect that the two slides remounted in the period 1933-1934 were remounted again in about 1944-1945, for reasons given below. Details of the three specimens are as follows:

(1) Specimen ACB750. Lectotype. Specimen mounted on a slide 75 mm×25 mm, squashed, in yellow-stained medium. The only trace of what was possibly the original labelling is a small pink label with "Cotype" in red (LHS). On the RHS of the slide is a label in Womersley's writing which reads *Calothrombium/retentus* (Banks)/Co-t [in red]/with Iridomyrmex nitidus/Ocean Grove, Vic./No. 17 Lea Coll.

(2) Specimen ACB749. A slide similar to the preceding, with the mite squashed and disrupted into three main parts and various lesser parts, in the same medium. It is labelled with a small pink label "Cotype" as in the preceding (LHS); on the RHS is a label in Womersley's writing *Calothrombium/retentus* (Bks)/ Co-t [in red] Ocean Grove, Vic./No. 17. Lea Coll.

This specimen is clearly a female, as about 20 spherical or spheroidal eggs can be counted in the fragments. These have a normally pigmented chorion, and measure about 140-195 by 120-160 in the least squashed specimens. There is no evidence of an embryo in any of the eggs. These eggs appear as normal Prostigmata-type eggs.

All legs are disrupted, and the lower (separated) part of the idiosoma retains only the trochanter I and trochanter II on one side, and trochanter IV on the other.

This slide contains fine acicular crystals which would confirm that it is mounted in a chloral hydrate-containing medium, at least in part. At the time when Womersley remounted it in 1933-1934, he was using exclusively gum-chloral media. However, a later possible use of a polyvinyl alcohol medium cannot be excluded; there is clear evidence of two zones in the mountant in the slide. The slide contains also some instar of an insect, possibly a primitive one, and also a rather stout and short trombidioid leg, different in character from the legs of *Scopitrombium retentum*. How this extra biological material got into the mountant is purely a matter for speculation.

In my opinion the specimen is in no condition to be designated a lectotype.

(3) ACB748. A slide of an almost undamaged adult mite, mounted on its side in balsam (thus indicating that the other two specimens have been remounted from balsam to water-miscible media), with a coverglass of 19 mm diameter. It bears in the writing believed to be that of Nathan Banks (Dr E. G. Matthews, Senior Curator of Insects, South Australian Museum, who is familiar with the writing and labelling of A. M. Lea, advises that this writing is not Lea's, so it may therefore confidently be attributed to Banks.): (R.H. label) Rhyncholophus/retentus/Bks/Microthrombium [this word in Womersley's writing] /Ocean Grove/Victoria/ with Iridomyrmex nitidus/Cotype/No. (I interpret this figure as 14) 14/Lea coll.; (L.H. label) (in Womersley's writing): Calothrombium retentus (Bks)/Co-t [in red] /Ocean Grove/Vic. No. 17/Lea Coll.

As it is mounted on its side with its legs partly flexed (see Fig. 10), it is clearly not the specimen mainly used by Banks for his original description. Despite the fact that it is the only specimen in which the original data remain on the slide, it is not the most suitable to be selected as the lectotype.

Further Remarks on the Type Series and Lectotype Designation

Banks (1916, p. 226) recorded three localities for this species: Lal Lal, Ocean Grove and Sea Lake in Victoria. Despite this, all three slides are labelled "Ocean Grove, Vic." and "No. 17 Lea coll." in Womersley's writing (see above). There were clearly at least two original slides (and probably three). The remaining balsam mount (ACB748) has clearly never been interfered with. The balsam mountant has yellowed in its more peripheral parts.

According to Banks, the specimen from Lal Lal was captured with the ants of *Polyrachis hexacantha*, while the specimens from Sea Lake and Ocean Grove were captured with *Iridomyrmex nitidus*. Accepting the accuracy of the data on slide ACB748 in Banks's writing, and if we accept that the notation of Womersley on slide ACB750 about the species being "with *Iridomyrmex nitidus*" is correct, it may be deduced that this specimen, the lectotype, in fact came from Sea Lake, and that specimen ACB749 in fact came from Lal Lal. Whether we are entitled to place any

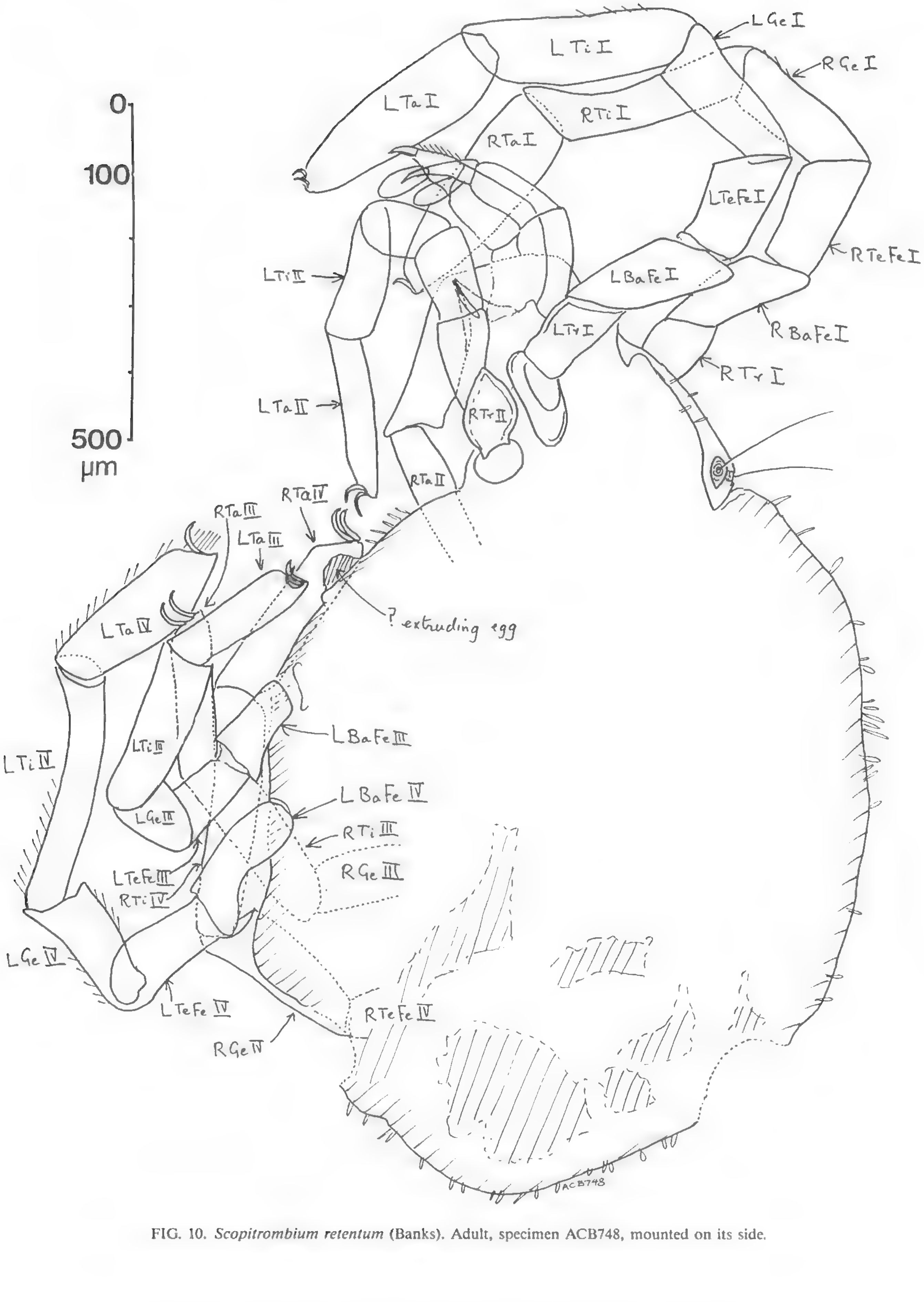

FIG. 10. *Scopitrombium retentum* (Banks). Adult, specimen ACB748, mounted on its side.

reliance upon such a deduction is conjectural, in view of Womersley's other obvious inaccuracies with data on the slide labels.

All three specimens have the distinctive type of dorsal setation recorded, and the tabular data of the chitinized parts also confirm that these three specimens are conspecific, in addition to the opinions of Banks and Womersley. For re-description, a lectotype needs to be selected. For this purpose, all three specimens in their present state have some defects. Specimen ACB748 is the only one retaining a presumably original label, but is unfortunately mounted on its side. Specimens ACB749 and 750 have been badly damaged by being remounted at some stage, undoubtedly by Womersley, and possibly at the time of his 1945 study. Despite the serious damage these latter specimens are more suitable for the usual standard descriptions used in prostigmatic and other mites, as the crista, eyes, dorsal setae and other parts remain describable.

Unfortunately Womersley was afflicted by poor vision, and he was often extremely destructive to specimens in an effort to make them easier to see. He likewise erred frequently in transcribing locality and host information and often destroyed earlier labels.

One may therefore conclude that Womersley mistranscribed the locality and other data for the two specimens ACB749 and 750, and presumably one of these came from Lal Lal, and the other from Sea Lake, but it appears there is now no way of determining which came from which.

In his writings upon this species, Womersley eventually (1945, p. 107) was aware of the three different localities in Victoria from which this species was collected, but this is unfortunately not reflected in his slide notations, which were presumably made first for his 1933-1934 study, but then re-transcribed for his 1937 study, in which he used the generic name *Calothrombium* Berlese, 1918.

There is nothing in the description and figures of Banks which allows the selection of one specimen as against the other for designation as a lectotype. Several important diagnostic characters were overlooked or misinterpreted by Banks. Thus he placed the species in the Erythraeidae, instead of the Trombidiidae (as then understood). He recorded only one eye on each side instead of two, and failed to see the sagitta to the crista. He gave almost no morphometric data, and his description of the species is such that, as far as present evidence allows, it could equally well be applied to either of these two specimens (or even three), as was probably intended by Banks in any case.

It is regrettable that Womersley re-mounted these specimens so crudely, and mistranscribed at least some of the data on the labels.

Of the choices available, I select ACB750 as the most suitable for redescription, and hereby designate it the lectotype.

Taxonomic Placing of Scopitrombium retentum

This species has had a rather chequered history of taxonomic placement. Originally it was placed by Banks in the family Erythraeidae. Correctly transferred to the Trombidiidae (*s.l.*) by Womersley in 1934, it was initially placed in *Microtrombidium* Haller, 1882, in the subfamily Microtrombidiinae, and later (1937) transferred to the genus *Calothrombium* in the Tanaupodinae. In 1945 Womersley recognized its affinities with other Leeuwenhoekiinae, and transferred it to this subfamily, which he elevated to a family, as a member of *Acomatacarus* Ewing, 1942.

The suite of characters listed above, however, set this species apart from the other members of the subfamily Leeuwenhoekiinae, and distinguish it from the Neotrombidiinae Feider, 1955, whose systematic position was clarified by Lindquist and Vercammen-Grandjean (1971).

The following is a key to the adults and nymphs of the subfamilies of the Trombiculidae (after Crossley, 1960; Lindquist and Vercammen-Grandjean, 1971) for which adults or nymphs are known.

1. Sagitta of the crista with one seta or without setae; if such a sagittal seta is present it is usually expanded somewhat or well ciliate. Palpal femur with few setae, equally numerous as, or less numerous than, in palpal genu. Sensillary setae of crista ciliate (except *Blankaartia* Oudemans, 1911) .... Trombiculinae

Sagitta of the crista with two setae. Palpal femur with numerous setae, more numerous than in genu. Sensillary setae of crista filiform 2

2(1) Eyes 2 + 2. Body setae conspicuously triramous. Coxa of at least the posterior leg with mosaic ornamentation. Two pairs of elongate elliptical discs or suckers to external genitalia in both nymph and adult .... Neotrombidiinae

Eyes 0 + 0, 1 + 1, or 2 + 2. Body setae ciliate, and may be branched or of other form, but not conspicuously triramous. Leg coxae without mosaic ornamentation. Adult with three pairs of oval discs or suckers along each side of external genitalia .. Leeuwenhoekiinae

Generic Classification of Adults and Nymphs in the Subfamily Leeuwenhoekiinae

Recent classifications of the status of the various genera and subgenera of a number of the Trombiculidae, particularly the subfamily Leeuwenhoekiinae, together with the present study of the adult of *Odontacarus*, and the separation of *Scopitrombium*, allow some revision of the generic classification.

The following is an attempt at a key to separate the genera, for the adults and nymphs, of the Leeuwenhoekiinae.

1. Eyes absent 2

Eyes present 4

2(1) Posterior dorsal body setae in two distinct forms, the shorter spindle-shaped, pointed, ciliate, the longer sword-like, with its proximal part ciliate .... *Odontacarus* Ewing 1929

Posterior and other body setae tend to be locally uniform 3

3(2) Posterior dorsal setae leaflike. Legs not longer than body. Tarsus I pyriform. Cheliceral blades narrowed, nearly shearlike .... *Whartonia* Ewing, 1944
Posterior dorsal setae somewhat expanded, but not leaflike. Cheliceral blades shearlike, not narrowed .... *Acomatacarus* Ewing, 1942
4(1) Eyes 1 + 1 5
Eyes 2 + 2 7
5(4) Sagittal setae expanded. Cheliceral blades long and dagger-like *Xenodontacarus* Loomis and Goff, 1973
Sagittal setae not expanded. Cheliceral blades not long and dagger-like 6
6(5) Posterior dorsal setae not expanded, ciliate, and ending in long attenuated tips. Crista prominently punctate. Legs longer than body. Tarsus I cylindrical, about 2.5 times as long as high .... *Chatia* Brennan, 1946
Posterior dorsal setae somewhat expanded, not ending in long attenuated tips. Crista a narrow rod, not prominently punctate. Legs of normal length. Tarsus I cylindrical, about 6.2 times as long as high .... *Comatacarus* Ewing, 1942
7(4) Body constricted, to a figure-of-eight shape. Posterior dorsal setae not expanded, rather elongate and ending in a hook-like process. Tarsus I cylindrical .... *Hannemania* Oudemans, 1911.
Body not constricted. Posterior dorsal setae terminally forked or branched. Tarsus I an elongate oval .... *Scopitrombium* gen. nov.

In preparing the above tabular key I have accepted the separation of the Neotrombidiinae (or Neotrombidiidae) from the Leeuwenhoekiinae, proposed by Lindquist and Vercammen-Grandjean (1971).

I have also omitted the genus *Parvithrombrium* André, 1962 (whose sole species is *P. crassitarsale* André, 1962, from Angola), which its author placed in the Leeuwenhoekiidae. In the somewhat speculative revisions of the classification of the Trombidioidea which have been proposed in recent years (Vercammen-Grandjean 1973a, b; Feider 1979) the genus *Parvithrombium* has been placed in the Anomalothrombiinae Feider, 1955 (later elevated to Anomalothrombidiidae and Anomalothrombidioidea by Feider, 1979) along with *Anomalothrombium* André, 1936.

Anomalothrombium adults, the only instar known, possess a small "naso" with two setae somewhat resembling the sagitta of the Leewenhoekiidae and the Trombiculidae. This genus appears to resemble the genus *Spelaeothrombium* Willmann, 1940, and as far as descriptions allow (André, 1936, 1938, 1939, 1945, 1958; Meyer and Ryke, 1960 (for *A. curiosetosum* (Meyer and Ryke)); Robaux, 1965) could be placed in the subfamily Spelaeothrombiinae as redefined by Robaux (1968, 1972).

It appears probable that the interrelationships between these mites, at present in a state of taxonomic instability, will be clarified only when the larva-adult correlations are known, at least in the first instance.

ACKNOWLEDGMENTS

I am greatly indebted to the South Australian Museum for access to type and other material in the acarological collection. I also thank Mr L. G. Veitch, Principal Research Scientist, CSIRO Division of Mathematical Statistics, for advice and assistance in statistical matters.

The National Health and Medical Research Council, Commonwealth of Australia, provided financial support for these studies.

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HISTORY OF THE DISCOVERY OF SPELEOGNATHUS AUSTRALIS WOMERSLEY (ACARINA: TROMBIDIFORMES), WITH NOTES ON ITS NATURAL HISTORY AND BEHAVIOUR

BY R. V. SOUTHCOTT

Summary

The early history of the discovery of Speleognathus australis Womersley, 1936, is recorded. In Australia over 100 specimens of the mite were observed personally on the water surface of three cattle- (and horse-) troughs between 1934 and 1939 at Glen Osmond, South Australia. Despite hundreds of observations in the subsequent years on the fauna of cattle-troughs and other water surfaces, including the original sites at Glen Osmond, and many other sites in Australia and Papua New Guinea, no further specimens of this species have been discovered in Australasia.

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(Manuscript accepted 23 January 1985)

ABSTRACT

SOUTHCOTT, R. V. 1986. History of the discovery of *Speleognathus australis* Womersley (Acarina: Trombidiformes), with notes on its natural history and behaviour. *Rec. S. Aust. Mus.* 19(13): 201-212.

The early history of the discovery of *Speleognathus australis* Womersley, 1936, is recorded. In Australia over 100 specimens of the mite were observed personally on the water surface of three cattle- (and horse-) troughs between 1934 and 1939 at Glen Osmond, South Australia. Despite hundreds of observations in the subsequent years on the fauna of cattle-troughs and other water surfaces, including the original sites at Glen Osmond, and many other sites in Australia and Papua New Guinea, no further specimens of this species have been discovered in Australasia.

This species has been recorded from two other locations as nasal endoparasites of bovids, once being found in the nasal fossae of Zebu cattle, *Bos indicus* L., at Astrida, former Belgian Congo, Africa, and on another occasion in the nasal fossae of the North American bison, *Bison bison athabascae* (Rhodes), near Cache, Oklahoma, United States.

Observations of mite behaviour on the water surface are also described.

INTRODUCTION

Speleognathus australis was described in 1936 by Herbert Womersley (1889-1962), Entomologist, South Australian Museum. In his original account Womersley (1936) gave the following field data:

"Locality.—Type, one of two specimens taken in moss at Glen Osmond, Adelaide, South Australia, in July 1934 (R. V. Southcott); four other specimens from same locality in January 1935 (R.V.S.)."

All of the specimens collected had been caught running over the surface of the water in three (or less) cattle- (and horse-) troughs, at Glen Osmond, South Australia, and this information had been passed on to Womersley. At the time I had been supplying him with large amounts of moss, leaf litter and soil from various localities in South Australia and Victoria, for his studies on the Collembola and Acarina. In view of the volume of this material that Womersley was handling, his initial mistake is understandable. As I was only 16 years old at the time, perhaps understandably he did not check the accuracy of the locality record before publishing.

However, this species of mite was unusual, not only in its morphological similarity to the ereynetid mites (*Riccardoella*) that are common upon slugs in the Adelaide area, but also in its behaviour. Its manner of running on the surface of water showed that it was quite at home there. As far as I was concerned, there was never the slightest question that every specimen found in Australia up to that time (and subsequently) had been collected only upon the water surface of these cattle-troughs. I had found that in collecting mites, Collembola and other anthropods, the surface of each of these cattle-troughs (about 45 cm across by about 150-180 cm long) provided an area for sampling in which all specimens were clearly visible, and at the collector's mercy apart from the occasional water-strider, water beetles, or other truly aquatic insect, and could be captured and bottled in alcohol without difficulty.

On the surface of the water, these light brown Acarina stood out by appearing to be either fully aquatic, or at least adapted to a life at the surface of the water. Specimens were collected from 1934 onwards and taken to Womersley, and repeated observations were made upon their behaviour by myself, both in the field and in the laboratory. These repeated observations were described to Womersley. In fact, on one occasion, I took Womersley, at his own request, to the troughs in question, some time before the publication of his 1936 paper, and possibly as late as April-May 1936, the exact date not being at present available. (Womersley and I lived in adjoining suburbs at the time, and the troughs were within easy walking distance).

It was recognized that the mites' unusual mode of life at the water surface indicated an adaptation to a moist surface, and the possibility of their being nasicolous parasites of cattle and horses was considered. Following the joint inspection, Womersley arranged for the noses of the cattle to be swabbed by a veterinarian on 20 May 1936 (see further later), but no mites were revealed.

When Womersley's paper appeared in 1936, I again advised him that all specimens had been collected at the cattle-troughs and asked him then and on several later occasions to correct the mistake at some time in the future. This Womersley declined to do.

In 1948 Elizabeth Boyd described a second species of mite in the family Speleognathidae, which Womersley had erected in 1936, and named it *Speleognathus sturni*, since it had been obtained from the nasal passages of starlings (*Sturnus vulgaris* L.) in North America. (A specimen of the mite had also been captured from the boat-tailed grackle, *Cassidix mexicanus*).

In 1952 Lawrence described an intranasal mite from a South African toad, *Bufo regularis*, which he named *Riccardoella eweri* Lawrence, 1952, thus recognizing, as Boyd (1948) had done, the ereynetid affinities of these mites. (This species was later removed to *Lawrencarus* by Fain in 1957, and is now known as *Lawrencarus eweri* (Lawrence, 1952).)

In 1952 also, Crossley described a species of intranasal mite from a small number of specimens obtained from the domestic pigeon, *Columba livia domestica*, in Texas, U.S.A., as *Speleognathus striatus*. That species is at present known as *Ophthalmognathus striatus* (Crossley, 1952) (see Fain 1963, Domrow 1969). Curiously enough, the discussion in Crossley's paper (1952, p. 386) contains the following:

"The type species of the family Speleognathidae, *Speleognathus australis*, was found in moss and has never been reported from a bird. In 1948, Boyd placed in this genus a nasal mite (*S. sturni*) from the starling. The many similarities of the two mites justified this action. Dr Womersley (sic) has suggested (private correspondence) that the type species, *S. australis*, may be a nasal mite and that drinking water may be the vehicle of transmission. The author is in complete agreement. *Speleognathus striatus* has a hydrophobic cuticle, enabling the mite to float on the surface of the water, and also is able to run quite rapidly."

The second Australian species of speleognathid (or speleognathine—the Speleognathidae are now generally considered as only of subfamily status, as Speleognathinae, by recent authors) mite to be discovered was described by Womersley (1953), who erected the genus *Boydaia* for *Speleognathus sturni* Boyd, 1948, and included in this new genus *B. angelae* Womersley 1953, found in "mucus under the tongue of a frog *Limnodynastes tasmaniensis* Gunther var." in Adelaide, by Miss Laura Madeline Angel, M.Sc., of the Zoology Department, University of Adelaide, while she was searching for internal parasites. This species is now placed as *Lawrencarus angelae* (Womersley, 1953) (see Domrow (1961, p. 379)).

Miss Angel has informed me (pers. comm., 1976) that the mite was found stuck in the mucus under the tongue of a frog, in whose oropharynx she was searching for trematode parasites. No mite behaviour was observed. This male frog had come from Meadows, Mt Lofty Ranges, South Australia, in October 1952 (coll. L. M. Angel). The frog was recorded as *L. tasmaniensis* var. *platycephalus*. Miss Angel has commented that she has examined many hundreds of frogs from the Adelaide to lower Murray River regions without finding any other specimens of speleognathine mites. Mr Michael Tyler, Department of Zoology, University of Adelaide, advises (pers. comm., 1976) that the variety *platycephalus* is no longer recognized, and the name of this species of frog remains as *Limnodynastes tasmaniensis* Gunther, 1858.

Womersley also included in his genus *Boydaia* the North American species *Speleognathus striatus* Crossley, 1952.

In his 1953 paper Womersley declared that *S. australis* had been collected by myself "in moss and also on the surface of water in horse troughs at Glen Osmond in 1934 and 1935 . . .

"As all the specimens were females and from the habitat on horse troughs it was thought that in the early stages they may have been parasites in the nasal cavities of birds or cattle drinking at the troughs.

"The swabbing of cattle and the examination of birds, however, failed to show any evidence of this."

A further mite from the Australian speleognathine fauna was described by Womersley in 1954, as *Boydaia derricki* Womersley, 1954. This was collected upon *Rattus assimilis* in Queensland, Australia, and was the first recorded speleognathine mite from a rodent. At the time Womersley believed that the association was "probably accidental". Subsequent work by Fain (1955b), Domrow (1961) and others has shown that several species of speleognathines are parasites of rodents. This species is now known as *Paraspeleognathopsis derricki* (Womersley, 1954) (see Fain 1963). Domrow (1961) has recorded this species in Queensland from *Rattus conatus* and *Rattus rattus*, as well as *Rattus assimilis*. No further reference to *Speleognathus australis* was made by Womersley in that paper (1954), which was his last contribution on the speleognathines.

In 1954 Cooreman recorded a further species of speleognathine mite, *Speleognathopsis galli*, as a new genus and species, from the nasal cavities of the domestic fowl, *Gallus gallus* L., at Astrida, in the then Belgian Congo. In the most recent revisions of the nomenclature (Fain 1963; Domrow 1969), this species remains as *Speleognathopsis galli* Cooreman, 1954.

Fain (1955a) described briefly, in an addendum, a speleognathine mite from Astrida, as *Speleognathus bovis* Fain, obtained from the nasal cavities of "bovidés" (species of cattle were not named). Fain later (1956b) described this species in more detail. Fain (1956a, b) stated that the maxillary and frontal sinuses were the actual sites for the mites. The cattle were still referred to as "bovidés"; recently (1983), in response to the present author's request, Dr Fain has advised that the mites were found in the maxillary and frontal sinuses of Zebu cattle, i.e. of *Bos indicus* L.

Later in 1956 Fain (1956c) was able to state that *S. bovis* was a synonym of *S. australis*, from an examination of authentic material which I collected from Glen Osmond. Moreover, the previous separation was based on inaccuracies in Womersley's descriptions and figures (Womersley's own admission, quoted by Fain (1956b, p. 662)). Fain was also able to include a statement from myself correcting the attribution of the Australian material to moss, and it is also corrected in Southcott's (1957) and Domrow's (1961) papers referring to speleognathine mites.

Drummond and Medley (1964) recorded that on one occasion, in November 1961, near Cache, Oklahoma, two out of three North American bison, *Bison bison athabascae* (Rhodes), examined had an infestation of *Speleognathus australis* in the nasal cavities, with evidence of an abnormal sinus condition, in the form of blackened areas of epithelium, and the sinuses filled with brownish fluid.

Thus the early suggestion that the original speleognathine discovered, *Speleognathus australis*, was an endoparasite upon domestic cattle was substantiated by the observations in central Africa, and in North America.

In subsequent years mites of this subfamily have been recorded from a wide variety of birds and mammals as well as other vertebrates, in several continents. In his review of the Speleognathinae Fain (1963) listed over 40 species, divided among 8 genera and further subgenera (omitting *Lawrencarus* and *Batracarus*, placed by him in the subfamily Lawrencarinae of the Ereynetidae). Since that time further nasicolous ereynetid mites have been described from Australia—see Domrow (1965, 1969, 1975)—and more general reviews have been published by Fain (1969, 1970a, b, 1971a, b), Fain and Aitken (1969), Fain and Hyland (1970, 1975), O'Connor (1978) and Hyland (1979). The nomenclature of these mites at present appears to have reached a degree of stability.

It is an interesting point that had it not been for the fortuitous circumstance that I used cattle-troughs in my area as a means of sampling and collecting small arthropods, *Speleognathus australis* might never have been known to occur in Australia at all. Moreover, had there not been, in Womersley's estimation, an affinity or resemblance to the mesostigmatic mite genus *Spelaeorhynchus* Neumann, 1902, it is safe to say that the history of the nomenclature of this subfamily of mites would have been vastly different.

The literature of these mites is now extensive, but it is not proposed to attempt any general survey here. Instead, the purpose of this paper is to place on record a number of early observations upon the times of occurrence, and certain details of the behaviour of the mite *Speleognathus australis* Womersley, which have either not been recorded at all, or else recorded scantily, and in a somewhat corrupted form in the literature. It is considered that this is justified, since all the Australian observations upon this species have been either in the notebooks or memory of one person, the present author, for 40 years or more. The mites have not been seen in Australia since 1939, and the opportunity of making observations on the species in Africa may well be limited for some time to come.

THE OCCURRENCE OF *SPELEOGNATHUS AUSTRALIS* IN AUSTRALIA

(a) Locality

Over the years 1934 to 1950 (as well as somewhat earlier and later), the area studied at Glen Osmond for *Speleognathus australis* consisted of some open paddocks upon the lower and north-west slopes of Mount Osmond (Fig. 1) at MR656807 to 655806, at a height of 183-191 m (600-625 ft) above mean sea level, on map Adelaide, 1939, No. 810, Zone 6, Sheet 154M/IV SE & SW (Military Survey of Australia, 1:63,360). This area is shown in Fig. 2. The two main paddocks were separated by a stranded wire fence and a roadway (Fig. 3). Both paddocks were used by a Mr Goldsack for agistment of small numbers of domestic cattle (*Bos taurus* L.) (invariably cows, as no bulls or

FIG. 1. General view of Mount Osmond, South Australia, from the north-west, from a photograph taken on 19 August 1938. All of the flatter land around the base of the mountain has been commonly called Glen Osmond. The three cattle troughs upon which all specimens of *Speleognathus australis* have been collected in Australia are at the middle level of the photograph. Trough A is situated somewhat to the right of the centre, in the dark clump of trees. Troughs B and C are further to the right, behind the line of trees.

FIG. 2. Map of the sites of the three cattle troughs at Glen Osmond, South Australia, from which all Australian *Speleognathus australis* Womersley, 1936 have been collected. A, B, C are the sites of troughs A, B, C respectively. The grid squares are 1000 yards square, or 974 m square.

steers were included), perhaps 10 to 20 at the most, and usually many fewer. Horses were also occasionally kept there. Mr Goldsack had no objection to his paddocks and cattle-troughs being used for purposes of biological surveys, as long as there was no interference with or disturbance of stock, and would occasionally ask what was being observed upon the cattle-troughs. The troughs were of the usual galvanized-iron type common in Australia; half-cylindrical, about 45 cm across, and with a float-operated cistern to replenish the water from the suburban reticulated water supply. Of the three troughs studied, one (trough A) (Figs 4 and 5) was actually on the ground surface, being supported against damage from the cattle by being banked up with the clayey soil along the sides. Some grass and weeds at times grew alongside the troughs, but the soil around each of them was largely bare from the continual tread of the cattle and horses. The other two (troughs B and C) (Figs 6 and 7) were close together, to the south-west of trough A, and were placed with the bottom of the trough perhaps 15-30 cm above the soil. Troughs B and C were supported by wooden posts at each end, and trough B also had additional supporting posts at about the middle (see Figs 6 and 7). Although the soil around troughs B and C was as well trodden as that of trough A, some weeds managed to grow underneath them and at the ends where access to the animals was denied. Each of the three tanks had some protective boarding over the cistern, to prevent it being damaged by the cattle. This, to some extent, limited observation of the water surfaces.

FIG. 3. The roadway, fences, and lines of *Eucalyptus cladocalyx* separating the paddock of trough A from that of troughs B and C. Looking southwards from near trough A. Photograph taken in about 1938.

FIG. 4. Trough A and its immediate surroundings, looking up the valley of the centre of the previous photograph (Fig. 3). One cow is present. The trough is on the ground, and is banked up by earth. Photograph taken on 28 January 1938, at about 6 p.m.

FIG. 5. Trough A, looking to the west; with the same cow at the trough as in Fig. 4. The large trees are *Eucalyptus cladocalyx*. Photograph taken 28 January 1938 at about 6 p.m.

FIG. 6. Trough B, looking to the north-east. The trough is in an open paddock. Note the straw on the ground, and many patches of dung. The trees are *Eucalyptus cladocalyx*. Photograph taken 28 January 1938.

Trough A was overhung by a row of sugar gum trees, *Eucalyptus cladocalyx*, which even in the 1930s must have been about 15 m high, and presumably a number of the psyllids and other insects found on the surface came from the foliage of these trees. The other two troughs were also placed about 10 m from a row of *Eucalyptus cladocalyx* bordering the adjacent paddock. All of these trees appeared to be part of one planting, and according to Gill (1905, p. 5), had been planted in 1895.

At times birds were seen to drink at the troughs, and feathers would be found floating in the tanks. There

FIG 7. Trough C, near trough B. Photograph taken 12 June 1938.

TABLE 1. NUMBERS OF SPECIMENS OF *SPELEOGNATHUS* OBSERVED* ON THE CATTLE-TROUGHS OVER 1934-1940

	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Total
Year													
1934	..	..	..	..	..	..	2	0	2	0	0	0	4
1935	—	2	0	0	22	3	2	1	0	0	0	0	30
1936	0	2	6	14	0	0	0	0	0	0	0	1	23
1937	5	3	18	1	1	0	1	1	1	0	0	8	39
1938	1	0	0	0	0	0	0	0	0	0	2	0	3
1939	4	0	1	25	1	0	0	0	0	0	0	3	34
1940	—	—	0	0	0	—	—	—	—	—	0	0	0
Totals	10	7	25	40	24	3	5	2	3	0	2	12	133

— No observation
.. Mites not recorded, presumably not observed
* Not all of these mites were taken. When they were numerous I was careful to take only a representative number, to preserve a presumed breeding population.

appears to be little doubt that these troughs were used freely by the usual range of birds found in suburban Adelaide at the time. The tanks were observed occasionally to have large insects such as small grasshoppers, floating in the water. It was observed also that bees, wasps, and other insects used these troughs for drinking, either directly from the surfaces, or from seepages.

No mammals other than cattle and horses were observed to drink at the troughs, but dogs and cats probably used them occasionally.

Among the local wild mammal fauna were possums (*Trichosurus vulpecula*), bats, rats, and doubtless others; there were no local kangaroos or wallabies. Although a few snakes occurred in the vicinity (the brown snake, *Pseudonaja textilis* (Duméril and Bibron) being occasionally observed), there was no evidence over the years that snakes actually came near the troughs. However frogs undoubtedly used these waters at times.

(b) *Times of Occurrence*

It was my practice for a number of years, to walk each week from my home at Glenunga Avenue, Glenunga, to the Glen Osmond sites for routine collecting. These sites are mentioned in my work (1946) on the Erythraeidae, and the location of the three cattle-troughs is close to the "second situation" mentioned in that paper (p. 7). I recorded my findings systematically until 1940, the only exemptions being when I was away on holiday. The numbers of mites observed over the years 1934 to 1940 are shown in Table 1.

Inspection of Table 1 shows that the numbers of mites on the water surfaces of the troughs were maximal in autumn to early winter (March to May), but there was only one month (October) in which no mites were found during the seven-year study.

Over the years I gained the impression that the most likely time to find mites on the surfaces of the troughs was during a spell of fine weather, after rain. It should be remembered that all the observations were made at a time when there was no knowledge of what the host animal's identity might be, or in fact if there were a host species of animal.

BEHAVIOUR OF *SPELEOGNATHUS AUSTRALIS*

I propose to quote in this section a number of the observations recorded in my notebooks, since similar studies have apparently not been made upon this species of mite in its only other known localities and sites of occurrence, in the nasal cavities of cattle in the former Belgian Congo, or of bison on Oklahoma, North America.

28.ii.1936. There were two animals [*Speleognathus australis*] found, one on the surface of water on horsetrough A,

> and another on the surface of horsetrough C. [Throughout my notes the term horsetrough is often used, although cattle were by far the major users of these troughs.] The mites seemed to be quite at home on the surface of the water; both were running quickly over it, stopping at times near small objects as though in search for food. The one on horsetrough C mounted the side of the iron trough about 4 cm above the level of the water and then descended. Then it came upon solid material (floating) it ran over it, but only for a few seconds at most.
>
> 14.iv.1936. I revisited the horsetroughs. The mites were present in abundance on horsetrough B; none was present on either of horsetroughs A and C. On horsetrough B 13 mites were counted; these were all running quickly over the water surface, apparently either in search of food and/or mates, or suitable places for egg-laying. They were all running fairly quickly, with no noticeable difference in their average speed. All, to the naked eye, were of the same size. One mite was observed to leave the surface of the water, then to mount the sides of the trough to a height of about 3 cm above the water, then to run along the trough for about 20 cm keeping nearly at the same level, then to descend and to run over the water surface once more. I again noticed the preference of the animals for the water surface; most of them did not leave the surface at all except to run over some floating grass etc. This was about 3 o'clock in the afternoon; there were about 10 cattle near the trough. There were no horses, although last Saturday there were about 4 horses there as well as cattle.
>
> The last two or three days have been fine and warm without exception; last Saturday (11.iv.36) was rather cool, and only one mite was found (horsetrough B). This seemed to be in a state of torpor or dead: it was lying on its back on the water.
>
> It appears that a warm spell is necessary to bring the mites out; I have noticed this several times.
>
> *Possible conclusions:*
>
> 1. Mites were all of the same sex.
> 2. Mites were seeking to lay eggs.
> 3. From the fact that it has only been found on the water surface of these three troughs it may be that it is parasitic in some stage in cattle, e.g. bronchial passages.

The continued search for clues as to the life history of *Speleognathus australis* led to a number of observations on the minutiae of behaviour. As none of these has been previously recorded, even though the mite has now been described for over 40 years, and as they have not been duplicated in the scanty observations on this species in Africa or North America, it seems worthwhile to publish them.

> 6.i.1937. One of the three mites taken on 6.i.1937 was kept in a glass jar on [the] surface of water for several days. Various insects were thrown on to the surface but the mite was not seen to feed on any. Piece[s] of grass etc were placed on the water, and although the mite ran readily over them it always came to rest on the water. It can move its legs about 10-15 times per sec; it would run near the side of the jar and vibrate its legs rapidly without changing its position. The purpose is to me, obscure, for the animal could easily move up the curved surface of the water to the edge.
>
> One other of the three was drowned by immersion for about 1 hour.
>
> 13.i.1937. Two were found on trough A. These were quite active. Next day they were put in a tube (without water) [and taken on a journey]. The day was hot. At night they were found to be dead.
>
> 27.ii.1937. The speed of the mites on the surface of the water in the troughs was estimated at 1-3 cm/sec.
>
> 2.iii.1937. Three were seen on trough A. These attacked a fly (*Musca*) in the water of the trough simultaneously [for] Food? [To lay] Eggs? [It now seems more likely that the fly might have had contact with oro-nasal mucus from the cattle, and thus provided a suitable attractant for the mites.]
>
> 26.iii.1937. Two specimens [were] captured running over the surface of trough A. These were placed in a tube, on the surface of some water from [the] trough, together with some of the insects [that had] fallen into the trough, and a specimen of *Cypris* (Crustacea: Ostracoda) from the water. After two days the mites were recorded as dormant, [and] exhibited no signs of life on touching with a needle. [They] remained like this for some time.
>
> The mites remained thus and were almost completely decomposed by 20.v.1937. On 14.viii.1937 the residual scraps of mite skins were removed and slide-mounted.
>
> 16.iv.1937. One decomposed mite was found on the trough.
>
> 10.vii.1937. Another dead mite was found; first mite found since 16.iv.1937.
>
> 16.xii.1937. One mite found on trough A, tipped over on its back. It moved its legs actively when first found, but was feeble a little later. Mite taken.
>
> 17.xii.1937. Another mite found and taken, active. It died by 19.xii.1937.
>
> 27.xii.1937. Trough A was examined at 4-5 p.m. Three specimens were present. One was dead and decomposed; the other two were active, plump, running actively over the surface of the water. The two came together, circled rapidly, and met (anterior end to anterior end). They were like this for a second or two, moving their legs all the time; then they separated by 2 or 3 mm, and were blown apart by the wind . . .
>
> The trough was re-examined at 8 p.m., when the decomposed mite was as before. One was moving its legs slowly; one was dormant with its legs drawn in under it.
>
> On trough C at 4-5 p.m. there was one very plump and active mite at the surface of the water. At 8 p.m. the (presumably same) mite was floating, tipped over on its back.

On 1.i.1938 I again examined the three troughs at 8 p.m., looking for evidence of possible nocturnal characteristics of the mite. I made the following note:

> The evidence of the past few days suggests strongly that the *Spel.* does not leave the water by climbing out [of] the trough—it is possible that it leaves it by means of the cattle drinking there.
>
> On 2.i.1938 the troughs were examined at about 7 p.m. (sunset). On trough A there was one *Speleognathus*, very plump, and running quickly over the water. This I took. Troughs B and C had none. The animal was observed on water in a dish. It moves by moving only the last 3 joints [i.e. segments] of its legs. The tarsus is practically at a right angle to the water surface when at rest, or when moving. It does not move by moving its trochanter on the coxa, but by moving its tarsus and metatarsus [i.e. tibia] backwards and forwards *in a more or less vertical plane*. The animal was drawn in outline, and in its main characteristics, and then killed with Carnoy's fluid. No trace of eggs could be seen in the body. Shape is as figured, widest anteriorly, narrower posteriorly, with sides becoming approximately parallel. (Figure is shown in Fig. 8).
>
> Speleognathus is delicate and cannot withstand much handling or shaking about—either on water or dry.

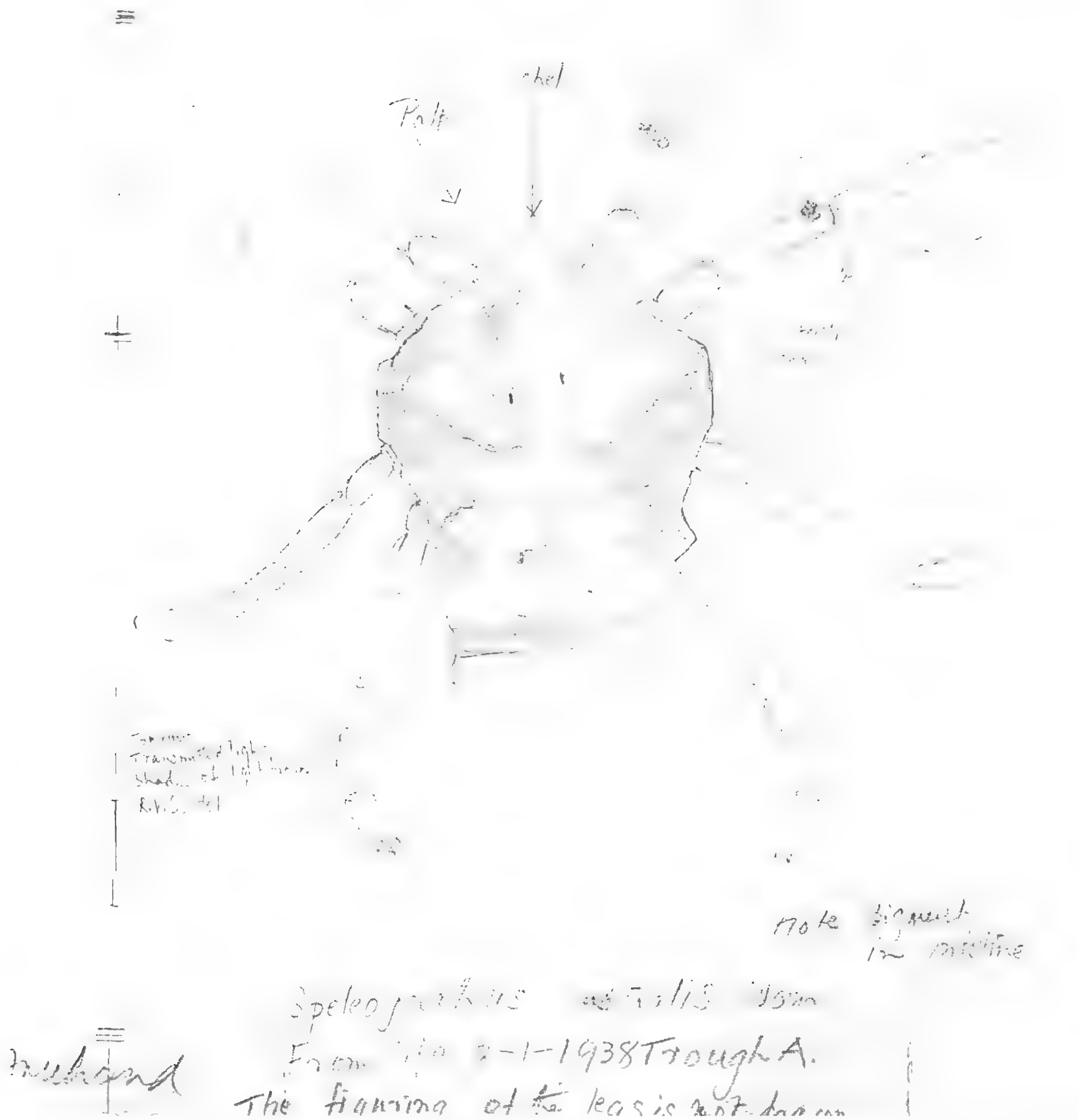

FIG. 8. *Speleognathus australis* Womersley. Living specimen from Glen Osmond, South Australia, 2 January 1938. Drawn freehand through the microscope, on the surface of water. The main lines have been darkened with pencil for reproduction purposes, otherwise the drawing is untouched. The reticular patterning of the legs is omitted.

On 28.i.1938 I photographed troughs A and B (see Figs 4-7) and recorded in my notebooks on that date:

> The cattle are shifted about constantly in the paddocks containing troughs A, B and C, but rarely are any of the paddocks containing the troughs without cattle for more than a few days.

A few further observations were made during 1939 and 1940, but I find from my notebooks that all records for 1940 were negative, and the last living mites seen by me were collected in December 1939. (Previous statements implying that the mites were seen as late as 1941 were based on faulty recollection.)

On 29.i.1939 I observed four mites on trough A, but none on B or C. One of the four was alive; three were dead (one apparently not long dead, one with legs flexed under it, and one decomposed). I made the following comments in my notebooks:

> Conclusions: The hot spell has brought out *Speleognathus*, following as it does fairly wet weather . . . *Note*: Dead Speleognathi are found *on the water.*
>
> I observed the living *Speleognathus* for about half an hour [on the trough]. When the . . . (just dead) *Speleognathus* was put in its way it ran over it without

> stopping. The animal seems to give no preference to light or shade. Ran for a length of a metre (with frequent stoppings, and many turns, and doublings back, and assisted by the wind, and water currents. Stops varied from 0-10 seconds, rarely the latter, usually about 3 seconds.
>
> It was put near the edge of the trough, but did not go up at all. Also, it took no notice of algae just below the surface of the water.
>
> Wasps, bees [are] observed drinking here. Cows drink here, and dogs sometimes; and birds (magpies) [This means the white-backed magpie of south-eastern Australia, *Gymnorhina hypoleuca* Gould. These frequently nest in tall trees, such as the rows of planted *Eucalyptus cladocalyx* bordering the paddocks containing the troughs.] live here), and some bird feathers [were] seen in [the] trough. Many ants [are] about; some fall in the water. One butterfly *(Danaus archippus)* [Now *Danaus plexippus plexippus* (L. 1758) (see Common and Waterhouse, 1972, p. 221)] [was] seen drinking.
>
> Troughs B and C were swarming with *Cypris*. Troughs A, B and C were swarming with nematidiform (almost) larvae. Small bugs run over the surface of the water. Water dirty, much alga present.

A sketch was made of the path of the *Speleognathus* on the water, over a small area, to indicate its many twists and turns. This is reproduced in Fig. 9.

FIG. 9. Drawing made on 19 January 1939, of the path of a specimen of *Speleognathus australis* on a limited area of the water surface of trough A at Glen Osmond, South Australia, reproduced at original size. The wind direction, and water current directions are shown. It is apparent from this sketch that the mite was not under the control of either the wind or water currents, and could move at will upon the water.

On 9.iv.1939 I observed 25 of these mites upon the surface of trough B; there were none on troughs A and C.

> All of these were dormant with the legs *strongly flexed*. Not one was seen to be in a state of decomposition. Not one was seen to give any movement at all, although several were stimulated by touching and several were taken (7 in all)—5 were taken as they were, 2 others put in alcohol—not seen to move at all). The mites were in any position e.g. tilted on their posterior ends, their sides, or in normal position. None was on its back. The occurrence is most remarkable . . . the only sunny day recently is today . . . no cattle were drinking at the troughs, or present in the paddocks . . . on 9.iv.1939. The five unpreserved mites were examined 6 hours later, but were unchanged, and were then preserved for histological study.

Observations continued, but did not throw any further light on the presumed host animals or life-history of these mites.

By 1940 I was systematically noting the various species of birds seen in the vicinity of the troughs, but without drawing any significant conclusions.

During 1941 I was able to make only a few observations, and thereafter, owing to military duties, I was not able to inspect the area again until 1946. By then troughs A and B had been removed. Trough C remained and was examined at irregular intervals from 1946 to 1949, and occasionally later, to 1953, but no further *Speleognathus* was found.

POSSIBLE HOSTS OF SPELEOGNATHUS AUSTRALIS

The possibility that these mites were endoparasites of the nasal or other respiratory passages of mammals and birds drinking at the troughs was entertained quite early. Since the only residual local marsupials were arboreal ones, such as *Trichosurus vulpecula* and smaller species, it did not seem likely that marsupials would prove to be the hosts. The animals drinking most commonly at the troughs were cattle, with a smaller population of horses, but it would seem likely, *prima facie*, that if such mites were parasites of the nasal spaces of cattle and horses, they could hardly fail to have been detected in Europe, the obvious source of the Australian domestic breeds of cattle and horses; not to mention the other domestic animals in South Australia, such as dogs, cats, and so on. Similar considerations applied to introduced rodents. Bats appeared to be another possibility, but rather a remote one, although insectivorous bats were not uncommon in the neighbourhood, even if mainly crepuscular or nocturnal.

Other possibilities that were considered, either then or later, were that the mites could be tracheal parasites of water insects occasionally seen upon the troughs. Conceivably also small gastropods might serve as hosts, in the same way as *Riccardoella* utilizes the common introduced slugs in South Australia, because of the obvious resemblance between *Speleognathus* and *Riccardoella*. However, no solid evidence was found to support seriously any suggestions of a non-vertebrate host.

Since the mites were reasonably common at times, and since the cattle were the commonest large mammal utilizing the troughs, it seemed worthwhile to investigate further the possible role of the cattle.

My notebooks record:

> 20.v.1936. Cattle drinking at troughs A, B and C at Glen Osmond, South Australia, had their nostrils swabbed. No *Speleog.* were obtained.
>
> This is not surprising, and probably the result does not mean very much, since more than a month had passed since any of these mites had been seen on the troughs. (Tests performed by C.S.I.R. officers, at suggestion of H. Womersley (to them, that is).)

I was not a witness to the event, the information having come from Womersley (1953, p. 82) who referred to it briefly.

After this negative result, no further attempt was made to locate the mites in the nostrils of the cattle. Subsequently the possible relationships remained matters of speculation, as the various new species of speleognathines were discovered in North America, Africa, and other continents. The next species to be discovered was by Elizabeth Boyd (1948), in North American birds.

At the end of 1938, under the existing means of study, I had summarized the possibilities of host-relationships in my notebooks as follows:

> (a) Nature of the appearances of the animal on the water surface
>
> 1. This cannot be fortuitous—from ease of its progression;
> 2. There are no streams left in this locality—even in winter they do not run (although they do contain water for a while)—and only remain with water in them for a short time. The troughs are from 10-25 m from the creek bed.
>
> (b) Fauna which might be related
>
> (1) Non-aquatic
> Birds (the word *especially* added in)
> pencil at some later date, and the)
> word *birds* underlined)) drink
> Cattle) here
> Insects including wasps, bees, bugs, etc
> (2) Aquatic)
> Trough contains a rich fauna of *Cypris*. In Dec. 1938 many nematodes (?) were present. (There is a good collection of filamentous algae in each trough) . . .
>
> (c) Flora which might be related
> (1) Non-aquatic—eucalypts, grass, weeds
> (2) Aquatic—green algae mainly ?*Spirogyra*
>
> Addendum 1.i.1939
>
> Only 3 *Speleog.* [were] seen in 1938 (and caught). (cp. 1935 with 26, 1936 with 23, 1937 with 34 (approx. figs.).
>
> It may be that the continual taking of the *Spel.* has reduced their number considerably.

That surmise was contradicted by the finding of a large number in 1939; in fact the count of 25 for March 1939 was the highest for any individual month over the whole period of the observation.

OTHER ATTEMPTS TO FIND *SPELEOGNATHUS* IN AUSTRALIA AND PAPUA-NEW GUINEA

Over the last 40 years I have looked systematically for *Speleognathus australis* (and related mites) when travelling in Australia and Papua-New Guinea. No cattle-trough encountered which contained water was ever left uninspected. Despite searches in Papua-New Guinea (two sojourns) and in every Australian state except Western Australia, none has been found. Additionally, a search has been made for intranasal mites in birds and other vertebrates from 1942 onwards, as opportunity permitted, but again all examinations failed to reveal any speleognathine mites.

After the discovery of *S. sturni* by Elizabeth Boyd (1948) in North America, I decided to make more systematic and frequent efforts to find these mites at bird drinking sites. I erected two troughs at my then home at Unley Park, a southern suburb of Adelaide, by cutting a 44-gallon drum in halves longitudinally. One (D) was erected about a metre above ground level, on the stump of a cypress tree, and the other (E) was erected on a wooden frame about two-thirds of a metre above ground level amidst trees, bushes and other vegetation. Birds were encouraged by suitable feeding to drink at the troughs. Trough D was observed regularly for nearly 4 years, and trough E for over 3 years. Observations were made daily, at times oftener, over much of this period. Despite these efforts, however, no speleognathines were found.

During 1952 and 1953 I carried out systematic observations of the horse-troughs still located around the streets, parks and other open spaces around Adelaide. Thus 40 observations were made in March-June, 1953, and observations continued into 1954, when they were abandoned. Again, no speleognathines were found.

DISCUSSION

It may reasonably be concluded from these many hundreds of observations that *Speleognathus australis* must be an uncommon species in Australia. If it were a common parasite of cattle, it is reasonable to believe that it would occasionally come to the notice of veterinarians. There is, of course, no evidence at present that this species of mite is concerned with disease transmission in any way, or in fact that it causes serious harm to its hosts. Nevertheless, the lesions recorded briefly in one specimen of North American bison by Drummond and Medley (1964) show that this species of mite is capable of causing some tissue damage. Presumably the mechanism is similar to that in, for example, *Riccardoella limucum* (Schrank) (Ereynetidae) which feeds on slugs and is capable of killing them under laboratory conditions of heavy infestations (Baker 1970a, b). Baker (1971) studied the ereynetid mite *Xenoparcarus africanus* Fain, Baker and Tinsley, 1969, which lives in the nasal passages of the African clawed toad *Xenopus laevis* Daudin, and demonstrated blood in the gut by histochemical tests. Both of these species of mites have mouthparts which appear capable of penetrating epithelium.

Baker (1973) discussed this further and commented (p. 51): "The feeding of ereynetid mites, involving the production of a stylostome, appears to be basically similar to that already described in such trombiculid mites as *Neotrombicula zachvatkini* Schluger and *Trombicula autumnalis* Shaw . . . ".

Other groups of invertebrates have exploited the same niches, such as various mesostigmatid mites, and the family Trombiculidae (*sensu lato*) of the Trombidiformes.

The second major question which a student of the distribution of *Speleognathus australis* will ask, is how can we explain the greatly separated distribution of the species, known only from three recorded localities: Glen Osmond in South Australia, Astrida in the former Belgian Congo, and Oklahoma in North America. In the African and North American cases there was evidence of nasal parasitization of a bovid, while in the Australian case there was evidence pointing to an association with cattle. Only one species is now classified in the genus *Speleognathus*; all other speleognathines, from a wide variety of vertebrate hosts, are now placed in other genera (Fain 1963).

We may reasonably accept that *Speleognathus australis* is a bovid-adapted nasicolous species.

The problem remains, however, of its extremely disjunct distribution as at present known. Although I stated (1963, p. 328) that this was "easily explicable since a number of the original cattle of Australia were of African origin", it now seems that that explanation was too facile, particularly in view of the finding of *Speleognathus australis* in North America. In any case the proposal did not explain the lack of reports of the mite in southern Africa, nor from New South Wales and other parts of Australia.

At this point we have to leave the study of its biology and distribution with much of the mite's natural history in Australia at last accurately recorded in some detail but with some major ecological questions still unanswered.

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DESCRIPTION OF ODONTACARUS VEITCHI SP. NOV. (ACARINA: TROMBICULIDAE)

BY R. V. SOUTHCOTT

Summary

Odontacarus veitchi sp. nov. (Acarina: Trombiculidae) larva from central Queensland is described. The classificatory key to the larval Odontacarus of the Australian, New Guinean and south-east Asian region is revised.

DESCRIPTION OF *ODONTACARUS VEITCHI* SP. NOV. (ACARINA: TROMBICULIDAE)

by

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(Manuscript accepted 13 January 1986)

ABSTRACT

SOUTHCOTT, R. V. 1986. Description of *Odontacarus veitchi* sp. nov. (Acarina: Trombiculidae). *Rec. S. Aust. Mus.* 19(14): 213-217.

Odontacarus veitchi sp. nov. (Acarina: Trombiculidae) larva from central Queensland is described. The classificatory key to the larval *Odontacarus* of the Australian, New Guinean and south-east Asian region is revised.

INTRODUCTION

The author recently (1986) described various stadia in the life history of *Odontacarus swani* Southcott, 1986, and revised the classification of the larvae of *Odontacarus* Ewing, 1929, for Australia and adjacent parts of the southwest Pacific area. Difficulties in the placement of *O. athertonensis* (Womersley, 1945) and related species were referred to. In a cognate* study detailed statistical analyses of morphological features of this group of larvae were presented (Veitch and Southcott, 1984), which showed significant metric differences between the species presenting classification difficulties: *O. mccullochi* (Womersley, 1944), *O. athertonensis* (Wom.), *O.* "species S"† (now *O. swani* Southcott), as well as some further specimens. This last-named group, from Queensland and Papua-New Guinea, included a few larvae in poor condition and hence unsuitable for detailed description, but also a series of six specimens from central Queensland (identification numbers ACB733A-F) of which five specimens were in good condition, suitable for detailed measurements and description. These had been considered as conspecific with *O. athertonensis* larvae by Womersley (slide identifications), and by Goff (1979). Re-examination of this series shows that it represents a separate species, which can be distinguished from other species of *Odontacarus* (subgenus *Leogonius* Vercammen-Grandjean, 1968), particularly by leg metric characters.

All measurements are in μm, unless stated otherwise. Seta and other terminology is as given by Southcott (1986) and Veitch and Southcott (1984).

Odontacarus veitchi sp. nov.

(Figs 1A-3, 2A-B)

Description of Holotype larva, N1981390 (ACB733F):

Colour in life not recorded, presumably red. Length of idiosoma (mounted on slide) 237, width 203; total length of animal from tip of cheliceral fangs to posterior pole of idiosoma 328.

Dorsal scutum slightly wider than long (nasus included); nasus well-developed, narrow, with rounded tip and slightly sinuous sides, meeting the body of shield at right angles. Anterolateral angles of scutum rounded, lateral borders slightly concave, running to rounded posterolateral angles, posterolateral borders concave, posterior pole evenly rounded, projecting. AM scutalae tapering, slightly pointed, lightly setulose; AL and PL scutalae similar. Sensillary setae normal, well setulose in distal half. Sensillary sockets slightly anterior to level of bases of PL setae, set slightly obliquely.

Standard and other metric data for type series as in Table 1.

Eyes 2+2, sessile, oval, conjoined, near PL angles of scutum. Maximum diameter of anterior eye 18, posterior 13.

Dorsal idiosomalae normal, slightly tapering, lightly setulose, pointed at tip, arranged 2 ('post-humerals'), 6, then in vague rows across dorsum, of ca 10, total 58.

Ventral surface of idiosoma with a pair of pointed, setulose setae between coxae III, ca 36 long. Venter of opisthosoma bears 48 further setae, 24-36 long, with outstanding setules; posterior setae longer and slightly blunted, similar to posterior dorsal idiosomalae. Anus (uroporus) oval, 23 long by 15 wide; about 23 setae anterior to mid-level of uroporus, and 25 setae posterior to same level. Urstigma oval, in normal site between the contiguous coxa I and II of each side, 18 long by 14 wide.

Coxalae 2, 1, 1. All coxalae long, well setulose, tapering to a fine point. Lateral coxala I 60 long, medial coxala I 60, coxala II 51, coxala III ca 55.

Legs well-developed, normal, I 416 long, II 368, III 430 (all lengths include coxae and claws). Leg scobalae normal, pointed, well setulose. Scobalar formulae (including mastalae): trochanters 1, 1, 1, femora 6, 5, 4, genua 4, 4, 5, tibiae 7, 6, 6, tarsi 20, 17, 13.

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* It was originally planned that that study would follow the paper here shown as Southcott (1986). However, unforeseen publication schedules reversed the order of appearances.

† Unrelated to an undescribed species mentioned as "S" by Vercammen-Grandjean (1968, p. 121).

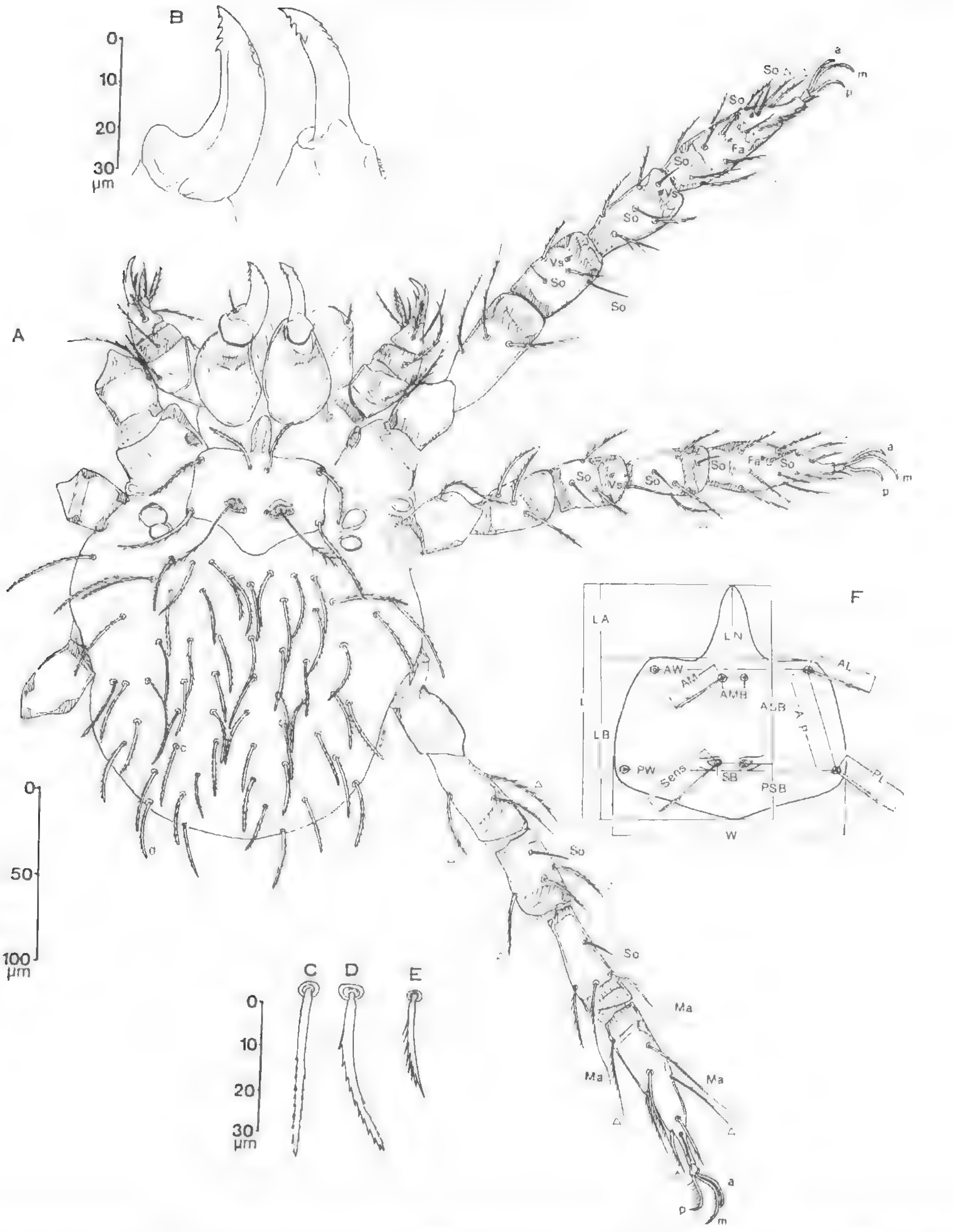

FIG. 1. *Odontacarus veitchi* sp. nov. A-E Larva, holotype, N1981390. A Dorsal view, legs on left omitted beyond trochanters. B Tips of chelicerae, seen in transparency. C, D Dorsal idiosomal setae (c, d in A, respectively). E Ventral idiosomal seta (e in Fig. 2a). All figures to nearest scale. F Diagram to show metric characters of dorsal shield. The symbol △ indicates that this seta is shown in both the dorsal and ventral figures for this mite.

Leg specialized setae as follows: SoGeI.32d (24 long), VsGeI.72d (4), SoGeI.72pd (27), SoTiI.55d (18), VsTiI.82d (4), SoTiI.85d (16) i.e. slightly distal, also anterior, to VsTiI.

SoGeII.25d (20), VsGeII.64d (3), SoTiII.36d (16), SoTiII.88d (15), SoGeIII.27d (22), SoTiIII.35d (20).

Both tarsus I and II bear a large central dorsal solenoidala, I 16 long, II 18 long. On tarsus I is famala FaTaI, 3 long, level with proximal SoTaI. On tarsus II is FaTaII, 4 long, proximal to SoTaII (see Fig. 1A). Tibia III has two long mastalae (mastisetae); tarsus III has one mastala. Pretarsal formula 1, 1, 0.

Tarsus I 91 long by 30 across, II 74×27, III 97×24 (tarsal lengths exclude claws and pedicle). Tarsal claws normal, falciform, slender, with strong setules (onychotrichs) on anterior and posterior; middle claw longer and more slender than neolaterals, with weak setules.

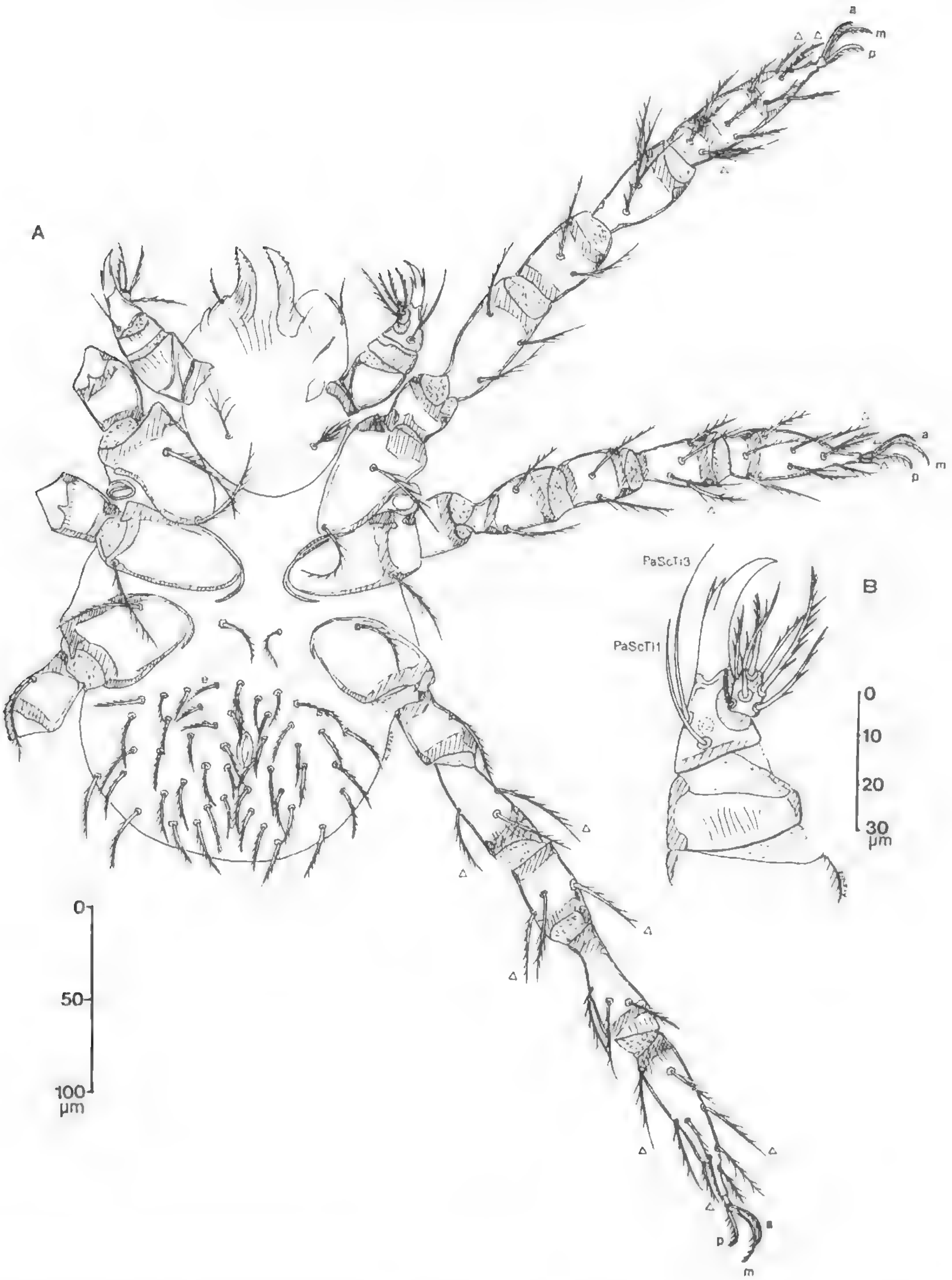

FIG. 2. *Odontacarus veitchi* sp. nov., larva. A Ventral aspect of holotype; legs on left omitted beyond trochanters. B Ventral view of palp of paratype N1981385. (Both to nearest scale).

Gnathosoma normal, well developed. Combined chelicerae bases ca 80 across; chelicerae 91 long from tip of fangs to posterior pole of bases. Cheliceral fangs stout, curved, pointed, with 3 or 4 strong retrorse teeth along concave, flexor (=dorsal) edge, and 2-5 blunted denticles along convex, extensor (=ventral) edge. Galeala 30 long, with one faint setule. Gnathobasal setae curved, pointed, 25 long, with several long setules.

Palpi normal, strong. Palpal setal formula 1, 1, 3, 8, with palpal setal formula B, B, BNN, So+7B. Palpal tibial claw trifurcate. No supracoxalae to legs or gnathosoma.

Material examined

Queensland: Mt. Jukes, 6.ix.1951, 6 larvae, collected on card, E. H. Derrick. Holotype with South Australian Museum registration number N1981390; it bears on the right hand label "*Acomatacarus athertonensis* Wom." and the locality information given above, also "G197". The word "Paratype", which was

TABLE 1. METRIC DATA FOR TYPE SERIES OF LARVAE OF *ODONTACARUS VEITCHI* SP. NOV. IN μm*

Specimen number	N1981390 ACB733F (Holotype)	N1981385 ACB733A	N1891386 ACB733B	N1981388 ACB733D	N1981389 ACB733E	Means
AW	67	77	77	71	73	73.0
PW	76	89	89	77	80	82.2
SB	25	29	27	26	29	27.2
ASB	53	58	56	51	52	54.0
PSB	28	29	30	29	30	29.2
L	81	87	86	80	82	83.2
LA	21	22	20	19	20	20.4
LB	60	65	66	61	62	62.8
LN	31	34	35	29	29	31.6
W	86	96	99	85†	85	90.2
AP	29	30	32	29	32	30.4
AM	34	40	36	38	41	37.8
AL	40	41	42	38	40	40.2
PL	49	60	64	52	49	54.8
AMB	9	11	12	10	13	11.0
Sens 51	51	48	38	—	47.0	
PW/LB	1.27	1.37	1.35	1.26	1.29	—
DS	36-58	36-62	35-66	33-62	35-64	35.0-62.4
MDS	33-35	31-38	33-38	33-35	35-38	33.2-36.8
PDS	36-38	38-42	40-43	36-40	36-42	37.2-41.0
GeI	54	59	59	53	58	56.6
TiI	61	66	66	60	62	63.0
GeII	46	49	48	47	46	47.2
TiII	49	54	54	51	51	51.8
GeIII	50	55	55	49	59	53.6
TiIII	67	68	71	65	69	68.0
AW/TiIII	1.00	1.13	1.08	1.09	1.06	—
PW/TiIII	1.13	1.31	1.25	1.18	1.16	—

* See the criteria given in footnote to Table 6 in Southcott (1986).

† Another estimate of this variate is 82 μm (see preceding footnote, and Veitch and Southcott (1984).

clearly in error, has been obliterated with white ink. On the left hand label is written "Was marked 'PARATYPE'/ACB733F/*Odontacarus veitchi* Southcott HOLOTYPE/N1981390.".

The five paratypes, from the same source and collector, have similar labels, with serial numbers on them as follows: N1981386, ACB733B, G193; N1981387, ACB733C, G197; N1981388, ACB733D, G196; N1981389, ACB733E, G206; N1981385, ACB733A, G192. The unofficial (personal) registration numbers with an ACB prefix have been used by me in previous publications (Veitch and Southcott, 1984; Southcott, 1986).

Systematic position

To distinguish this new species, criterion number 17 in my key (Southcott, 1986, p. 180) should be altered to the following:

17 Ventral opisthosomal setae 48-54 in number 17A
Ventral opisthosomal setae in range of 35-45 in number 18

17A Longer dorsal idiosomal setae 42-56 long.
Genu I 42-49 long. Tibia III 57-65 long.
Palpal setal formula B, B, BBB, So + 7B .... *O. athertonensis* (Womersley)
Longer dorsal idiosomal setae 58-66 long.
Genu I 54-59 long. Tibia III 65-71 long.
Palpal setal formula B, B, BNN So+7B .... *O. veitchi* sp. nov.

Remarks

Further details of the analyses of the statistical data for this and related species are given in Veitch and Southcott (1984).

Nomenclature

The species is dedicated to Mr L. G. Veitch, CSIRO Division of Mathematical Statistics, in recognition of his assistance in the metric studies of Australian trombidioid mites.

ACKNOWLEDGMENTS

I thank the South Australian Museum for access to these specimens.

Thanks are due to the National Health and Medical Research Council, Commonwealth of Australia, for assistance.

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RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

VOLUME 19 NUMBER 15 AUGUST 1986

No. 15 A CHECKLIST OF HELMINTHS FROM AUSTRALIAN BIRDS

by PATRICIA M. MAWSON, L. MADELINE ANGEL and S. J. EDMONDS

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Summary

This checklist includes all original published records (to the end of 1983) of the helminths occurring in Australian birds, as well as undescribed specimens known to the authors to be held in museums or other institutions.

A CHECKLIST OF HELMINTHS FROM AUSTRALIAN BIRDS

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(Manuscript accepted 7 November, 1985)

ABSTRACT

MAWSON, P.M., ANGEL, L.M., and EDMONDS, S.J. 1986. A checklist of the helminths from Australian birds. *Rec. S. Aust. Mus.* 19(15): 219-325.

This checklist includes all original published records (to the end of 1983) of the helminths occurring in Australian birds, as well as undescribed specimens known to the authors to be held in museums or other institutions.

Taxonomic lists given are (1) bird hosts, numbered consecutively, with the helminths from each bird noted below it, with the locality of collection and the authority for each record; and (2) helminths, with the bird hosts listed below each helminth species.

There are also three alphabetical lists, one of the bird families, one of the bird species and one of the helminth species, all referring by number to the host in List 1.

The incidence of helminths in birds dissected by us and by the late T.H. Johnston is noted and brief comments made on the birds and on the helminths. A complete reference list is also given.

CONTENTS

INTRODUCTION

No complete list of helminths from Australian birds—not even a complete list of any major group of helminths—has been published for over forty years. During this time a great deal of research has been done on the taxonomy of helminths from Australian birds, much of it by the present authors, and it is considered timely to draw all these records together. Comprehensive lists published earlier than 1923 were made by T.H. Johnston (1910, 1912b, 1918) and J.B. Cleland (1922). Partial lists dealing with the parasites in restricted geographical areas or with one group of parasites were published by Bancroft (1889), Cleland and T.H. Johnston (1910, 1912), T.H. Johnston (1916); Breinl (1913), Nicoll (1914a,b), and T.H. Johnston and Deland (1929). In 1939 M.R. Young published a list of helminth parasites of Australia. Since then, restricted lists have been issued by Mackerras (1962) on filarial nematodes of Australian vertebrates and by Munday and Green (1972) on all helminth parasites of Tasmanian vertebrates.

Without these earlier works the compilation of the present list would have been a formidable task. The present authors are indebted to them and to the host and parasite files started by T.H. Johnston and now continued as part of the Australian Helminthological Collection (at present housed in the South Australian Museum).

Very little serious collecting of helminths from birds has taken place in Australia. Most known helminths have been found incidental to bird collection. Museum ornithologists who collect birds for taxonomic purposes have usually no need to keep the carcases when the skins are removed, so that unless a helminthologist can arrange to obtain a carcase from a bird collector, much valuable helminthological material may be lost. We have been fortunate in having such liaison with successive ornithologists (H.T. Condon and S.A. Parker) at the South Australian Museum, and with officers of the (then) Animal Industry and Agriculture Branch of the Northern Territory Administration, who undertook extra work in labelling and transmitting to us the frozen, skinned torsos of birds which they had collected.

This list of helminths is concerned only with those from native Australian birds; the parasites of introduced birds, caged or feral, have not been included. Nor have birds taken on Macquarie Island or in the Australian Antarctic Territory been included. We have found no case of interchange of helminth parasites between introduced and native birds dissected by ourselves except when the latter are in captivity. *Syngamus trachea* has been recorded by others from uncaged birds, as noted in the text.

ACKNOWLEDGMENTS

Information for this checklist was obtained from all major Museums and collections in Australia and from the British Museum (Natural History). We are grateful for all the trouble taken by the staff of these institutions in sending details of relevant material and, in some cases, specimens.

We wish to acknowledge special help from Mr Shane Parker with the nomenclature of birds, Dr Gordon Gross for advice on the arrangement of the manuscript, and to many helminthologists in Australian universities for help in obtaining specimens and with references, and identifications.

Our warm thanks go also to colleagues in the Zoology Department of the University of Adelaide and the South Australian Museum, and to friends in various places, who have responded with patience and tolerance to our frequent inquiries about Australian birds and their helminth inhabitants.

EXPLANATION OF FORMAT AND CONTENTS

This checklist has been compiled from all published records up to the end of 1983, which are known to us, and from unpublished material, lists of which have been made available to us, held in Museums and other institutions. Published work which is merely a repetition of an earlier record is not included. Some of the material listed is not fully identified. This applies particularly to cestodes, as less work has been done in Australia on these parasites than on other helminths; and because none of the authors can claim expertise in this field. All specimens, whether identified or not, have been included, not only to show the range of parasitism, but also in the hope that interested taxonomists may wish to examine the specimens. We have not ourselves seen all the material listed, and have examined only that in the Australian Helminthological Collection, that described in our own papers, and some of that in the Veterinary School, University of Melbourne and in the Commonwealth Institute of Health, University of Sydney.

In this work the information is arranged in the following sections:

List 1. Bird species arranged systematically and numbered consecutively, with the helminths from each listed in taxonomic order under it; the locality and authority are given for each record. Synonymy is indicated where necessary.

List 2. Helminths arranged systematically, with bird hosts under each, and with numerical references to List 1.

List 3. Families of birds listed, in alphabetic order, with page numbers (in this paper).

List 4. Bird species listed alphabetically, with numbers referring to List 1.

List 5. Helminth species arranged alphabetically in each of the four helminth groups, with numerical references to List 1. Synonyms named in List 1 are included in alphabetic sequence.

References.

J.B. Cleland (1922) gave a list of parasites from Australian birds. He included, as well as a list of earlier records, a section on birds examined by himself and the parasites found in them. The helminths in this section were seldom identified further than to one of the four helminth groups. The present whereabouts of many of these specimens is not known, but some have been described since, and some are in the Australian Helminthological Collection and are noted as such in List 1.

Abbreviations used in the text:

Authors whose names appear frequently are referred to, where appropriate, by initials, as follows:

LMA	L. Madeline Angel
SJE	Stanley J. Edmonds
SJJ	Stephen J. Johnston
THJ	T. Harvey Johnston
PMM	Patricia M. Mawson

The four major groups of helminths are referred to by their initials:

A	Acanthocephala
C	Cestoda
N	Nematoda
T	Trematoda

Museums and other Institutions which are referred to as having bird helminths in their collections are abbreviated as follows:

AHC	Australian Helminthological Collection, at present housed in the South Australian Museum, Adelaide, South Australia
AM	Australian Museum, Sydney, New South Wales
BM(NH)	British Museum (Natural History), London, England
CIH	Commonwealth Institute of Helminthology, St Albans, Herts, England
CIHUS	Commonwealth Institute of Health, University of Sydney, New South Wales
DWRR	Division of Wildlife & Rangelands Research (C.S.I.R.O.), Canberra, A.C.T.
NMV	(*Formerly* National) Museum of Victoria, Melbourne, Victoria
QM	Queensland Museum, Brisbane, Queensland
SAM	South Australian Museum, Adelaide, South Australia
UMVS	University of Melbourne, Victoria, School of Veterinary Science
UQDP	University of Queensland, Brisbane, Department of Parasitology
WAM	Western Australian Museum, Perth, Western Australia

Localities from which birds and parasites are recorded are given as the State in which they lie, though more detail is usually available in the references cited. State names are abbreviated as follows:

ACT	Australian Capital Territory
EA	Eastern Australia
NSW	New South Wales, including Lord Howe Island
NT	Northern Territory
Qld	Queensland, including islands of the Great Barrier Reef
SA	South Australia, including Kangaroo I. and Pearson I.
Tas	Tasmania, including the Bass Strait Islands (King I. & Flinders I.)
Vic	Victoria
WA	Western Australia

If a host is known to have been captive (cage, aviary, etc.) the record is marked 'cage'.

COMMENTS ON THE BIRD HOSTS

Bird nomenclature, both English and scientific, and the order in which the names are listed, follow that of Schodde *et al.* (1978), except for certain amendments made since 1978.

The birds in the host-parasite list have been numbered 1-443. These numbers do not refer to any previously published list of Australian birds, but are given to facilitate cross-reference from other lists in this work to the first, which contains greater reference detail.

In the first list, birds which migrate regularly to and from other countries are noted as 'migratory', the term here not including those which migrate within Australia, or those which occur outside Australia but are not regular migrants. If a bird occurs only in Australia it is noted as 'endemic'. We have not included helminths taken from migratory birds, or from those which occur naturally in other countries, if they were collected outside their Australian range. However, we have included records from birds of distinctly Australian origin in captivity in other countries. Any record from a bird known to have been in captivity, in Australia or elsewhere, is marked '(cage)'. As mentioned earlier, helminths from birds introduced into Australia since the advent of the white man have not been included. It is hoped that this omission may be rectified later.

The Cattle Egret, *Ardeola ibis*, was not actually introduced into Australia by man. It is thought to have followed the introduced Water Buffalo, after this had become established in northern Australia. The Cattle Egret was first noted by ornithologists to be present in the late 1940s, and has now extended its range to southern Australia.

The legends (numbers and letters) which appear directly under the name of some birds in List 1 refer to autopsies undertaken by ourselves or by Professor T.H. Johnston. Careful records of these dissections were kept in the Zoology Department, University of Adelaide, by Johnston from 1922 to his death in 1951, and since then by Angel and Mawson. In these legends, the figures indicate the number of birds examined/number found with helminths, and the letters refer to the group of helminth, the number after each letter being the number of birds infested with that group.

Seven hundred and six species of native Australian birds, representing 82 bird families, are listed by Schodde *et al.* (1978). Helminths are known to occur in 384 (54%) of these birds; at least 55 (8%) other species have been examined but have not yielded helminths. This means that about 40% of the Australian birds are unexplored territory for internal parasites. Bird families represented in Australia from which no helminths have been recorded are (with the number of Australian species in brackets) Pandionidae (1); Rostratulidae (1); Phalaropidae (3); Stercorariidae (5); Opositidae (1); Nectariniidae (1); Dicaeidae (1); Atrichornithidae (2); and Sturnidae (1). In List 3 the number of Australian bird species in each family is noted after the family name, together with the number from which helminths have been recorded.

Before the studies of Rowley (1967, 1970) the distribution and taxonomy of Australian corvids were poorly known or understood. Indeed it was not until these studies were made that *Corvus mellori* (Little Raven) and *C. tasmaniensis* (Forest Raven) were recognised as species distinct from *C. coronoides* (Australian Raven). For a substantial number of early records, the identity of the corvid hosts can be established by recourse to the original (museum) skin, or reasonably assumed from the locality involved. For other old records, however, where host specimens were not retained and where the provenance falls within a zone of overlap between the now-recognised species, the identity of the corvid host will probably always remain uncertain. Records from such uncertain origins are marked '? host sp;'.

COMMENTS ON THE HELMINTHS

In general, the helminths from Australian birds resemble those from other parts of the world. There are very few genera which are limited to Australian birds, although many species and some sub-species are so restricted. Some helminth species are found in related birds in many parts of the world: such overlap may become more evident with greater knowledge of the various genera.

Helminths of the gut are rare in free-ranging psittaciform birds in Australia. Of about 160 such birds dissected by us, cestodes were present in 5, nematodes (minute larvae) in 2, and trematodes and acanthocephalans in none (PMM, 1985, p. 190). However, the trematode *Platynosomum proxillicens* and the nematodes *Ascaridia columbae* and *A. platyceri* have been taken from native birds which have been held in captivity in Australia or in other countries. Two possible reasons for this may be that the caged bird is more vulnerable to infection (and many of the infestations were very heavy and were said to have caused the death of the host), or that it is exposed to the eggs or larvae of parasites through proximity to other (? introduced) caged birds or to domestic stock such as pigeons. *Ascaridia platyceri* has recently been found in a feral colony of *Agapornis roseicollis* near Cowell, SA (Coll.S. Parker, ident. PMM, in AHC).

Birds dissected by ourselves had often been frozen before we received them, a treatment particularly damaging to flat worms. However, rather than disregard poor specimens we have listed them to record their presence, and given what classification is possible.

In this work we have not referred to sub-species, either of helminths or hosts.

Trematoda

The classification and nomenclature followed here are for the most part those of Yamaguti (1971). The main exception is in the Strigeidae, in which we follow Dubois (1938 et seq.). Entries in the checklist are placed according to the order in which families are placed by Yamaguti (1971, p. 475). Families of Digenea from fish also follow the order used by Yamaguti (1971, p. 19) (Cysts of these trematodes are often recorded from the alimentary canals of birds).

Since the number and arrangement of collar spines is important in the identification of echinostomes, they have been recorded for incompletely indentified specimens of this group in one of the following ways, as appropriate:

Unidentified echinostome: [spines (35(5))] indicates that the total number of spines is 35, including 5 corner spines on each side.

Echinostomatidae: [spines missing].

Echinostomatinae: [spines? (35(5))]: total number ?35, including 5 corner spines on each side.

In *Echinochasmus* sp.: [spines 20]: total number 20, no corner spines.

In *Patagifer* sp.: [spines 2 x (30(4))]: total number 60, 30 on each side including 4 corner spines.

In *Patagifer* sp.: [spines 2 x ? (29(4))]: total number ?58, including 4 corner spines on each side.

Cestoda

For the most part the names used for cestodes follow the classification adopted by Yamaguti (1959). Other more recent works consulted in special cases were Baer and Bona (1960) and Bona (1975) for cestodes of Ciconiformes, Palmer (1981) for cestodes of the Black Swan, *Cygnus atratus*, and Schmidt (1972) for some cestodes from honeyeaters (Meliphagidae) and parrots. None of the present authors is well versed in cestode taxonomy; cestode lists here are the responsibility of PMM.

It may be noted here that P.A. Maplestone deposited four lots of cestodes in the Australian Institute of Tropical Medicine (now the Commonwealth Institute of Health, University of Sydney) under names which apparently have never been published. All are labelled as "new species, Maplestone". The names are *"Shipleya lobivanellus"* and *"Monopylidium lobivanelli"*, both from *"Vanellus miles"*; *"Hymenolepis variabilis"*, from *Cygnus atratus*; and *"H. eurystomi"*, from *Eurystomus orientalis*. The explanation which occurs to us is that Maplestone examined this material while he was in Queensland, decided that it belonged to these four new species, and deposited paratypes in what is now the CIHUS Collection before returning to England. After his return, Maplestone published a number of papers, some with Southwell, on Australian cestodes, from the same hosts and localities but with different scientific names; one such species is *Monopylidium macracanthum* Maplestone and Southwell, 1923, which may be the unpublished *"M. lobivanelli"*. In one of the papers he identified *Hymenolepis lanceolata* (Bloch, 1782) from *Cygnus atratus*; the CIHUS material labelled *"H. variabilis* Maplestone' may belong to this species.

In the Australian Helminthological Collection there are slides of the first two of these unpublished species, presumably given to T.H.Johnston by Maplestone when they were both in Queensland. The AHC material labelled *"Shipleya lobivanellus* Maplestone' has been examined by Schmidt (1972) who identified it as *Infula burhini* Burt, 1939.

Nematoda

Nomenclature in this section follows on the whole that adopted by Anderson, Chabaud and Willmott, 1974-1982, (CIH keys to the nematode parasites of vertebrates) as far as these keys are completed. Some points to be noted are:

Anisakis diomedeae (Linstow, 1888) is recorded from a number of procellariform birds. The validity of this species has recently been upheld (Mawson 1983, p. 247). It is the only species of the genus *Anisakis* known from birds, but is commonly found in albatrosses and petrels along the Australian coast. Linstow described it, as *Ascaris diomedeae*, from material collected by the Challenger Expedition in the northern Pacific Ocean, from *Diomedea brachyura*.

Contracaecum spiculigerum (Rudolphi, 1809), commonly recorded from waterbirds was considered by Hartwich (1964) to be a junior synonym of *C. microcephalum* (Rudolphi, 1809), and Hartwich suggested that the specimens hitherto allotted to *C. spiculigerum* belong either to *C. microcephalum* or to *C. rudolphi* Hartwich, 1964. However, in this checklist the name *C. spiculigerum* is retained, pending further review of the Australian species of *Contracaecum*. Hartwich also suggested that *C. magnipapillatum* Johnston and Mawson, 1941, is a junior synonym of *C. variegatum* (Rudolphi, 1809) but the two species appear to us to be quite distinct.

Three different species of *Schistogendria* have been examined from various birds, but have not been described. They are referred to by numbers; voucher specimens are in the AHC.

Cyrnea spiralis Mawson, 1968d, is now considered likely to belong to, or near, *Microhadjelia* Jogis, 1968, and is referred to in this work as *?Microhadjelia spiralis*.

Acanthocephala

The system of classification of acanthocephalans used in this paper is that of Yamaguti (1963). However, most of the changes in nomenclature made since 1963, especially those of Schmidt (1983) have been adopted. No new genus of Acanthocephala from Australian birds has so far been recorded.

The embryonated eggs of an acathocephalan are shed with the faeces of the host. The first intermediate host in the life cycle of the parasite is thought to be always an arthropod, which is infected by eating the eggs. Sometimes a second intermediate host (often called a paratenic host or "l'hôte d'attente") is necessary. A final or definitive host is infected when it ingests an infected intermediate host. Consequently adult acanthocephalans in birds occur in those which are partly or wholly carnivorous. This possibly explains why no acanthocephalans have so far been collected from the Emu, *Dromaius novaehollandiae*, or from psittaciform birds, which are principally seed eaters.

The life cycles of Australian avian acanthocephalans are poorly known and none have been determined experimentally. What information about life cycles is available has been obtained by a comparison of the size and armature of the introverts of larval and adult forms. Using such a method T.H. Johnston and Edmonds (1949) considered that one of the larval stages of *Porrorchis* (= *Gordiorhynchus*) *hylae* (Johnston, 1912), the adult stages of which occur in the birds *Podargus strigoides* and *Centropus phasianinus*, is found as a cyst in the mesenteries and muscles of a number of frogs. The frog is infected, it is assumed, by eating an infected crustacean or insect. Some light has been thrown on the life cycles of two other avian Acanthocephala. The adult form of *Polymorphus biziurae* T.H. Johnston and Edmonds (1948) occurs in the small intestine of the Musk Duck, *Biziura lobata*. T.H. Johnston and Edmonds (1948) considered that the freshwater yabbie, *Cherax destructor*, is an intermediate host of the parasite. One of the commonest acanthocephalans known to dissectors of birds in Australia is a small cyst, 2-3 mm long and shaped like a "grain of rice", which occurs in the subcutaneous tissues of the neck and thorax of a large number of passerine birds. It was called *Echinorhynchus pomatostomi* by T.H.Johnston and Cleland (1912). Schmidt (1983) has found that the introvert of *E. pomatostomi* matches that of an acanthocephalan found in the intestine of dingos and feral cats in Australia. From this information he has concluded that the cyst known as *E. pomatostomi* is an early stage of the acanthocephalan found in dingos and feral cats. Since the adult form is an *Oncicola* and not an *Echinorhynchus*, the parasite (including the cyst) is now *Oncicola pomatostomi* (T.H. Johnston and Cleland, 1912). The carnivores are infected by ingesting the cysts in their bird prey. The first host is probably a scavenging insect, though at present there is no evidence for this.

LIST 1. BIRDS IN TAXONOMIC ORDER, AND THEIR PARASITES

Explanation of the symbols used in this section are given in "Comments on bird hosts" on p. 221.

Family DROMAIIDAE

1. *Dromaius novaehollandiae* (Latham)
Emu (endemic)
1/1 : C

T. *Philophthalmus* sp.
NT: AHC

C. *Cotugnia collini* Fuhrmann, 1909
EA: Fuhrmann, 1909, p.116
Cotugnia sp.
NSW: AHC
Raillietina australis (Krabbe, 1869)
NSW: AHC
syn. *Davainea australis* (Krabbe, 1869)
NSW: THJ, 1909c, p.xxix
NSW, WA: THJ, 1910, p.86
Qld: THJ, 1916, p.45
syn. *Taenia australis Krabbe*, 1869
Copenhagen (cage): Krabbe, 1869, p.343
Raillietina sp.
NSW, SA: AHC
Vic: AHC, UMVS
Unidentified
Qld, NSW, Vic, SA, WA: AHC

N. *Dromaeostrongylus bicuspis* Lubimov, 1933
Moscow (cage): Lubimov, 1933, p.173
Vic: Durette-Desset, 1979, p.1015
NSW, Vic: AHC
Trichostrongylus tenuis (Mehlis, 1846, in Creplin, 1846)
Aust: Arundel, 1982, pers. comm.

Family CASUARIIDAE

2. *Casuarius casuarius* (Linné)
Southern Cassowary

C. Unidentified
Qld: Macgillivray, 1917, p.80

Family PODICIPEDIDAE

3. *Podiceps cristatus* (Linné)
Great Crested Grebe
5/5 : T1 C4 N4

T. Schistosomatidae, unidentified
SA: AHC
Petasiger australis T.H. Johnston & Angel, 1941b
SA: AHC
Diplostomum podicipinum Kozicka & Niewiadomska, 1960
SA: Dubois & LMA, 1972, p.208
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205 (cysts)

C. Unidentified
SA: AHC
WA: WAM

Krefft (1873, pp.216,217) recorded *Taenia paradoxa* and *T. novaehollandiae* from the "Little Grebe *(Podiceps australis)*". *P. australis* is now placed as a synonym of the Crested Grebe, *(P. cristatus)*, and it is considered that Krefft's records refer to *Tachybaptus novaehollandiae*, which was then called the Little Grebe (q.v.).

N. *Capillaria* sp.
SA: THJ & PMM, 1949, p.64
Contracaecum podicipitis T.H. Johnston & Mawson, 1949
SA: THJ & PMM, 1949, p.67
NSW, Vic: AHC
Tetrameres gubanovi Shigin, 1957
SA: PMM, 1979, p.180
Syncuaria sp.
ACT: PMM, 1982, p.21

4. *Poliocephalus poliocephalus* (Jardine & Selby)
Hoary-headed Grebe (endemic)
5/4 : T3 C3 N3

T. *Paramonostomum caeci* Smith & Hickman, 1983b
Tas: Smith & Hickman, 1983b, p.86
Cyclocoelum jaenschi T.H. Johnston & Simpson, 1940b

SA: THJ & Simpson, 1940b, p.273
Echinostoma sp. [spines (37(4))]
NSW: AHC
Patagifer sp. [spines 2x (26-27(3-4))]
Qld: AHC
Petasiger australis T.H. Johnston & Angel, 1941b
SA: THJ & LMA, 1941b, p.285
Echinostomatidae, unidentified
NSW: Bradley, 1926, p.575; 1927, p.675
Psilochasmus oxyurus (Creplin, 1825)
Tas: S.J. Smith, 1981, p.181
Psilostomum sp. A, S.J. Smith, 1981
Tas: S.J. Smith, 1981, p.201
Psilostomum sp. B, S.J. Smith, 1981
Tas: S.J. Smith, 1981, p.214
Atriophallophorus coxiellae S.J. Smith, 1974
Tas: S.J. Smith, 1981, p.151
Levinseniella tasmaniae (S.J. Smith, 1974)
Tas: S.J. Smith, 1981, p.107
Maritrema calvertense S.J. Smith, 1974
Tas: S.J. Smith, 1981, p.64
Pachytrema sp.
Tas: S.J. Smith, pers. comm., 1979
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205 (cysts)
? *Cephalogonimus* sp.
SA: AHC

C. *Dioecocestus* sp.
Qld: BM(NH)
Gyrocoelia sp.
Aust: BM(NH)
Unidentified
NSW: Bradley, 1926, p.572, 1927, p.675
NSW: Cleland, 1922, p.105
Qld, NSW, SA: AHC

N. *Capillaria* sp.
SA: AHC
Contracaecum praestriatum Mönnig, 1923
Qld: CIHUS, BM(NH)
Streptocara recta (Linstow, 1879)
SA: THJ & PMM, 1941e, p.16
Unidentified
? loc: Bradley, 1927, p.675

5. *Tachybaptus novaehollandiae* (Stephens)

Australian Grebe
13/10 : T8 C10 N8

T. *Cyclocoelum jaenschi* T.H. Johnston & Simpson, 1940b
SA: THJ & Simpson, 1940b, p.273
Petasiger australis T.H. Johnston & Angel, 1941b
SA: THJ & LMA, 1941b, p.285
SA: AHC
Echinostomatidae, very immature, [spines ? (37)]
SA: discarded
Maritrema oöcystum (Lebour, 1907)
Qld: Deblock & Pearson, 1968b, p.459
Microphallidae, unidentified
SA: (believed lost)
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205 (cysts)

C. Dilepididae, unidentified
NSW: DWRR
Dioecocestus novaehollandiae (Krefft, 1873)
syn. *Taenia novaehollandiae* Krefft, 1873
NSW: Krefft, 1873, p.216
syn. *Taenia paradoxa* Krefft, 1873
NSW: Krefft, 1873, p.217
Unidentified
NSW: AM
Qld, NSW, SA: AHC

N. *Contracaecum podicipitis* T.H. Johnston & Mawson, 1949
SA: THJ & PMM, 1949, p.67
Tetrameres gubanovi Shigin, 1957
NSW: PMM, 1979, p.180
Skrjabinoclava horrida (Rudolphi, 1809)
Qld: AHC
Streptocara recta (Linstow, 1879)
SA: THJ & PMM, 1941e, p.260; PMM, 1955, p.6
SA: AHC
Streptocara sp.
NSW: DWRR
Syncuaria sp.
NSW: DWRR

6. *Podicipedidae*

Unidentified grebe

C. Unidentified
Qld: AHC

N. *Capillaria* sp.
Qld: AHC

Family SPHENISCIDAE

7. *Aptenodytes patagonicus* Miller

King Penguin

C. Tetrabothriidae, unidentified
Tas: AHC

8. *Eudyptes chrysocome* (Forster)

Rockhopper Penguin

N. Anisakidae
Tas: AHC (larva)

9. *Eudyptes pachyrhynchus* Gray

Fiordland Penguin

N. *Contracaecum* sp.
Tas: AHC

10. *Eudyptes schlegeli* Finsch

Royal Penguin

C. Unidentified
Tas: AHC

11. *Eudyptula minor* (Forster)

Little Penguin
4/4 : T2 C4 N4 A2

T. *Mawsonotrema eudyptulae* Angel, 1973
SA: LMA, 1973, p.857
Vic: UMVS
Tas: AHC
Renicola sp.
Tas: AHC
Galactosomum angelae Pearson, 1973
SA: Pearson, 1973, p.361
C. *Tetrabothrius lutzi* Parona, 1901
Tas: Prudhoe, 1969, p.185
Tetrabothrius sp.
NSW, Vic, SA: AHC
Tetrabothriidae, unidentified
Vic: AHC
Unidentified
SA: Cleland, 1922, p.105
NSW, Vic, Tas, SA: AHC
N. *Anisakis* sp.
NSW, SA: THJ & PMM, 1942a, p.94
Contracaecum spiculigerum (Rudolphi, 1809)
Vic, Tas, SA: AHC
Contracaecum eudyptulae T.H. Johnston & Mawson, 1942a
NSW, Vic, Tas, SA, WA: THJ & PMM, 1942a, p.93
syn. unidentified nematode
SA: Cleland, 1922, p.107
Filarioidea, unidentified
SA: AHC (from heart)
Unidentified
Vic: UMVS
A. *Corynosoma* sp.
SA: AHC

Family DIOMEDEIDAE

12. *Diomedea exulans* Linné
Wandering Albatross (migratory)
1/1 : C N

C. *Tetrabothrius diomedeae* (Fuhrmann in Shipley, 1900)
syn. *Prosthecocotyle diomedeae* Fuhrmann in Shipley, 1900
'Pacific Ocean, NE of Austr.': Fuhrmann, in Shipley, 1900, p.557
Tetrabothrius sp.
NSW: THJ, 1912b, p.106
Unidentified
NSW, SA: AHC
N. *Anisakis diomedeae* (Linstow, 1888)
NSW, Tas: THJ & PMM, 1942d, p.6
syn. *Contracaecum diomedeae* (Linstow, 1888)
Tas: THJ, 1938, p.15
Contracaecum sp.
SA: AHC (immature)
Seuratia shipleyi (Stossich, 1900)
NSW, SA: AHC
Stegophorus diomedeae (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria diomedeae* T.H. Johnston & Mawson, 1942d
NSW: THJ & PMM, 1942d, p.69
Stegophorus sp.
SA: AHC

13. *Diomedea melanophrys* Temminck
Black-browed Albatross
1/1 : C N

C. *Tetrabothrius* sp.
NSW: THJ, 1912b, p.106
Tas: AHC
Cyclophyllidea, unidentified
Tas: Munday & Green, 1972, p.4
Unidentified
NSW, SA: AHC
N. *Capillaria convolutor* Fourment, 1885
SA: THJ & PMM, 1945a, p.151
Anisakis diomedeae (Linstow, 1888)
NSW, SA: THJ & PMM, 1942d, p.67
syn. *Stomachus* sp.
Tas: Munday & Green, 1972, p.9
Contracaecum pelagicum T.H. Johnston & Mawson, 1942d
NSW, SA: THJ & PMM, 1942d, p.67
Anisakidae, unidentified
Tas: Munday & Green, 1972, p.9
Seuratia shipleyi (Stossich, 1900)
SA: THJ & PMM, 1942d, p.69
Stegophorus diomedeae (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria diomedeae* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.67

14. *Diomedea bulleri* Rothschild
Buller's Albatross

N. *Seuratia shipleyi* (Stossich, 1900)
NSW: AHC

15. *Diomedea chrysostoma* Forster
Grey-headed Albatross
4/4 : C1 N4

C. Unidentified
SA: AHC
N. *Anisakis diomedeae* (Linstow, 1888)
SA: THJ & PMM, 1942d, p.67
Tas: AHC
syn. *Stomachus* sp.
Tas: Munday & Green, 1972, p.9
Seuratia shipleyi (Stossich, 1900)
SA: THJ & PMM, 1952, p.33
Stegophorus diomedeae (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria diomedeae* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.69; 1952, p.33
Stegophorus macronectes (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria macronectes* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.70

Diomedenema diomedeae T.H. Johnston & Mawson, 1952
SA: THJ & PMM, 1952, p.32

16. ***Diomedea chlororhynchos*** Gmelin
Yellow-nosed Albatross
3/3 : C3 N3

C. *Tetrabothrius* sp.
SA: AHC
Unidentified
SA: AHC
N. *Anisakis diomedeae* (Linstow, 1888)
SA: THJ & PMM, 1942d, p.67
Contracaecum pelagicum T.H. Johnston & Mawson, 1942d
NSW: THJ & PMM, 1942d, p.67
Tetrameres certa (Leidy 1886)
syn. *Tetrameres diomedeae* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.67
Seuratia shipleyi (Stossich, 1900)
SA: THJ & PMM, 1942d, p.67

17. ***Diomedea cauta*** Gould
Shy Albatross
1/1 : C N

C. Unidentified
SA: not kept
Tas: AHC
N. *Anisakis diomedeae* (Linstow, 1888)
SA: THJ & PMM, 1942d, p.67
Vic: UMVS
Tas: AHC
Contracaecum magnicollare T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.67
Tetrameres certa (Leidy, 1886)
syn. *Tetrameres diomedeae* T.H. Johnston & Mawson, 1942d
Tas: AHC
Stegophorus diomedeae T.H. Johnston & Mawson, 1942d
Tas: AHC
Diomedenema diomedeae T.H. Johnson & Mawson, 1952
Tas: AHC

18. ***Phoebetria palpebrata*** (Forster)
Light-mantled Sooty Albatross

C. *Tetrabothrius* sp.
SA: AHC
N. *Contracaecum* sp.
Vic: AHC
Seuratia shipleyi (Stossich, 1900)
SA: AHC

19. ***Macronectes giganteus*** (Gmelin)
Southern Giant Petrel
10/9 : C2 N9 A1

C. *Tetrabothrius* sp.
SA: AHC
Unidentified
Qld, SA: AHC
N. *Capillaria convolutor* (Fourment, 1885)
SA: AHC
Anisakis diomedeae (Linstow, 1888)
SA: THJ & PMM, 1942d, p.67
Phocascaris sp.
SA: THJ & PMM, 1942d, p.68
Seuratia shipleyi (Stossich, 1900)
SA: THJ & PMM, 1942d, p.69
SA: AHC
Stegophorus macronectes (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria macronectes* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.70
A. Unidentified
SA: not kept

20. ***Fulmarus glacialoides*** (Smith)
Southern Fulmar

C. Unidentified
SA: AHC
N. *Seuratia shipleyi* (Stossich, 1900)
SA: AHC

21. ***Daption capense*** (Linné)
Cape Petrel
2/2 : C1 N2

C. Unidentified
SA: AHC
N. *Anisakis diomedeae* (Linstow, 1888)
SA: THJ & PMM, 1942d, p.67
Seuratia shipleyi (Stossich, 1900)
SA: THJ & PMM, 1942d, p.69
Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
SA: AHC
Spirurida, unidentified
Tas: Munday & Green, 1972, p.10

22. ***Pterodroma macroptera*** (Smith)
Great-winged Petrel

N. *Anisakis* sp.
Tas: AHC
syn. *Stomachus* sp.
Tas: Munday & Green, 1972, p.9
Seuratia shipleyi (Stossich, 1900)
Tas: Munday & Green, 1972, p.11
Tas: AHC
Spirurida, unidentified
Tas: Munday & Green, 1972, p.9

23. ***Pterodroma lessonii*** (Garnot)
White-headed Petrel
3/3 : C1 N3

C. Unidentified
SA: AHC

N. *Anisakis* sp.
SA: THJ & PMM, 1942d, p.67
Seuratia shipleyi (Stossich, 1900)
SA: AHC
Stegophorus macronectes (T.H. Johnston & Mawson, 1942d)
SA: AHC

24. **Pterodroma brevirostris** (Lesson)
Kerguelen Petrel
1/1 : N

C. *Tetrabothrius* sp.
SA: AHC

N. *Seuratia shipleyi* (Stossich, 1900)
SA: AHC
Stegophorus macronectes (T.H. Johnston & Mawson, 1942d)
SA: AHC

25. **Pachyptila vittata** (Forster)
Broad-billed Prion
6/5 : C2 N5

C. *Tetrabothrius* sp.
SA: AHC
Unidentified
SA: AHC

N. *Skrjabinoclava* sp.
Tas: AHC
Seuratia shipleyi (Stossich, 1900)
SA: THJ & PMM, 1942d, p.69
Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria pachyptilae* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.70
SA: AHC

26. **Pachyptila salvini** (Mathews)
Lesser Broad-billed Prion
5/1 : N

N. *Seuratia shipleyi* (Stossich, 1900)
SA: AHC
Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
SA: AHC

27. **Pachyptila desolata** (Gmelin)
Antarctic Prion
11/4 : N

N. *Anisakis* sp., ? *diomedeae* (Linstow, 1888)
SA: THJ & PMM, 1942c, p.184
Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria pachyptilae* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942c, p.184
SA: AHC

28. **Pachyptila belcheri** (Mathews)
Slender-billed Prion
2/2 : N

N. *Anisakis* sp.
SA: AHC (immature)
Seuratia shipleyi (Stossich, 1900)
SA: AHC

29. **Pachyptila turtur** (Kuhl)
Fairy Prion
4/4 : C3 N4

C. Unidentified
SA: AHC

N. *Skrjabinoclava* sp.
Tas: AHC
Seuratia shipleyi (Stossich, 1900)
SA: AHC
Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
SA: AHC

A. *Plagiorhynchus* sp.
Tas: AHC

30. **Procellaria cinerea** Gmelin
Grey Petrel

C. Unidentified
NSW: AHC

31. **Puffinus pacificus** (Gmelin)
Wedge-tailed Shearwater
2/1 : N

T. *Galactosomum renincolum* Pearson, 1973
Qld: Pearson, 1973, p.409

C. Unidentified
NSW: Cleland, 1922, p.105

N. *Seuratia shipleyi* (Stossich, 1900)
Qld: AHC

32. **Puffinus griseus** (Gmelin)
Sooty Shearwater

C. *Tetrabothrius* sp.
NSW, Vic: AHC
Unidentified
NSW: AHC

N. *Contracaecum magnicollare* T.H. Johnston & Mawson, 1941c
Vic: AHC
Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
syn. *Paryseria pachyptilae* T.H. Johnston & Mawson, 1942d
SA: THJ & PMM, 1942d, p.70

33. **Puffinus tenuirostris** (Temminck)
Short-tailed Shearwater (migratory)
12/8 : C3 N7

T. *Renicola* sp.
    NSW: AHC
  Cryptocotyle sp.
    Tas: AHC
C. Tetrabothriidae, unidentified
    Vic: AHC
  Unidentified
    Tas: Cleland, 1922, p.105 (AHC)
    Tas: Munday & Green, 1972, p.4
    EA, NSW, SA: AHC
N. *Contracaecum magnicollare* T.H. Johnston & Mawson, 1941c
    Vic: AHC
  Seuratia shipleyi (Stossich, 1900)
    Vic, Tas, SA: AHC
    Bass Str: BM(NH)
  Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d)
    Tas, SA: AHC
  Stegophorus stellaepolaris (Parona, 1901)
    NSW, Bass Str: BM(NH)
    Tas: AHC

34. ***Puffinus gavia*** (Forster)
Fluttering Shearwater
1/1 : C N

T. *Renicola* sp.
    Tas: AHC
C. Unidentified
    SA: AHC
N. Unidentified
    SA: not kept (pieces only)

Family OCEANITIDAE

35. ***Pelagodroma marina*** (Latham)
White-faced Storm Petrel
6/3 : N

N. *Seuratia shipleyi* (Stossich, 1900)
    Tas: AHC
  syn. *Seuratia marina* T.H. Johnston & Mawson, 1941e
    Tas: THJ & PMM, 1941e, p.259; THJ & PMM, 1944, p.62
    SA: THJ & PMM, 1942d, p.69
  syn. "nematode"
    SA: Cleland, 1922, p.107 (AHC)

Family PELECANOIDIDAE

36. ***Pelecanoides urinatrix*** (Gmelin)
Common Diving Petrel
2/2 : N

N. Spirurida, unidentified
    Tas: AHC (larva)

Family PELECANIDAE

37. ***Pelecanus conspicillatus*** Temminck
Australian Pelican
12/12 : T12 C12 N12 A1

T. *Ornithobilharzia* sp.
    SA: AHC
  Dendritobilharzia sp.
    SA: AHC
  Schistosomatinae, unidentified
    Qld, SA: AHC
  Echinochasmus pelecani T.H. Johnston & Simpson, 1944
    SA: THJ & Simpson, 1944, p.113
    Qld: AHC
  Echinostomatidae [spines missing]
    SA: AHC
  Renicola sp.
    Qld: Pearson, 1979 (? 2 spp.)
    Qld: AHC
  Ascocotyle sp.
    Qld: AHC
  Haplorchis sprenti Pearson, 1964
    Qld: Pearson, 1964, p. 639
  syn. *Haplorchis* sp.
    Qld: Pearson, 1960, p.93
  Haplorchis paravanissimus Pearson & Ow-Yang, 1982
    SA: Pearson & Ow-Yang, 1982, p.50
  Haplorchis vanissimus Africa, 1938
    SA: Pearson & Ow-Yang, 1982, p.50
  Procerovum varium Onji & Nishio, 1916
    Qld: Pearson, 1964, p.653
  syn. *Procerovum* sp.
    Qld: Pearson, 1960, p.93
  Stictodora caballeroi Martin, 1955
    Qld: Pearson, 1960, p.93
  Clinostomum sp.
    Qld: AHC
  Mesostephanus haliasturis Tubangui & Masilungan, 1941
    SA: Dubois & LMA, 1972, p.214
  syn. *M. minor* Dubois & Pearson, 1965
    Qld: Dubois & Pearson, 1967, p.202
  Bolbophorus confusus (Krause, 1914)
    Qld: Dubois & Pearson, 1965, p.95
    SA: Dubois & LMA, 1972, p.205
  Bolbophorus sp.
    SA: THJ & LMA, 1942a, p.59
  Diplostomum parvulum Dubois & Angel, 1972
    SA: Dubois & LMA, 1972, p.206
  Diplostomum sp.
    Qld: AHC
  Posthodiplostomum australe Dubois, 1937a
    SA: Dubois & LMA, 1972, p.212
  Schwartzitrema pandubi (Pande, 1939)
    SA: Dubois & LMA, 1972, p.205 (cysts)
C. *Hymenolepis murrayensis* T.H. Johnston & Clark, 1948a*
    SA: THJ & Clark, 1948a, p.77

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*omitted by Yamaguti, 1959

Hymenolepis jaenschi T.H. Johnston & Clark, 1948a*
SA: THJ & Clark, 1948a, p.79
Qld: AHC
Hymenolepis ellisi T.H. Johnston & Clark, 1948a†
SA: THJ & Clark, 1948a, p.81
Hymenolepis sp.
SA: AHC
Unidentified
Qld, NSW, Tas, SA, WA: AHC
N. *Eustrongylides* sp.
Qld: CIHUS (posterior end ♂, in gular pouch)
Capillaria jaenschi T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p. 245
Contracaecum clelandi T.H. Johnston & Mawson, 1941c
WA: THJ & PMM, 1941c, p.113
Tas: AHC
Contracaecum micropapillatum (Stossich, 1890)
Qld: CIHUS
syn. *Contracaecum bancrofti* T.H. Johnston & Mawson, 1941c
Qld, NSW, Vic, SA: THJ & PMM, 1941c, p.113
Contracaecum spiculigerum (Rudolphi, 1809)
Vic: AHC
syn. *Ascaris spiculigerum* Rudolphi, 1809
NSW: THJ, 1912a, p.74
Tetrameres greeni Mawson, 1979
Qld: PMM, 1979, p.180
syn. *Tetrameres pelecani* T.H. Johnston & Mawson, 1942e, sensu T.H. Johnston & Mawson, 1942c
SA: THJ & PMM, 1942c, p.185
Microtetrameres pelecani (T.H. Johnston & Mawson, 1942e)
Qld: PMM, 1979, p.182
syn. *Tetrameres pelecani* T.H. Johnston & Mawson, 1942e nec 1942c
SA: THJ & PMM, 1942e, p.72
Cosmocephalus jaenschi T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1942e, p.185
Synhimantus sirry Khalil, 1931
Qld, Vic: PMM, 1982, p.23
syn. *Dispharynx pelecani* T.H. Johnston & Mawson, 1942c
SA: THJ & PMM, 1942c, p.185
Filarioidea, unidentified
Qld: AHC (from eye)
A. *Polymorphus biziurae* T.H. Johnston & Edmonds, 1948
SA: AHC

Family SULIDAE

38. **Sula serrator** (Gray)
Australasian Gannet
6/4 : T1 C1 N4

T. *Galactosomum angelae* Pearson, 1973
SA: Pearson, 1973, p.361
C. Tetrabothriidae, unidentified
SA: AHC
N. *Contracaecum magnicollare* T.H. Johnston & Mawson, 1941c
Tas: AHC
Contracaecum sp.
SA: AHC

39. **Sula dactylatra** Lesson
Masked Booby

N. Unidentified
NSW: AHC

40. **Sula sula** (Linné)
Red-footed Booby
1/1 : N

N. Unidentified
Qld: AHC

41. **Sula leucogaster** (Boddaert)
Brown Booby
2/1 : N

N. *Seuratia shipleyi* (Stossich, 1900)
Qld, SA: AHC

Family ANHINGIDAE

42. **Anhinga melanogaster** Pennant
Darter

T. *Maritrema oocystum* (Lebour, 1907)
Qld: Deblock & Pearson, 1968b, p.459
Clinostomum australiense S.J. Johnston, 1917
Qld: SJJ, 1917, p.230
Qld: THJ, 1942b, p187
Mesostephanus haliasturis Tubangui & Masilungan, 1941
syn. *M. minor* Dubois & Pearson, 1965
Qld: Dubois & Pearson, 1967, p.202
Diplostomum auriculosum Dubois & Pearson, 1967
Qld: Dubois & Pearson, 1967, p.193
Schwartzitrema novaehollandiae Dubois & Pearson, 1967
Qld: Dubois & Pearson, 1967, p.187
N. *Eustrongylides plotinus* T.H. Johnston & Mawson, 1941e
Qld: THJ & PMM, 1941e, p.256
Contracaecum rodhaini (Gedoelst, 1916)
Qld: CIHUS, BM(NH)
Contracaecum sinulabiatum T.H. Johnston & Mawson, 1941c
Qld: THJ & PMM, 1941c, p.114
syn. *Ascaris spiculigerum* Rudolphi, 1809
Qld: THJ, 1912a, p.74
Contracaecum tricuspe (Gedoelst, 1916)
Qld: THJ & PMM, 1941c, p.114
Qld: CIHUS, BM(NH)
SA: AHC

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* listed by Yamaguti, 1959 in appendix to Hymenolepididae

syn. *Ascaris* sp. Krefft, 1873, p.213
Qld: Krefft, 1873, p.213
Synhimantus sp.
syn. *Dispharynx* sp.
Qld: THJ & PMM, 1941e, p.257
Microfilaria sp.
Qld: THJ, 1912a, p.78

Family PHALACROCORACIDAE

43. ***Leucocarbo fuscescens*** (Vieillot)
Black-faced Shag (endemic)
8/8 : T4 C4 N8 A3

T. *Echinoparyphium phalacrocoracis* Yamaguti, 1939a
SA: AHC
Paryphostomum radiatum (Dujardin, 1845)
syn. *P. tenuicolle* (S.J. Johnston, 1917)
SA: THJ & LMA, 1942b, p.120
Petasiger exaeretus Dietz, 1909
SA: discarded
Renicola sp.
SA: AHC
Galactosomum sinuilacte Pearson, 1973
SA: Pearson, 1973, p.415
Galactosomum sp.
SA: AHC (immature)
Haplorchis vanissimus Africa, 1938
SA: AHC
Stictodora diplacantha T.H. Johnston, 1942a
SA: AHC
Hysteromorpha triloba (Rudolphi, 1819)
SA: THJ, 1942a, p.238
C. *Paradilepis scolecina* (Rudolphi, 1819)
Tas: Prudhoe, 1969, p.190
Paradilepis sp.
Qld: CIHUS
SA: AHC
Unidentified
SA: AHC
N. *Eustrongylides phalacrocoracis* T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1942c, p.186
Tas: THJ & PMM, 1945a, p.149
Capillaria jaenschi T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945a, p.151
Capillaria sp.
Tas: THJ & PMM, 1945a, p.151
Contracaecum spiculigerum (Rudolphi, 1809)
SA: THJ & PMM, 1941c, p.111
Tas, SA: AHC
Qld: CIHUS
Cosmocephalus jaenschi T.H. Johnston & Mawson, 1942c
Tas: THJ & PMM, 1945a, p.143
A. *Corynosoma clavatum* Goss, 1940
SA: AHC

44. ***Phalacrocorax carbo*** Linné
Great Cormorant
7/7 : T5 C5 N7

T. *Echinoparyphium phalacrocoracis* Yamaguti, 1939a
SA: THJ, 1942a, p.238
Paryphostomum radiatum (Dujardin, 1845)
syn. *Paryphostomum tenuicolle* (S.J. Johnston, 1917)
SA: THJ & LMA, 1942b, p.120
Petasiger exaeretus Dietz, 1909
NSW, SA: THJ, 1942a, p.236
Qld: AHC
Haplorchis vanissimus Africa, 1938
SA: AHC (cysts)
Hysteromorpha triloba (Rudolphi, 1819)
NSW, SA: THJ, 1942a, p.238
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205
C. *Paradilepis scolecina* (Rudolphi, 1819)
SA: Clark, 1957, p.124
Unidentified
NSW, SA: AHC
N. *Eustrongylides phalacrocoracis* T.H. Johnston & Mawson, 1941e
SA: TJH & PMM, 1941e, p.255
Capillaria jaenschi T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.245
Contracaecum spiculigerum (Rudolphi, 1809)
Qld, NSW, SA, WA: THJ & PMM, 1941c, p.111
Tas: Munday & Green, 1972, p.9
Tas: AHC
syn. *Ascaris* sp.
NSW: THJ, 1912b, p.108
Contracaecum sinulabiatum T.H. Johnston & Mawson, 1941c
Qld: THJ & PMM, 1941c, p.113
Procamallanus murrayensis T.H. Johnston & Mawson, 1940b
SA: THJ & PMM, 1944, p.64
Cosmocephalus jaenschi T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.259
Echinuria squamata (Linstow, 1883)
SA: THJ & PMM, 1941e, p.257
SA: AHC
Synhimantus sp.
NSW: AHC
Microfilaria sp.
Qld: Mackerras, 1962, p.436
Unidentified
NSW: AM

45. ***Phalacrocorax varius*** (Gmelin)
Pied Cormorant
5/5 : T5 C1 N4 A3

T. *Renicola* sp.
SA: AHC
Galactosomum sinuilacte Pearson, 1973
Qld, SA: Pearson, 1973, p.415
Stictodora diplacantha T.H. Johnston, 1942a
SA: THJ, 1942a, p.239
SA: AHC

Cardiocephaloides ovicorpus Dubois & Angel, 1972
SA: Dubois & LMA, 1972, p.204
Strigeidae, unidentified
SA: AHC (larval)
Fellodistomidae, unidentified
syn. Steringophoridae, unidentified
WA: Goss, 1940, p.7
C. *Dilepis maxima* Goss, 1940
WA: Goss, 1940, p.8
Trypanorhyncha, unidentified
SA: AHC (cysts)
Unidentified
SA: AHC
N. *Capillaria jaenschi* T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.245
Contracaecum spiculigerum (Rudolphi, 1809)
WA: THJ & PMM, 1941c, p.111
SA: AHC
A. *Corynosoma clavatum* Goss, 1940
WA: Goss, 1940, p.12
SA: AHC

46. ***Phalacrocorax sulcirostris*** (Brandt)
Little Black Cormorant
8/8 : T8 C6 N6 A5

T. *Echinochasmus* sp. [spines (20)]
Qld: AHC
Echinoparyphium phalacrocoracis Yamaguti, 1939a
SA: THJ, 1942a, p.238
Paryphostomum radiatum (Dujardin, 1845)
Qld, Vic, SA, WA: THJ, 1942a, p.236
Qld: AHC
syn. *P. tenuicolle* (S.J. Johnston, 1917)
SA: THJ & LMA, 1942b, p.120
syn. *P. phalacrocoracis* Goss, 1940
WA: Goss, 1940, p.2
Petasiger exaeretus Dietz, 1909
SA: THJ, 1942a, p.236
Qld: AHC
Echinostomatinae [spines missing]
SA, NT: AHC
Haplorchis sprenti Pearson, 1964
Qld: Pearson, 1964, p.639
Haplorchis paravanissimus Pearson & Ow-Yang, 1982
Qld: Pearson & Ow-Yang, 1982, p.50
syn. *H. vanissimus* of Pearson, 1964 (in part) not Africa, 1938
Qld: Pearson, 1964, p.639
Haplorchis vanissimus Africa, 1938
Qld: Pearson, 1964, p.633; Pearson & Ow-Yang, 1982, p.49
Stictodora diplacantha T.H. Johnston, 1942a
SA: AJC
Hysteromorpha triloba (Rudolphi, 1819)
NSW, SA: THJ, 1942a, p.238
SA: AHC
syn. *Diplostomum granulosum* Goss, 1940
WA: Goss, 1940, p.6
Posthodiplostomum australe Dubois, 1937a
SA: Dubois & LMA, 1972, p.212
QD: AHC
Diplostomidae, unidentified
Qld: AHC (immature)
Schwartzitrema pandubi (Pande, 1939)
Qld: Dubois & Pearson, 1965, p.89
SA: Dubois & LMA, 1972, p.205
Unidentified
SA: AHC
C. *Paradilepis minima* (Goss, 1940)
SA: Clark, 1957, p.126
syn. *Dilepis minima* Goss, 1940
WA: Goss, 1940, p.10
Unidentified
Qld, Vic, SA: AHC
N. *Eustrongylides* sp.
NT: AHC
Capillaria jaenschi T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.245
WA: BM(NH)
Contracaecum spiculigerum (Rudolphi, 1809)
Qld, SA: THJ & PMM, 1941c, p.111
SA: AHC
syn. *Ascaris spiculigerum* Rudolphi, 1809
Qld: THJ, 1912a, p.64
Streptocara recta (Linstow, 1879)
SA: AHC
Desmidocercella sp.
NT: AHC
Microfilaria sp.
Qld: THJ, 1912a, p.78
A. *Corynosoma clavatum* Goss, 1940
SA: AHC
WA: Goss, 1940, p.12
? *Centrorhynchus* sp.
NT: AHC

47. ***Phalacrocorax melanoleucos*** (Vieillot)
Little Pied Cormorant
25/25 : T23 C24 N21 A9

T. *Echinoparyphium phalacrocoracis* Yamaguti, 1939a
SA: THJ, 1942a, p.238
Paryphostomum radiatum (Dujardin, 1845)
Qld, NSW, Vic, SA: THJ, 1942a, p.233
SA: AHC
syn. *Echinochasmus tenuicollis* S.J. Johnston, 1917
NSW: SJJ, 1917, p.206
Qld: THJ, 1918, p.212
syn. *Paryphostomum tenuicolle* (SJJ, 1917)
SA: THJ & LMA, 1942b, p.120
syn. *Paryphostomum phalacrocoracis* Goss, 1940
WA: Goss, 1940, p.2
Petasiger exaeretus Dietz, 1909
NSW, SA: THJ, 1942a, p.236
SA: AHC
Echinostomatidae [spines (27(4))]
NSW: AHC

Prosthogonimus vitellatus Nicoll, 1914a
SA: LMA, 1973, p.859
Haplorchis pumilio (Looss, 1896)
Qld: Pearson, 1960, p.93; 1964, p.618
Haplorchis sprenti Pearson 1964
Qld: Pearson, 1964, p.639
syn. *Haplorchis* sp.
Qld: Pearson, 1960, p.93
Procerovum sp.
Qld: Pearson, 1960, p.93
Stellantchasmus aspinosus Pearson, 1964
Qld: Pearson, 1964, p.668
syn. *Stellantchasmus falcatus* of Pearson, 1960, not Onji & Nishio, 1916
Qld: Pearson, 1960, p.93
Hysteromorpha triloba (Rudolphi, 1819)
Vic, SA: THJ, 1942a, p.238
Posthodiplostomum australe Dubois, 1937a
SA: Dubois & LMA, 1972, p.212
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205
Dolichosacculus solecarius (S.J. Johnston, 1917)
syn. *Dolichosaccus solecarius* S.J. Johnston, 1917
NSW: SJJ, 1917, p.218

C. *Paradilepis minima* (Goss, 1940)
SA: Clark, 1957, p.126
syn. *Dilepis minima* Goss, 1940
WA: Goss, 1940, p.10
Paradilepis sp.
SA: Clark, 1957, p.129
Microsomacanthus cormoranti (Ortlepp, 1938)
syn. *Hymenolepis cormoranti* Ortlepp, 1938
SA: Clark, 1957, p.131
Woodlandia phalacrocoracis (Woodland, 1929)
syn. *Hymenolepis phalacrocoracis* Woodland, 1929
SA: Clark, 1957, p.132
Unidentified
Qld, NSW, Vic, SA: AHC

N. *Eustrongylides phalacrocoracis* T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.255
Capillaria jaenschi T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.245
Contracaecum spiculigerum (Rudolphi, 1909)
Qld, NSW, SA: THJ & PMM, 1941c, p.111
Contracaecum sinulabiatum T.H. Johnston & Mawson, 1941c
SA: THJ & PMM, 1941c, p.113
Tetrameres sp.
SA: AHC
Synhimantus sp.
SA: THJ & PMM, 1942e, p.71
SA: AHC
Chevreuxia sp.
SA: AHC
Streptocara recta (Linstow, 1879)
SA: THJ & PMM, 1942e, p.71
Desmidocercella sp.
SA: AHC
Microfilaria sp.
NSW: Cleland & THJ, 1912, p.430

A. *Corynosoma clavatum* Goss, 1940
WA: Goss, 1940. p.12
SA: AHC
Unidentifiable
Qld: AHC

48. ***Phalacrocorax*** sp.

T. *Renicola* sp.
Vic: UMVS
Stictodora diplacantha T.H. Johnston, 1942a
SA: AHC
Posthodiplostomum australe Dubois, 1937a
NT: AHC

Family FREGATIDAE

49. ***Fregata minor*** (Gmelin)
Great Frigatebird
1/1 : N

C. *Tetrabothrius* sp.
Qld: THJ, 1912b, p.108
Unidentified
Qld: AHC

N. *Contracaecum* sp.
Qld, Vic: AHC
Seuratia shipleyi (Stossich, 1900)
Qld: AHC

50. ***Fregata ariel*** (Gray)
Least Frigatebird
1/1 : C N

C. *Tetrabothrius polyorchis* Nybelin, 1917
WA: Nybelin, 1917, p.15

N. *Seuratia shipleyi* (Stossich, 1900)
Qld: not kept

Family PHAETHONTIDAE

51. ***Phaethon rubricauda*** Boddaert
Red-tailed Tropicbird
1/1 : N

N. *Contracaecum* sp.
SA: AHC (immature)

Family ARDEIDAE

52. ***Ardea pacifica*** Latham
Pacific Heron

T. *Distoma* sp.
NSW: Krefft, 1873, p.213

C. No record. *Dendrouterina australiensis* Baer & Bona, 1960, p.13, was attributed to *A. pacifica* in mistaken identification of 'Grey Heron'

N. *Contracaecum spiculigerum* (Rudolphi, 1809)
Qld: THJ & PMM, 1941c, p.111
Porrocaecum reticulatum (Linstow, 1899)
Qld: THJ & PMM, 1941c, p.115
Desmidocercella sp.

Qld: AHC
'Filarial worms'
Qld: Mackerras, 1962, p.435

53. ***Ardea novaehollandiae*** Latham
White-faced Heron
14/14 : T12 C12 N12

T. *Eucotyle* sp.
Tas: AHC
Proacetabulorchis dogieli Belopolskaya & Bychovskaya-Pavlovskaya, 1954
Qld: LMA & Pearson, 1977, p.130
Maritrema oocystum (Labour, 1907)
Tas: S.J. Smith, 1981, p.393
Haplorchis sprenti Pearson, 1964
Qld: Pearson, 1964, p.639
Procerovum varium Onji & Nishio, 1916
Qld: Pearson, 1964, p.654
Diplostomum galaxiae Smith & Hickman, 1983a
Tas: Smith & Hickman, 1983a, p.29
Posthodiplostomum australe Dubois, 1937a
Qld: Dubois & Pearson, 1967, p.201
SA: Dubois & LMA, 1972, p.212
Apharyngostrigea simplex (S.J. Johnston, 1904)
SA: Dubois & LMA, 1972, p.197
Vic, SA: AHC
syn. *Holostomum simplex* S.J. Johnston, 1904
NSW: SJJ, 1904, p.112
Parastrigea repens (Chase, 1921)
syn. *Holostomum repens* Chase, 1921
NSW: Chase, 1921, p.500
Schwartzitrema pandubi (Pande, 1939)
SA: AHC (cysts)
Unidentified
SA: AHC (cysts, metacercariae)

C. *Dendrouterina australiensis* Baer & Bona, 1960
NSW, SA: Baer & Bona, 1960, p.13; Bona, 1975, p.91
Paradilepis urceina Bona, 1975
SA: Bona, 1975, p.503. 'Grey Heron', quoted by Baer & Bona, is *Ardea novaehollandiae* (colloquial use)
Parvitaenia ardeae (T.H. Johnston, 1913)
syn. *Bancroftiella ardeae* T.H. Johnston, 1913
Qld: THJ, 1913, p.85; 1912b, p.107
Parvitaenia clavipera Baer & Bona, 1960
Qld: Baer & Bona, 1960, p.13; Bona, 1975, p.244
syn. *Bancroftiella glandularis* of THJ, 1912b, (in part) not (Fuhrmann, 1905)
Qld, NSW: THJ, 1912b, p.107
Parvitaenia paracyclorchida Baer & Bona, 1960
NSW: Baer & Bona, 1960, p.3; Bona, 1975, p.247
syn. *Bancroftiella glandularis* of THJ, 1912b, (in part), not (Fuhrmann, 1905)
Qld, NSW: THJ, 1912b, p.107
Unidentified
NSW, Tas, SA: AHC

N. *Contracaecum spiculigerum* (Rudolphi, 1809)
NSW: THJ & PMM, 1941c, p.111
Contracaecum sp.
SA: THJ & PMM, 1941c, p.115
Vic: AHC
Porrocaecum sp.
Qld: AHC
Tetrameres sp.
Qld, SA: AHC

54. ***Ardeola ibis*** (Linné)
Cattle Egret

N. *Microtetrameres egretes Rasheed, 1960*
SA: AHC

55. ***Egretta alba*** (Linné)
Great Egret
4/3 : T2 C1 N3

T. *Apharyngostrigea* sp.
Qld: CIHUS
Echinoparyphium oxyurum S.J. Johnston, 1917
Qld: SJJ, 1917, p.201
Echinostoma sp.
Qld: THJ, 1912b, p.107
Qld: CIHUS
Patagifer fraternus S.J. Johnston, 1917
Qld: SJJ, 1917, p.213
Renicola sp.
SA: AHC (cysts, metacercariae)
Haplorchis sprenti Pearson, 1964
Qld: Pearson, 1964, p.639
Procerovum varium Onji & Nishio, 1916
Qld: Pearson, 1964, p.653
Heterophyidae, unidentified
SA: AHC
Posthodiplostomum australe Dubois, 1937a
SA: Dubois & LMA, 1972, p.212
Distoma sp.
NSW: Krefft, 1873, p.213

C. *Anomotaenia asymmetrica* T.H. Johnston, 1913
Qld: THJ, 1913, p.81
Parvitaenia glandularis (Fuhrmann, 1905)
syn. *Bancroftiella glandularis* (Fuhrmann, 1905)
Qld: THJ, 1913, p.84
? Qld: CIHUS

N. *Contracaecum* sp.
SA: THJ & PMM, 1941c, p.114
Qld: CIHUS (immature)
Porrocaecum reticulatum (Linstow, 1899)
Qld: THJ & PMM, 1941c, p.115
Qld: CIHUS
Thelazia sp.
Qld: CIHUS, BM(NH)

A. Unidentified
? loc: CIHUS

56. ***Egretta garzetta*** (Linné)
Little Egret

T. *Nephrostomum* sp.
Tas: AHC
Echinostomatidae [spines (49(4))]
Tas: AHC

Diplostomum amygdalum Dubois & Pearson, 1965
Qld: Dubois & Pearson, 1965, p.90
Apharyngostrigea simplex (S.J. Johnston, 1904)
Qld: Dubois & Pearson, 1965, p.79

57. ***Egretta intermedia*** (Wagler)
Intermediate Egret

T. *Haplorchis pumilio* (Looss, 1896)
Qld: Pearson, 1964, p.618
Haplorchis sprenti Pearson, 1964
Qld: Pearson, 1964, p.639
Procerovum varium Onji & Nishio, 1916
Qld: Pearson, 1964, p.655
Diplostomum amygdalum Dubois & Pearson, 1965
Qld: Dubois & Pearson, 1965, p.90
Apharyngostrigea simplex (S.J. Johnston, 1904)
Qld: Dubois & Pearson, 1965, p.79

C. None recorded. Baer & Bona (1960) and Bona (1975) mistakenly quote this bird as host of *Anomotaenia asymmetrica* THJ, 1913, and of *Bancroftiella glandularis* (Fuhrmann) of THJ, 1913, but THJ gives host of both species as *Herodias timorensis* Lesson, now *Egretta alba.*

58. ***Egretta sacra*** (Gmelin)
Eastern Reef Egret

T. *Austrobilharzia terrigalensis* S.J. Johnston, 1917
Qld: Rohde, 1977, p.39

C. *Baerbonia parvitaeniunca* (Baer & Bona, 1960)
Qld: Bona, 1975, p.166
syn. *Valipora parvitaeniunca* Baer & Bona, 1960
Qld: Baer & Bona, 1960, p.9

59. ***Butorides striatus*** (Linné)
Striated Heron
4/4 : N

N. *Contracaecum* sp.
WA: WAM

60. ***Nycticorax caledonicus*** (Gmelin)
Rufous Night Heron
3/3 : T2 C2 N3

T. *Haplorchis paravanissimus* Pearson & Ow-Yang, 1982
Qld: Pearson & Ow-Yang, 1982, p.50
syn. *H. vanissimus* of Pearson, 1964 (in part) not Africa, 1938
Qld: Pearson, 1964, p.633
Haplorchis vanissimus Africa, 1938
Qld: Pearson, 1964, p.633
Procerovum varium Onji & Nishio, 1916
Qld: Pearson, 1964, p.654
Stellantchasmus falcatus Onji & Nishio, 1916
Qld: Pearson, 1964, p.664
Clinostomum complanatum (Rudolphi, 1814)
syn. *Clinostomum hornum* Nicoll, 1914b
Qld: Nicoll, 1914b, p.123
Diplostomum amygdalum Dubois & Pearson, 1965
Qld: Dubois & Pearson, 1965, p.90
SA: Dubois & LMA, 1972, p.206
Posthodiplostomum australe Dubois, 1937a
NT: Dubois & LMA, 1972, p.212

C. *Parvitaenia ardeae* (T.H. Johnston, 1913)
SA: Bona, 1975, p.232
NSW: AHC
syn. *Bancroftiella ardeae* T.H. Johnston, 1913
Qld: THJ, 1913, p.85
Hymenolepis sp.
NSW: T.H. Johnston, 1912b, p.107
Qld, NSW: AHC
Unidentified
Qld, NSW, SA, NT: AHC

N. *Eustrongylides* sp.
NT: AHC
Contracaecum microcephalum (Rudolphi, 1809)
Qld: CIHUS
Contracaecum nycticoracis T.H. Johnston & Mawson, 1941c
NSW: THJ & PMM, 1941c, p.111
Contracaecum spiculigerum (Rudolphi, 1809)
Qld, SA, NT: AHC
Desmidocercella sp.
NT: AHC

61. ***Ixobrychus minutus*** (Linné)
Little Bittern
2/1 : N

N. *Contracaecum* sp.
SA: AHC (immature)
Desmidocercella sp.
SA: specimen lost

62. ***Botaurus poiciloptilus*** (Wagler)
Australian Bittern
1/1 : T C N

T. *Clinostomum complanatum* (Rudolphi, 1814)
syn. *Clinostomum hornum* Nicoll, 1914b
Qld: Nicoll, 1914b, p.123 (immature)
Posthodiplostomum australe Dubois, 1937a
Qld: Dubois, 1937b, p.341
Posthodiplostomum oblongum Dubois, 1937a
Qld: Dubois, 1938, p.291
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205 (metacercariae)
Hexangium sp.
Qld: CIHUS (? in food)
Gyliauchen sp.
Qld: CIHUS (? in food)
Unidentified
NSW: DWRR

C. *Bancroftiella* sp.
Qld: BM(NH)
Unidentified
Qld, NSW: AHC
SA: AHC (cysticercoids)

N. *Capillaria* sp.
Qld: AHC
Contracaecum spiculigerum (Rudolphi, 1809)
SA: THJ & PMM, 1941c, p.111

Contracaecum sp., ? *microcephalum* (Rudolphi, 1809)
Qld: CIHUS
A. *Arhythmorhynchus brevis* Van Cleave, 1916
Qld: CIHUS

Family CICONIIDAE

63. **Xenorhynchus asiaticus** (Latham)
Black-necked Stork
1/1 : T C N

T. *Chaunocephalus ferox* (Rudolphi, 1795)
Qld: Nicoll, 1914b, p.117
C. *Clelandia parva* T.H. Johnston, 1909b
NSW: THJ, 1909b, p.146
N. *Contracaecum* sp.
SA: THJ & PMM, 1941c, p.114
Unidentified
SA (cage): AHC (larva, encysted)

Family PLATALEIDAE

64. **Plegadis falcinellus** (Linné)
Glossy Ibis
1/0

T. *Patagifer bilobus* (Rudolphi, 1819)
Qld: Nicoll, 1914a, p.338
N. *Contracaecum spiculigerum* (Rudolphi, 1809)
Qld: AHC
Physaloptera sp.
Qld: AHC

65. **Threskiornis aethiopica** (Latham)
Sacred Ibis
7/7 : T5 C4 N5 A4

T. *Echinostoma acuticauda* Nicoll, 1914b
Qld: AHC
Patagifer acuminatus S.J. Johnston, 1917
Qld: SJJ, 1917, p.210
syn. *Echinostoma* sp.
Qld: THJ, 1912b, p.107
syn. *Patagifer bilobus* of THJ, 1916, not (Rudolphi, 1819)
Qld: THJ, 1916, p.47
Patagifer sp. [spines 2x (30(4))]
SA: AHC
Patagifer sp. [spines 2x (29(3))]
Vic: AHC
Platynotrema biliosum Nicoll, 1914b
Qld: Nicoll, 1914b, p.118
Hysteromorpha plataleae Dubinina & Dubinin, 1940
Qld: Dubois & LMA, 1972, p.208
Parastrigea sp.
Qld: Dubois & LMA, 1972, p.198
Strigea baylisi Dubois, 1937a
SA: Dubois & LMA, 1972, p.198
Unidentified
SA: AHC (cysts)

C. *Paradilepis urceina* Bona, 1975
SA: Bona, 1975, p.503
Hymenolepididae, unidentified
SA: AHC
Unidentified
Qld, Vic, SA: AHC
N. *Capillaria* sp.
SA: AHC
'Nematoda (? hookworm)'
Qld: CIHUS
Skrjabinoclava sp. cf. *S. alii* Ali, 1968
SA: AHC
Syncuaria contorta (Molin, 1858)
Vic, SA: PMM, 1982, p.19
A. *Polymorphus biziurae* T.H. Johnston & Edmonds, 1948
Tas, SA: AHC

66. **Threskiornis spinicollis** (Jameson)
Straw-necked Ibis
2/1 : N

T. *Echinostoma acuticauda* Nicoll, 1914b
Qld: Nicoll, 1914b, p.110
Patagifer bilobus (Rudolphi, 1819)
Qld: Nicoll, 1914b, p.115
NSW: CIHUS
Strigea baylisi Dubois, 1937a
Qld: Dubois, 1937b, p.235
Opisthorchis obsequens Nicoll, 1914b
NSW: CIHUS
C. *Hymenolepis ibidis* T.H. Johnston, 1913
Qld: CIHUS
Hymenolepis sp.
Aust: BM(NH)
Unidentified
Qld: AHC
Vic: UMVS
N. *Capillaria* sp.
SA: AHC
Physaloptera sp.
Qld: THJ & PMM, 1941e, p.257

67. **Platalea regia** Gould
Royal Spoonbill
1/1 : A

T. *Orchipedum sufflavum* Nicoll, 1914b
Qld: Nicoll, 1914b, p.108
Patagifer bilobus (Rudolphi, 1819)
Qld: SJJ, 1913, p.371
? loc: CIHUS
C. *Cyclorchida omalancristrota* (Wedl, 1856)
Qld: THJ, 1913, p.86; Bona, 1975, p.412
A. Unidentified
SA: specimens lost.

68. **Platalea flavipes** Gould
Yellow-billed Spoonbill
5/5 : T5 C4 N2 A2

T. *Patagifer* sp. [spines 2x ? (29(4))]
SA: AHC

Patagifer sp. [spines 2x (27(? 3))]
Qld: AHC
Schwartzitrema pandubi (Pande, 1939)
SA: Dubois & LMA, 1972, p.205 (cysts)
Strigea baylisi Dubois, 1937a
SA: Dubois & LMA, 1972, p.198
C. *Paradilepis patriciae* Baer & Bona, 1960
SA: Baer & Bona, 1960, p.17; Bona, 1975, p.530
Hymenolepis ibidis T.H. Johnston, 1913
Qld: THJ, 1913, p.88
Hymenolepis sp.
SA: AHC
Unidentified
Qld, SA: AHC
N. *Contracaecum* sp.
SA: AHC
A. *Polymorphus biziurae* T.H. Johnston & Edmonds, 1948
SA: AHC

Family ANATIDAE

69. ***Anseranas semipalmata*** (Latham)

Magpie Goose
1/1 : T C N

T. Schistosomatidae (eggs, from nasal mucosa)
Qld: Blair & Otteson, 1979, p.984
Notocotylus attenuatus (Rudolphi, 1809)
Qld: Nicoll, 1914b, p.125
NT: AHC
Typhlocoelum reticulare S.J. Johnston, 1913
Qld: SJJ, 1913, p. 372
NT: AHC
Echinostoma revolutum (Froelich, 1802)
Qld: Nicoll, 1914b, p.115
Qld: AHC
C. *Angularella australis* (Maplestone, 1921b)*
Aust: BM(NH)
Biuterina sp.
Aust: BM(NH)
Cloacotaenia megalops (Nitzsch in Creplin, 1829)
syn. *Hymenolepis megalops* (Nitzsch, 1829)
Qld: THJ, 1913, p.89
Passerilepis stylosa (Rudolphi, 1810)
Aust: BM(NH)
Sobolevicanthus terraereginae (T.H. Johnston, 1913)
syn. *Hymenolepis terraereginae* T.H. Johnston, 1913
Qld: THJ, 1913, p.89
Unidentified
Qld, Vic, NT: AHC
N. *Amidostomum anseris* (Zeder, 1800)
Vic (cage): UMVS
Epomidiostomum sp.
NT: AHC
Heterakis sp.
Vic (cage): UMVS
Tetrameres anseranas Mawson, 1979
NT: PMM, 1979, p.178
Vic (cage): UMVS
Tetrameres fissispina (Diesing, 1851)
Philadelphia Zoo: Canavan, 1931, p.221
Streptocara crassicauda (Creplin, 1829)
Vic (cage): UMVS

70. ***Dendrocygna arcuata*** (Horsfield)

Wandering Whistling-Duck

T. Schistosomatidae, unidentified
Qld: Blair & Otteson, 1979, p.984 (eggs from nasal mucosa)
Notocotylidae, unidentified
Qld: AHC
Echinostomatinae [spines ? (35(5))]
Qld: AHC
C. *Ophiotaenia hylae* T.H. Johnston, 1912e
Qld: Maplestone, 1921a, p.404 (? with food)
Cloacotaenia megalops (Nitzsch in Creplin, 1829)
Qld: CIHUS
Diorchis flavescens (Krefft, 1873)
Qld: Maplestone, 1921a, p.403
Diplogynia oligorchis (Maplestone, 1922a)
syn. *Coturnia oligorchis* Maplestone, 1922a
Qld: Maplestone, 1922a, p.55
syn. *Diploposthe laevis* of THJ, 1913, not (Bloch, 1782)
Qld: THJ, 1913, p.91
Hymenolepis ibidis (T.H. Johnston, 1913)
Qld: CIHUS
? *Passerilepis zosteropis* (Fuhrmann, 1918)
Aust: BM(NH)
Unidentified
Qld: AHC

71. ***Dendrocygna eytoni*** (Eyton)

Plumed Whistling-Duck (endemic)

T. Schistosomatidae, unidentified
Qld: Blair & Otteson, 1979, p.984 (eggs from nasal mucosa)

72. ***Cygnus atratus*** (Latham)

Black Swan (endemic)
19/19 : T14 C19 N13 A3

T. *Trichobilharzia* sp.
SA: THJ, 1941, p.276
Notocotylus attenuatus (Rudolphi, 1809)
Qld: Nicoll, 1914b, p.125
Notocotylus sp.
Tas, SA: AHC
Paramonostomum caeci Smith & Hickman, 1983b
Tas: Smith & Hickman, 1983b, p.86
Notocotylid, ? sp. B, S.J. Smith, 1981
Qld, Tas: S.J. Smith, 1981, p.256
Notocotylidae, unidentified
NSW, Tas, SA: AHC
Hyptiasmus magnus S.J. Johnston, 1917

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* Yamaguti, 1959, p.235, notes that this species cannot be referred to *Angularella* (syn. *Angularia*) and probably belongs to some other genus.

Vic: SJJ, 1917, p.244
syn. *Monostomum* sp.
Vic: THJ, 1910, p.97
Cyclocoelidae, unidentified
NSW, Vic, SA: AHC
Echinoparyphium ellisi T.H. Johnston & Simpson, 1944
SA: THJ & LMA, 1949, p.251
syn. *Echinoparyphium* sp.
? Qld: Verma, 1936, p.155; see THJ & LMA, 1949, p.253
Echinoparyphium gizzardai Verma, 1936
?Qld: Verma, 1936, p.155; see THJ & LMA, 1949, p.253
? *Echinostoma minimum* Verma, 1936
see Verma, 1936, p.150. We consider the host given by Verma as 'Black Swan' from Patna, Behar, to be an error for Mute Swan, cited as the host of *Echinostoma longicirrum* from the same locality (p.152)
Echinostoma revolutum (Froelich, 1802)
Qld: Nicoll, 1914b, p.115
SA: THJ & LMA, 1941c, p.321
Echinostoma sp. [spines (37(4-5))]
Tas: AHC
Vermatrema longitestis (Verma, 1936)
Calcutta (? cage): Srivastava, 1972, p.177
syn. *Euparyphium longitestis* Verma, 1936
Calcutta (? Qld): Verma, 1936, p.156; see THJ & LMA, 1949, p.253
Echinostomatidae, unidentified
NSW: AHC
Echinostomatinae [spines 41(5))]
SA: AHC (immature)
Psilochasmus oxyurus (Creplin, 1825)
Tas: S.J. Smith, 1981, p.181
Psilostomum sp. A, S.J. Smith, 1981
Tas: S.J. Smith, 1981, p.201 (? this host)
Psilostomum sp. B, S.J. Smith, 1981
Tas: S.J. Smith, 1981, p.214
Psilostomum sp.
SA: AHC
Cylindrotrema cygni Angel, 1973
SA: LMA, 1973, p.854
Apatemon intermedius (S.J. Johnston, 1904)
SA: THJ & LMA, 1951, p.67
syn. *Hemistomum intermedium* S.J. Johnston, 1904
NSW: SJJ, 1904, p.110
Cotylurus magniacetabulus Dubois & Angel, 1972
SA: Dubois & LMA, 1972, p.204
Unidentified
NSW: AHC

C. *Armadoskrjabinia globosa* (Szpotanska, 1931)
syn. *Hymenolepis globosa* Szpotanska, 1931
Aust: Szpotanska, 1931, p.260
Qld: BM(NH)
Australiolepis southwelli (Szpotanska, 1931)
syn. *Hymenolepis southwelli* Szpotanska, 1931
Aust: Szpotanska, 1931, p.260
syn. *Echinorhynchotaenia nana* Maplestone & Southwell, 1922b
Qld: Maplestone & Southwell, 1922b, p.193
Cloacotaenia megalops (Nitzsch in Creplin, 1829)
Warsaw (cage): Kotechi, 1970, p.332
Qld: BM(NH), CIHUS
NSW: DWRR
Vic, SA: AHC
Diorchis spiralis Szpotanska, 1931
Aust: Szpotanska, 1931, p.258
Diorchis stefanski Czaplinski, 1955
Warsaw (cage): Kotechi, 1970, p.332
Drepanidotaenia lanceolata (Bloch, 1872)
Aust: Szpotanska, 1931, p.254
Qld: BM(NH)
NSW: WLRR
Vic, SA: AHC
syn. *Hymenolepis lanceolata* (Bloch, 1782)
Qld: Maplestone & Southwell, 1922b, p.197
Drepanidotaenia rapida (Szpotanska, 1931)
syn. *Hymenolepis rapida* Szpotanska, 1931
Aust: Szpotanska, 1931, p.251
Drepanidotaenia sp.
SA: AHC
Dicranotaenia coronula (Dujardin, 1845)
Warsaw (cage): Kotechi, 1970, p.332
Hymenolepis chenopis Palmer, 1981
Vic: Palmer, 1981, p.126
Hymenolepis sp.
Bengal (cage): Southwell, 1916, p.11
Qld: BM(NH)
Hymenolepis (s.l.) liophallos Krabbe, 1869
Europe (cage): Krabbe, 1869, p.291
"*Hymenolepis variabilis* n.sp. Maplestone"
Qld: CIHUS. We have found no record of publication of this species by Maplestone.
Hymenolepis (s.l.) micrancristrota (Wedl, 1855)
syn. *Taenia micrancristrota* Wedl, 1855
Hungary (cage): Wedl, 1855, p.6
Monosaccanthes curiosa (Szpotanska, 1931)
syn. *Hymenolepis curiosa* Szpotanska, 1931
Aust: Szpotanska, 1931, p.252
Qld: BM(NH)
Monosaccanthes kazachstanica (Maksinova, 1963)
Vic: Palmer, 1981, p.135
Monosaccanthes sp.
SA: AHC
Parabisaccanthes bisacculina (Szpotanska, 1931)
Vic: Palmer, 1981, p.130
Qld: BM(NH)
SA: AHC
syn. *Drepanidotaenia bisacculina* Szpotanska, 1931
Aust: Szpotanska, 1931, p.247
Tscherlkovilepis krabbei (Kowolewski, 1895)
Warsaw (cage): Kotechi, 1970, p.332
Gastrotaenia sp.
SA: AHC
Nematoparataenia paradoxa Maplestone & Southwell, 1922b
Qld: Maplestone & Southwell, 1922b, p.189
Vic, SA: AHC
Aust: BM(NH)
Cyclophyllidea, unidentified
SA: AHC
Unidentified

NSW: Cleland, 1922, p.105
Aust: AM
Qld, NSW, Tas, SA: AHC
Qld: CIHUS (larvae)
Vic: UMVS
N. *Capillaria obsignata* Madison, 1945
England (cage): Wakelin, 1963, p.381
syn. *Capillaria anatis* (Schrank, 1790)
England (cage): Wakelin, 1963, p.381.
Capillaria ellisi T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.247
Amidostomum cygni Wehr, 1933
SA: THJ & PMM, 1947, p.550; PMM, 1980, p.10
Tas: AHC
Amidostomum sp.
NSW: DWRR
Vic: AHC
Pseudamidostom sp.
NSW: DWRR
Trichostrongylus tenuis
England (cage): Wakelin, 1963, p.381.
Heterakis circumvallata (Linstow, 1906b)
Germany: Linstow, 1906b, p.251
Heterakis vesicularis (Froelich, 1791)
syn. *Heterakis papillosa* (Bloch, 1782)
Berlin Zoo: Schneider, 1866, p.69
Tetrameres australis T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.262
SA: AHC
Echinuria uncinata (Rudolphi, 1819)
Vic: UMVS
Tas, SA: AHC
A. *Polymorphus* sp.
SA: AHC
Corynosoma sp.
SA: AHC

73. **Stictonetta naevosa** (Gould)
Freckled Duck (endemic)
19/11 T4 C7 N10

T. Notocotylidae, unidentified
SA: AHC
Echinoparyphium sp. [spines (41(4))]
SA: AHC
Psilochasmus sp.
SA: AHC
Psilostomum sp.
SA: AHC
C. *Diorchis* sp.
NSW: DWRR
Cloacotaenia sp.
NSW: DWRR
Unidentified
SA: AHC
N. *Amidostomum acutum* (Lundahl, 1848)
SA: PMM, 1980, p.9
Amidostomum 'sp. 6'
NSW: DWRR
Tetrameres sp.
SA: AHC
Synhimantus sp.
SA: AHC

74. **Cereopsis novaehollandiae** Latham
Cape Barren Goose (endemic)

T. *Psilochasmus* sp.
Tas: AHC
C. *Fimbriarioides intermedia* (Fuhrmann, 1913)
syn. *Fimbriaria intermedia* Fuhrmann, 1913
Calcutta (cage): Meggitt, 1933, p.153
Sobolevicanthus sp.
SA: AHC
N. *Amidostomum anseris* (Zeder, 1800)
Tas: PMM, 1980, p.9
Heterakis vesicularis (Froelich, 1791)
SA: AHC
syn. *Heterakis caudata* (Linstow, 1906)
Calcutta Zoo: Maplestone, 1932, p.413
Heterakis chenonettae T.H. Johnston, 1912a
Tas: AHC
Heterakis dispar (Schrank, 1790)
Bass Str: BM(NH)

75. **Tadorna tadornoides** (Jardine & Selby)
Australian Shelduck (endemic)
5/5 : T2 C3 N3

T. *Echinoparyphium* sp. [spines incomplete]
SA: AHC
Echinostoma revolutum (Froelich, 1802)
SA: AHC
syn. *"echinostome larvae"*, Bradley, 1927
NSW: Bradley, 1927, p.675
C. *Staphylepis lamellata* (Woodland, 1930)
syn. *Hymenolepis lamellata* Woodland, 1930
London Zoo: Woodland, 1930, p.226
Hymenolepis sp.
Vic: AHC
Unidentified
NSW, SA, Vic: AHC
N. *Epomidiostomum* sp.
NSW: AHC
Tetrameres sp.
Vic: AHC
Echinuria uncinata (Rudolphi, 1819)
Vic: AHC
Streptocara crassicauda (Creplin, 1829)
Vic: AHC

76. **Tadorna radjah** Garnot
Radjah Shelduck
1/1 : N

N. *Amidostomum acutum* (Lundahl, 1848)
NT: PMM, 1980, p.9

77. **Anas superciliosa** Gmelin
Pacific Black Duck
19/19 : T11 C13 N8

T. *Trichobilharzia australis* Blair & Islam, 1983
Qld: Blair & Islam, 1983, p.89

Trichobilharzia sp.
Qld: Blair & Otteson, 1979, p.983
Schistosomatidae (eggs, nasal mucosa)
Qld, NSW, Vic: Blair & Otteson, 1979, p.984
Notocotylus attenuatus (Rudolphi, 1809)
Qld: Nicoll, 1914b, p.127
Paramonostomum bursae Smith & Hickman, 1983b
Tas: Smith & Hickman, 1983b, p.95
Paramonostomum caeci Smith & Hickman, 1983b
Tas: Smith & Hickman, 1983b, p.86
Notocotylidae, unidentified
Qld, SA: AHC
Typhlocoelum sp.
Qld, Vic, SA: AHC
Echinostoma revolutum (Froelich, 1802)
Qld: SJJ, 1913, p.370
NSW, SA: THJ & LMA, 1941c, p.321
Tas: AHC
syn. *Echinostoma* sp.
Qld, NSW: THJ, 1912b, p.108
Hypoderaeum sp.
Qld, SA: AHC
Patagifer sp. [spines 2x ? (26(3))]
NSW: AHC
Echinostomatinae [spines (37(5))]
Qld, SA: AHC
Echinostomatinae [spines (37(5))]
SA: AHC
Echinostomatinae [spines (45(5))]
SA: AHC
Psilochasmus oxyurus (Creplin, 1825)
Tas: S.J. Smith, 1981, p.181
Psilostomum sp.
Qld: AHC
? *Prosthogonimus* sp.
SA: AHC
Levinseniella tasmaniae (S.J. Smith, 1974)
syn. *Microphallus tasmaniae* S.J. Smith, 1974
Tas: S.J. Smith, 1981, p.107
Maritrema calvertense S.J. Smith, 1974
Tas: S.J. Smith, 1981, p.64
Apalemon gracilis (Rudolphi, 1819)
Tas: Smith & Hickman, 1983a, p.23
Cotylurini, unidentified
Qld, SA: AHC
Diplostomidae, unidentified
SA: AHC

C. *Cloacotaenia megalops* (Nitzsch in Creplin, 1829)
Qld: CIHUS
NSW: DWRR
WA: BM(NH)
syn. *Hymenolepis megalops* (Nitzsch in Creplin, 1829)
NSW: THJ, 1912b, p.108
syn. *Taenia cylindrica* Krefft, 1873
NSW: Krefft, 1873, p.220
Diorchis flavescens (Krefft, 1873)
Qld: THJ, 1912a, p.66
Qld: CIHUS
NSW: AHC, DWRR
syn. *Taenia flavescens* Krefft, 1873
EA: Krefft, 1873, p.219
Drepanidotaenia lanceolata (Bloch, 1782)
Qld: BM(NH)
Hymenolepis sp.
NSW: THJ, 1912b, p.108
Qld, SA: AHC
Microsomacanthus collaris (Batsch, 1786)
syn. *Hymenolepis collaris* (Batsch, 1786)
NSW: THJ, 1912b, p.108
syn. *Taenia bairdii* Krefft, 1873
EA: Krefft, 1873, p.224
Fimbriaria fasciolaris (Pallas, 1871)
NSW: THJ, 1912b, p.108
syn. *Taenia pediformis* Krefft, 1873
EA: Krefft, 1873, p.222
Fimbriaria sp.
SA: AHC
Diploposthe laevis (Bloch, 1782)
NSW: THJ, 1912d, p.12
Gastrotaenia sp.
NSW: DWRR
Unidentified
NSW: Cleland, 1922, p.105
Tas: Munday & Green, 1972, p.4
Qld, NSW, Tas, SA, NT: AHC
Vic: MUVS

N. *Capillaria* sp.
NSW: Cleland, 1922, p.105 (AHC)
Amidostomum acutum (Lundahl, 1848)
Tas, SA: Mawson, 1980, p.9
Amidostomum sp.
NSW: DWRR
Epomidiostomum sp.
NSW: DWRR
Tas, SA, NT: AHC
Porrocaecum crassum (Deslongchamps, 1824)
Tas: AHC
Contracaecum microcephalum (Rudolphi, 1809)
NSW: THJ & PMM, 1941c, p.114
Tetrameres fissispina (Diesing, 1861)
SA: THJ & PMM, 1949, p.67
Tas, NT: AHC
Physaloptera sp.
NSW: THJ & PMM, 1941e, p.257
Echinuria sp.
NSW: DWRR

78. ***Anas gibberifrons*** S. Müller

Grey Teal
14/11 : T5 C8 N6

T. *Trichobilharzia* sp.
NSW: Bearup, 1957, p.163 (eggs in nasal mucosa)
Schistosomatidae
Qld, NSW, Vic: Blair & Otteson, 1979, p.984 (eggs in nasal mucosa)
Notocotylidae, unidentified
SA: AHC
Typhlocoelum sp.
SA: AHC
Cyclocoelidae, unidentified
NSW: AHC
Echinostoma sp. [spines (35(4 or 5))]

NT: AHC
Hypoderaeum sp.
SA: AHC
Echinostomatidae, unidentified
NSW: AHC
Echinostomatinae [spines (45(5))]
SA: AHC
Unidentified
NSW: AHC
C. *Cloacotaenia ? megalops*
NSW: DWRR
Diorchis flavescens (Krefft, 1873)
Qld: Baylis, 1934b, p.129
NSW: DWRR
Hymenolepis robertsi Baylis, 1934b
Qld: Baylis, 1934b, p.129
Haploparaxis veitchi Baylis, 1934b
Qld: Baylis, 1934b, p.129
Staphylepis lamellata (Woodland, 1930)
SA: AHC
Gastrotaenia sp.
NSW: DWRR
Unidentified
Vic, SA, NT: AHC, UMVS
N. *Strongyloides* sp.
NSW: DWRR
Capillaria sp.
NSW: DWRR
NT: AHC
Amidostomum acutum (Lundahl, 1848)
SA: PMM, 1980, p.9
Epomidiostomum uncinatum (Lundahl, 1848)
SA: THJ & PMM, 1942e, p.73
Vic: UMVS
Epomidiostomum sp.
NSW: AHC
Tetrameres sp.
SA: THJ & PMM, 1942e, p.71
NSW: DWRR
Echinuria uncinata (Rudolphi, 1819)
NT: AHC
syn. *Echinuria querquedulae* T.H. Johnston & Mawson, 1942e
SA: THJ & PMM, 1942e, p.71
Echinuria sp.
NSW: DWRR
Streptocara sp.
SA: THJ & PMM, 1942e, p.72
NSW: DWRR

79. ***Anas castanea*** (Eyton)
Chestnut Teal (endemic)
1/1 : T C N

T. *Hypoderaeum conoideum* (Bloch, 1782)
Tas: AHC
Hypoderaeum sp.
NSW: AHC
Levinseniella tasmaniae (S.J. Smith, 1974)
syn. *Microphallus tasmaniae* S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.202
Maritrema calvertense S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.201
C. *Cloacotaenia megalops* (Nitzsch in Creplin, 1829)
syn. *Hymenolepis megalops* (Nitzsch in Creplin, 1829)
NSW: THJ, 1912a, p.66
Diorchis flavescens (Krefft, 1873)
NSW: THJ, 1912d, p.15
Diorchis sp.
NSW: DWRR
Diploposthe laevis (Bloch, 1782)
NSW: THJ, 1912d, p.12
Microsomacanthus collaris (Batsch, 1786)
syn. *Hymenolepis collaris* (Batsch, 1786)
NSW: THJ, 1912b, p.108
Fimbriaria fasciolaris (Pallas, 1871)
syn. *Taenia pediformis* Krefft, 1873
NSW: Krefft, 1873, p.222
NSW: THJ, 1912a, p.66
Unidentified
Vic: AHC
N. *Capillaria anatis* (Schrank, 1790)
G. Brit. (cage): Wakelin, 1965, 0.293
Capillaria sp.
Tas: AHC
Epomidiostomum sp.
Tas: AHC
Tetrameres fissispina (Diesing, 1861)
Tas: AHC
Echinuria uncinata (Rudolphi, 1819)
Tas: AHC

80. ***Anas rhynchotis*** Latham
Australian Shoveler
5/5 : T2 C5 N5

T. Schistosomatidae, unidentified
NSW: Blair & Otteson, 1979, p.984 (eggs from nasal mucosa)
Echinostoma revolutum (Froelich, 1802)
SA: THJ & LMA, 1941c, p.321
Echinostomatidae, unidentified,
NSW: AHC
Echinostomatinae [spines (45(5))]
SA: AHC
C. *Cloacotaenia ? megalops* (Nitzsch in Creplin, 1829)
NSW: DWRR
Diorchis flavescens (Krefft, 1873)
syn. *Taenia flavescens* Krefft, 1873
NSW: Krefft, 1873, p.219
Gastrotaenia sp.
NSW: DWRR
Unidentified
NSW: UMVS
SA: AHC
N. *Capillaria* sp.
SA: AHC
Amidostomum acutum (Lundahl, 1848)
NSW: UMVS
Tetrameres sp.
SA: AHC
Streptocara crassicauda (Creplin, 1829)
SA: AHC
Streptocara sp.

NSW: UMVS
Acuariidae, unidentified
NSW: UMVS

81. ***Malacorhynchus membranaceus*** (Latham)

Pink-eared Duck (endemic)
3/2 : T2 C2 N2

T. *Paramonostomum* sp.
SA: AHC
Notocotylidae, unidentified
Vic, SA: AHC
Cyclocoelum sp.
Vic: AHC
Echinostoma sp. [spines incomplete]
Vic: AHC (immature)
? Microphallidae, unidentifiable
SA: AHC
Unidentified
Vic, SA: AHC
C. Unidentified
Vic, SA: AHC
N. *Capillaria* sp.
SA: AHC
Acuariidae, unidentified
SA: AHC (larva)

82. ***Aythya australis*** (Eyton)

Hardhead
5/4 : T3 C4 N2

T. Schistosomatidae (eggs, nasal mucosa)
Qld, NSW: Blair & Otteson, 1979, p.984
Echinostomatidae, unidentified
NSW, SA: AHC
Cyclocoelidae
NSW: AHC
SA: AHC (eggs)
C. *Cloacotaenia*, sp.
NSW: WLRR
Diorchis flavescens (Krefft, 1873)
NSW: THJ, 1912d, p.15
Diplogynia oligorchis (Maplestone, 1922)
Qld: CIHUS
Diplogynia, sp.
NSW: WLRR
? *Sobolevicanthus* sp.
NSW: WLRR
Diploposthe laevis (Bloch, 1782)
Qld: Maplestone, 1922a, p.60
NSW: THJ, 1912d, p.4
Aust: BM(NH)
syn. *Taenia tuberculata* Krefft, 1873
NSW: Krefft, 1873, p.215
Fimbriaria sp.
NSW: WLRR
SA: not kept
Gastrotaenia, sp.
NSW: WLRR
Unidentified
Qld, SA, NT: AHC
Vic: UMVS
N. *Capillaria* sp.
SA: AHC
Epomidiostomum sp.
NSW: WLRR ('sp. 3')
Streptocara crassicauda (Creplin, 1829)
Tas: AHC
Streptocara sp.
Tas: Munday & Green, 1972, p.12

83. ***Chenonetta jubata*** (Latham)

Maned Duck (endemic)

T. Schistosomatidae, unidentified
Qld: Blair & Otteson, 1979, p.984 (eggs from nasal mucosa)
Echinostomatidae, unidentified
NSW: AHC
N. *Heterakis chenonettae* T.H. Johnston, 1912a
NSW: THJ, 1912a, p.71; THJ & PMM, 1941c, p.115
Amidostomum sp.
Qld, NSW: WLRR
Epomidiostomum sp.
NSW: WLRR

84. ***Nettapus coromandelianus*** (Gmelin)

Cotton Pygmy-Goose

T. *Cyclocoelum* sp.
Qld: AHC

85. ***Nettapus pulchellus*** Gould

Green Pygmy-Goose
2/1 : C N

T. *Notocotylus attenuatus* (Rudolphi, 1809)
Qld: Nicoll, 1914b, p.125
Echinostoma revolutum (Froelich, 1802)
Qld: Nicoll, 1914b, p.115
C. Unidentified
NSW: AHC
N. *Echinuria uncinata* (Rudolphi, 1819)
NT: AHC

86. ***Oxyura australis*** Gould

Blue-billed Duck (endemic)
5/5 : T4 C5 N2 A1

T. Notocotylidae, unidentified
Tas, SA: AHC
Echinostomatinae [spines ? (37(5))]
SA: AHC (immature)
Echinostomatinae [spines ? (40(5))]
SA: AHC
Apatemon intermedius (S.J. Johnston, 1904)
SA: Dubois & LMA, 1972, p.201
C. Unidentified
Tas: Munday & Green, 1972, p.4
Tas, SA: AHC
N. *Capillaria* sp.
SA: AHC
Epomidiostomum sp.
Tas: AHC

Streptocara crassicauda (Creplin, 1829)
Tas: AHC
A. Unidentified
Tas: specimens lost

87. ***Biziura lobata*** (Shaw)
Musk Duck (endemic)
17/17 : T16 C13 N7 A9

T. Notocotylidae, unidentified
NSW, SA: AHC
Echinoparyphium ellisi (T.H. Johnston & Simpson, 1944)
SA: THJ & LMA. 1949, p.248
Echinostoma revolutum (Froelich, 1802)
Qld, SA: THJ & LMA, 1941c, p.321
Echinostomatinae [spines (35(5))]
Qld, SA: AHC
Echinostomatidae [spines (37(5))]
NSW
Echinostomatidae, unidentified
NSW: AHC
Psilochasmus sp.
SA: AHC
Apatemon vitelliresiduus Dubois & Angel, 1972
Qld, SA: Dubois & LMA, 1972, p.199
Unidentified
NSW: AHC
C. *Taenia moschata* Krefft, 1873
NSW: Krefft, 1873, p.223
(THJ, 1912d, p.3 noted that specimens lost)
Cyclophyllidea, unidentified
SA: AHC
Cloacotaenia ? megalops (Nitzsch in Creplin, 1829)
NSW: DWRR
Sobolevicanthus sp.
NSW: DWRR
Gastrotaenia sp.
NSW: DWRR
Unidentified
Qld, NSW, Tas, SA: AHC
N. *Capillaria* sp.
NSW: DWRR
Amidostomum biziurae T.H. Johnston & Mawson, 1947
SA: THJ & PMM, 1947, p.551; PMM, 1959, p.152
NSW, SA: PMM, 1980, p.9
Amidostomum sp. (sp. 5)
NSW: DWRR
Tetrameres biziurae T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.261
NSW: AHC
Streptocara recta (Linstow, 1879)
SA: AHC
Streptocara formosensis Sugimoto, 1930
NSW: AHC
A. *Polymorphus biziurae* T.H. Johnston & Edmonds, 1948
SA: THJ & Edmonds, 1948, p.71
NSW, SA: AHC

Family ACCIPITRIDAE

88. ***Elanus notatus*** Gould
Black-shouldered Kite (endemic)
3/0

N. *Porroccaeum circinum* T.H. Johnston & Mawson, 1941b
Vic: AHC

89. ***Aviceda subcristata*** Gould
Pacific Baza

T. *Neodiplostomum spathula* (Creplin, 1829)
syn. *Neodiplostomum australiense* Dubois, 1937a
Qld: Dubois, 1937b, p.337
A. *Centrorhynchus asturinus* (T.H. Johnston, 1913)
NSW: THJ, 1918, p.215
syn. *Echinorhynchus bazae* Southwell & Macfie, 1925
Qld: Southwell & Macfie, 1925, p.177
Unidentified
Qld: CIHUS

90. ***Milvus migrans*** (Boddaert)
Black Kite
3/1 C N

C. Unidentified
SA: AHC
N. *Procyrnea mansioni* (Seurat, 1914)
SA: AHC

91. ***Haliastur sphenurus*** (Vieillot)
Whistling Kite
9/5 : T3 C1 N1

T. Echinostomatinae [spines (45(5))]
SA: AHC (not mature)
Haplorchis paravanissimus Pearson & Ow-Yang, 1982
Qld: Pearson & Ow-Yang, 1982, p.50
syn. *H. vanissimus* of Pearson, 1964 (in part) not Africa, 1938
Qld: Pearson, 1964, p.633; Pearson & Ow-Yang, 1982, p.50
Haplorchis vanissimus Africa, 1938
Qld: Pearson, 1964, p.633; Pearson & Ow-Yang, 1982, p.49
Haplorchis yokogawai (Katsuta, 1932)
Qld: Pearson, 1964, p.622
Procerovum varium Onji & Nishio, 1916
Qld: Pearson, 1964, p.654
Stellantchasmus falcatus Onji & Nishio, 1916
Qld: Pearson, 1964, p.665
Mesostephanus haliasturis Tubangui & Masilungan, 1941
SA: AHC
syn. *Mesostephanus minor* Dubois & Pearson, 1965
Qld: Dubois & Pearson, 1965, p.97
? *Diplostomum spathaceum* (Rudolphi, 1819)
SA: AHC

Neodiplostomum spathula (Creplin, 1829)
Qld: Dubois & Pearson, 1967, p.196
NSW: Dubois, 1938, p.264
Neodiplostomum subaequipartitum Dubois & Pearson, 1967
Qld: Dubois & Pearson, 1967, p.199
SA: Dubois & LMA, 1972, p.210
Strigea glandulosa Dubois, 1937a
Qld: Dubois, 1937b, p.244
SA: Dubois & LMA, 1972, p.198
Allocreadiidae, unidentified
SA: AHC (metacercariae)

C. Unidentified
SA, NT: AHC

N. *Capillaria* sp.
SA: AHC
Contracaecum ceylanicum (Linstow, 1904)
Qld: CIHUS
Procyrnea mansioni (Seurat, 1914)
syn. *Cyrnea mansioni* (Seurat, 1914)
Qld: PMM, 1968d, p.749
Microfilaria sp.
Qld: Mackerras, 1962, p.436

92. ***Accipiter fasciatus*** (Vigors & Horsfield)
Brown Goshawk
10/8 : T2 N8 A3

T. *Apatemon intermedius* (S.J. Johnston, 1904)
SA: Dubois & LMA, 1972, p.201

C. Unidentified
Qld, SA: AHC

N. *Microtetrameres paraccipiter* Mawson, 1977
Qld, Tas, SA, NT: PMM, 1977, p.253
Microtetrameres sp.
Vic: AHC
Spirurida, unidentified
NT: AHC (larva)

A. *Centrorhynchus asturinus* (T.H. Johnston, 1913)
Qld: Southwell & Macfie, 1925, p.163
SA: THJ & Deland, 1929, p.148
NT: AHC
syn. *Echinorhynchus* sp.
NSW: THJ, 1910, p.100

93. ***Accipiter cirrhocephalus*** (Vieillot)
Collared Sparrowhawk
5/5 : T2 C1 N5

T. *Neodiplostomum spathula* (Creplin, 1829)
Qld: Dubois & LMA, 1972, p.209
Tas: AHC
syn. Strigeidae, unidentified
Tas: Munday & Green, 1972, p.3

C. *Anomotaenia accipitris* T.H. Johnston, 1913
Qld: THJ, 1913, p.82
Unidentified
Tas: Munday & Green, 1972, p.4

N. *Physaloptera* sp.
SA: AHC (immature Qs)
Microtetrameres sp.
Tas, SA: PMM, 1977, p.257
Synhimantus sp.
Tas: AHC
Serratospiculum tendo (Nitzsch in Giebel, 1857)
Qld: Mackerras, 1962, p.432
? loc: CIHUS
Serratospiculum guttatum (Schneider, 1866)
NT: AHC
Tas: Munday & Green, 1972, p.12
Hamatospiculum sp.
Qld: THJ & PMM, 1941b, p.35
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.430
Qld: Mackerras, 1962, p.436
Spirurida, unidentified
Tas: AHC (encysted larvae)

A. *Centrorhynchus asturinus* (T.H. Johnston, 1913)
Qld: Southwell & Macfie, 1925, p.163
Qld: CIHUS
NSW: THJ & Deland, 1929, p.148

94. ***Accipiter novaehollandiae*** (Gmelin)
Grey Goshawk

N. *Porrocaecum circinum* T.H. Johnston & Mawson, 1941b
Qld: THJ & PMM, 1941b, p.34
Thelazia aquilina Baylis, 1934a
Qld: Baylis, 1934a, p.150
Qld: THJ & PMM, 1941b, p.34
syn. 'nematode'
Qld: Cleland, 1922, p.107
Procyrnea mansioni (Seurat, 1914)
syn. *Cyrnea mansioni* (Seurat, 1914)
Qld: PMM, 1968d, p.749
Procyrnea ? leptoptera (Rudolphi, 1819)
? Qld: BM(NH)
Synhimantus fieldingi (Baylis, 1934a)
syn. *Acuaria fieldingi* Baylis, 1934a
Qld: Baylis, 1934a, p.144

A. *Centrorhynchus asturinus* (T.H. Johnston, 1913)
Qld: THJ, 1918, p.215
Qld: Southwell & Macfie, 1925, p.163
syn. *Gigantorhynchus asturinus* T.H. Johnston, 1913
Qld: THJ, 1912b, p.108

95. ***Haliaeetus leucogaster*** (Gmelin)
White-bellied Sea-Eagle
1/1 : T

T. *Scaphanocephalus australis* S.J. Johnston, 1917
NSW: SJJ, 1917, p.188
syn. *Scaphanocephalus* sp.
? NSW: SJJ, 1914, p.243
Neodiplostomum spathula (Creplin, 1829)
SA: Dubois & LMA, 1972, p.209

N. *Capillaria* sp.
Tas: AHC
Thelazia aquilina Baylis, 1934a
Qld: Baylis, 1934a, p.150
Synhimantus sp.
Tas: AHC

96. ***Aquila audax*** (Latham)
Wedge-tailed Eagle
4/1 : N

T. *Neodiplostomum spathula* (Creplin, 1829)
SA: Dubois, 1982, p.109
Strigea glandulosa Dubois, 1937a
SA: Dubois, 1982, p.109
N. *Thelazia aquilina* Baylis, 1934l
Qld: Baylis, 1934a, p.150
Microtetrameres paraccipiter Mawson, 1977
Tas: AHC
'Eye worms'
Qld: Nicoll, 1914c, p.243

97. ***Hieraaetus morphnoides*** (Gould)
Little Eagle
1/0

N. *Porrocaecum circinum* T.H. Johnston & Mawson, 1941b
SA: THJ & PMM, 1941b, p.30

98. ***Circus assimilis*** Jardine & Selby
Spotted Harrier
1/1 : N A

C. *Cladotaenia feuta* Meggitt, 1933
Calcutta Zoo: Meggitt, 1933, p.161
Cladotaenia sp.
Vic: AHC
N. *Porrocaecum circinum* T.H. Johnston & Mawson, 1941b
SA: THJ & PMM, 1941b, p.30
Procyrnea mansioni (Seurat, 1914)
NT: AHC
Microtetrameres circi PMM, 1977
NT: PMM, 1977, p.255
A. Unidentified
NT: specimen not kept

99. ***Circus approximans*** Peales
Swamp Harrier
4/4 : T2 C3 N2

T. *Opisthorchis* sp.
SA: AHC
Neodiplostomum spathula (Creplin, 1829)
SA: Dubois & LMA, 1972, p.209
Parastrigea repens (Chase, 1921)
SA: Dubois & LMA, 1972, p.198
Strigea glandulosa Dubois, 1937a
SA: Dubois & LMA, 1972, p.198
C. *Cladotaenia* sp.
Vic: AHC
Unidentified
Tas, SA: AHC
N. *Capillaria* sp.
SA: AHC
Porrocaecum sp.
Tas: AHC
A. *Centrorhynchus asturinus* (T.H. Johnston, 1913)
Qld: THJ, 1918, p.216
NSW, SA: AHC

Family FALCONIDAE

100. ***Falco subniger*** Gray
Black Falcon (endemic)
1/0

T. *Neodiplostomum spathula* (Creplin, 1829)
SA: Dubois & LMA, 1972, p.209
Strigea glandulosa Dubois, 1937a
SA: Dubois & LMA, 1972, p.199
C. *Cladotaenia* sp.
SA: AHC
N. *Serratospiculum tendo* (Nitzsch in Giebel, 1857)
SA: AHC

101. ***Falco peregrinus*** Tunstall
Peregrine Falcon
3/3 : T1 C1 N3

T. *Neodiplostomum spathula* (Creplin, 1829)
SA: Dubois & LMA, 1972, p.209
Neodiplostomum sp.
NSW: CIHUS
Diplostomidae, unidentified
SA: AHC
Strigeidae, unidentified
SA: AHC
C. Unidentified
SA: AHC
N. *Contracaecum* sp.
NSW: AHC
Microtetrameres raptoris Mawson, 1977
SA: PMM, 1977, p.255
Physaloptera sp.
SA: AHC
Serratospiculum guttatum (Schneider, 1866)
SA: Bain & PMM, 1981, p.275
Serratospiculum tendo (Nitzsch in Giebel, 1857)
SA: Bain & PMM, 1981, p.275
NSW: AHC
Vic: UMVS
syn. *S. guttatum* (Schneider, 1866)
SA, NT: THJ & PMM, 1941b, p.34
Spirurida, unidentified
SA: AHC (encysted larva)

102. ***Falco longipennis*** Swainson
Australian Hobby
7/7 : N7 A1

N. *Physaloptera alata* Baylis, 1925
Qld: Baylis, 1925, p.115
Procyrnea falco (Mawson, 1968d)
Tas, SA, NT: AHC
syn. *Cyrnea falco* Mawson, 1968d
NT: PMM, 1968d, p.752
Tas: Munday & Green, 1972, p.10
Tetrameres sp.
NT: AHC
Microtetrameres raptoris Mawson, 1977

NT: PMM, 1977, p.255
Geopetitia falco Mawson, 1966
NT: PMM, 1966, p.717
Synhimantus falco Mawson, 1982
WA: AHC
Serratospiculum guttatum (Schneider, 1866)
SA, WA: THJ & PMM, 1941b, p.34
Tas: Munday & Green, 1972, p.12
SA: Bain & PMM, 1981, p.273
Vic, Tas, NT: AHC
syn. *S. attenuatum* (Rudolphi, 1819)
Qld: Baylis, 1925, p.112
Serratospiculum tendo (Nitzsch in Giebel, 1857)
Qld: BM(NH)
SA, NT: AHC
Splendidofilariinae, unidentified
NT: AHC
'Filarial worms'
Tas: Cleland, 1922, p.107
Spirurida, unidentified
NT: AHC (encysted larvae)
A. Unidentified
NT: specimen not kept

103. ***Falco hypoleucos*** Gould
Grey Falcon (endemic)

C. Unidentified
SA: AHC
N. *Hamatospiculum* sp., near *H.quadridens* (Molin, 1858)
Qld: CIHUS, BM(NH)
Serratospiculum guttatum (Schneider, 1866)
NSW: BM(NH)
Microfilaria sp.
Qld: Breinl, 1913a, p.34 (CIHUS)

104. ***Falco berigora*** Vigors & Horsfield
Brown Falcon
13/11 : C1 N11 A6

T. *Episthmium prosthovitellatum* (Nicoll, 1914b)
Qld: CIHUS
syn. *Echinochasmus prosthovitellatus* Nicoll, 1914b
Qld: Nicoll, 1914b, p.115
Psilochasmus sp.
Qld: CIHUS
Opisthorchis obsequens Nicoll, 1914b
Qld: Nicoll, 1914b, p.106
Strigea glandulosa Dubois, 1937a
syn. *Strigea falconis* Dubois, 1937b (not Szidat, 1928)
Aust. (? Qld): Dubois, 1937b, pp.244,247
Strigea sp., indeterminable
Qld: CIHUS
C. Unidentified
Tas, SA, NT: AHC
Tas: Cleland, 1922, p.105 (AHC)
Tas: Munday & Green, 1972, p.4
N. *Capillaria* sp.
Qld: CIHUS
Porrocaecum angusticolle (Molin, 1860)
Qld: CIHUS
Procyrnea falco (Mawson, 1968d)
Tas, NT: AHC
syn. *Cyrnea falco* Mawson, 1968d
SA: PMM, 1968d, p.752
Procyrnea mansioni (Seurat, 1914)
syn. *Cyrnea mansioni* (Seurat, 1914)
NSW: PMM, 1968d, p.749
Procyrnea ? leptoptera (Rudolphi, 1819)
Qld: BM(NH)
Tetrameres sp.
NT: AHC
Microtetrameres raptoris Mawson, 1977
SA, NT: PMM, 1977, p.255
Synhimantus flindersi (T.H. Johnston & Mawson, 1941b)
syn. *Acuaria flindersi* T.H. Johnston & Mawson, 1941b
Tas: THJ & PMM, 1941b, p.31
syn. 'nematode'
Tas: Cleland, 1922, p.105 (AHC)
Synhimantus falco Mawson, 1982
SA: PMM, 1982, p.24
Tas: AHC
Physaloptera hieracidiae T.H. Johnston & Mawson, 1941b
Tas: THJ & PMM, 1941b, p.31
Bancroftinema dentatum T.H. Johnston & Mawson, 1941b
Qld: THJ & PMM, 1941b, p.33
Thelazia aquilina Baylis, 1934a
Qld: Baylis, 1934a, p.150
Qld: CIHUS
Serratospiculum guttatum (Schneider, 1866)
syn. *Filaria guttata* Schneider, 1866
SA: Schneider, 1866, p.80
Diplotriaena falconis (Connal, 1912)
SA: Bain & Mawson, 1981, p.283
'Eye worms'
Qld: Nicoll, 1914c, p.244
A. *Centrorhynchus falconis* (T.H. Johnston & Best, 1943)
syn. *Gordiorhynchus falconis* T.H. Johnston & Best, 1943
NT: THJ & Best, 1943, p.229
Centrorhynchus asturinus (T.H. Johnston, 1913)
Qld: Southwell & Macfie, 1925, p.164
NSW: THJ & Deland, 1929, p.148
SA, NT: AHC
Qld: CIHUS

105. ***Falco cenchroides*** Vigors & Horsfield
Australian Kestrel
7/5 : C1 A4

C. Unidentified
SA: AHC
N. *Procyrnea falco* (Mawson, 1968d)
SA, NT: AHC
Procyrnea paraleptoptera (T.H. Johnston & Mawson, 1941b)
syn. *Cyrnea paraleptoptera* T.H. Johnston & Mawson, 1941b

Qld: THJ & PMM, 1941b, p.32
Microtetrameres raptoris Mawson, 1977
SA: PMM, 1977, p.255
Synhimantus falco Mawson, 1982
SA: PMM, 1982, p.24
A. *Centrorhynchus asturinus* (T.H. Johnston, 1913)
Qld, SA: AHC

Family MEGAPODIIDAE

106. ***Leipoa ocellata*** Gould
Mallee Fowl (endemic)
2/2 : C2 N2

C. *Raillietina leipoae* T.H. Johnston & Clark, 1948b
SA: THJ & Clark, 1948b, p.88
Raillietina sp.
SA: THJ & Clark, 1948b, p.90
N. *Leipoanema ellisi* THJ & PMM, 1942e
SA: THJ & PMM, 1942e, p.73

107. ***Alectura lathami*** Gray
Australian Brush Turkey (endemic)

C. *Davainea* sp.
Qld: AHC
Raillietina sp.
SA (cage): AHC
Unidentified
Qld: AHC
N. *Capillaria* sp.
Qld: AHC
Syngamus sp.
Qld: AHC
Odontoterakis bancrofti (T.H. Johnston, 1912a)
Qld: AHC
syn. *Heterakis bancrofti* T.H. Johnston, 1912a
Qld: THJ, 1912a, p.72
Ascaridia catheturina (T.H. Johnston, 1912a)
Qld: THJ & PMM, 1942a, p.93
syn. *Heterakis catheturinus* T.H. Johnston, 1912a
Qld: THJ, 1912a, p.73
Gongylonema alecturae T.H. Johnston & Mawson, 1942a
Qld: THJ & PMM, 1942a, p.92
Lissonema sp.
Qld: AHC
A. *Mediorhynchus alecturae* (T.H. Johnston & Edmonds, 1947)
syn. *Empodius alecturae* T.H. Johnston & Edmonds, 1947
Qld: THJ & Edmonds, 1947, p.557
syn. *Echinorhynchus* sp.
Qld: THJ, 1912b, p.106

Family PHASIANIDAE

108. ***Coturnix novaezelandiae*** Quoy & Gaimard
Stubble Quail (endemic)
5/1 : C

C. Unidentified
NSW: AM
SA: AHC

109. ***Coturnix ypsilophora*** Bosc
Swamp Quail
10/9 : T1 N8

T. Echinostomatidae [spines missing]
Tas: discarded
C. *Metroliasthes* sp.
Vic: AHC
N. *Tetrameres* sp.
Tas: AHC
Cyrnea colini Cram, 1927
Tas: AHC
Cheilospirura gruveli (Gendre, 1913)
Tas: PMM, 1982, p.23
A. Unidentified
SA (cage): AHC (cyst)

Family TURNICIDAE

110. ***Turnix castanota*** (Gould)
Chestnut-backed Button-quail (endemic)
2/2 : T1 A2

T. *Skrjabinosomum mawsoni* Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.124
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: AHC (cyst)

111. ***Turnix velox*** (Gould)
Little Button-quail (endemic)
4/1 : N

N. Acuariidae, unidentified
NT: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
Qld: Hall Exped. Report, 1974, p.35 (cyst)

112. ***Turnix pyrrhothorax*** (Gould)
Red-chested Button-quail (endemic)

N. *Capillaria* sp.
SA (cage): AHC

Family PEDIONOMIDAE

113. ***Pedionomus torquatus*** Gould
Plains Wanderer (endemic)
1/1 : A

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Deland, 1929, p.148 (cyst)

Family RALLIDAE

114. ***Rallus philippensis*** Linné
Buff-banded Rail
4/1 : T

T. *Leucochloridium* sp.
SA: AHC
A. Unidentified
Qld: AHC (part of worm only)

115. ***Rallus pectoralis*** Temminck
Lewin's Rail
3/3 : T1 N2

T. Unidentified
Tas: specimen not kept
N. *Capillaria* sp.
Tas: Munday & Green, 1972, p.6
Tas: AHC

116. ***Porzana pusilla*** (Pallas)
Baillon's Crake
3/3 : T1 N2

T. ? *Catatropis* sp.
SA: AHC
Echinostoma sp. [spines missing]
SA: AHC
Echinostomatinae [spines (45(4-5))]
SA: AHC (immature)
N. *Capillaria* sp.
SA: AHC
Tetrameres globosa (Linstow, 1879)
SA: PMM, 1979, p.180

117. ***Porzana fluminea*** Gould
Australian Crake (endemic)
14/13 : T3 N13

T. ? *Catatropis* sp.
SA: AHC
Cyclocoelidae, unidentified
SA: AHC (larvae)
Echinostomatinae [spines missing]
SA: discarded (immature)
N. *Capillaria* sp.
SA: AHC
Porrocaecum ensicaudatum (Zeder, 1800)
SA: AHC
Tetrameres globosa (Linstow, 1879)
SA, NT: PMM, 1979, p.180
Acuariidae, unidentified
SA: not kept (larva)

118. ***Porzana tabuensis*** (Gmelin)
Spotless Crake
2/2 : N

N. *Tetrameres globosa* (Linstow, 1879)
SA: PMM, 1979, p.180

119. ***Gallinula mortierii*** (Du Bus)
Tasmanian Native-hen (endemic)
5/3 : N

N. *Capillaria* sp.
Tas: AHC
Tetrameres globosa (Linstow, 1879)
Tas: AHC
syn. *Tetrameres* sp.
Tas: Munday & Green, 1972, p.11

120. ***Gallinula ventralis*** Gould
Black-tailed Native-hen (endemic)
7/4 : T2 N2

T. ? *Catatropis* sp.
SA: AHC
? *Echinostomam hilliferum* Nicoll, 1914b
Qld: AHC
Echinostomatidae, unidentified
SA: believed lost (immature)
C. Unidentified
Qld: AHC
N. *Amidostomum tribonyx* Mawson, 1980
SA: PMM, 1980, p.10

121. ***Gallinula tenebrosa*** Gould
Dusky Moorhen
12/7 : T7 C2 N2

T. *Catatropis gallinulae* T.H. Johnston, 1928
SA: THJ, 1928, p.135
? *Paramonostomum* sp.
NSW: AHC
Echinostoma australe T.H. Johnston, 1928
SA: THJ, 1928, p.138
Echinostoma bancrofti T.H. Johnston, 1928
Qld: THJ, 1928, p.140
? *Echinostoma revolutum* (Froelich, 1802)
SA: discarded
Echinostoma sp. [spines (37(5))]
Qld, SA: AHC
Unidentified
SA: AHC (immature)
C. Unidentified
Qld, SA: AHC
N. *Capillaria* sp.
SA: AHC
Amidostomum sp.
NSW: WLRR

122. ***Porphyrio porphyrio*** (Linné)
Purple Swamphen
18/5 : T4 N1

T. *Echinostoma hilliferum* Nicoll, 1914b
Qld: Nicoll, 1914b, p.112
Qld, SA: AHC
Cyclocoelum sp.
NSW: CIHUS
Echinostoma sp. [spines (35(5))]
SA: AHC
Echinostomatinae [spines 35(5))]
SA: AHC
Echinostomatinae [spines ? (27(4))]
SA: AHC
Distoma sp.
NSW: Krefft, 1873, p.213
C. Unidentified
SA: AHC
N. *Capillaria* sp.
? loc: AHC
Tetrameres globosa (Linstow, 1879)
SA: AHC

123. ***Fulica atra*** Linné
Eurasian Coot
3/3 : T1 N2

T. *Echinostoma hilliferum* Nicoll, 1914b
Qld: Nicoll, 1914b, p.112
'Echinostome larvae'
NSW: Bradley, 1926, p.575; 1927, p.675
Psilochasmus oxyurus (Creplin, 1825)
Tas: S.J. Smith, 1981, p.181
Atriophallophorus coxiellae S.J. Smith, 1974
Tas: S.J. Smith, 1981, p.181
C. *Hymenolepis* sp.
Qld: AHC
Unidentified
NSW: Bradley, 1927, p.675
Qld, SA: AHC
N. *Amidostomum fulica* (Rudolphi, 1819)
Vic: UMVS
SA: AHC
Pelecitus fulicaeatrae (Diesing, 1861)
Vic: UMVS
Unidentified
NSW: Bradley, 1927, p.675 (non-bursate)

Family GRUIDAE

124. ***Grus rubicundus*** (Perry)
Brolga

T. *Allopyge antigones* S.J. Johnston, 1913
Qld: SJJ, 1913, p.375
syn. 'monostome'
Qld: Nicoll, 1914c, p.244
Echinostoma australasianum Nicoll, 1914a
Qld: Nicoll, 1914a, p.337
Prosthogonimus sp.
Qld: AHC
N. *Porrocaecum serpentulum* (Rudolphi, 1809)
syn. *Ascaris serpentula* Rudolphi, 1809
Germany (Mus.): Linstow, 1899, p.7
Ascaridia stroma (Linstow, 1899)
Qld: UQDP

125. ***Grus antigone*** (Linné)
Sarus Crane

N. *Ascaridia stroma* (Linstow, 1899)
NSW (cage): AHC

Family OTIDIDAE

126. ***Ardeotis australis*** (Gray)
Australian Bustard (endemic)
1/1 : C

T. *Philophthalmus* sp.
NT: AHC
C. *Idiogenes* sp.
Vic (cage): AHC
Ascometra sp.
Vic (cage): AHC
Unidentified
Qld, Vic (cage), SA (cage), NT: AHC
Vic (cage): UMVS
N. *Hartertia* sp.
WA: AHC
Excisa dentifera (T.H. Johnston & Mawson, 1941d)
syn. *Cyrnea dentifera* T.H. Johnston & Mawson, 1941d
NT: THJ & PMM, 1941d, p.255

Family JACANIDAE

127. ***Irediparra gallinacea*** (Temminck)
Comb-crested Jacana
1/1 : T

T. ? Echinostomatidae, unidentifiable
NT: AHC (fragment)

Family BURHINIDAE

128. ***Burhinus magnirostris*** (Latham)
Bush Thick-knee

T. *Notocotylus attenuatus* (Rudolphi, 1809)
Qld: Nicoll, 1914b, p.125
Echinostoma ignavum Nicoll, 1914b
Qld: CIHUS
Platynotrema biliosum Nicoll, 1914b
Qld: Nicoll, 1914b, p.118
Platynotrema jecoris Nicoll, 1914b
Qld: Nicoll, 1914b, p.120
Strigea nicolli Dubois, 1937a
Qld: Dubois, 1937b, p.241
C. *Angularella australis* (Maplestone, 1921b)*

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*Yamaguti, 1959, p.235, notes that this species cannot be referred to *Angularella* (syn. *Angularia*) and probably belongs to some other genus.

syn. *Angularia australis* Maplestone, 1921b
Qld: Maplestone, 1921b, p.407
Choanotaenia sp.
Aust: BM(NH)
Paricterotaenia sp.
Aust: BM(NH)
Unidentified
Qld: AHC

Family HAEMATOPODIDAE

129. ***Haematopus longirostris*** Vieillot
Pied Oystercatcher

C. Unidentified
Qld, SA: AHC
A. *Prosthorhynchus* sp.
Tas: AHC

130. ***Haematopus fuliginosus*** Gould
Sooty Oystercatcher (endemic)
1/1 : C N A

C. Unidentified
SA: AHC
N. *Sciadocara* sp.
SA: AHC
A. *Filicollis sphaerocephalus* (Bremser, 1819)
Tas, SA: AHC

Family CHARADRIIDAE

131. ***Vanellus miles*** (Boddaert)
Masked Lapwing
11/11 : C7 N10 A2

T. *Notocotylus attenuatus* (Rudolphi, 1809)
Qld: Nicoll, 1914b, p.125
Cyclocoelum obscurum (Leidy, 1887)
Qld: Hall Exped. Report, 1974, p.354
Haematrotrephus consimilis Nicoll, 1914b
Qld: Nicoll, 1914b, p.124
Plagiorchiidae, unidentified
syn. Lepodermatidae, unidentified
Qld: Nicoll, 1914b, p.106
Echinostoma ignavum Nicoll, 1914b
Qld: Nicoll, 1914b, p.114
Echinostoma sp. [spines ? (35(5))]
Tas: AHC
C. *Angularella* sp.
SA: AHC
Choanotaenia southwelli Fuhrmann, 1932
syn. *Monopylidium macracanthum* of Maplestone & Southwell, 1923, not Fuhrmann, 1907
Qld: Maplestone & Southwell, 1923, p.322
Qld: CIHUS
Lapwingia adelaidae Schmidt, 1972
Qld: Schmidt, 1972, p.1085
Gyrocoelia australiensis T.H. Johnston, 1910
Qld: Maplestone & Southwell, 1922a, p.61
Qld, SA: Schmidt, 1972, p.1089
syn. *Gyrocoelia* sp.
Qld: THJ, 1914a, p.108
Gyrocoelia sp.
NSW: CIHUS
Infula burhini Burt, 1939
Qld, SA: Schmidt, 1972, p.1038
syn. '*Shipleya lobivanellus* Maplestone'
Qld: CIHUS, AHC
Unidentified
? NSW: Bradley, 1927, p.675
Tas: Munday & Green, 1972, p.6
Qld, Tas, SA: AHC
N. *Capillaria triloba* Linstow, 1875
SA: PMM, 1968b, p.279
Tas: Munday & Green, 1972, p.6
Porrocaecum lobibicis Mawson, 1968b
SA: PMM, 1968b, p.284
Tas: Munday & Green, 1972, p.9
Tas, Vic: AHC
Tetrameres lobibicis Mawson, 1968b
SA: PMM, 1968b, p.300
Tas: AHC
Tetrameres sp.
Tas: Munday & Green, 1972, p.11
Streptocara crassicauda (Creplin, 1829)
Tas: Munday & Green, 1972, p.12
Streptocara sp.
Tas: AHC
Pseudaproctella ? sp.
Qld: PMM, 1968b, p.302
Microfilaria sp.
Qld: Mackerras, 1962, p.436
A. *Prosthorhynchus* sp.
Tas: AHC

132. ***Vanellus tricolor*** (Vieillot)
Banded Lapwing (endemic)
6/4 : C3 N1 A1

C. *Paricterotaenia zoniferae* (T.H. Johnston, 1912c)
syn. *Choanotaenia zoniferae* T.H. Johnston, 1912c
NSW: THJ, 1912c, p.212
Unidentified
SA: AHC
N. Unidentified
NT: specimen lost
A. Unidentified
SA: specimen lost

133. ***Pluvialis dominica*** (P.L.S. Müller)
Lesser Golden Plover

T. *Acanthoparyphium spinulosum* S.J. Johnston, 1917
NSW: SJJ, 1917, p.198
Tas: AHC
syn. *Echinostoma* sp.
NSW: THJ, 1910, p.93
Echinostomatidae, unidentified
Tas: Munday & Green, 1972, p.3
Levinseniella howensis S.J. Johnston, 1917
NSW: SJJ, 1917, p.221
NSW: Pearson & Deblock, 1979, p.32

Levinseniella microovata Belopolskaya, 1958
Qld: Deblock & Pearson, 1970, p. 777
Microphallus papillornatus Deblock & Pearson, 1969
Qld: Deblock & Pearson, 1969, p.396
Microphallus vaginosus Deblock & Pearson, 1969
Qld: Deblock & Pearson, 1969, p.403
C. Unidentified
NSW: AHC

134. ***Erythrogonys cinctus*** Gould

Red-kneed Dotterel
10/10 : T6 C10 N1

T. Notocotylidae, unidentified
SA: AHC (immature)
Echinostomatidae [spines ? (35-37(5))]
SA: AHC (immature)
Echinostomatidae [spines ? (33(4))]
SA: AHC (immature)
Unidentified
SA: AHC (immature)
C. Unidentified
SA: AHC
N. Acuaridae, unidentified
SA: AHC (larva)

135. ***Charadrius rubricollis*** Gmelin

Hooded Plover (endemic)
2/2 : N2 A2

T. *Atriophallophorus coxiellae* S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.200 (immature)
Levinseniella tasmaniae (S.J. Smith, 1974)
syn. *Microphallus tasmaniae* S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.203
Maritrema calvertense S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.201
N. *Stellocaronema charadrii* Mawson, 1968b
SA: PMM, 1968b, p.294
Skrjabinoclava horrida (Rudolphi, 1809)
SA: PMM, 1968b, p.292
A. *Plagiorhynchus charadrii* (Yamaguti, 1939b)
syn. *Prosthorhynchus charadrii* Yamaguti, 1939b
SA: THJ & SJE, 1947, p.561

136. ***Charadrius mongolus*** Pallas

Mongolian Plover (migratory)

T. *Endocotyle incana* Belopolskaya, 1952
Qld: Deblock & Pearson, 1968b, p.463
Gynaecotyla brisbanensis Deblock & Pearson, 1968a
Qld: Deblock & Pearson, 1968a, p.141
Levinseniella microovata Belopolskaya, 1958
Qld: Deblock & Pearson, 1970, p.777
Levinseniella monodactyla Deblock & Pearson, 1970
Qld: Deblock & Pearson, 1970, p.774
Maritrema eroliae Yamaguti, 1939a
Qld: Deblock & Pearson, 1968b, p.458
Microphallus papillornatus Deblock & Pearson, 1969
Qld: Deblock & Pearson, 1969, p.396
Microphallus sp.
Qld: Deblock & Pearson, 1969, p.400
C. Unidentified
Tas, SA: AHC

137. ***Charadrius bicinctus*** Jardine & Selby

Double-banded Plover (migratory)
2/2 : C1 N2

C. Unidentified
SA: AHC
N. *Capillaria* sp.
SA: AHC
Streptocara crassicauda (Creplin, 1829)
SA: AHC

138. ***Charadrius leschenaultii*** Lesson

Large Sand Plover (migratory)

T. *Acanthoparyphium marilae* Yamaguti, 1934
Qld: CIHUS
Acanthoparyphium spinulosum S.J. Johnston, 1917
Qld: Bearup, 1960, p.219
Maritrema sp.
Qld: CIHUS
C. Unidentified
Qld: CIHUS

139. ***Charadrius ruficapillus*** Temminck

Red-capped Plover (endemic)
17/14 : T2 C10 N10 A6

T. *Acanthoparyphium spinulosum* S.J. Johnston, 1917
SA: AHC
Atriophallophorus coxiellae S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.200 (immature)
Levinseniella tasmaniae (S.J. Smith, 1974)
syn. *Microphallus tasmaniae* S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.203
Microphallidae, unidentified
Tas: Munday & Green, 1972, p.3
SA: AHC
C. Unidentified
Tas: Munday & Green, 1972, p.4
Tas, SA: AHC
N. *Capillaria* sp.
SA: AHC
Tetrameres nouveli (Seurat, 1914)
SA: PMM, 1968b, p.297
Tetrameres sp.
Tas: Munday & Green, 1972, p.11
Echinuria heterobrachiata Wehr, 1937
SA: PMM, 1968b, p.289
Skrjabinoclava horrida (Rudolphi, 1809)
SA: PMM, 1968b, p.292
Tas: AHC
syn. *Skrjabinoclava* sp.
Tas: Munday & Green, 1972, p.12
Streptocara crassicauda (Creplin, 1829)
SA: PMM, 1968b, p.293
Tas: AHC

syn. *Streptocara* sp.
Tas: Munday & Green, 1972, p.12
Spirurida, unidentified
SA: AHC
A. *Plagiorhynchus charadrii* (Yamaguti, 1939b)
Tas, SA: AHC

140. *Charadrius melanops* Vieillot
Black-fronted Plover (endemic)
12/7 : T3 C3 N1

T. Echinostomatidae [spines (37(5))]
SA: AHC (immature)
Echinostomatidae [spines ? (41(5))]
SA: AHC (immature)
Levinseniella tasmaniae (S.J. Smith, 1974)
syn. *Microphallus tasmaniae* S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.203
Maritrema calvertense S.J. Smith, 1974
Tas: S.J. Smith, 1974, p.202
C. Unidentified
SA: AHC
N. *Chevreuxia australis* T.H. Johnston & Mawson, 1941e
SA: PMM, 1968b, p.292

141. *Peltohyas australis* Gould
Inland Dotterel (endemic)

C. Unidentified
SA: AHC
A. Unidentified
Aust: AHC (fragments)

Family RECURVIROSTRIDAE

142. *Himantopus leucocephalus* (Gould)
White-headed Stilt
1/1 : C N

T. *Trichobilharzia* sp.
NT: CIHUS
Aust: Bearup & Langsford, 1966, p.523
Bilharziellinae, unidentified
NT: AHC
Haematotrephus adelphus S.J. Johnston, 1917
SA: SJJ, 1917, p.241
SA, NT: AHC
syn. *Monostomum* sp.
SA: THJ, 1910, p.94
Unidentified
Qld: CIHUS
C. *Davainea himantopodis* T.H. Johnston, 1911
syn. *Davainea* sp.
SA: THJ, 1910, p.95
SA: AHC
Diorchis flavescens (Krefft, 1873)
NSW: AHC
Hymenolepis sp.
SA: THJ, 1910, p.95
Acoleus hedleyi T.H. Johnston, 1910
SA: THJ, 1912d
syn. *Taenia rugosa* Krefft, 1873
NSW: Krefft, 1873, p.223
Gyrocoelia australiensis (T.H. Johnston, 1910)
NSW: THJ, 1912d, p.28
syn. *Dilepis australiensis* T.H. Johnston, 1910
NSW: THJ, 1910, p.95
syn. *Taenia coronata* Krefft, 1873
NSW: Krefft, 1873, p.220
Infula burhini Burt, 1939
'Aust': Voge & Read, 1954, p.483
Unidentified
SA, NT: AHC
Qld: CIHUS
N. *Capillaria triloba* Linstow, 1875
SA: PMM, 1968b, p.279
Amidostomum acutum (Lundahl, 1848)
NT: PMM, 1980, p.9
syn. *A. chevreuxi* Seurat, 1918
SA: PMM, 1968b, p.283
Contracaecum sp.
SA: PMM, 1968b, p.287
Tetrameres nouveli (Seurat, 1914)
SA: PMM, 1968b, p.297
NT: AHC
? *Chevreuxia revoluta* (Rudolphi, 1819)
NT: AHC

143. *Cladorhynchus leucocephalus* (Vieillot)
Banded Stilt (endemic)
7/7 : T5 C4 N6

T. Bilharziellinae, unidentified
SA: AHC
Notocotylidae, unidentified
SA: AHC
Haematotrephus adelphus S.J. Johnston, 1917
SA: AHC
?Omphalometridae, unidentified
SA: AHC
Acanthoparyphium sp. [spines (23(0))]
SA: AHC
C. *Davainea* sp.
SA (cage): AHC
Diorchis flavescens (Krefft, 1873)
NSW: AHC
Gyrocoelia sp.
SA: BM(NH)
Unidentified
SA: AHC (immature)
N. *Tetrameres cladorhynchi* Mawson, 1968b
SA: PMM, 1968b, p.299
Echinuria heterobrachiata Wehr, 1937
SA: PMM, 1968b, p.289

144. *Recurvirostra novaehollandiae* Vieillot
Red-necked Avocet (endemic)
4/4 : T1 C4 N3

T. Notocotylidae, unidentified
SA: AHC

Cyclocoelidae, unidentified
WA: AHC
C. *Hymenolepis* sp.
SA: AHC
Davainia sp.
SA: AHC
Himantocestus sp.
SA: AHC
Unidentified
SA, WA: AHC
N. *Capillaria triloba* Linstow, 1875
SA: PMM, 1968b, p.279
Capillaria recurvirostrae Mawson, 1968b
SA: PMM, 1968b, p.280
Tetrameres nouveli (Seurat, 1914)
SA: PMM, 1968b, p.297
Chevreuxia revoluta (Rudolphi, 1819)
SA: AHC
Echinuria heterobrachiata Wehr, 1937
SA: AHC

Family SCOLOPACIDAE

145. ***Numenius madagascariensis*** (Linné)
(Linné)
Eastern Curlew (migratory)

T. *Himasthla harrisoni* S.J. Johnston, 1917
Qld: SJJ, 1917, p.195
syn. *Echinostoma* sp.
Qld: THJ, 1912b, p.107
syn. *Echinostoma (Acanthochasmus)* sp.
Qld: THJ, 1916, p.46; THJ, 1918, p.211
C. Unidentified
Qld, NSW, SA: AHC
A. *Arhythmorhynchus johnstoni* Golvan, 1960
syn. *Arhythmorhynchus frassoni* of THJ & SJE, 1951, not Molin, 1858
Qld: THJ & SJE, 1951, p.3
syn. *Echinorhynchus* sp.
Qld: THJ, 1912b, p.107; 1914a, p.110
Arhythmorhynchus sp.
Qld: CIHUS

146. ***Tringa glareola*** (Linné)
Wood Sandpiper (migratory)
3/3 : C1 N3

T. Cyclocoelidae, unidentified
NSW: AHC
C. Unidentified
SA, NT: AHC
N. *Tetrameres scolopacidis* Mawson, 1968b
SA: PMM, 1968b, p.381
NT: AHC

147. ***Tringa brevipes*** (Vieillot)
Grey-tailed Tattler (migratory)
1/1, N

N. *Skrjabinoclava* sp.
WA: WAM

148. ***Tringa hypoleucos*** Linné
Common Sandpiper (migratory)

T. *Echinoparyphium* sp.
? loc: CIHUS
Echinostoma sp.
? loc: CIHUS
Echinostomatidae [spines missing]
SA: discarded (very young)
Platynotrema sp.
Qld: CIHUS
Maritrema sp.
Qld: CIHUS
C. *Haploparaxis australis* (T.H. Johnston, 1913)
Qld: CIHUS
Unidentified
Qld: CIHUS

149. ***Tringa nebularia*** (Gunnerus)
Greenshank (migratory)
5/4 : T1 C3 N1

T. *Haematotrephus* sp.
SA: AHC
C. Unidentified
SA: AHC
N. Unidentified
SA: believed lost

150. ***Tringa stagnatilis*** (Bechstein)
Marsh Sandpiper (migratory)
2/2 : C2 N1

C. *Paruterina rauschi* Freeman, 1957
SA: AHC
N. Unidentified
SA: AHC (immature)

151. ***Tringa terek*** (Latham)
Terek Sandpiper (migratory)
1/1 : N A

N. *Skrjabinoclava decorata* (Solonitzin, 1928)
SA: AHC
Schistorophus cornutus Sobolev, 1943
SA: AHC
Viktorocara limosae Mawson, 1968b
SA: AHC
Viktorocara schejkini Gushanskaya, 1950
SA: AHC
A. Unidentified
SA: specimen not kept

152. ***Gallinago hardwickii*** (Gray)
Latham's Snipe (migratory)
2/2 : C

C. *Haploparaxis australis* (T.H. Johnston, 1913)
syn. *Aploparaksis australis* T.H. Johnston, 1913
Qld: THJ, 1913, p.90
Unidentified
SA: Cleland, 1922, p.105
Qld: AHC

153. ***Gallinago megala*** **Swinhoe**
Swinhoe's Snipe (migratory)

C. *Haploparaxis australis* (T.H. Johnston, 1913)
Qld: AHC, CIHUS
Unidentified
Qld: AHC

154. ***Limosa lapponica*** **(Linné)**
Bar-tailed Godwit (migratory)
1/1 : C N

T. *Cyclocoelum taxorchis* S.J. Johnston, 1917
NSW: SJJ, 1917, p.239
Cyclocoelum sp.
Qld: CIHUS
Acanthoparyphium marilae Yamaguti, 1934
Qld: Bearup, 1960, p.219
Acanthoparyphium squatarolae Yamaguti, 1934
Qld: Bearup, 1960, p.219
Himasthla ? megacotyla Yamaguti, 1939a
Qld: CIHUS
Platynotrema sp.
Qld: CIHUS
Maritrema sp.
Qld: CIHUS
Heterophyidae, unidentified
Qld: CIHUS
C. Unidentified
NSW, SA: AHC
Qld: CIHUS
N. *Streptocara* sp.
SA: AHC
Schistorophus limosae Mawson, 1968b
Qld: Mawson, 1968b, p.287
Viktorocara limosae Mawson, 1968b
Qld: PMM, 1968b, p.287
A. *Arhythmorhynchus limosae* Edmonds, 1971
Qld: Edmonds, 1971, p.58
Unidentified
Qld: CIHUS

155. ***Calidris canutus*** **(Linné)**
Red Knot (migratory)
8/7 : T7 N7

T. Cyclocoelidae, unidentified
NT: AHC
Acanthoparyphium marilae Yamaguti, 1934
Qld: Bearup, 1960, p.219
Cloeophora sp. [spines ? (21)]
NT: AHC
Himasthlinae [spines ? (31(4))]
NT: AHC
N. *Tetrameres calidris* Mawson, 1968b
NT: PMM, 1968b, p.300
Sciadiocara umbellifera (Molin, 1860)
NT: PMM, 1968b, p.285
Schistorophus longicornis (Hemprich & Ehrenberg, in Schneider, 1866)
NT: PMM, 1968b, p.285
Viktorocara sp.
NT: PMM, 1968b, p.289

156. ***Calidris tenuirostris*** **(Horsfield)**
Great Knot (migratory)

T. *Acanthoparyphium marilae* Yamaguti, 1934
Qld: Bearup, 1960, p.219
Acanthoparyphium squatarolae Yamaguti, 1934
Qld: Bearup, 1960, p.219
Himasthla kusasigi Yamaguti, 1939a
Qld: CIHUS
Unidentified
Qld: CIHUS (? from pancreas)

157. ***Calidris acuminata*** **(Horsfield)**
Sharp-tailed Sandpiper (migratory)
32/15 : T4 C12 N7

T. ? Notocotylidae, unidentified
SA: AHC (immature)
Echinostomatinae [spines (45(5))]
SA: AHC (immature)
Echinostomatidae [spines ? (37)]
SA: AHC (immature)
Endocotyle incana Belopolskaya, 1952
Qld: Deblock & Pearson, 1968b, p.463
? Microphallinae, unidentified
SA: believed lost
Unidentified
SA: AHC (immature)
Unidentified
SA: AHC (cysts)
C. *Trichocephaloides* sp.
SA: AHC
Unidentified
NSW: Cleland, 1922, p.105 (AHC)
NSW, SA: AHC
N. *Tetrameres scolopacidis* Mawson, 1968b
SA: PMM, 1968b, p.301

158. ***Calidris ruficollis*** **(Pallas)**
Red-necked Stint (migratory)
29/28 : C23 N15 A1

T. Microphallidae, unidentified
Tas: AHC
? Heterophyidae, unidentified
Tas: AHC
Trematoda, unidentified
Tas: AHC (cyst)
C. Unidentified
Tas, SA: AHC
N. *Stellocaronema glareolae* Mawson, 1968b
SA: AHC
Tetrameres scolopacidis Mawson, 1968b
SA: PMM, 1968b, p.301
Tas: AHC
Tetrameres sp.
Tas: AHC
Echinuria heterobrachiata Wehr, 1937
SA: PMM, 1968b, p.289
Skrjabinoclava sp.
SA: AHC
A. Unidentified
Tas: AHC

159. **Calidris ferruginea** (Pontoppidan)
Curlew Sandpiper (migratory)
3/1 : C

C. Unidentified
SA: AHC

160. **Calidris alba** (Pallas)
Sanderling (migratory)
1/1 : C

C. Unidentified
SA: AHC

161. **Limicola falcinellus** (Pontoppidan)
Broad-billed Sandpiper (migratory)
1/0

No helminths recorded

Family GLAREOLIDAE

*162. **Stiltia isabella** Vieillot*
Australian Pratincole (migratory)
2/2 : C2 N1

C. Unidentified
SA, NT: AHC
N. Stellocaronema glareolae Mawson, 1968b
SA: PMM, 1968b, p.296

Family LARIDAE

163. ***Larus novaehollandiae*** Stephens
Silver Gull
36/36 : T22 C27 N8 A9

T. *Austrobilharzia terrigalensis* S.J. Johnston, 1917
Qld: Rohde, 1977, p.39
NSW: SJJ, 1917, p.235
NSW: Bearup, 1956, p.471
SA: THJ, 1941, p.282
WA: Appleton, 1983, p.249
Vic, SA: AHC
Gigantobilharzia sp.
Qld: Rohde, 1978, p.40
Schistosomatidae, unidentified
NSW: CIHUS
Cloacitrema narrabeenense Howell & Bearup, 1967
NSW: Howell & Bearup, 1967, p.182
Parorchis acanthus (Nicoll, 1906)
SA: LMA, 1954, p.173
NSW: CIHUS
Philophthalmus burrili Howell & Bearup, 1967
NSW: Howell & Bearup, 1967, p.182
Acanthoparyphium spinulosum S.J. Johnston, 1917
NSW: Bearup, 1960, p.219 (exptl)
? *Echinoparyphium* sp. [spines (35(5))]
SA: AHC
Echinostoma sp. [spines missing]
SA: AHC
Stephanoprora sp.
Tas: AHC
Echinostomatinae [spines (33(5))]
SA: AHC
Echinostomatinae [spines (37(4-5))]
SA: AHC
Prosthogonimus sp.
NSW: CIHUS
Gynoecotyla brisbanensis Deblock & Pearson, 1968a
Qld: Deblock & Pearson, 1968a, p.141
Levinseniella sp.
NSW: CIHUS
Microphallus papillornatus Deblock & Pearson, 1969
Qld: Deblock & Pearson, 1969, p.396
Pachytrema calculus Looss, 1907
NSW, SA: LMA, 1971, p.105
Vic: AHC
Galactosomum angelae Pearson, 1973
SA: Pearson, 1973, p.364
Galactosomum bearupi Pearson, 1973
Qld: Pearson, 1973, p.370
Galactosomum ussuriense Oshmarin, 1963
Qld: Pearson, 1973, p.429
Heterotestophyes sp.
Qld: CIHUS
Stictodora diplacantha T.H. Johnston, 1942a
SA: AHC
Stictodora lari Yamaguti, 1939a
NSW: Bearup, 1961, p.251 (exptl & natural)
syn. *Stictodora* sp.
NSW: Bearup, 1958, p.219 (exptl)
Diplostomum spathaceum (Rudolphi, 1819)
syn. *Diplostomum murrayense* (T.H. Johnston & Cleland, 1938)
SA: THJ & LMA, 1941a, p.140
SA: Dubois & LMA, 1972, p.208
Diplostomum sp.
Qld: CIHUS
Neodiplostomum pricei Krull, 1934
Washington DC, USA (cage): Krull, 1934, p.353
Cardiocephaloides hillii (S.J. Johnston, 1904)
SA: Dubois & LMA, 1972, p.201
Tas: AHC
syn. *Holostomum hillii* S.J. Johnston, 1904
NSW: SJJ, 1904, p.111
C. *Tetrabothrius* sp.
NSW: CIHUS
Anomotaenia hydrochelidonis Dubinina, 1954
WA: BM(NH)
Unidentified
NSW, Tas, SA: AHC
Vic: UMVS
N. *Capillaria jaenschi* T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.245
Capillaria laricola Wassilikova & Gushanskaya, 1930
SA: THJ & PMM, 1947, p.549
Capillaria thomascameroni Mawson, 1969
SA: PMM, 1969, p.1104
Tetrameres sp.
Tas, SA: AHC

Pectinospirura argentata Wehr, 1933
Tas: AHC
Eufilaria sp.
SA: PMM, 1969, p.1110
Filarial worm, unidentifiable
Tas: AHC
Microfilaria sp.
London Zoo: Scott, 1926, p.237
A. *Filicollis sphaerocephalus* (Bremser, 1819)
SA: THJ & SJE, 1947, p.255

164. ***Chlidonias hybrida*** (Pallas)
Whiskered Tern
20/18 : T13 C7 N8

T. ? *Ornithobilharzia* sp.
SA: AHC
Echinostomatidae, [spines (41-43(5))]
SA: AHC (metacercariae)
Prosthogonimus vitellatus Nicoll, 1914a
SA: LMA, 1973, p.859
Pachytrema calculus Looss, 1907
SA: LMA, 1971, p.105
Diplostomum spathaceum (Rudolphi, 1819)
syn. *Diplostomum murrayense* (T.H. Johnston & Cleland, 1938)
SA: THJ & LMA, 1941a, p.140
Cardiocephaloides musculosus (S.J. Johnston, 1904)
SA: Dubois & LMA, 1972, p.202
C. Unidentified
SA: AHC
N. *Capillaria jaenschi* T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.245
Contracaecum sp.
SA: THJ & PMM, 1947, p.551
Tetrameres sp.
SA: AHC
Chevreuxia australis T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.259
Cosmocephalus jaenschi T.H. Johnston & Mawson, 1941e
SA: AHC
Acuaria (s.l.) sp.
SA: THJ & PMM, 1941e, p.260
Streptocara recta (Linstow, 1879)
SA: THJ & PMM, 1942e, p.71
Spirurida, unidentified
SA: AHC (larva)

165. ***Gelochelidon nilotica*** (Gmelin)
Gull-billed Tern
1/1 : N

N. Habronematinae, unidentified
SA: PMM, 1969, p.1110
Tetrameres sp.
SA: PMM, 1969, p.1109

166. ***Hydroprogne caspia*** (Pallas)
Caspian Tern (migratory)
6/6 : T1 C3 N5 A1

T. *Echinostoma* sp.
Qld: CIHUS
Echinostomatinae [spines (45(5))]
SA: AHC (immature)
Galactosomum angelae Pearson, 1973
SA: Pearson, 1973, p.364
Galactosomum bearupi Pearson, 1973
Qld: Pearson, 1973, p.370
Galactosomum ussuriense Oshmarin, 1963
Qld: Pearson, 1973, p.429
Galactosomum sp.
Qld: CIHUS
SA: AHC (2 spp.)
Heterophyidae, unidentified
Qld: CIHUS
Diplostomum parvulum Dubois & Angel, 1972
SA: Dubois & LMA, 1972, p.206
Posthodiplostomum australe Dubois, 1937a
SA: Dubois & LMA, 1972, p.212
Cardiocephaloides musculosus (S.J. Johnston, 1904)
Qld: Dubois & LMA, 1972, p.202
C. Unidentified
Qld: CIHUS
SA: AHC
N. *Trichostrongylus incertus* T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.254
Streptocara pectinifera Neumann, 1900
SA: AHC
Acuariidae, unidentified
SA: THJ & PMM, 1941e, p.260 (larva)
A. Unidentified
SA: AHC (poor specimen)

167. ***Sterna sumatrana*** Raffles
Black-naped Tern
1/0

No helminths recorded

168. ***Sterna fuscata*** Linné
Sooty Tern
2/1 : N

T. *Galactosomum bearupi* Pearson, 1973
Qld: Pearson, 1973, p.370
Galactosomum renincolum Pearson, 1973
Qld: Pearson, 1973, p.412
Galactosomum ussuriense Oshmarin 1963
Qld: Pearson, 1973, p.429
N. *Seuratia shipleyi* (Stossich, 1900)
Qld, NSW: AHC

169. ***Sterna albifrons*** Pallas
Little Tern

T. *Stictodora* sp. cf. *S. manilensis* Africa & Garcia, 1935
Qld: Pearson, 1960, p.93

170. ***Sterna nereis*** (Gould)
Fairy Tern
2/1 : A

A. Unidentified
SA: AHC

171. ***Sterna bergii*** Lichtenstein
Crested Tern
5/4 : T3 C3 N3

T. *Austrobilharzia terrigalensis* (S.J. Johnston, 1917)
NSW: Bearup, 1955, p.955
Brachylecithum megastomum (S.J. Johnston, 1917)
syn. *Lyperosomum megastomum* S.J. Johnston, 1917
NSW: SJJ, 1917, p.225
Galactosomum angelae Pearson, 1973
SA: Pearson, 1973, p.36
Heterophyinae, unidentified
Qld: CIHUS
Cardiocephaloides musculosus (S.J. Johnston, 1904)
syn. *Holostomum musculosum* S.J. Johnston, 1904
NSW: SJJ, 1904, p.112
Maritrema sp. cf. *eroliae* Yamaguti, 1939a
Qld: CIHUS
C. *Tetrabothrius* sp.
Qld, NSW (cage): AHC
Unidentified
SA: Cleland, 1922, p.105 (AHC)
NSW, SA: AHC
N. *Capillaria* sp.
SA: AHC
Anisakis sp.
SA: AHC (immature)
Cosmocephalus jaenschi T.H. Johnston & Mawson, 1941d
Tas: AHC
Skrjabinocerca sp.
SA: AHC
Stegophorus sp.
SA: AHC

172. ***Sterna bengalensis*** Lesson
Lesser Crested Tern

T. *Galactosomum bearupi* Pearson, 1973
Qld: Pearson, 1973, p.370

173. ***Anous stolidus*** (Linné)
Common Noddy
2/1, N

N. *Contracaecum magnicollare* T.H. Johnston & Mawson, 1941c
Qld: THJ & PMM, 1941c, p.114
Coral Sea: PMM, 1969, p.1104
Seuratia shipleyi (Stossich, 1900)
Coral Sea: PMM, 1969, p.1108

174. ***Anous minutus*** Boie
Black Noddy
2/2 : N

T. *Galactosomum bearupi* Pearson, 1973
Qld: Pearson, 1973, p.371
Galactosomum renincolum Pearson, 1973
Qld: Pearson, 1973, p.412
N. *Anisakis* sp.
syn. *Stomachus* sp. (larvae)
Qld: THJ & PMM, 1951, p.294
Contracaecum magnicollare T.H. Johnston & Mawson, 1941c
Qld: AHC
Acuariidae, unidentified
Qld: AHC (larva)

Family COLUMBIDAE

175. ***Macropygia phasianella*** (Temminck)
Brown Cuckoo-Dove

C. Unidentified
Qld: AHC

176. ***Geopelia placida*** Gould
Peaceful Dove
5/1 : C

C. Unidentified
NT: not kept

177. ***Geopelia cuneata*** (Latham)
Diamond Dove (endemic)
5/0

No helminths recorded

178. ***Geopelia humeralis*** (Temminck)
Bar-shouldered Dove
4/1 : N

N. *Ascaridia* sp.
ACT (cage): AHC (poor specimen)

179. ***Chalcophaps indica*** (Linné)
Emerald Dove

C. Unidentified
Qld: Cleland, 1922, p.104

180. ***Phaps chalcoptera*** (Latham)
Common Bronzewing (endemic)
7/0

C. Unidentified
Vic: AHC
N. *Ascaridia columbae* (Gmelin, 1790)
Vic (cage): AHC

181. ***Phaps elegans*** (Temminck)
Brush Bronzewing (endemic)
2/1 : C

C. Unidentified
SA: Cleland, 1922, p.104
SA: AHC

182. ***Ocyphaps lophotes*** (Temminck & Laugier)
Crested Pigeon (endemic)
20/2 : C

C. Unidentified
SA: AHC

183. ***Petrophassa albipennis*** Gould
White-quilled Rock-pigeon (endemic)
1/0

No helminths recorded

184. ***Geophaps plumifera*** Gould
Spinifex Pigeon (endemic)
3/0

N. *Microfilaria* sp.
London (cage): Plimmer, 1912, p.408

185. ***Geophaps scripta*** (Temminck)
Squatter Pigeon (endemic)
1/0

C. Unidentified
Qld: AHC

186. ***Geophaps smithii*** (Jardine & Selby)
Partridge Pigeon (endemic)

C. Unidentified
NT: AHC

187. ***Leucosarcia melanoleuca*** (Latham)
Wonga Pigeon (endemic)

T. *Brachylaima pulchellum* (S.J. Johnston, 1917)
Qld: AHC
syn. *Harmostomum pulchellum* S.J. Johnston, 1917
NSW: SJJ, 1917, p.227
Brachylaima sp.
? loc: AHC
C. *Davainea* sp.
NSW: THJ, 1912b, p.106
Qld: AHC
Unidentified
Qld: AHC
N. *Odontoterakis bancrofti* (T.H. Johnston, 1912a)
syn. *Heterakis bancrofti* T.H. Johnston, 1912a
Qld: THJ & PMM, 1941d, p.251

Family CACATUIDAE

188. ***Calyptorhynchus magnificus*** (Shaw)
Red-tailed Black-Cockatoo (endemic)
1/1 : C

C. Unidentified
NT: specimens not kept

189. ***Calyptorhynchus funereus*** (Shaw)
Yellow-tailed Black-Cockatoo (endemic)
1/0

N. *Syngamus trachea* (Montagu, 1811)
Vic (cage): Harrigan & Arundel, 1978, p.360

190. ***Callocephalon fimbriatum*** (Grant)
Gang-gang Cockatoo (endemic)

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
SA (cage): AHC

191. ***Cacatua roseicapilla*** Vieillot
Galah (endemic)
13/0

C. *Hemiparonia* sp.
SA (? cage): AHC
Raillietina leptosoma (Diesing, 1850)
syn. *Davainea leptosoma* Diesing, 1850
Aust.: Fuhrmann, 1908, p.160
N. *Ascaridia* sp.
New Zealand: Weekes, 1982, p.457

192. ***Cacatua tenuirostris*** (Kuhl)
Long-billed Corella (endemic)
1/0

No helminths recorded

193. ***Cacatua*** sp.
A corella

N. *Aprocta* sp.
Qld: AHC

194. ***Cacatua sanguinea*** Gould
Little Corella
3/0

N. *Microfilaria* sp.
Qld: Mackerras, 1962, p.436

195. ***Cacatua leadbeateri*** (Vigors)
Pink Cockatoo (endemic)
1/0

C. *Hemiparonia cacatuae* (Maplestone, 1922b)
  syn. *Hemiparonia merotomochaeta* Woodland, 1930
    Aust: Woodland, 1930, p.221
N. *Heterakis gallinarum* (Schrank, 1788)
  syn. *Heterakis gallinae* (Gmelin, 1790)
    NSW (cage): THJ & PMM, 1941d, p.251

196. ***Cacatua galerita*** (Latham)
Sulphur-crested Cockatoo
1/0

T. *Platynosomum proxillicens* (Canavan, 1937)
    Fla, Wis, USA (cage): Kazakos et al, 1980, p.788
  syn. *Dicrocoelium proxillicens* Canavan, 1937
    Penn, USA (cage): Canavan, 1937, p.478
  syn. 'Trematodes'
    Penn, USA (cage): Ratcliffe, 1933, p.21
  syn. *Platynosomum ventroplicatum* Heidegger & Mendheim, 1938b
  syn. *P. fallax* Heidegger & Mendheim, 1938a
    Germany (cage): Heidegger & Mendheim, 1938a, p.94; 1938b, p.674
  Dicrocoeliinae, unidentified
    Cal. USA (cage): AHC
  syn. Dicrocoeliidae, unidentified
    Cal. USA (cage): Koch & Duhamel, 1982, p.1388
C. *Hemiparonia cacatuae* (Maplestone, 1922b)
    Qld: Schmidt, 1972, p.1092
    SA (cage): AHC
  syn. *Schizotaenia cacatuae* Maplestone, 1922b
    Qld: Maplestone, 1922b, p.305
  Raillietina cacatuina (T.H. Johnston, 1913)
    Qld: Schmidt, 1972, p.1088
    Indonesia (cage): Sukarish, 1981, p.53
  syn. *Davainea cacatuina* T.H. Johnson, 1913
    Qld: THJ 1913, p.79
  Raillietina paucitesticulata (Fuhrmann, 1908)
    Aust: BM(NH)
  Unidentified
    NSW (cage): Cleland, 1922, p.105 (AHC)
    Qld: AHC
N. *Microfilaria* sp.
    Qld: Mackerras, 1962, p.436

Family PSITTACIDAE

197. ***Eclectus roratus*** (P.L.S. Müller)
Eclectus Parrot

C. Unidentified
    Qld: AHC
N. *Ascaridia columbae* (Gmelin, 1790)
    SA (cage): PMM, 1985, p.191

198. ***Geoffroyus geoffroyi*** (Bechstein)
Red-cheeked Parrot

N. *Cardiofilaria dubia* (T.H. Johnston & Mawson, 1940a)
  syn. *Carinema dubia* T.H. Johnston & Mawson, 1940a
    Qld: THJ & PMM, 1940a, p.357
  syn. 'Filarial worm'
    Qld: Cleland, 1922, p.107 (AHC)

Family LORIDAE

199. ***Trichoglossus haematodus*** (Linné)
Rainbow Lorikeet
4/0

C. *Paronia trichoglossi* (Linstow, 1888)
    Qld: Schmidt, 1972, p.1092
    Qld: CIHUS
    Tas: Fuhrmann, 1908, p.159; 1932, p.283 (no detail given, may be repetition of Linstow's record, with mistaken locality for 'Cape York')
  syn. *Moniezia trichoglossi* (Linstow, 1888)
    Qld: THJ, 1913, p.78
  syn. *Taenia trichoglossi* Linstow, 1888
    Qld: Linstow, 1888, p.14
  Unidentified
    Qld: Cleland, 1922, p.105
N. *Microfilaria* sp.
    Qld: Bancroft, 1889, p.61

200. ***Glossopsitta concinna*** (Shaw)
Musk Lorikeet (endemic)
6/0

N. *Microfilaria* sp.
    NSW: Mackerras, 1962, p.436

201. ***Glossopsitta porphyrocephala*** (Dietrichsen)
Purple-crowned Lorikeet (endemic)
4/0

No helminths recorded

202. ***Glossopsitta pusilla*** (White)
Little Lorikeet (endemic)

N. *Microfilaria* sp.
    Qld: Cleland & THJ, 1912, p.430

Family POLYTELIDAE

203. ***Alisterus scapularis*** (Lichtenstein)
Australian King Parrot (endemic)

N. *Ascaridia columbae* (Gmelin, 1790)
    Qld (cage): Mines & Green, 1983, p.279
  Ascaridia platyceri Hartwich & Tscherner, 1979
    Qld (cage), Vic (cage), SA (cage): PMM, 1985, p.191

204. ***Aprosmictus erythropterus*** Gmelin
Red-winged Parrot

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
  syn. *Ascaridia sprenti* Mines, 1979
    Vic (cage): Mines, 1979, p.374

205. ***Polytelis swainsonii*** (Desmarest)
Superb Parrot (endemic)
1/0

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
    Tas (cage): PMM, 1985, p.191

206. ***Polytelis anthopeplus*** (Lear)
Regent Parrot (endemic)

C. *Cotugnia polytelidis* Burt, 1940
    Ceylon (cage): Burt, 1940, p.65
N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
    Berlin (cage): Hartwich & Tscherner, 1979, p.64
  syn. *Ascaridia sprenti* Mines, 1979
    Vic (cage): Mines, 1979, p.374
  Ascaridia sp.
    New Zealand (cage): Weekes, 1983, p.457

207. ***Polytelis alexandrae*** Gould
Princess Parrot (endemic)

N. *Ascaridia columbae* (Gmelin, 1790)
    Qld (cage): Mines & Green, 1983, p.279
    NSW (cage): THJ & PMM, 1941d, p.253
  Ascaridia platyceri Hartwich & Tscherner, 1979
    Vic (cage), SA (cage): PMM, 1985, p.191
  syn. *Ascaridia sprenti* Mines, 1979
    Vic (cage): Mines, 1979, p.371

208. ***Nymphicus hollandicus*** (Kerr)
Cockatiel (endemic)
3/0

N. *Filaria (s.l.)* sp.
    NSW: THJ & PMM, 1940a, p.361
  Baylisascaris sp.
    Iowa, USA (cage): Myers, Monroe & Greeve, 1983, p.1089.
  Ascaridia platyceri Hartwich & Tscherner, 1979
    Berlin (cage): Hartwich & Tscherner, 1979, p.64
    SA (cage): AHC
  Ascaridia sp.
    New Zealand (cage): Weekes, 1983, p.457.

Family PLATYCERCIDAE

209. ***Melopsittacus undulatus*** (Shaw)
Budgerigah (endemic)
2/0

T. *Austrobilharzia terrigalensis* S.J. Johnston, 1917
    NSW: Bearup, 1956, p.471 (exptl.)
  Trichobilharzia sp.
    NSW: CIHUS (exptl)
N. *Capillaria* sp.
    Qld (? cage): AHC
  Ascaridia columbae (Gmelin, 1790)
    Qld (cage): Mines & Green, 1983, p.279
  Ascaridia platyceri Hartwich & Tscherner, 1979
    Vic (cage), SA (cage): PMM, 1985, p.191
  Ascaridia sp.
    New Zealand (cage): Weekes, 1983, p.457
  Procyrnea incerta (A.J. Smith, 1908)
  syn. *Spiroptera incerta* A.J. Smith, 1908
    USA (cage): A.J. Smith, 1908, p.269

210. ***Lathamus discolor*** (White)
Swift Parrot (endemic)

N. *Ascaridia columbae* (Gmelin, 1790)
    SA (cage): PMM, 1985, p.191
  Ascaridia platyceri Hartwich & Tscherner, 1979
    SA (cage): PMM, 1985, p.191

211. ***Platycercus caledonicus*** (Gmelin)
Green Rosella (endemic)
3/1 : N

N. Unidentified
    Tas: AHC (larva)

212. ***Platycercus elegans*** (Gmelin)
Crimson Rosella (endemic)
29/4 : C3 N1

C. *Hemiparonia bancrofti* (T.H. Johnston, 1912c)
    SA: AHC
  Unidentified
    Vic: AHC
N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
    Berlin (cage): Hartwich & Tscherner, 1979, p.64
    Qld (cage): UQDP
    Vic (cage), SA (cage): PMM, 1985, p.191
  Unidentified
    SA: AHC (larva in mesentery)

213. ***Platycercus eximius*** (Shaw)
Eastern Rosella (endemic)
11/2 : C

C. *Hemiparonia bancrofti* (T.H. Johnston, 1912c)
    NSW: Schmidt, 1972, p.1092
  syn. *Dilepis bancrofti* T.H. Johnston, 1912c
    Qld, NSW: THJ, 1912c, p.211
  Cotugnia seni Meggitt, 1926
    Burma (cage): Meggitt, 1926, p.231
  Cotugnia brotogerys Meggitt, 1915
    ? loc: cited by Fuhrmann, 1932, p.282, without reference to his authority
  Raillietina leptosoma (Diesing, 1850)
    ? loc: cited by Fuhrmann, 1932, p.282, without reference to his authority
N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
    Berlin (cage): Hartwich & Tscherner, 1979, p.64
    Vic (cage): PMM, 1985, p.191
  Procyrnea incerta (A.J. Smith, 1908)

syn. *Spiroptera incerta* A.J. Smith, 1908
Philadelphia Zoo: A.J. Smith, 1908, p.269

214. ***Platycercus adscitus*** (Latham)
Pale-headed Rosella (endemic)

N. *Microfilaria* sp.
Qld: Mackerras, 1962, p.436

215. ***Platycercus venustus*** (Kuhl)
Northern Rosella (endemic)
3/1 : N

N. Splendidofilariinae, unidentified
NT: AHC

216. ***Platycercus icterotis*** (Kuhl)
Western Rosella (endemic)

C. *Cotugnia platycerci* Weerekoon, 1944
Ceylon Zoo: Weerekoon, 1944, p.155
N. *Microfilaria* sp.
London Zoo: Plimmer, 1912, p.408

217. ***Platycercus*** sp.
A rosella parrot

C. *Raillietina polychalix* (Kotlan, 1921)
NSW: Schmidt, 1972, p.1088
Hemiparonia bancrofti (T.H. Johnston, 1912c)
NSW: Schmidt, 1972, p.1092
N. *Ascaridia* sp.
New Zealand (cage): Weekes, 1983, p.457
Ascaridia platyceri Hartwich & Tscherner, 1979
SA (cage): PMM, 1985, p.191

218. ***Barnardius barnardi*** (Vigors & Horsfield)
Mallee Ringneck (endemic)
12/1 : C

C. *Hemiparonia bancrofti* (T.H. Johnson, 1912c)
NSW: Schmidt, 1972, p.1092
syn. 'unidentified'
NSW: Cleland, 1922, p.105 (AHC)
Unidentified
SA (cage): AHC
N. *Ascaridia columbae* (Gmelin, 1790)
SA (cage): PMM, 1985, p.191
Ascaridia platyceri Hartwich & Tscherner, 1979
Qld (cage), Vic (cage), SA (cage): PMM, 1985, p.191
syn. *Ascaridia sprenti* Mines, 1979
Vic (cage): Mines, 1979, p.371
Procyrnea incerta (A.J. Smith, 1908)
syn. *Spiroptera incerta* A.J. Smith, 1908
Philadelphia Zoo: A.J. Smith, 1908, p.269

219. ***Barnardius zonarius*** (Shaw)
Port Lincoln Ringneck (endemic)
7/1 : C

C. Unidentified
NT: specimen not kept
N. *Ascaridia columbae* (Gmelin, 1790)
SA (cage): PMM, 1985, p.191
Ascaridia platyceri Hartwich & Tscherner, 1979
Qld (cage), Tas (cage), SA (cage): PMM, 1985, p.191

220. ***Psephotus haematonotus*** (Gould)
Red-rumped Parrot (endemic)
13/0*

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
Berlin (cage): Hartwich & Tscherner, 1979, p.64

221. ***Psephotus varius*** Clark
Mulga Parrot (endemic)
9/0

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
Vic (cage): PMM, 1985, p.191

222. ***Psephotus chrysopterygius*** Gould
Golden-shouldered Parrot (endemic)

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
SA (cage): PMM, 1985, p.191

223. ***Psephotus dissimilis*** Collett
Hooded Parrot (endemic)
1/0

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
SA (cage): PMM, 1985, p.191

224. ***Northiella haematogaster*** (Gould)
Blue Bonnet (endemic)
6/0

N. *Heterakis* sp.
SA (cage): AHC
Ascaridia platyceri Hartwich & Tscherner, 1979
SA (cage): PMM, 1985, p.191
syn. *Ascaridia sprenti* Mines, 1979
Vic (cage): Mines, 1979, p.371

225. ***Northiella narethae*** (H.L. White)
Naretha Blue Bonnet (endemic)
3/0

No helminths recorded

226. **Neophema bourkii (Gould)**
Bourke's Parrot
(endemic) 5/0

N. *Ascaridia columbae* (Gmelin, 1790)
Qld (cage): Mines & Green, 1983, p.279

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*One body, without skin, head or legs, given to the authors as that of *Psephotus haematonotus*, has been omitted from consideration here, as the identification is very doubtful. The record of *Cyrnea* sp. (PMM, 1968d, p. 755, Vic) for this host is now considered incorrect.

Ascaridia platyceri Hartwich & Tscherner, 1979
Berlin (cage): Hartwich & Tscherner, 1979, p.84
Vic (cage), SA (cage): PMM, 1985, p.191
syn. *Ascaridia sprenti* Mines, 1979
Vic (cage): Mines, 1979, p.371

227. ***Neophema chrysostoma*** (Kuhl)
Blue-winged Parrot (endemic)
2/0

No helminths recorded

228. ***Neophema elegans*** (Gould)
Elegant Parrot (endemic)
10/1 : A

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
syn. *Ascaridia sprenti* Mines, 1979
Vic (cage): Mines, 1979, p.371
A. Unidentified
SA: AHC (cysts)

229. ***Neophema petrophila*** (Gould)
Rock Parrot (endemic)

C. *Raillietina polychalix* (Kotlan, 1921)
SA: Schmidt, 1972, p.1088

230. ***Neophema pulchella*** Shaw
Turquoise Parrot (endemic)

N. *Ascaridia platyceri* Hartwich & Tscherner, 1979
syn. *Ascaridia sprenti* Mines, 1979
Vic (cage): Mines, 1979, p.371

231. ***Neophema splendida*** (Gould)
Scarlet-chested Parrot (endemic)

C. *Raillietina* sp.
Qld (cage): AHC
N. *Capillaria* sp.
SA: AHC
Ascaridia platyceri Hartwich & Tscherner, 1979
Qld (cage): PMM, 1985, p.191
syn. *Ascaridia sprenti* Mines, 1979
Vic (cage): Mines, 1979, p.371

Family CUCULIDAE

232. ***Cuculus pallidus*** (Latham)
Pallid Cuckoo
5/1 : N

N. *Microtetrameres coracinae* Mawson, 1977
NT: PMM, 1977, p.253

233. ***Cuculus variolosus*** Vigors & Horsfield
Brush Cuckoo
1/1 : N

N. *Microtetrameres cacomantis* Mawson, 1977
NT: PMM, 1977, p.253

234. ***Cuculus flabelliformis*** (Latham)
Fan-tailed Cuckoo
11/4 : T1 C2 N2

T. *Pleuropsolus* sp.
SA: AHC
C. Unidentified
SA: AHC
N. *Capillaria* sp.
Tas: AHC
Microtetrameres cacomantis Mawson, 1977
SA: AHC
Microtetrameres sp.
Tas, SA: PMM, 1977, p.258

235. ***Chrysococcyx basalis*** (Horsfield)
Horsfield's Bronze Cuckoo
6/1 : N

N. ? *Microhadjelia spiralis* (Mawson, 1968d)
NT: AHC

236. ***Chrysococcyx lucidus*** (Gmelin)
Shining Bronze Cuckoo
4/1 : N

N. *Ascaridia galli* (Schrank, 1788)
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
Microtetrameres sp.
SA: AHC

237. ***Eudynamys scolopacea*** (Linné)
Common Koel (migratory)
1/0

N. Spirurida, unidentified
Qld: CIHUS (larva)

238. ***Scythrops novaehollandiae*** Latham
Channel-billed Cuckoo (migratory)

N. *Allodapa suctoria* (Molin, 1860)
syn. *Subulura clelandi* T.H. Johnston & Mawson, 1941d
Qld: THJ & PMM, 1941d, p.251

239. ***Centropus phasianinus*** (Latham)
Pheasant Coucal
2/2 : N2 A2

T. *Echinostoma emollitum* Nicoll, 1914b
Qld: Nicoll, 1914b, p.111
N. *Ascaridia galli* (Schrank, 1788)
Qld: BM(NH)
Ascaridia lineata (Schneider, 1866)
Qld: CIHUS
Ascaridia sp.
NT: AHC
Allodapa differens (Sonsino, 1890)
syn. *Subulura differens* (Sonsino, 1890)
Qld: THJ & PMM, 1942a, p.93
Torquatoides sp. (? *T. torquata* (Gendre, 1922))

Qld: AHC
syn. *Torquatella* sp.
NT: PMM, 1968d, p.765
Aprocta australis (T.H. Johnston & Mawson, 1942a)
syn. *Vagrifilaria australis* T.H. Johnston & Mawson, 1942a
Qld: THJ & PMM, 1942a, p.93
Lissonema rotundata (Linstow, 1903)
Qld: CIHUS, BM(NH), QM, AHC
syn. *Aprocta rotundata* (Linstow, 1903)
Qld: Mackerras, 1962, p.433
A. *Porrorchis hylae* (T.H. Johnston, 1914b)
Qld, NT: AHC
Qld: CIHUS
syn. *Pseudoporrorchis hylae* (T.H. Johnston, 1914b)
Qld: Edmonds, 1957, p.76
syn. *Echinorhynchus bulbocaudatus* Southwell & Macfie, 1925
Qld: Southwell & Macfie, 1925, p.178

Family STRIGIDAE

240. ***Ninox rufa*** (Gould)
Rufous Owl

N. *Hamatospiculum mcneilli* T.H. Johnston & Mawson, 1941b
Qld: THJ & PMM, 1941b, p.35
syn. 'nematodes'
Qld: Cleland, 1922, p.107 (AHC)

241. ***Ninox strenua*** (Gould)
Powerful Owl (endemic)

T. *Strigea promiscua* Nicoll, 1914a
Qld: Dubois & LMA, 1972, p.199
N. *Allodapa* sp.
syn. *Subulura* sp.
Qld: THJ & PMM, 1941b, p.34
Synhimantus affinis (Seurat, 1916)
Vic: UMVS
A. *Centrorhynchus bancrofti* (T.H. Johnston & Best, 1943)
syn. *Gordiorhynchus bancrofti* T.H. Johnston & Best, 1943
Qld: THJ & Best, 1943, p.226

242. ***Ninox novaeseelandiae*** (Gmelin)
Southern Boobook
22/18 : T1 N15 A7

T. *Echinoparyphium* sp. [spines (41(4))]
SA: AHC
Echinostoma sp. [spines (45(4))]
Vic: AHC
Brachylecithum harrisoni (S.J. Johnston, 1917)
syn. *Lyperosomum harrisoni* S.J. Johnston, 1917
NSW: SJJ, 1917, p.226
Neodiplostomum brachyurum (Nicoll, 1914a)
SA: Dubois & LMA, 1972, p.209
syn. *Hemistomum brachyurum* Nicoll, 1914a
Qld: Nicoll, 1914a, p.346
Neodiplostomum lanceolatum Dubois & Angel, 1972
SA: Dubois & LMA, 1972, p.209
SA: AHC
Strigea promiscua Nicoll, 1914a
Qld: Nicoll, 1914a, p.347
SA: Dubois & LMA, 1972, p.199
C. Unidentified
Qld, Tas, SA: Cleland, 1922, p.105
N. *Capillaria* sp.
SA: AHC
Heterakis sp.
SA: AHC (? from prey)
Allodapa suctoria (Molin, 1860)
SA: AHC
Oxyuridae, unidentified
Tas, SA: AHC (? from prey)
Oxyspirura sp.
SA: AHC
Hartertia sp.
SA: AHC
Physaloptera sp.
NT: AHC
Excisa biloba Mawson, 1968d
Qld, SA, NT: PMM, 1968d, p.755
Procyrnea dollfusi (Mawson, 1968d)
syn. *Cyrnea dollfusi* Mawson, 1968d
NT: PMM, 1968d, p.750
Tetrameres sp.
SA: AHC
Microtetrameres raptoris Mawson, 1977
NT: PMM, 1977, p.255
Microtetrameres ninoctis Mawson, 1977
SA, NT: PMM, 1977, p.256
Synhimantus laticeps (Rudolphi, 1819)
SA: PMM, 1982, p.23
Synhimantus sp.
SA: AHC
Hamatospiculum mcneilli T.H. Johnston & Mawson, 1941a
Qld: THJ & PMM, 1941a, p.12
Qld: Hall Exped. Report, 1974, p.354
Qld: Ogden, 1967, p.506
Lissonema brevicaudata (Chow, 1939)
syn. *Aprocta brevicaudata,* Chow, 1939
Qld: Ogden, 1967, p.507
Qld: Hall Exped. Report, 1974, p.354
Lissonema sp.
NT: Bain & Mawson, 1981, p.271
Filaria (s.l.) sp.
Vic, WA: THJ, 1912b, p.109
A. *Centrorhynchus bancrofti* (T.H. Johnston & Best, 1943)
NSW, SA: AHC
syn. *Echinorhynchus* sp. THJ, 1912b
Qld: THJ, 1912b, p.109
syn. *Centrorhynchus* sp.
Qld: THJ, 1918, p.216

243. ***Ninox connivens*** (Latham)
Barking Owl

N. *Skrjabinura brevicaudatum* (T.H. Johnston & Mawson, 1941b)
syn. *Seuratinema brevicaudatum* T.H. Johnston & Mawson, 1941b
Qld: THJ & PMM, 1941b, p.33
Filarial worm, unidentified
NT: NMV

Family TYTONIDAE

244. ***Tyto alba*** (Scopoli)
Barn Owl
1/5 : T2 C5 N3

T. Echinostomatinae [spines (41(5))]
SA: AHC
Petasiger sp. [spines (27(4))]
SA: AHC
WA: WAM
Neodiplostomum brachyurum (Nicoll, 1914a)
SA: Dubois & LMA, 1972, p.209
WA: SAM
Neodiplostomum spathula (Creplin, 1829)
Qld: Dubois & Pearson, 1967, p.197
C. *Paruterina rauschi* Freeman, 1957
SA: AHC
Unidentified
SA: AHC
N. Oxyuridae, unidentified
SA: AHC (? in food)
Microtetrameres tytonis Mawson, 1977
NT: PMM, 1977, p.257
Spirurida, unidentified
SA: AHC (encysted larva)

245. ***Tyto novaehollandiae*** (Stephens)
Masked Owl
2/1 : N

T. Unidentified
Tas: AHC
N. *Capillaria* sp.
Tas: AHC
Spirurida, unidentified,
Tas: AHC (larva)

Family PODARGIDAE

246. ***Podargus strigoides*** (Latham)
Tawny Frogmouth (endemic)
14/13 : T1 C1 N11 A3

T. *Echinoparyphium* sp. [spines ? (41(4))]
SA: AHC
Echinostoma elongatum Nicoll, 1914a
Qld: Nicoll, 1914a, p.336
Himasthlinae [spines (35(5))]
Qld: AHC
Brachylecithum podargi Angel & Pearson, 1977
Qld: LMA & Pearson, 1977, p.122
Strigea flosculus Nicoll, 1914a
Qld: Nicoll, 1914a, p.348
Qld: AHC
C. Unidentified
Qld, NSW, Tas, SA: AHC
N. *Capillaria* sp.
SA: AHC
Ornithostrongylinae, unidentified
Qld: AHC
Allodapa suctoria (Molin, 1860)
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
Qld, SA, NT: AHC
syn. *Subulura clelandi* T.H. Johnston & Mawson, 1941d
Qld, WA: THJ & PMM, 1941d, p.251
Qld, SA, NT: AHC
Allodapa sp.
Qld: CIHUS (immature)
Skrjabinura sp.
syn. *Seuratinema* sp.
Qld: Ogden, 1967, p.505
Excisa biloba Mawson, 1968d
Qld, SA, NT: PMM, 1968d, p.755
SA: AHC
Excisa excisiformis (Yamaguti, 1935)
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
Hadjelia acuariana (Gushanskaya, 1937)
Qld, SA, NT: PMM, 1968d, p.759
Qld: AHC
Viguiera chabaudi Mawson, 1968d
SA: PMM, 1968d, p.761
Synhimantus laticeps (Rudolphi, 1819)
SA: AHC
Synhimantus podargi Mawson, 1982
SA: PMM, 1982, p.24
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: Cleland & THJ, 1912, p.431
Qld: Cleland, 1915, p.35
A. *Porrorchis hylae* (T.H. Johnston, 1914b)
Qld, SA: AHC
syn. *Pseudoporrorchis hylae* (T.H. Johnston, 1914b)
Qld: Edmonds, 1957, p.76
syn. *Gordiorhynchus hylae* (T.H. Johnston, 1914b)
Qld: THJ & Edmonds, 1948, p.74

247. ***Podgarus ocellatus*** Quoy & Gaimard
Marbled Frogmouth

C. Unidentified
Qld: AHC
N. *Excisa biloba* Mawson 1968d
syn. 'nematode'
Qld: Cleland, 1922, p.105 (AHC)

Family AEGOTHELIDAE

248. ***Aegotheles cristatus*** (J. White)
Australian Owlet-Nightjar
6/3 : N3 C1

C. Unidentified
SA: AHC
N. *Alainchabaudia aegotheles* (T.H. Johnston & Mawson, 1941e)
SA: PMM, 1968c, p.743
syn. *Habronema aegotheles* T.H. Johnston & Mawson, 1941e
SA: THJ & PMM, 1941e, p.256
Microtetrameres aegotheles Mawson, 1977
SA: PMM, 1977, p.253
Acuaria sp.
WA: WAM
Microfilaria sp.
Qld: THJ, 1916, p.51

Family CAPRIMULGIDAE

249. ***Eurostopodus mystacalis*** (Temminck)
White-throated Nightjar (migratory)
1/1 : T C N

T. *Eumegacetes* sp.
Qld: AHC
C. Unidentified
Qld: AHC
N. *Allodapa suctoria* (Molin, 1860)
WA, Qld: AHC

250. ***Caprimulgus argus*** (Hartert)
Spotted Nightjar (endemic)
6/1: N

N. *Allodapa suctoria* (Molin, 1860)
WA: AHC

Family APODIDAE

251. ***Collocalia spodiopygia*** (Peale)
White-rumped Swiftlet (endemic)

C. Unidentified
Qld: AHC

Family ALCEDINIDAE

252. ***Ceyx azurea*** (Latham)
Azure Kingfisher
3/1 : N

N. Spirurida, unidentified
NT: specimen not kept (broken)

253. ***Dacelo novaeguineae*** (Hermann)
Laughing Kookaburra (endemic)
16/6 : T3 N4

T. *Echinoparyphium* sp. [spines (45(4))]
Tas: AHC
Brachylecithum dacelonis Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.122
Basantisia queenslandensis Deblock & Pearson, 1968a
Qld: Deblock & Pearson, 1968a, p.136
Diplostomum triangulare (S.J. Johnston, 1904)
Qld: Dubois & Pearson, 1967, p.190
syn. *Hemistomum triangulare* S.J. Johnston, 1904
NSW: SJJ, 1904, p.108
C. *Similuncinus dacelonis* T.H. Johnston, 1909a
NSW: THJ, 1909a, p.246
Pseudophyllidea, plerocercoids
NSW (cage): AHC
Unidentified
Qld, NSW, Tas: AHC
N. *Protospirura* sp.
SA: AHC (? from prey)
Skrjabinura magnum (T.H. Johnston & Mawson, 1941d)
syn. *Seuratinema magnum* T.H. Johnston & Mawson, 1941d
NSW: THJ & PMM, 1941d, p.256
syn. 'nematode'
NSW: Cleland, 1922, p.107
Alainchabaudia alcedinis Mawson, 1968c
NSW: PMM, 1968c, p.741
Tetrameres dacelonis Mawson, 1979
Qld, ACT: PMM, 1980, p.108
Spirurida, unidentified
Tas: AHC (larva)
A. *Centrorhynchus horridus* (Linstow, 1898a)
Qld, SA: AHC

254. ***Dacelo leachii*** Vigors & Horsfield
Blue-winged Kookaburra
1/1 : N

N. *Thelazia dacelonis* (Breinl, 1913b)
syn. *Filaria dacelonis* Breinl, 1913b
Qld: Breinl, 1913b, p.42
? *Schistorophus* sp.
NT: AHC

255. ***Halycon macleayii*** Jardine & Selby
Forest Kingfisher
1/0

C. Unidentified
Qld: Cleland, 1922, p.105 (AHC)

256. ***Halycon pyrrhopygia*** Gould
Red-backed Kingfisher (endemic)
1/0

N. *Hamatospiculum halcyonis* T.H. Johnston & Mawson, 1941a

SA: THJ & PMM, 1941a, p.14
? *Hamatospiculum* sp.
NT: AHC

257. **Halycon sancta** Vigors & Horsfield
Sacred Kingfisher
4/3 : N3

C. Unidentified
NSW: AHC
N. *Alainchabaudia alcedinis* Mawson, 1968c
Qld, SA: PMM, 1968c, p.741
Cheilonematodum halcyonis T.H. Johnston & Mawson, 1941d
Qld, NSW: THJ & PMM, 1941d, p.253
Ancyracanthopsis sp.
SA: AHC
Schistogendria sp. (2)
SA: AHC
Schistogendria sp. (3)
Qld: AHC
Hamatospiculum howense T.H. Johnston & Mawson, 1940a
syn. *Filaria* sp.
NSW: THJ, 1912b, p.109
Hamatospiculum halcyonis T.H. Johnston & Mawson, 1941a
SA: THJ & PMM, 1941a, p.14
A. *Centrorhynchus horridus* (Linstow, 1898a)
Qld: THJ & Edmonds 1948, p.69
syn. *Echinorhynchus* sp.
NSW: THJ, 1910, p.105

258. **Halycon chloris** (Boddaert)
Collared Kingfisher
1/1/ : N

N. *Contracaecum* sp.
WA: WAM
Spirurida, unidentified
NT: AHC (larva)

259. **Syma torotora** Lesson
Yellow-billed Kingfisher

C. Unidentified
Qld: Cleland, 1922, p.105 (AHC)

Family MEROPIDAE

260. **Merops ornatus** Latham
Rainbow Bee-eater
7/4 : N

N. *Porrocaecum* sp.
NT: AHC
Torquatoides balanocephala (Gendre, 1922)
Vic, NT: AHC
syn. *Torquatella balanocephala* (Gendre, 1922)
SA, NT: PMM, 1968d, p.764

Family CORACIIDAE

261. **Eurystomus orientalis** (Linné)
Dollarbird
1/1 : C N

C. *'Hymenolepis eurystomi* Maplestone'
Qld: CIHUS. This appears to be another unpublished species
Unidentified
Qld, NSW: AHC
N. *Capillaria* sp.
Qld: AHC
Hadjelia truncatus (Creplin, 1825)
Qld: PMM, 1968d, p.758
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: Cleland & THJ, 1912, p.431
Qld: Cleland, 1915, p.33
London (cage): Scott, 1927, p.189

Family PITTIDAE

262. **Pitta erythrogaster** Temminck
Red-bellied Pitta (migratory)

N. *Thelazia pittae* T.H. Johnston & Mawson, 1941e
Qld: THJ & PMM, 1941e, p.256
syn. 'nematode'
Qld: Cleland, 1922, p.107 (AHC)

263. **Pitta versicolor** Swainson
Noisy Pitta

C. Unidentified
Qld: Cleland, 1922, p.105 (AHC)
N. *Porrocaecum* sp.
Qld: AHC
Inglisonema typos Mawson, 1968a
Qld: PMM, 1968a, p.71
Microfilaria sp.
Qld: Breinl, 1913a, p.43

Family MENURIDAE

264. **Menura novaehollandiae** Latham
Superb Lyrebird (endemic)

N. *Porrocaecum menurae* T.H. Johnston & Mawson, 1942b
NSW: THJ & PMM, 1942b, p.113
Vic: AHC
A. *Plagiorhynchus menurae* (T.H. Johnston, 1912b)
Vic: AHC
syn. *Prosthorhynchus menurae* (T.H. Johnston, 1912b)
Qld: THJ & Best, 1943, p.226
syn. *Echinorhynchus menurae* T.H. Johnston, 1912b
Qld: THJ, 1912a, p.83

Family ALAUDIDAE

265. *Mirafra javanica* Horsfield
Singing Bushlark
2/1 : N

C. Unidentified
SA: Cleland, 1922, p.106
N. *Microtetrameres mirafrae* Mawson, 1977
NT: PMM, 1977, p.249
Acuaria mirafrae Mawson, 1972
NT: PMM, 1972, p.147

Family HIRUNDINIDAE

266. ***Hirundo neoxena*** Gould
Welcome Swallow
22/10 : T10 C1

T. *Plagiorchis maculosus* (Rudolphi, 1802)
SA: LMA, 1959, p.265
SA: AHC
C. Unidentified
Qld, SA: AHC

267. ***Cheramoeca leucosternum*** (Gould)
Black and White Swallow (endemic)

C. Unidentified
NSW: Cleland, 1922, p.105 (AHC)

268. ***Cecropis nigricans*** (Vieillot)
Tree Martin

T. *Brachylecithum parvum* (S.J. Johnston, 1917)
SA: LMA & Pearson, 1977, p.118
C. Unidentified
Qld: Cleland, 1922, p.105 (AHC)

269. ***Cecropis ariel*** (Gould)
Fairy Martin (endemic)
5/1 : T

T. *Plagiorchis maculosus* (Rudolphi, 1802)
SA: AHC
syn. *Plagiorchis clelandi* S.J. Johnston, 1917
NSW: SJJ, 1917, p.216
C. Unidentified
NSW: Cleland, 1922, p.105

Family MOTACILLIDAE

270. ***Anthus novaeseelandiae*** (Gmelin)
Richard's Pipit
12/3 : T1 C2 N3

T. *Plagiorchis maculosus* (Rudolphi, 1802)
syn. *Plagiorchis spatulatus* S.J. Johnston, 1917
Qld: SJJ, 1917, p.214
C. Unidentified
Tas: Cleland, 1922, p.106 (AHC)
Qld, NSW, SA: AHC
N. *Porrocaecum clelandi* T.H. Johnston & Mawson, 1941d
SA: THJ & PMM, 1941d, p.252
Microtetrameres sp.
SA: AHC
Unidentified
Qld: Hall Exped. Report, 1974, p.354 (from eye socket)
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.354 (cyst)

Family CAMPEPHAGIDAE

271. ***Coracina novaehollandiae*** (Gmelin)
Black-faced Cuckoo-shrike
5/3 : N3

C. Unidentified
NSW: AHC
N. *Capillaria graucalinum* T.H. Johnston & Mawson, 1941d
Qld: THJ & PMM, 1941d, p.250
? *Microhadjelia spiralis* (Mawson, 1968d)
NT: AHC
Microtetrameres coracinae Mawson, 1977
SA: PMM, 1977, p.253
Paraprocta graucalina (T.H. Johnston & Mawson, 1940a)
syn. *Carinema graucalinum* T.H. Johnston & Mawson, 1940a*
Qld: THJ & PMM, 1940a, p.358
Microfilaria sp.
Qld: Mackerras, 1962, p.437

272. ***Coracina papuensis*** (Gmelin)
White-bellied Cuckoo-shrike
1/1 : N T

T. Dicrocoeliidae, unidentified
NT: discarded
N. *Microtetrameres coracinae* Mawson, 1977
NT: PMM, 1977, p.253
Diplotriaena tricuspis (Fedtschenko, 1874)
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
Diplotriaena sp.
NT: AHC
Filaria sp.
Qld: THJ, 1912b, p.109

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* *Carinema graucalinum* was transferred to *Paraprocta* by Anderson (1957). The change was misrepresented in Zoological Record (Vol.94(6), p.108) as being to *Pseudaproctella*. It was later correctly quoted by Mackerras (1962).

273. *Pteropodocys maxima* (Rüppell)
Ground Cuckoo-shrike (endemic)
1/0

No helminths recorded

274. *Lalage sueurii* (Vieillot)
White-winged Triller
3/2 : C1 N2

C. Unidentified
SA: AHC
N. ? *Microhadjelia spiralis* (Mawson, 1968d)
syn. *Cyrnea spiralis Mawson, 1968d*
SA: PMM, 1968d, p.753
Microtetrameres sp.
SA: PMM, 1977, p.258

275. *Lalage leucomela* (Vigors & Horsfield)
Varied Triller
7/5 : N5 A1

N. *Acuaria petterae* Mawson, 1972
NT: PMM, 1972, p.144
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
NT: not kept (cyst)

Family MUSCICAPIDAE

276. *Zoothera dauma* (Latham)
White's Thrush
3/1 : N

C. Unidentified
Qld, NSW, SA: AHC
N. *Porrocaecum clelandi* T.H. Johnston & Mawson, 1941d
Qld: THJ & PMM, 1941d, p.252
SA: AHC
syn. 'nematode'
Tas: Cleland, 1922, p.108 (AHC)
Microfilaria sp.
NSW: THJ, 1910, p.108
A. *Echinorhynchus* sp.
NSW: THJ, 1910, p.108
Oncicola pomatostomi (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
Qld, SA: Cleland, 1922, p.108 (cyst)

277. *Drymodes superciliaris* Gould
Northern Scrub-robin

C. Unidentified
Qld: AHC

278. *Drymodes brunneopygia* Gould
Southern Scrub-robin (endemic)
2/1 : N

N. *Acuaria petterae* Mawson, 1972
SA: PMM, 1972, p.144

279. *Petroica phoenicea* Gould
Flame Robin (endemic)
2/0

N. *Synhimantus* sp.
SA: AHC
'Filarial worms'
Tas: Cleland, 1922, p.107

280. *Petroica multicolor* (Gmelin)
Scarlet Robin
10/1 : N

N. *Pseudaprocta copemani* Bain & Mawson, 1981
Tas: Bain & Mawson, 1981, p.266
syn. Aproctidae, unidentified
Tas: Munday & Green, 1972, p.12

281. *Petroica goodenovii* (Vigors & Horsfield)
Red-capped Robin (endemic)
14/2 : N

C. *Hymenolepis* sp.
SA: THJ, 1910, p.106
N. Spirurida, unidentified
SA, NT: AHC (larva)
Aproctidae, unidentified
Tas: Munday & Green, 1972, p.12

282. *Melanodryas cucullata* (Latham)
Hooded Robin (endemic)
9/1 : A

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: specimen not kept (cyst)
Unidentified
NT: AHC (cyst)

283. *Eopsaltria pulverulenta* Salvadori
Mangrove Robin

N. *Skrjabinura* sp.
syn. *Seuratinema* sp.
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354

284. *Eopsaltria australis* (Shaw)
Eastern Yellow Robin (endemic)
3/3 : N

C. Unidentified
Qld: Cleland, 1922, p.105
N. *Microtetrameres eopsaltriae* Mawson, 1977
SA: PMM 1977, p.253
Unidentified
SA: not kept (larva)

285. **Eopsaltria griseogularis** Gould
Western Yellow Robin (endemic)
1/0

No helminths recorded

286. **Microeca flavigaster** Gould
Lemon-bellied Flycatcher
2/0

No helminths recorded

287. **Microeca leucophaea** (Latham)
Jacky Winter
12/6 : T1 N5

T. *Echinoparyphium harveyanum* S.J. Johnston, 1917
Qld: SJJ, 1917, p.204
Skrjabinosomum sp.
SA: LMA & Pearson, 1977, p.127
C. Unidentified
Qld: AHC
N. *Viguiera longicollis Mawson, 1968d*
NT: PMM, 1968d, p.759
Microtetrameres mirafrae Mawson, 1977
SA, NT: PMM, 1977, p.249
Acuaria microeca Mawson, 1972
SA: PMM, 1972, p.145
Diplotriaena sp.
SA: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
Qld: Hall Exped. Report, 1974, p.355 (cyst)

288. **Falcunculus frontatus** (Latham)
Crested Shrike-tit (endemic)
2/1 : N

N. *Schistogendria* sp. (1)
SA: AHC

289. **Pachycephala olivacea**
Vigors & Horsfield
Olive Whistler (endemic)
1/0

C. Unidentified
Tas: Cleland, 1922, p.105 (AHC)
SA: AHC

290. **Pachycephala inornata** Gould
Gilbert's Whistler (endemic)
7/1 : N

N. *Microtetrameres* sp.
SA: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Cleland, 1912, p.112 (cyst)

291. **Pachycephala pectoralis** (Latham)
Golden Whistler
10/7 : N

N. ? *Microhadjelia spiralis* (Mawson 1968d)
syn. *Cyrnea spiralis* Mawson, 1968d
SA: AHC
Pseudaprocta copemani Bain & Mawson, 1981
SA: Bain & Mawson, 1981, p.266
Spirurida, unidentified
SA: AHC

292. **Pachycephala melanura** Gould
Mangrove Golden Whistler

C. Unidentified
Qld: Cleland, 1922, p.105 (AHC)

293. **Pachycephala rufiventris** (Latham)
Rufous Whistler
7/3 : C1 N2 A2

C. *Sphaeruterina punctata* T.H. Johnston, 1914b
Qld: THJ, 1914b, p.76
Unidentified
Qld, NSW: Cleland, 1922, p.105 (AHC)
N. *Acuaria colluricincli* Mawson, 1972
SA: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
NT: AHC (cyst)

294. **Colluricincla harmonica** (Latham)
Grey Shrike-thrush
14/10 : T1 N8 A4

T. Unidentified
SA: AHC
C. Unidentified
Tas, SA: Cleland, 1922, p.106 (AHC)
NSW: AHC
N. *Capillaria* sp.
SA: AHC
Viguiera longicollis Mawson, 1968d
SA: PMM, 1968d, p.759
NT: AHC
Acuaria colluricinclae Mawson, 1972
SA: PMM, 1972, p.145
Schistogendria sp.
NT: AHC
Diplotriaena golvani Anderson, 1959
WA: Ogden, 1967, p.505
WA: Hall Exped. Report, 1974, p.354
Microfilaria sp.
NSW; Cleland, 1915, p.33
A. Mediorhynchus sp.
SA: AHC
Oncicola pomatostomi (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H.

Johnston & Cleland, 1912
SA: THJ & Deland, 1929, p.149 (cyst)*

295. ***Colluricincla megarhyncha*** (Quoy & Gaimard)
Little Shrike-thrush
1/1 : N

N. *Diplotriaena* sp.
NT: AHC

296. ***Oreoica gutturalis*** (Vigors & Horsfield)
Crested-Bellbird (endemic)
6/6 : N6 A1

N. *Microtetrameres* sp.
SA, NT: PMM, 1977, p.258
Acuaria petterae Mawson, 1972
NT: PMM, 1972, p.144
Diplotriaena spratti Bain & Mawson, 1981
NT: Bain & Mawson, 1981, p.277
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
NT: specimen not kept (cyst)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: Hall Exped. Report, 1974, p.355 (cyst)

297. ***Monarcha trivirgatus*** (Temminck)
Spectacled Monarch

N. *Diplotriaena halli* Ogden, 1967
Qld: Odgen, 1967, p.515
Qld: Hall Exped. Report, 1974, p.354

298. ***Arses kaupi*** Gould
Pied Monarch (endemic)

N. *Diplotriaena* sp.
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354

299. ***Myiagra rubecula*** (Latham)
Leaden Flycatcher
1/1 : N

N. *Rictularina spinosa* T.H. Johnston & Mawson, 1941d
Qld: THJ & PMM, 1941d, p.254
Filarioidea, unidentified
NT: AHC
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Unidentified
Qld: Cleland, 1922, p.107

300. ***Myiagra alecto*** (Temminck)
Shining Flycatcher
2/1 : N

C. Unidentified
Qld: Cleland, 1922, p.105 (larva, subcut.)
N. Spirurida, unidentified
NT: not kept (larva)

301. ***Myiagra inquieta*** (Latham)
Restless Flycatcher
3/1 : N

N. *Acuaria petterae* Mawson, 1972
SA: PMM, 1972, p.144
Filarioidea, unidentified
NT: :AHC
A. 'echinorhynch'
NSW: Cleland, 1922, p.108

302. ***Rhipidura fuliginosa*** (Sparrman)
Grey Fantail
8/4 : T3 C1 N1

T. *Plagiorchis maculosus* (Rudolphi, 1802)
SA: AHC
C. Unidentified
SA: AHC
N. Unidentified
SA: not kept (larva)

303. ***Rhipidura rufiventris*** Quoy & Gaimard
Northern Flycatcher
2/0

No helminths recorded

304. ***Rhipidura leucophrys*** (Latham)
Willie Wagtail
25/15 : T13 C5 N1 A1

T. *Plagiorchis maculosus* (Rudolphi, 1802)
SA: LMA, 1959, p.265
Prosthogonimus sp.
SA: AHC
Eumegacetes sp.
SA: AHC
Lecithodendriidae, unidentified
SA: AHC
C. Unidentified
SA: AHC
N. *Mawsonofilaria rhipidurae* (T.H. Johnston & Mawson, 1952)
syn. *Austrofilaria rhipidurae* T.H. Johnston & Mawson, 1952
SA: THJ & PMM, 1952, p.31
A. *Mediorhynchus* sp.
SA: AHC

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* THJ & Deland referred to the host in this record as *'Cinclosoma' rufiventris* presumably an error in transcription for *Colluricincla rufiventris*, a synonym of *C. harmonica*. THJ's dissection record notes this parasite from *Colluricincla rufiventris* from the same locality, Pt Lincoln, SA.

Family ORTHONYCHIDAE

305. *Psophodes olivaceus* (Latham)
Eastern Whipbird (endemic)

C. Unidentified
NSW: AHC
N. *Schistogendria* sp. (1)
Qld: AHC
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.431
A. *Echinorhynchus* sp.
NSW: THJ, 1910, p.107
Qld: Cleland, 1922, p.108

306. *Psophodes cristatus* (Gould)
Chirruping Wedgebill (endemic)
2/0

No helminths recorded

307. *Cinclosoma punctatum* (Shaw)
Spotted Quail-thrush (endemic)
1/1 N

N. *Porrocaecum clelandi* T.H. Johnston & Mawson, 1941d
Tas: THJ & PMM, 1941d, p.252

308. *Cinclosoma castanotum* Gould
Chestnut Quail-thrush (endemic)
3/0

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Deland, 1929, p.149 (cyst)

309. *Cinclosoma cinnamomeum* Gould
Cinnamon Quail-thrush (endemic)
8/4 : N3 A1

N. *Capillaria* sp.
NT: AHC
Viguiera sp.
SA: AHC
? *Microhadjelia spiralis* (Mawson, 1968d)
NT: AHC
Acuaria petterae Mawson, 1972
NT: AHC

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
NT: AHC (cyst)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: Cleland, 1922, p.108
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.354 (cyst)

Family TIMALIIDAE

310. *Pomatostomus temporalis* (Vigors & Horsfield)
Grey-crowned Babbler
7/4 : C1 A3

C. Paruterinae, unidentified
Qld: BM(NH)
Unidentified
Qld, NT: AHC
N. *Skrjabinura brevicaudatum* (T.H. Johnston & Mawson, 1941b)
syn. *Seuratinema brevicaudatum* T.H. Johnston & Mawson, 1941b
Qld: Inglis, 1967, p.130
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
Microfilaria sp.
Qld: Bancroft, 1889, p.61
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
NT: AHC
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
NSW, WA: THJ & Cleland, 1912, p.112 (cyst)
NSW: Cleland, 1922, p.108 (cyst)
syn. *Echinorhynchus* sp.
WA: THJ, 1910, p.108
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
Qld: Hall Exped. Report, 1974, p.354 (cyst)

311. *Pomatostomus superciliosus* (Vigors & Horsfield)
White-browed Babbler (endemic)
37/33 : T16 C2 N16 A22

T. *Leucochloridium australiense* T.H. Johnston & Cleland, 1938
SA: THJ & Simpson, 1940a, p.119
Plagiorchis maculosus (Rudolphi, 1802)
SA: LMA, 1959, p.265
Skrjabinosomum pomatostomi Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.126
Laterotrema sp.
SA: AHC
C. Paruterinae, unidentified
WA: BM(NH)
Unidentified
SA: AHC
N. *Capillaria pomatostomi* T.H. Johnston & Mawson 1945b
SA: THJ & PMM, 1945b, p.247
SA: AHC
Skrjabinura pomatostomi (T.H. Johnston & Mawson, 1941d)
syn. *Seuratinema pomatostomi* T.H. Johnston & Mawson, 1941d
NSW: THJ & PMM, 1941d, p.255
Spirurida, unidentified
SA: THJ & PMM, 1941e, p.261 (larva)

SA: AHC (larva)
syn. 'nematode'
NSW: Cleland, 1922, p.107
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
SA, WA, NT: AHC (cyst)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
Qld, WA: Cleland, 1922, pp.107,108 (cyst)
syn. *Echinorhynchus* sp.
SA: THJ, 1910, p.107 (cyst)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.354 (cyst)

312. ***Pomatostomus ruficeps*** (Hartlaub)

Chestnut-crowned Babbler (endemic)
2/1 : N A

N. *Capillaria* sp.
SA: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Deland, 1929, p.150 (cyst)
SA: AHC (cyst)

Family SYLVIIDAE

313. ***Megalurus gramineus*** (Gould)

Little Grassbird
2/0

C. Unidentified
SA: AHC

314. ***Eremiornis carteri*** North

Spinifexbird (endemic)
2/0

No helminths recorded

315. ***Cisticola exilis*** (Vigors & Horsfield)

Golden-headed Cisticola

N. *Diplotriaena tricuspis* (Fedchenko, 1874)
Qld: THJ & PMM, 1941a, p.15
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354

316. ***Cinclorhamphus mathewsi*** Iredale

Rufous Songlark (endemic)
2/0

No helminths recorded

317. ***Cinclorhamphus cruralis*** (Vigors & Horsfield)

Brown Songlark (endemic)
5/0

No helminths recorded

Family MALURIDAE

318. ***Malurus cyaneus*** (Latham)

Superb Fairy-wren (endemic)
14/3 : N

C. *Choanotaenia taylori* T.H. Johnston, 1912c
SA: THJ, 1912c, p.213
Unidentified
NSW: Cleland, 1922, p.106
Tas: Munday & Green, 1972, p.4
N. *Synhimantus* sp.
SA: AHC
Willmottia australis Mawson, 1982
Tas: PMM, 1982, p.28
Diplotriaena sp.
SA: AHC
Filaria (s.l.) sp.
Tas: Cleland, 1922, p.108

319. ***Malurus splendens*** (Quoy & Gaimard)

Splendid Fairy-wren (endemic)

T. Unidentified (incomplete)
WA: WAM
C. Unidentified
SA: AHC

320. ***Malurus lamberti*** Vigors & Horsfield

Variegated Fairy-wren (endemic)
8/1 : N

C. Unidentified
Tas: AHC
N. *Tetrameres* sp.
NT: AHC
Diplotriaena delta T.H. Johnston & Mawson, 1940a
SA: THJ & PMM, 1940a, p.360
Qld, SA, WA: Ogden, 1967, p.511
Qld, SA, WA: Hall Exped. Report, 1974, p.354
Diplotriaena halli Ogden, 1967
WA: Ogden, 1967, p.515
WA: Hall Exped. Report, 1974, p.354
Diplotriaena sp.
Qld: AHC
Unidentified
NT: AHC (larva)

321. ***Malurus pulcherrimus*** Gould

Blue-breasted Fairy-wren (endemic)
2/0

No helminths recorded

322. ***Malurus leucopterus*** Dumont

White-winged Fairy-wren (endemic)
18/1 : N

N. *Capillaria* sp.
SA: AHC
Porrocaecum sp.
SA: AHC
Viguiera sp.

SA: AHC
Acuaria microeca Mawson, 1972
SA: AHC
Filaria (s.l.) sp.
SA: THJ & PMM, 1941a, p.15 (cysts - ? identification)

323. ***Stipiturus ruficeps*** Campbell
Rufous-crowned Emu-wren (endemic)
1/0

No helminths recorded

324. ***Amytornis goyderi*** (Gould)
Eyrean Grasswren (endemic)
6/0

N. *Diplotriaena delta* T.H. Johnston & Mawson, 1940a
SA: Bain & Mawson, 1981, p.281

325. ***Amytornis textilis*** (Dumont)
Thick-billed Grasswren
3/0

No helminths recorded*

326. ***Amytornis purnelli*** Mathews
Dusky Grasswren
4/0

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)*

Family ACANTHIZIDAE

327. ***Dasyornis broadbenti*** (McCoy)
Rufous Bristlebird (endemic)
1/0

No helminths recorded

328. ***Sericornis citreogularis*** Gould
Yellow-throated Scrubwren (endemic)

N. Larval nematode
Qld: AHC

329. ***Sericornis frontalis*** (Vigors & Horsfield)
White-browed Scrubwren (endemic)
2/0

A. *Echinorhynchus* sp.
SA: THJ & Deland, 1929, p.150 (cyst)

330. ***Sericornis pyrrhopygius***
(Vigors & Horsfield)
Chestnut-rumped Hylacola (endemic)

C. Unidentified
NSW, SA: Cleland, 1922, p.105
SA: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: AHC
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Cleland, 1912, p.112 (cyst)

331. ***Sericornis cautus*** (Gould)
Shy Hylacola (endemic)
5/1 : A

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: AHC (cyst)

332. ***Sericornis brunneus*** (Gould)
Redthroat (endemic)
2/1 : A

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Deland, 1929, p.150 (cyst)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)

333. ***Sericornis fuliginosus***
(Vigors & Horsfield)
Calamanthus (endemic)
1/0

N. *Diplotriaena alpha* T.H. Johnston & Mawson, 1940a
SA: PMM, 1955, p.6
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)

334. ***Smicrornis brevirostris*** (Gould)
Weebill (endemic)
5/1 : C

C. Unidentified
SA: not kept (cysts)

335. ***Gerygone fusca*** (Gould)
Western Gerygone
1/0

No helminths recorded

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* The 'A. *textilis*' of the Hall Report was in fact *A. purnelli*, (*vide* Parker, Emu 72, pp.157-166)

336. ***Acanthiza pusilla*** (Shaw)
Brown Thornbill (endemic)
16/2 : N

T. *Prosthogonimus* sp.
SA: AHC
N. Spirurida, unidentified
SA: AHC (larva)

337. ***Acanthiza apicalis*** Gould
Inland Thornbill (endemic)
3/0

No helminths recorded

338. ***Acanthiza uropygialis*** Gould
Chestnut-rumped Thornbill (endemic)
1/0

No helminths recorded

339. ***Acanthiza reguloides***
Vigors & Horsfield
Buff-rumped Thornbill (endemic)
5/0

No helminths recorded

340. ***Acanthiza iredalei*** Mathews
Slender-billed Thornbill (endemic)
4/0

No helminths recorded

341. ***Acanthiza chrysorrhoa***
(Quoy & Gaimard)
Yellow-rumped Thornbill (endemic)
18/3 : T1 N1 A1

T. Unidentified
SA: AHC
N. Unidentified
SA: not kept (larva)
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: specimen lost
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)

342. ***Acanthiza lineata*** Gould
Striated Thornbill (endemic)
5/0

No helminths recorded

343. ***Aphelocephala leucopsis*** (Gould)
Southern Whiteface (endemic)
9/3 : A

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus* sp.
SA: THJ, 1910, p.109 (cyst)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: Cleland, 1922, p.108 (cyst)

344. ***Aphelocephala nigricincta*** (North)
Banded Whiteface (endemic)

N. *Aprocta vestibulata* (T.H. Johnston & Mawson, 1952)
syn. *Austrofilaria vestibulata* T.H. Johnston & Mawson, 1952
SA: THJ & PMM, 1952, p.31

Family NEOSITTIDAE

345. ***Daphoenositta chrysoptera*** (Latham)
Varied Sitella (endemic)
5/0

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
WA: Hall Exped. Report, 1974, p.355 (cyst)

Family CLIMACTERIDAE

346. ***Climacteris leucophaea*** (Latham)
White-throated Treecreeper (endemic)
5/2 : N

C. Unidentified
EA: AHC
N. Spirurida, unidentified
SA: AHC (larva)
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: THJ & Deland, 1929, p.151 (cyst)

347. ***Climacteris picumnus*** Temminck
Brown Treecreeper (endemic)
9/3 : A

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
SA: Cleland, 1922, p.108; THJ & Deland, 1929, p.150 (cyst)

348. ***Climacteris rufa*** Gould
Rufous Treecreeper (endemic)
3/0

No helminths recorded

349. ***Climacteris melanura*** Gould
Black-tailed Treecreeper (endemic)

N. *Microfilaria* sp.
NT: Mackerras, 1962, p.438

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
WA: THJ, 1910, p.109 (cyst)

Family MELIPHAGIDAE

350. ***Anthochaera carunculata*** (White)
Red Wattlebird (endemic)
16/7 : C4 N7 A1

T. Lecithodendriidae, unidentified
SA: AHC
C. *Dilepis* sp.
NSW: AHC
Capiuterilepis australiensis Schmidt, 1972
SA: Schmidt, 1972, p.1089
Unidentified
SA: AHC
N. *Oxyspirura anthochaerae* (T.H. Johnston, 1912a)
syn. *Ceratospira anthochaerae* T.H. Johnston, 1912a
NSW: THJ, 1912a, p.80
syn. *Ascaris* sp.
NSW: Krefft, 1873, p.213
Viguiera longicollis Mawson, 1968d
SA: PMM, 1968d, p.759
Microtetrameres meliphagidae Mawson, 1977
SA: PMM, 1977, p.31
Geopetitia sp.
SA: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)
Unidentified
SA: AHC (fragments)

351. ***Anthochaera paradoxa*** (Daudin)
Yellow Wattlebird (endemic)

N. *Diplotriaena* sp.
Tas: Munday & Green, 1972, p.11

352. ***Anthochoera chrysoptera*** (Latham)
Little Wattlebird (endemic)
10/3 : C1 N2

C. *Choanotaenia* sp.
Qld: AHC
Unidentified
SA: AHC
N. *Microtetrameres meliphagidae* Mawson, 1977
SA: PMM, 1977, p.248
Filaria (s.l.) sp.
Qld: Bancroft, 1889, pp.60,61
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: THJ, 1910, p.111
Qld: Cleland & THJ, 1910, p.108 (two species noted)
NSW: Mackerras, 1962, p.439
A. *Mediorhynchus* sp.
SA: AHC

353. ***Anthochaera*** sp.
a wattlebird
2/2 : T1 C1 N1

T. Unidentified
SA: AHC
C. *Capiuterilepis australiensis* Schmidt, 1972
SA: Schmidt, 1972, p.1089
Hymenolepsis sp.
SA: AHC
N. *Microtetrameres meliphagidis* Mawson, 1977
SA: AHC
Acuaria petterae Mawson, 1972
SA: AHC

354. ***Acanthagenys rufogularis*** Gould
Spiny-cheeked Honeyeater (endemic)
26/12 : C1 N12

C. Unidentified
NSW, SA: Cleland, 1922, p.106
NT: AHC
N. *Capillaria* sp.
SA: AHC
Microtetramères meliphagidae Mawson, 1977
SA: PMM, 1977, p.248
Acuaria petterae Mawson, 1972
SA: PMM, 1972, p.144
Diplotriaena zeta T.H. Johnston & Mawson, 1940a
SA: THJ & PMM, 1940a, p. 359
Diplotriaena smithi Bain & Mawson, 1981
SA, WA: Bain & Mawson, 1981, p.280
Filaria (s.l.) sp.
NSW: THJ, 1912b, p.111
Qld: THJ & PMM, 1940a, p.361
Unidentified
NSW: Cleland, 1922, p.108
A. *Mediorhynchus* sp.
SA: AHC

355. ***Plectorhyncha lanceolata*** Gould
Striped Honeyeater (endemic)

N. *Microfilaria* sp.
Qld: Cleland & THJ, 1912, p.433

356. ***Philemon argenticeps*** (Gould)
Silver-crowned Friarbird (endemic)
3/3 : N

N. ? *Microhadjelia spiralis* (Mawson 1968d)
syn. *Cyrnea spiralis* Mawson, 1968d
NT: PMM, 1968d, p.753
Microtetrameres philemon Mawson, 1977
NT: PMM, 1977, p.249
Spirurida, unidentified
NT: AHC (larva)

357. ***Philemon corniculatus*** (Latham)
Noisy Friarbird

C. *Capiuterilepis meliphagicola* Schmidt, 1972
Qld: Schmidt, 1972, p.1091

N. *Diplotriaena smithi* Bain & Mawson, 1981
Qld: Bain & Mawson, 1981, p.280
syn. *Diplotriaena* sp.
Qld: Mackerras, 1962, p.432

358. ***Philemon citreogularis*** (Gould)
Little Friarbird
3/3 : N

C. *Raillietina conopophilae* (T.H. Johnston, 1913)
syn. *Davainea conopophilae* T.H. Johnston, 1913
Qld: THJ, 1913, p.80
Hymenolepididae, unidentified
Qld: CIHUS

N. *Oxyspirura bancrofti* T.H. Johnston & Mawson, 1941d
Qld: THJ & PMM, 1941d, p.255
Microtetrameres philemon Mawson, 1977
NT: PMM, 1977, p.249
Filaria sp.
Qld: THJ, 1912a, p.78
Microfilaria sp.
? loc: Cleland, 1922, p.91

359. ***Entomyzon cyanotis*** (Latham)
Blue-faced Honeyeater
5/2 : N2 A1

C. *Raillietina conopophilae* (T.H. Johnston, 1913)
syn. *Davainea conopophilae* T.H. Johnston, 1913
Qld: THJ, 1913, p.80
Anoncotaenia globata (Linstow, 1879)
NSW: Schmidt, 1972, p. 1087 (S. mistakenly gives locality as Qld)
syn. 'Unidentified'
NSW: Cleland, 1922, p.106 (AHC)
Hymenolepididae, unidentified
? Qld : CIHUS
Unidentified
Qld: AHC
Qld: CIHUS (spargana)

N. ? *Microhadjelia spiralis* (Mawson, 1968d)
syn. *Cyrnea spiralis* Mawson, 1968d
NT: PMM, 1968d, p.763
Microtetrameres philemon Mawson, 1977
ACT, SA: PMM, 1977, p.248
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld, NSW: Cleland & THJ, 1912, p.434
Qld, NSW: Mackerras, 1962, p.439
London (cage): Plimmer, 1912, p.408
Spirurida, unidentified
NT: AHC (larva)

A. Unidentified
NT: specimen not kept (adult)

360. ***Manorina melanophrys*** (Latham)
Bell Miner (endemic)

T. *Urotocus* sp.
NSW (cage): AHC

361. ***Manorina melanocephala*** (Latham)
Noisy Miner (endemic)
10/3 : N

N. *Capillaria* sp.
SA: AHC
Microtetrameres meliphagidae Mawson, 1977
ACT, SA: PMM, 1977, p.248
Filaria (s.l.) sp. (? Filarioidea)
Qld: Bancroft, 1889, pp.60, 62
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld, NSW: Cleland & THJ, 1912, p.434
London (cage): Plimmer, 1912, p.408

362. ***Manorina flavigula*** (Gould)
Yellow-throated Miner (endemic)
10/4 : T1 C1 N2

T. *Skrjabinosomum mawsoni* Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.124

C. Unidentified
NSW: Cleland, 1922, p.106
NT: specimens not kept

N. *Capillaria* sp.
SA: AHC
Porrocaecum sp.
SA: THJ & PMM, 1941d, p.253 (larva)
Microtetrameres meliphagidae Mawson, 1977
SA, WA: PMM, 1977, p.248
Pseudaprocta myzanthae T.H. Johnston & Mawson, 1940a
SA: THJ & PMM, 1940a, p.358
syn. 'nematode'
SA: Cleland, 1922, p.108 (AHC)

A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: AHC (cyst)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)

363. ***Meliphaga lewini*** (Swainson)
Lewin's Honeyeater (endemic)
3/0

C. *Pseudochoanotaenia meliphagidarum* (T.H. Johnston, 1911)
syn. *Choanotaenia meliphagidarum* T.H. Johnston, 1911
NSW: THJ, 1911, p.58
syn. *Choanotaenia* sp.
NSW: THJ, 1910, p.110

N. *Synhimantus lichenostomi* Mawson, 1982
Qld: PMM, 1982, p.26

364. ***Stomiopera unicolor*** (Gould)
White-gaped Honeyeater (endemic)
2/0

No helminths recorded

365. ***Lichenostomus chrysops*** (Latham)
Yellow-faced Honeyeater (endemic)
3/0

No helminths recorded

366. ***Lichenostomus virescens*** (Vieillot)
Singing Honeyeater
26/6 : C1 N6

C. *Hymenolepis* sp.
SA: discarded
N. *Capillaria* sp.
SA: AHC
Microtetrameres meliphagidae Mawson, 1977
SA: PMM, 1977, p.248
Acuaria petterae Mawson, 1972
NT: PMM, 1972, p.144
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)

367. ***Lichenostomus leucotis*** (Latham)
White-eared Honeyeater (endemic)
10/2 : N

C. *Pseudochoanotaenia meliphagidarum* (T.H. Johnston, 1911)
syn. *Choanotaenia meliphagidarum* T.H. Johnston, 1911
NSW: THJ, 1911, p.58
syn. *Choanotaenia* sp.
NSW: THJ, 1910, p.110
N. *Microtetrameres meliphagidae* Mawson, 1977
SA: PMM, 1977, p.248

368. ***Lichenostomus melanops*** (Latham)
Yellow-tufted Honeyeater (endemic)

C. Unidentified
NSW: Cleland, 1922, p.106 (AHC)

369. ***Lichenostomus cratitius*** (Gould)
Purple-gaped Honeyeater
1/0

No helminths recorded

370. ***Lichenostomus keartlandi*** (North)
Grey-headed Honeyeater (endemic)
3/0

No helminths recorded

371. ***Lichenostomus ornatus*** (Gould)
Yellow-plumed Honeyeater (endemic)
8/3 : T2 N1

T. *Pancreatrema meliphagae* Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.129
C. Unidentified
SA: Cleland, 1922, p.106
N. *Microtetrameres* sp.
SA: AHC

372. ***Lichenostomus plumulus*** (Gould)
Grey-fronted Honeyeater (endemic)
4/1 : N

C. *Pseudochoanotaenia meliphagidarum* (T.H. Johnston, 1911)
syn. *Choanotaenia meliphagidarum* T.H. Johnston, 1911
NSW: THJ, 1911, p.58
syn. *Choanotaenia* sp.
NSW: THJ, 1910, p.110
N. ? *Microhadjelia spiralis* (Mawson, 1968d)
NT: AHC
Acuaria petterae Mawson, 1972
NT: PMM, 1972, p.144
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
WA: Hall Exped. Report, 1974, p.355 (cyst)

373. ***Lichenostomus fuscus*** (Gould)
Fuscous Honeyeater (endemic)
1/0

C. Unidentified
NSW: Cleland, 1922, p.106 (AHC)
Qld: AHC
N. *Microfilaria* sp.
Qld: Cleland & THJ, 1912, p.434

374. ***Lichenostomus penicillatus*** (Gould)
White-plumed Honeyeater (endemic)
21/2 : C1 N1

C. Unidentified
SA: AHC
N. *Synhimantus lichenostomi* Mawson, 1982
SA: PMM, 1982, p.26
Schistogendria sp. 1
SA: AHC
Unidentified
SA: Cleland, 1922, p.108

375. ***Melithreptus brevirostris*** (Vigors & Horsfield)
Brown-headed Honeyeater (endemic)
4/0

No helminths recorded

376. ***Melithreptus albogularis*** Gould
White-throated Honeyeater

N. *Microfilaria* sp.
Qld: Mackerras, 1962, p.438

377. ***Melithreptus lunatus*** (Vieillot)
White-naped Honeyeater (endemic)
4/0

No helminths recorded

378. ***Lichmera indistincta***
(Vigors & Horsfield)
Brown Honeyeater
5/1 : N T

T. Cyclocoelidae, unidentified
NT: AHC
Acanthoparyphium sp. [spines (23(0))]
NT: AHC
Himasthlinae [spines (31(4))]
NT: AHC
C. Unidentified
Qld: Cleland, 1922, p.106
NSW: AHC
N. *Capillaria* sp.
NT: AHC
Microfilaria sp.
NSW: Cleland & THJ, 1912, p.434

379. ***Phylidonyris pyrrhoptera*** (Latham)
Crescent Honeyeater (endemic)
9/0

No helminths recorded

380. ***Phylidonyris novaehollandiae***
(Latham)
New Holland Honeyeater (endemic)
30/5 : C3 N2

C. *Pseudochoanotaenia meliphagidarum* (T.H. Johnston, 1911)
SA: Schmidt, 1972, p.1038
syn. *Choanotaenia meliphagidarum* T.H. Johnston, 1911
NSW: THJ, 1911, p.58
syn. *Choanotaenia* sp.
NSW: THJ, 1910, p.111
Unidentified
NSW, SA: AHC
N. *Synhimantus falco* Mawson, 1982
SA: PMM, 1982, p.24
Xenocordon patonae Mawson, 1982
SA: PMM, 1982, p.27
A. *Echinorhynchus* sp.
NSW: THJ, 1910, p.111

381. ***Phylidonyris nigra*** (Bechstein)
White-cheeked Honeyeater (endemic)
1/0

C. *Pseudochoanotaenia meliphagidarum* (T.H. Johnston, 1911)
syn. *Choanotaenia meliphagidarum* T.H. Johnston, 1911
NSW: THJ, 1911, p.58
syn. *Choanotaenia* sp.
NSW: THJ, 1910, p.110
Unidentified
Qld: Cleland, 1922, p.106 (AHC)
NSW: AHC

382. ***Phylidonyris albifrons*** (Gould)
White-fronted Honeyeater (endemic)
7/1 : N

C. Unidentified
SA: Cleland, 1922, p.106
N. *Microtetrameres meliphagidae* Mawson, 1977
SA: AHC

383. ***Phylidonyris melanops*** (Latham)
Tawny-crowned Honeyeater (endemic)
7/1 : N

N. Unidentified
SA: AHC (cysts)

384. ***Conopophila albogularis*** (Gould)
Rufous-banded Honeyeater

C. *Raillietina conopophilae* (T.H. Johnston, 1913)
syn. *Davainea conopophilae* T.H. Johnston, 1913*
Qld: THJ, 1913, p.80

385. ***Conopophila rufogularis*** (Gould)
Rufous-throated Honeyeater (endemic)
1/0

No helminths recorded

386. ***Acanthorhynchus tenuirostris***
(Latham)
Eastern Spinebill (endemic)
3/0

No helminths recorded

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* T.H. Johnston recorded the host of this cestode as 'White-throated Honeyeater, *Conopophila albogularis*'. It is possible that he was dealing with what is now referred to as the White-throated Honeyeater, *Melithreptus albogularis* (as listed in the CIHUS), but, in view of the specific name given to the cestode, unlikely. *'Entomophila'* the host genus on the type slide, is a synonym of *Conopophila*.

387. ***Certhionyx pectoralis*** (Gould)
Banded Honeyeater (endemic)
3/0

No helminths recorded

388. ***Certhionyx variegatus*** Lesson
Pied Honeyeater (endemic)
3/0

No helminths recorded

389. ***Myzomela obscura*** Gould
Dusky Honeyeater
2/0

No helminths recorded

390. ***Myzomela sanguinolenta*** (Latham)
Scarlet Honeyeater (endemic)

C. *Pseudochoanotaenia meliphagidarum* (T.H. Johnston, 1911)
SA: AHC
N. *Microfilaria* sp.
Qld: Cleland & THJ, 1912, p.433
Qld: Cleland, 1915, p.33

Family EPHTHIANURIDAE

391. ***Ephthianura tricolor*** Gould
Crimson Chat (endemic)
5/0

No helminths recorded

392. ***Ephthianura aurifrons*** Gould
Orange Chat (endemic)
4/0

No helminths recorded

393. ***Ephthianura albifrons***
(Jardine & Selby)
White-fronted Chat (endemic)
5/1 : N

N. Acuariidae, unidentified
SA: AHC (larva)

394. ***Ashbyia lovensis*** (Ashby)
Gibberbird (endemic)
1/0

No helminths recorded

Family DICAEIDAE

395. ***Dicaeum hirundinaceum*** (Shaw)
Mistletoe bird
2/0

No helminths recorded

Family PARDALOTIDAE

396. ***Pardalotus punctatus***
(Shaw & Nodder)
Spotted Pardalote (endemic)
3/0

No helminths recorded

397. ***Pardalotus xanthopygus*** McCoy
Yellow-rumped Pardalote (endemic)
2/0

No helminths recorded

398. ***Pardalotus rubricatus*** Gould
Red-browed Pardalote (endemic)
1/1 : C

C. Unidentified
Qld: not kept

399. ***Pardalotus striatus*** (Gmelin)
Striated Pardalote (endemic)
23/7 : T2 C6 N1

T. *Plagiorchis maculosus* (Rudolphi, 1802)
SA: AHC
Unidentified
SA: AHC
C. *Anonchotaenia arhyncha* Fuhrmann, 1918
SA: Schmidt, 1972, p.1087
Hymenolepis sp.
SA: AHC
Unidentified
Tas, SA: Cleland, 1922, p.106
SA: AHC
N. *Diplotriaena* sp.
NT: AHC
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.433
Unidentified
SA: Cleland, 1922, p.108

Family ZOSTEROPIDAE

400. ***Zosterops lateralis*** (Latham)
Silvereye
19/2 : C

C. *Zosteropicola clelandi* T.H. Johnston, 1912c
NSW: THJ, 1912c, p.214
Unidentified
NSW, Tas: Cleland, 1922, p.106 (AHC)
Tas: Munday & Green, 1972, p.4
NSW, SA: AHC
N. *Diplotriaena* sp.
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
Tas: AHC
Microfilaria sp.
Qld: Mackerras, 1962, p.438

Family PLOCEIDAE

401. **Emblema temporale** (Latham)
Red-browed Firetail (endemic)
8/0

No helminths recorded

402. **Emblema bellum** (Latham)
Beautiful Firetail (endemic)
3/0

N. Acuariidae, unidentified
Tas (cage): AHC

403. **Emblema pictum** Gould
Painted Firetail (endemic)

C. Dilepididae, unidentified
NSW (cage): AHC

404. **Emblema guttatum** (Shaw)
Diamond Firetail (endemic)
2/0

C. Choanotaenia sp.
Vic: AHC

405. **Neochmia phaeton**
(Hombron & Jacquinot)
Crimson Finch
7/0

No helminths recorded

406. **Poephila guttata** (Vieillot)
Zebra Finch
25/3 : C

C. Unidentified
SA: AHC

407. **Poephila bichenovii**
(Vigors & Horsfield)
Double-banded Finch (endemic)
1/0

C. *Choanotaenia* sp.
Vic: AHC
Dilepididae, unidentified
NSW (cage): AHC
N. *Microfilaria* sp.
London (cage): Plimmer, 1915, p.129

408. **Poephila personata** Gould
Masked Finch (endemic)

N. *Microfilaria* sp.
London (cage): Scott, 1926, p.237

409. **Poephila acuticauda** (Gould)
Long-tailed Finch (endemic)
1/0

No helminths recorded

410. **Poephila cincta** (Gould)
Black-throated Finch (endemic)

C. Dilepididae, unidentified
NSW (cage): AHC
Unidentified
Qld: AHC
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
Qld: Hall Exped. Report, 1974, p.355 (cyst)

411. **Lonchura castaneothorax** (Gould)
Chestnut-breasted Mannikin
3/0

No helminths recorded

412. **Erythrura trichroa** (Kittlitz)
Blue-faced Finch

C. Unidentified
NSW (cage): AHC
Vic (cage): UMVS
N. *Acuaria skrjabini* Ozerskaya, 1926
Vic (cage): AHC

413. **Erythrura gouldiae** (Gould)
Gouldian Finch (endemic)
9/0

No helminths recorded

Family ORIOLIDAE

414. **Oriolus sagittatus** (Latham)
Olive-backed Oriole
3/1 : N

N. ? *Microhadjelia spiralis* (Mawson, 1968d)
syn. *Cyrnea spiralis* Mawson, 1968d
NT: PMM, 1968d, p.753
Microtetrameres oriolus Petrov & Tschertkova, 1950
NT: PMM, 1977, p.246
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: Cleland & THJ, 1912, p.435

415. **Sphecotheres viridis** Vieillot
Figbird
2/1 : N

C. *Raillietina sphecotheridis (T.H. Johnston, 1914a)*
Qld: CIHUS
syn. Davainea sphecotheridis T.H. Johnston, 1914a, p. 354

Qld: THJ, 1914a, p.106
Raillietina sp.
Qld: Hall Exped. Rep. 1974, p.354
Dendrouterina sp.
Aust: BM(NH)
Biuterina sp.
Qld: BM(NH), CIHUS

N. *Microtetrameres sphecotheres* Mawson, 1977
NT: PMM, 1977, p.253
Diplotriaena ? pungens (Schneider, 1866)
Qld: BM(NH)
Diplotriaena tridens (Molin, 1858)
? loc: Anderson, 1959, p.248
Onchocercidae, unidentified
Qld: CIHUS
Microfilaria sp.
Qld: Mackerras, 1962, p.439

Family DICRURIDAE

416. ***Dicrurus hottentottus*** (Linné)
Spangled Drongo
1/1 : N

T. *Plagiorchis nisbetii* (Nicoll, 1914a)
syn. *Lepoderma nisbetii* Nicoll, 1914a
Qld: Nicoll, 1914a, p.341
Prosthogonimus vitellatus Nicoll, 1914a
Qld: Nicoll, 1914a, p.345

N. *Viguiera chibiae* Mawson, 1968d
NT: PMM, 1968d, p.763
Geopetitia chibiae Mawson, 1966
NT: PMM, 1966, p.716
Diplotriaena sp.
Qld: Mackerras, 1962, p.432
NT: AHC
Hamatospiculum chibiae T.H. Johnston & Mawson, 1941a
Qld: THJ & PMM, 1941a, p.14
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: Mackerras, 1962, p.439

Family PARADISAEIDAE

417. ***Ptilonorhynchus violaceus*** (Vieillot)
Satin Bowerbird (endemic)

C. Unidentified
Qld: Cleland, 1922, p.107 (AHC)

N. *Microfilaria* sp.
Qld: Mackerras, 1962, p.439
NSW: CIHUS

418. ***Sericulus chrysocephalus*** (Lewin)
Regent Bowerbird (endemic)
1/0

C. Unidentified
Qld: Cleland, 1922, p.107 (AHC)
Qld: AHC

N. *Microfilaria* sp.
Qld: Bancroft, 1889, p.61

419. ***Chlamydera maculata*** (Gould)
Spotted Bowerbird (endemic)
1/0

C. *Paricterotaenia chlamyderae* (Krefft, 1873)
syn. *Taenia chlamyderae* Krefft, 1873
NSW: Krefft, 1873, p.224
Hymenolepis sp.
Qld: AHC

420. ***Ailuroedus melanotis*** (Gray)
Spotted Catbird

No helminths recorded

421. ***Ailuroedus crassirostris*** (Paykull)
Green Catbird

T. *Lutztrema ailuroedi* Angel & Pearson, 1977
Qld: LMA & Pearson, 1977, p.127
Qld: AHC

C. Unidentified
Qld: Cleland, 1922, p.107 (AHC)

N. Filarioidea, unidentified
Qld: AHC (broken specimens)

422. ***Ptiloris paradiseus*** Swainson
Paradise Riflebird (endemic)
1/1 : T C N

T. Unidentified
SA (cage): not kept (eggs only, in pancreas)

C. Unidentified
SA (cage): AHC

N. *Microtetrameres* sp.
SA (cage): PMM, 1977, p.258

Family CORCORACIDAE

423. ***Corcorax melanorhamphos*** (Vieillot)
White-winged Chough (endemic)
10/8 : T1 C6 N2 A6

T. *Leucochloridium australiense* T.H. Johnston & Cleland, 1938
SA: THJ & Simpson, 1940a, p.119

C. *Davainea* sp.
SA: AHC
Hymenolepididae, unidentified
NSW: CIHUS
Unidentified
Qld, NSW, SA: Cleland, 1922, p.106 (AHC)
Qld, Vic, SA: AHC

N. *Viguiera* sp.
SA: AHC
Microtetrameres helix Cram, 1927
Vic, SA: PMM, 1977, p.245
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.436
? NSW: Mackerras, 1962, p.439

A. *Mediorhynchus corcoracis* T.H. Johnston & Edmonds, 1951

Qld, NSW, SA: THJ & Edmonds, 1951, p.1
Vic: AHC
syn. *Echinorhynchus* sp.
NSW, SA: Cleland, 1922, p.108
Unidentified
NSW: CIHUS

424. ***Struthidea cinerea*** Gould
Apostle bird (endemic)
1/0

N. *Microtetrameres* sp.
SA: AHC
Splendidofilaria sp.
NSW: AHC
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.435 (two species noted)

Family GRALLINIDAE

425. ***Grallina cyanoleuca*** (Latham)
Australian Magpie-lark
27/19 : T10 C12 N11 A4

T. ? *Plagiorchis maculosus* (Rudolphi, 1802)
SA: LMA, 1959, p.265
Echinostomatinae [spines?]
SA: AHC
Prosthogonimus sp.
Qld: Nicoll, 1914b, p.106
Lecithodendriidae, unidentified
SA: AHC
Neodiplostomulum sp.
SA: Dubois & LMA, 1972, p.212 (metacercaria)
Strigea nicolli Dubois, 1937a
syn. *Strigea suttoni* Dubois, 1937a
Qld: Dubois, 1937b, p.237
C. *Hymenolepis* sp.
Qld: BM(NH)
Unidentified
SA: AHC
N. *Capillaria grallinae* T.H. Johnston & Mawson, 1945b
SA: THJ & PMM, 1945b, p.247
Microfilaria sp. Mackerras, 1962
Qld: Mackerras, 1962, p.437
A. *Echinorhynchus* sp.
Qld: THJ, 1912b, p.110; 1914a, p.110
Mediorhynchus garruli (Yamaguti, 1939b)
NSW: CIHUS
Mediorhynchus sp.
SA: AHC
Oncicola pomatostomi (T.H. Johnston & Cleland, 1912)
NT: AHC (cyst)

Family ARTAMIDAE

426. ***Artamus leucorhynchus*** (Linné)
White-breasted Woodswallow

C. Unidentified
Qld: Cleland, 1922, p.106 (AHC)
N. *Microfilaria* sp.
Qld: Cleland & THJ, 1912, p.432

427. ***Artamus personatus*** (Gould)
Masked Woodswallow (endemic)

C. Unidentified
SA: Cleland, 1922, p.106 (AHC)
N. *Microfilaria* sp.
Qld: Mackerras, 1962, p.437

428. ***Artamus superciliosus*** (Gould)
White-browed Woodswallow (endemic)

C. Unidentified
NSW: AHC
N. *Microfilaria* sp.
London, UK. (cage): Plimmer, 1916, p.85

429. ***Artamus cinereus*** Vieillot
Black-faced Woodswallow
5/2 : N

C. Unidentified
NSW: Cleland, 1922, p.106 (AHC)
N. *Acuaria petterae* Mawson, 1972
SA, NT: PMM, 1972, p.144
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.432
A. *Oncicola pomatostomi* (T.H. Johnston & Cleland, 1912)
syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912)
Qld: Hall Exped. Report, 1974, p.355 (cyst)

430. ***Artamus cyanopterus*** (Latham)
Dusky Woodswallow (endemic)
4/1 : N

C. Unidentified
NSW: Cleland, 1922, p.106 (AHC)
N. *Microfilaria* sp.
NSW: Mackerras, 1962, p.437
Qld: Cleland & THJ, 1912, p.432
Spirurida, unidentified
SA: AHC (larva)

431. ***Artamus minor*** Vieillot
Little Woodswallow (endemic)
2/0

No helminths recorded

Family CRACTICIDAE

432. *Cracticus torquatus* (Latham)
Grey Butcherbird (endemic)
5/3 : T1 N2

T. *Brachylecithum latius* Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.123
C. *Choanotaenia fieldingi* (Maplestone & Southwell, 1923)
syn. *Monopylidium fieldingi* Maplestone & Southwell, 1923
Qld: Maplestone & Southwell, 1923, p.318
N. *Capillaria* sp.
SA: AHC
Microtetrameres cractici Mawson, 1977
SA: PMM, 1977, p.251
Diplotriaena epsilon T.H. Johnston & Mawson, 1940a
Qld: THJ & PMM, 1940a, p.360
Filaria (*s.l.*) sp. (? Filarioidea)
Qld: Bancroft, 1889, pp.59,62
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: Cleland & THJ, 1912, p.432
Qld: Mackerras, 1962, p.438

433. ***Cracticus nigrogularis*** (Gould)
Pied Butcherbird (endemic)
7/3 : N

N. *Physaloptera* sp.
NT: AHC
Acuaria petterae Mawson, 1972
NT: PMM, 1972, p.144
Microfilaria sp.
Qld: Cleland & THJ, 1912, p.432
Spirurida, unidentified
NT: AHC (larva)

434. ***Gymnorhina tibicen*** (Latham)
Australian Magpie
77/56 : T9 C10 N45 A4

T. *Plagiorchis maculosus* (Rudolphi, 1802)
SA: LMA, 1959, p.265
Prosthogonimus vitellatus Nicoll, 1914a
SA: LMA, 1973, p.859
Brachylecithum latius Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.123
Brachylecithum sp.
SA: LMA & Pearson, 1977, p.124
Strigea nicolli (Dubois, 1937a)
NSW: Dubois & LMA, 1972, p.199
Unidentified
NSW: lost
C. Dilepididae, unidentified,
SA: AHC
Unidentified
Qld, ACT, Vic, Tas, SA, WA: AHC
N. *Capillaria gymnorhinae* T.H. Johnston & Mawson, 1947
SA: THJ & PMM, 1947, p.548
ACT, SA: AHC
Syngamus trachea (Montagu, 1811)
Vic: Harrigan & Arundel, 1978, p.360
Tas: Obendorf, 1984, p.7
Porrocaecum streperae T.H. Johnston & Mawson, 1941d
ACT, SA: AHC
Porrocaecum wui Hs-f9-, 1933
ACT: BM(NH)
Oxyspirura streperae T.H. Johnston & Mawson, 1941a
ACT: BM(NH)
Microtetrameres gymnorhinae Mawson, 1977
ACT, SA, NT: PMM, 1977, p.251
Acuaria petterae Mawson, 1972
ACT, SA, NT: PMM, 1977, p.251
Qld: AHC
Xenocordon gymnorhinis (de Chaneet & Robertson, 1983)
Qld, NSW, Vic, SA: AHC
syn. *Cheilospirura gymnorhinis* de Chaneet & Robertson, 1983
SA, WA: de Chaneet & Robertson, 1983, p.143
Diplotriaena clelandi (T.H. Johnston, 1912b)
syn. *Filaria clelandi* T.H. Johnston, 1912b
Qld: THJ, 1912b, p.110
Splendidofilariinae, unidentified
SA: AHC
Microfilaria gymnorhinae Gilruth, Sweet & Dodd, 1910
SA: Gilruth, Sweet & Dodd, 1910, p.236, Mackerras (1962) notes that G., S. & D. describe 3 species under this heading.
Microfilaria sp.
Qld: Bancroft, 1889, p.61
NSW: Cleland & THJ, 1910, p.107
NSW: Mackerras, 1962, p.438
London (cage): Plimmer, 1912, p.408
Spirurida, unidentified
SA: AHC (larva)
A. *Prosthorhynchus cylindraceus* (Goeze, 1782)
Vic, Tas: AHC
Oncicola pomatostomi (T.H. Johnston & Cleland, 1912)
SA, NT: AHC
syn. *Oligacanthorhynchus pomatostomi* T.H. Johnston & Cleland, 1912
SA: Hall Exped. Report, 1974, p.355 (cyst)

435. ***Strepera graculina*** (White)
Pied Currawong (endemic)

T. Dicrocoeliinae, unidentified
Qld: AHC
C. Hymenolepididae, unidentified
NSW: CIHUS
Unidentified
Qld: Cleland, 1922, p.107 (AHC)
Qld, NSW: AHC
N. *Porrocaecum streperae* T.H. Johnston & Mawson, 1941d
SA: AHC
Oxyspirura streperae T.H. Johnston & Mawson, 1941a

Qld: AHC
Acuaria streperina T.H. Johnston & Mawson, 1941d
Qld: AHC
Diplotriaena alpha T.H. Johnston & Mawson, 1941a
SA: THJ & PMM, 1940a, p.359
syn. *'Filaria'*
SA: Cleland, 1922, p.108
Paralemdana clelandi T.H. Johnston & Mawson, 1940a (sp. *inq.* in CIH keys)
NSW: THJ & PMM, 1940a, p.356
syn. *'Filaria'*
NSW: Cleland, 1922, p.108
Aprocta boulengeri Bain & Mawson, 1981
Qld: Bain & Mawson, 1981, p.269
Microfilaria sp.
Qld: Bancroft, 1889, p.61

436. ***Strepera fuliginosa*** (Gould)
Black Currawong (endemic)

N. *Oxyspirura streperae* T.H. Johnston & Mawson, 1941a
SA: THJ & PMM, 1941a, p.11
Acuaria streperina T.H. Johnston & Mawson, 1941d
SA: THJ & PMM, 1941d, p.254
Diplotriaena sp.
Vic: AHC
Microfilaria sp.
London, U.K. (cage): Plimmer, 1912, p.408

437. ***Strepera versicolor*** (Latham)
Grey Currawong (endemic)
8/5 : T1 C2 N4

T. Echinostomatinae [spines ? (35(5))]
SA: AHC
Brachylecithum parvum (S.J. Johnston, 1917)
syn. *Lyperosomum parvum* S.J. Johnston, 1917
NSW: SJJ, 1917, p.223
C. Unidentified
NSW, SA: AHC
N. *Porrocaecum streperae* T.H. Johnston & Mawson, 1941d
NSW: THJ & PMM, 1941d, p.253
Geopetitia streperae Mawson, 1966
SA: PMM, 1966, p.715
Microtetrameres streperae Mawson, 1977
SA: PMM, 1977, p.251
Acuaria streperina T.H. Johnston & Mawson, 1941d
SA: THJ & PMM, 1941d, p.254

Family CORVIDAE

For note on host spp. in this family, see p. 221.

438. ***Corvus coronoides*** Vigors & Horsfield
Australian Raven (endemic)
2/2 : T1 C2 N2

T. Prosthogonimidae, unidentified
Qld: AHC
Brachylecithum latius Angel & Pearson, 1977
SA: LMA & Pearson, 1977, p.123
C. *Davainea* sp.
NSW: THJ, 1912b, p.112
Unidentified
NSW: Cleland, 1922, p.107 (AHC)
EA: AHC (? host sp.)
SA: AHC
N. *Microtetrameres helix* Cram, 1927
SA: PMM, 1977, p.245
Acuaria anthuris (Rudolphi, 1819)
SA: PMM, 1972, p.141
Aprocta bakeri Bain & Mawson, 1981
SA: AHC

439. ***Corvus tasmanicus*** Mathews
Forest Raven (endemic)
48/48 : T2 C14 N48 A1

T. Echinostomatinae [spines missing]
Tas: AHC
Brachylecithum parvum (S.J. Johnston, 1917)
Tas: LMA & Pearson, 1977, p.118
Dicrocoeliidae, unidentified
Tas: Munday & Green, 1972, p.2
C. Unidentified
Tas: Cleland, 1922, p.107 (AHC)
Tas: Munday & Green, 1972, p.4
Tas: AHC
N. *Capillaria* sp.
Tas: AHC
Syngamus trachea (Montagu, 1811)
Tas: Obendorf, 1982, p.7
Microtetrameres helix Cram, 1927
Tas: PMM, 1977, p.245
syn. *Microtetrameres* sp.
Tas: Munday & Green, 1972, p.11
Acuaria anthuris (Rudolphi, 1819)
Tas: PMM, 1972, p.141
Tas: Munday & Green, 1972, p.11
Spirurida, unidentified
Tas: AHC (larva)
A. *Mediorhynchus corcoracis* T.H. Johnston & Edmonds, 1951
Tas: AHC

440. ***Corvus mellori*** Mathews
Little Raven
16/13 : T1 C7 N11 A6

T. ? Tanaisiinae, unidentified
SA: AHC
Echinostomatinae [spines (37(5))]
Vic: AHC
C. *Hymenolepis* sp.
Vic: AHC
Unidentified
Vic, SA: AHC
N. *Capillaria* sp.
Vic, SA: AHC
Porrocaecum sp.
Vic: AHC
Microtetrameres helix Cram, 1927

SA: PMM, 1977, p.245
Vic: AHC
Acuaria anthuris (Rudolphi, 1819)
SA: PMM, 1972, p.141
Vic: AHC
Aprocta bakeri Bain & Mawson, 1981
Vic: AHC
Spirurida, unidentified
SA: AHC (larva)
A. *Mediorhynchus corcoracis* T.H. Johnston & Edmonds, 1951
SA: AHC

441. ***Corvus bennetti*** North
Little Crow (endemic)
2/2 : N2

C. Unidentified
SA: AHC
N. *Microtetrameres helix* Cram, 1927
NT: PMM, 1977, p.245
Acuaria anthuris (Rudolphi, 1819)
NT: PMM, 1972, p.141
'Filarial worms'
Qld: Mackerras, 1962, p.435
A. *Mediorhynchus corcoracis* T.H. Johnston & Edmonds, 1951
SA: THJ & Edmonds, 1951, p.1

442. ***Corvus orru*** Bonaparte
Torresian Crow
8/6 : T1 C1 N6

T. Dicrocoeliinae, unidentified
Qld: AHC
C. *Raillietina corvina* (Fuhrmann, 1905)
Qld: BM(NH)
Unidentified
Qld: Cleland, 1922, p.107 (AHC)
NT: AHC
N. *Microtetrameres helix* Cram, 1927
NT: PMM, 1977, p.245
Acuaria anthuris (Rudolphi, 1819)
NT: PMM, 1972, p.141
Qld: AHC
syn. *A. corvicola* T.H. Johnston & Mawson, 1941a
SA: THJ & PMM, 1941a, p.10
Diplotriaena beveridgei Bain & Mawson, 1981
Qld: Bain & Mawson, 1981, p.278
Diplotriaena flabellata (Linstow, 1888)
Qld: Ogden, 1967, p.505
Qld: Hall Exped. Report, 1974, p.354
syn. *D. beta* T.H. Johnston & Mawson, 1940a
Qld: THJ & PMM, 1940a, p.360
Diplotriaena sp.
Qld: AHC
Aprocta bakeri Bain & Mawson, 1981
Qld: Bain & Mawson, 1981, p.269
Aprocta corvicola T.H. Johnston & Mawson, 1940a
SA: THJ & PMM, 1940a, p.358 (? host sp.)
Filaria (s.l.) sp. (? Filarioidea)
Qld: Bancroft, 1889, p.62
Microfilaria sp.
Qld: Bancroft, 1889, p.61
Qld: Cleland & THJ, 1912, p.435
NSW: Cleland & THJ, 1910, p.108

443. ***Corvus*** sp.

C. *Hymenolepis* sp.
SA: AHC
N. *Synhimantus* sp.
SA: AHC
A. *Mediorhynchus corcoracis* T.H. Johnston & Edmonds, 1951
SA: AHC
Mediorhynchus sp.
NT: AHC

List 2. HELMINTHS IN TAXONOMIC ORDER, AND THEIR HOSTS

In this section the host names are listed after the name of each helminth. Synonyms of the helminths are given if they have been cited elsewhere in the work, but the list is in no way intended as a complete synonymy of any species. Species are listed alphabetically in their families or subfamilies, which are in taxonomic order, or within each superfamily within each order (Nematoda). Specimens not identified further than to Trematoda, Cestoda, Nematoda, or Acanthocephala have been omitted from this list.

PHYLUM PLATYHELMINTHES

Class Trematoda

Order Digenea

Family SCHISTOSOMATIDAE Stiles & Hassall, 1898

Schistosomatidae, unidentified, Blair & Otteson, 1979.
Anseranas semipalmata, 69; *Dendrocygna arcuata*, 70; *D. eytoni*, 71; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. rhynchotis*, 80; *Aythya australis*, 82; *Chenonetta jubata*, 83.

Schistosomatidae, unidentified.
Podiceps cristatus, 3; *Larus novaehollandiae*, 163.

Austrobilharzia terrigalensis S.J. Johnston, 1917.
Egretta sacra, 58; *Larus novaehollandiae*, 163; *Sterna bergii*, 171; *Melopsittacus undulatus*, 209.

Bilharziellinae, unidentified.
Himantopus leucocephalus, 142; *Cladorhynchus leucocephalus*, 143.

Dendritobilharzia sp.
Pelecanus conspicillatus, 37.

Gigantobilharzia sp.
Larus novaehollandiae, 163.

Ornithobilharzia sp.
Pelecanus conspicillatus, 37; *Chlidonias hybrida*, 164.

Schistosomatinae, unidentified.
Pelecanus conspicillatus, 37.

Trichobilharzia australis Blair & Islam, 1983.
Anas superciliosa, 77.

Trichobilharzia sp., Blair & Otteson, 1979.
Anas superciliosa, 77.

Trichobilharzia sp., Bearup, 1957.
Anas gibberifrons, 78.

Trichobilharzia sp., Bearup & Langsford, 1966.
Himantopus leucocephalus, 142.

Trichobilharzia sp., T.H. Johnston, 1941.
Cygnus atratus, 72.

Trichobilharzia sp.
Himantopus leucocephalus, 142; *Melopsittacus undulatus*, 209.

Family NOTOCOTYLIDAE Lühe, 1909

Notocotylidae, unidentified.
Dendrocygna arcuata, 70; *Cygnus atratus*, 72; *Stictonetta naevosa*, 73; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *Malacorhynchus membranaceus*, 81; *Oxyura australis*, 86; *Biziura lobata*, 87; *Erythrogonys cinctus*, 134; *Cladorhynchus leucocephalus*, 143; *Recurvirostra novaehollandiae*, 144; *Calidris acuminata*, 157.

Notocotylid, ? sp. B of S.J. Smith, 1981.
Cygnus atratus, 72.

Catatropis gallinulae T.H. Johnston, 1928.
Gallinula tenebrosa, 121.

Catatropis sp.
Porzana pusilla, 116; *P. fluminea*, 117; *Gallinula tenebrosa*, 120.

Notocotylus attenuatus (Rudolphi, 1809).
Anseranas semipalmata, 69; *Cygnus atratus*, 72; *Anas superciliosa*, 77; *Nettapus pulchellus*, 85; *Burhinus magnirostris*, 128; *Vanellus miles*, 131; *Calidris acuminata*, 157.

Paramonostomum bursae Smith & Hickman, 1983b.
Anas superciliosa, 77.

Paramonostomum caeci Smith & Hickman, 1983b.
Poliocephalus poliocephalus, 4; *Cygnus atratus*, 72; *Anas superciliosa*, 77.

Paramonostomum sp.
Malacorhynchus membranaceus, 81; *Gallinula tenebrosa*, 121.

Family CYCLOCOELIDAE Stossich, 1902

Cyclocoelidae, unidentified.
Cygnus atratus, 72; *Anas gibberifrons*, 78; *Aythya australis*, 82; *Leucosarcia melanoleuca*, 117; *Recurvirostra novaehollandiae*, 144; *Tringa glareola*, 146; *Calidris canutus*, 155; *Lichmera indistincta*, 378.

Allopyge antigones S.J. Johnston, 1913, syn. 'Monostome' of Nicoll, 1914c.
Grus rubicundus, 124.

Cyclocoelum jaenschi T.H. Johnston & Simpson, 1940b.
Poliocephalus poliocephalus, 4; *Tachybaptus novaehollandiae*, 5.

Cyclocoelum obscurum (Leidy, 1887).
Vanellus miles, 131.

Cyclocoelum taxorchis S.J. Johnston, 1917.
Limosa lapponica, 154.

Cyclocoelum sp.
Malacorhynchus membranaceus, 81; *Nettapus coromandelianus*, 84; *Porphyrio porphyrio*, 122; *Limosa lapponica*, 154.

Haematotrephus adelphus S.J. Johnston, 1917, syn. *Monostomum* sp., T.H. Johnston, 1910.
Himantopus leucocephalus, 142; *Cladorhynchus leucocephalus* 143.

Haematotrephus consimilis Nicoll, 1914b.
Vanellus miles, 131.

Haematotrephus sp.
Tringa nebularia, 149.

Hyptiasmus magnus S.J. Johnston, 1917, syn. *Monostomum* sp., T.H. Johnston, 1910.
Cygnus atratus, 72.

Typhlocoelum reticulare S.J. Johnston, 1913.
Anseranas semipalmata, 69.

Typhlocoelum sp.
Anas superciliosa, 77; *A. gibberifrons*, 78.

Family EUCOTYLIDAE Skrjabin, 1924

Eucotyle sp.
Ardea novaehollandiae, 53.

Tanaisiinae, unidentified.
Corvus mellori, 440.

Family PHILOPHTHALMIDAE Looss, 1899

Cloacitrema narrabeenense Howell & Bearup, 1967.
Larus novaehollandiae, 163.

Parorchis acanthus (Nicoll, 1906).
Larus novaehollandiae, 163.

Philophthalmus burrili Howell & Bearup, 1967.
Larus novaehollandiae, 163.

Philophthalmus sp.
Dromaius novaehollandiae, 1; *Ardeotis australis*, 126.

Family BRACHYLAEMIDAE Joyeux & Foley, 1930

Brachylaima pulchellum (S.J. Johnston, 1917), syn. *Harmostomum pulchellum* S.J. Johnston, 1917.
Leucosarcia melanoleuca, 187.

Brachylaima sp.
Leucosarcia melanoleuca, 187.

Family LEUCOCHLORIDIIDAE Poche, 1907

Leucochloridium australiense T.H. Johnston & Cleland, 1938.
Pomatostomus superciliosus, 311; *Corcorax melanorhamphos*, 423.

Leucochloridium sp.
Rallus philippensis, 114.

Urotocus sp.
Manorina melanocephala, 360.

Family OMPHALOMETRIDAE Looss, 1899

- Omphalometridae, unidentified.
  - *Cladorhynchus leucocephalus*, 143.
- *Dolichosacculus solecarius* (S.J. Johnston, 1917), syn. *Dolichosaccus solecarius* S.J. Johnston, 1917.
  - *Phalacrocorax melanoleucos*, 47.

Family PLAGIORCHIIDAE Lühe, 1901

- *Plagiorchis maculosus* (Rudolphi, 1802), syn. *P. clelandi* S.J. Johnston, 1917, *P. spatulatus* S.J. Johnston, 1917.
  - *Hirundo neoxena*, 266; *Cecropis ariel*, 269; *Anthus novaeseelandiae*, 270; *Rhipidura fuliginosa*, 302; *R. leucophrys*, 304; *Pomatostomus superciliosus*, 311; *Pardalotus striatus*, 399; *Grallina cyanoleuca*, 425; *Gymnorhina tibicen*, 434.
- *Plagiorchis nisbetii* (Nicoll, 1914a), syn. *Lepoderma nisbetii* Nicoll, 1914a.
  - *Dicrurus hottentottus*, 416.
- Plagiorchiidae, unidentified, syn. Lepodermatidae, unidentified, Nicoll, 1914b.
  - *Vanellus miles*, 131.

Family ECHINOSTOMATIDAE Looss, 1899

- Echinostomatidae, unidentified, Bradley 1926, 1927.
  - *Poliocephalus poliocephalus*, 4.
- Echinostomatidae, unidentified, Munday & Green, 1972.
  - *Pluvialis dominica*, 133.
- Echinostomatidae, unidentified.
  - *Tachybaptus novaehollandiae*, 5; *Pelecanus conspicillatus*, 37; *Phalacrocorax melanoleucos*, 47; *Egretta garzetta*, 56; *Cygnus atratus*, 72; *Anas gibberifrons*, 78; *A. rhynchotis*, 80; *Aythya australis*, 82; *Chenonetta jubata*, 83; *Biziura lobata*, 87; *Coturnix ypsilophora*, 109; *Gallinula ventralis*, 120; *Irediparra gallinacea*, 127; *Erythrogonys cinctus*, 134; *Charadrius melanops*, 140; *Tringa hypoleucos*, 148; *Calidris acuminata*, 157; *Chlidonias hybrida*, 164.
- *Acanthoparyphium marilae* Yamaguti, 1934.
  - *Charadrius leschenaultii*, 138; *Limosa lapponica*, 154; *Calidris canutus*, 155; *Calidris tenuirostris*, 156.
- *Acanthoparyphium spinulosum* S.J. Johnston, 1917.
  - *Pluvialis dominica*, 133; *Charadrius leschenaultii*, 138; *C. ruficapillus*, 139; *Larus novaehollandiae*, 163.
- *Acanthoparyphium squatarolae* Yamaguti, 1934.
  - *Limosa lapponica*, 154; *Calidris tenuirostris*, 156.
- *Acanthoparyphium* sp.
  - *Cladorhynchus leucocephalus*, 143; *Lichmera indistincta*, 378.
- *Chaunocephalus ferox* (Rudolphi, 1795).
  - *Xenorhynchus asiaticus*, 63.
- *Cloeophora* sp.
  - *Calidris canutus*, 155.
- *Echinochasmus pelecani* T.H. Johnston & Simpson, 1944.
  - *Pelecanus conspicillatus*, 37.
- *Echinochasmus* sp.
  - *Phalacrocorax sulcirostris*, 46.
- *Echinoparyphium ellisi* (T.H. Johnston & Simpson, 1944), syn. *E.* sp., Verma, 1936.
  - *Cygnus atratus*, 72; *Biziura lobata*, 87.
- *Echinoparyphium gizzardai* Verma, 1936.
  - *Cygnus atratus*, 72.
- *Echinoparyphium harveyanum* S.J. Johnston, 1917.
  - *Microeca leucophaea*, 287.
- *Echinoparyphium oxyurum* S.J. Johnston, 1917.
  - *Egretta alba*, 55.
- *Echinoparyphium phalacrocoracis* Yamaguti, 1939a.
  - *Leucocarbo fuscescens*, 43; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *P. melanoleucos*, 47.
- *Echinoparyphium* sp.
  - *Stictonetta naevosa*, 73; *Tadorna tadornoides*, 75; *Tringa hypoleucos*, 148; *Larus novaehollandiae*, 163; *Ninox novaeseelandiae*, 242; *Podargus strigoides*, 246; *Dacelo novaeguineae*, 253.
- *Echinostoma acuticauda* Nicoll, 1914b.
  - *Threskiornis aethiopica*, 65; *T. spinicollis*, 66.
- *Echinostoma australasianum* Nicoll, 1914a.
  - *Grus rubicundus*, 124.
- *Echinostoma australe* T.H. Johnston, 1928.
  - *Gallinula tenebrosa*, 121.
- *Echinostoma bancrofti* T.H. Johnston, 1928.
  - *Gallinula tenebrosa*, 121.
- *Echinostoma elongatum* Nicoll, 1914a.
  - *Podargus strigoides*, 246.
- *Echinostoma emollitum* Nicoll, 1914b.
  - *Centropus phasianus*, 239.
- *Echinostoma hilliferum* Nicoll, 1914b.
  - *Gallinula ventralis*, 120; *Porphyrio porphyrio*, 122; *Fulica atra*, 123.
- *Echinostoma ignavum* Nicoll, 1914b.
  - *Burhinus magnirostris*, 128; *Vanellus miles*, 131.
- *Echinostoma minimum* Verma, 1936.
  - *Cygnus atratus*, 72.
- *Echinostoma revolutum* (Froelich, 1802), syn. 'echinostome larva', Bradley, 1927, *Echinostoma* sp., T.H. Johnston 1912b.
  - *Anseranas semipalmata*, 69; *Cygnus atratus*, 72; *Tadorna tadornoides*, 75; *Anas superciliosa*, 77; *A. rhynchotis*, 80; *Nettapus pulchellus*, 85; *Biziura lobata*, 87; *Gallinula tenebrosa*, 121.
- *Echinostoma* sp., T.H. Johnston, 1910.
  - *Pluvialis dominica*, 133.
- *Echinostoma* sp., T.H. Johnston, 1912b.
  - *Egretta alba*, 55.
- *Echinostoma* sp.
  - *Poliocephalus poliocephalus*, 4; *Egretta alba*, 55; *Cygnus atratus*, 72; *Anas gibberifrons*, 78; *Malacorhynchus membranaceus*, 81; *Porzana pusilla*, 116; *Gallinula tenebrosa*, 121; *Porphyrio porphyrio*, 122; *Vanellus miles*, 131; *Tringa hypoleucos*, 148; *Larus novaehollandiae*, 163; *Hydroprogne caspia*, 166; *Ninox novaeseelandiae*, 242.
- 'Echinostome larva' of Bradley, 1926, 1927.
  - *Fulica atra*, 123.
- Echinostomatinae, unidentified.
  - *Phalacrocorax sulcirostris*; 46; *Dendrocygna*

arcuata, 70; *Cygnus atratus*, 72; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. rhynchotis*, 80; *Oxyura australis*, 86; *Biziura lobata*, 87; *Haliastur sphenurus*, 91; *Porzana pusilla*, 116; *P. fluminea*, 117; *Porphyrio porphyrio*, 122; *Calidris acuminata*, 157; *Larus novaehollandiae*, 163; *Hydroprogne caspia*, 166; *Tyto alba*, 244; *Grallina cyanoleuca*, 425; *Strepera versicolor*, 437; *Corvus tasmanicus*, 439; *C. mellori*, 440.

Episthmium prosthovitellatum (Nicoll, 1914b), syn. *Echinochasmus prosthovitellatum* Nicoll, 1914b.

Falco berigora, 104.

Euparyphium longitestis Verma, 1936.

Cygnus atratus, 72.

Himasthla harrisoni S.J. Johnston, 1917, syn. *Echinostoma* sp., T.H. Johnston, 1912b, *Echinostoma (Acanthochasmus)* sp., T.H. Johnston, 1916, 1918.

Numenius madagascariensis, 145.

Himasthla kusasigi Yamaguti, 1939a.

Calidris tenuirostris, 156.

Himasthla megacotyla Yamaguti, 1939a.

Limosa lapponica, 154.

Himasthlinae, unidentified.

Calidris canutus, 155; *Podargus strigoides*, 246; *Lichmera indistincta*, 378.

Hypoderaeum conoideum (Bloch, 1782).

Anas castanea, 79.

Hypoderaeum sp.

Anas superciliosa, 77; *A. gibberifrons*, 78; *A. castanea*, 79.

Nephrostomum sp.

Egretta garzetta, 56.

Paryphostomum radiatum (Dujardin, 1845), syn. *Echinochasmus tenuicollis* S.J. Johnston, 1917; *Paryphostomum tenuicolle* (S.J. Johnston, 1917); *Paryphostomum phalacrocoracis* Goss, 1940.

Leucocarbo fuscescens, 43; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *P. melanoleucos*, 47.

Patagifer acuminatus S.J. Johnston, 1917, syn. *Echinostoma* sp., T.H. Johnston, 1912b, *Patagifer bilobus* of T.H. Johnston, 1916, not (Rudolphi, 1819).

Threskiornis aethiopica, 65.

Patagifer bilobus (Rudolphi, 1819).

Plegadis falcinellus, 64; *Threskiornis spinicollis*, 66; *Platalea regia*, 67.

Patagifer fraternus S.J. Johnston, 1917.

Egretta alba, 55.

Patagifer sp.

Poliocephalus poliocephalus, 4; *Threskiornis aethiopica*, 65; *Platalea flavipes*, 68; *Anas superciliosa*, 77.

Petasiger australis T.H. Johnston & Angel, 1941b.

Podiceps cristatus, 3; *Poliocephalus poliocephalus*, 4; *Tachybaptus novaehollandiae*, 5.

Petasiger exaeretus Dietz, 1909.

Leucocarbo fuscescens, 43; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *P. melanoleucos*, 47.

Petasiger sp.

Tyto alba, 244.

Stephanoprora sp.

Larus novaehollandiae, 163.

Vermatrema longitestis (Verma, 1936), syn. *Euparyphium longitestis* Verma, 1936.

Cygnus atratus, 72.

Family PSILOSTOMIDAE Looss, 1900

Psilochasmus oxyurus (Creplin, 1825).

Poliocephalus poliocephalus, 4; *Cygnus atratus*, 72; *Anas superciliosa*, 77; *Fulica atra*, 123.

Psilochasmus sp.

Stictonetta naevosa, 73; *Cereopsis novaehollandiae*, 74; *Biziura lobata*, 87; *Falco berigora*, 104.

Psilostomum sp. A, of S.J. Smith, 1981.

Poliocephalus poliocephalus, 4; *Cygnus atratus*, 72.

Psilostomum sp. B, of S.J. Smith, 1981.

Poliocephalus poliocephalus, 4; *Cygnus atratus*, 72.

Psilostomum sp.

Cygnus atratus, 72; *Stictonetta naevosa*, 73; *Anas superciliosa*, 77.

Family PROSTHOGONIMIDAE Lühe, 1909

Prosthogonimidae, unidentified.

Corvus coronoides, 438.

Prosthogonimus sp., Nicoll, 1914b.

Grallina cyanoleuca, 425.

Prosthogonimus sp., unidentified.

Anas superciliosa, 77; *Grus rubicundus*, 124; *Larus novaehollandiae*, 163; *Rhipidura leucophrys*, 304; *Acanthiza pusilla*, 336.

Cylindrotrema cygni Angel, 1973.

Cygnus atratus, 72.

Mawsonotrema eudyptulae Angel, 1973.

Eudyptula minor, 11.

Prosthogonimus vitellatus Nicoll, 1914a.

Phalacrocorax melanoleucos, 47; *Chlidonias hybrida*, 164; *Dicrura hottentottus*, 416; *Gymnorhina tibicen*, 434.

Family DICROCOELIIDAE Looss, 1899

Dicrocoeliidae, unidentified, Koch & Duhamel, 1982.

Cacatua galerita, 196.

Dicrocoeliidae, unidentified, Munday & Green, 1972.

Corvus tasmanicus, 439.

Dicrocoeliidae, unidentified.

Coracina papuensis, 272.

Brachylecithum dacelonis Angel & Pearson, 1977.

Dacelo novaeguineae, 253.

Brachylecithum harrisoni (S.J. Johnston, 1917), syn. *Lyperosomum harrisoni* S.J. Johnston, 1917.

Ninox novaeseelandiae, 242.

Brachylecithum latius Angel & Pearson, 1977.

Cracticus torquatus, 432; *Gymnorhina tibicen*, 434; *Corvus coronoides*, 438.

Brachylecithum megastomum (S.J. Johnston, 1917), syn. *Lyperosomum megastomum* S.J. Johnston, 1917.

Sterna bergii, 171.

Brachylecithum parvum (S.J. Johnston, 1917), syn. *Lyperosomum parvum* S.J. Johnston, 1917.

Cecropis nigricans, 268; *Strepera versicolor*, 437; *Corvus tasmanicus*, 439.

Brachylecithum podargi Angel & Pearson, 1977.

Podargus strigoides, 46.

Brachylecithum sp.

Gymnorhina tibicen, 434.

Dicrocoeliinae, unidentified.

Cacatua galerita, 196; *Strepera graculina*, 435; *Corvus orru*, 442.

Lutztrema ailuroedi Angel & Pearson, 1977.

Strepera versicolor, 421.

Pancreatrema meliphagae Angel & Pearson, 1977.

Lichenostomus ornatus, 371.

Platynosomum proxillicens (Canavan, 1937), syn. *Dicrocoelium proxillicens* Canavan, 1937; *Platynosomum fallax* Heidegger & Mendhein, 1938a; *P. ventroplicatum* Heidegger & Mendheim, 1938b.

Cacatua galerita, 196.

Platynotrema biliosum Nicoll, 1914b.

Threskiornis aethiopica, 65; *Burhinus magnirostris*, 128.

Platynotrema jecoris Nicoll, 1914b.

Burhinus magnirostris, 128.

Platynotrema sp.

Tringa hypoleucos, 148; *Limosa lapponica*, 154.

Proacetabulorchis dogieli Belopolskaya & Bychovskaya-Pavlovskaya, 1954.

Ardea novaehollandiae, 53.

Skrjabinosomum mawsoni Angel & Pearson, 1977.

Turnix castanota, 110; *Manorina flavigula*, 362.

Skrjabinosomum pomatostomi Angel & Pearson, 1977.

Pomatostomus superciliosus, 311.

Skrjabinosomum sp., Angel & Pearson, 1977.

Microeca leucophaea, 287.

Family LATEROTREMATIDAE Yamaguti, 1958

Laterotrema sp.

Pomatostomus superciliosus, 311.

Family EUMEGACETIDAE Travassos, 1922

Eumegacetes sp.

Eurostopodus mystacalis, 249; *Rhipidura leucophrys*, 304.

Family LECITHODENDRIIDAE Lühe, 1901

Lecithodendriidae, unidentified.

Rhipidura leucophrys, 304; *Anthochaera carunculata*, 350; *Grallina cyanoleuca*, 425.

Pleuropsolus sp.

Cuculus flabelliformis, 234.

Family ORCHIPEDIDAE Skrjabin, 1913

Orchipedum sufflavum Nicholl, 1914b.

Platalea regia, 67.

Family MICROPHALLIDAE Ward, 1901

Microphallidae, unidentified, Munday & Green, 1972.

Charadrius ruficapillus, 139; *Calidris ruficollis*, 158.

Microphallidae, unidentified.

Tachybaptus novaehollandiae, 5; *Malacorhynchus membranaceus*, 81; *Charadrius ruficapillus*, 139.

Atriophallophorus coxiellae S.J. Smith, 1974.

Poliocephalus poliocephalus, 4; *Fulica atra*, 123; *Charadrius rubricollis*, 135; *C. ruficapillus*, 139.

Basantisia queenslandensis Deblock & Pearson, 1968a.

Dacelo novaeguineae, 253.

Endocotyle incana Belopolskaya, 1952.

Charadrius mongolus, 136; *Calidris acuminata*, 157.

Gynaecotyla brisbanensis Deblock & Pearson, 1968a.

Charadrius mongolus, 136; *Larus novaehollandiae*, 163.

Levinseniella howensis S.J. Johnston, 1917.

Pluvialis dominica, 133.

Levinseniella microovata Belopolskaya, 1958.

Pluvialis dominica, 133; *Charadrius mongolus*, 136.

Levinseniella monodactyla Deblock & Pearson, 1970.

Charadrius mongolus, 136.

Levinseniella tasmaniae (S.J. Smith, 1974), syn. *Microphallus tasmaniae* S.J. Smith, 1974.

Poliocephalus poliocephalus, 4; *Anas superciliosa*, 77; *Anas castanea*, 79; *Charadrius rubricollis*, 135; *C. ruficapillus*, 139; *C. melanops*, 140.

Levinseniella sp.

Larus novaehollandiae, 163.

Maritrema calvertense S.J. Smith, 1974.

Poliocephalus poliocephalus, 4; *Anas superciliosa*, 77; *A. castanea*, 79; *Charadrius rubricollis*, 135; *C. melanops*, 140.

Maritrema eroliae Yamaguti, 1939a.

Charadrius mongolus, 136; *Sterna bergii*, 171.

Maritrema oocystum (Lebour, 1907).

Tachybaptus novaehollandiae, 5; *Anhinga melanogaster*, 42; *Ardea novaehollandiae*, 53.

Maritrema sp.

Charadrius leschenaultii, 138; *Tringa hypoleucos*, 148; *Limosa lapponica*, 154; *Sterna bergii*, 171.

Microphallinae, unidentified.

Calidris acuminata, 157.

Microphallus papillornatus Deblock & Pearson, 1969.

Pluvialis dominica, 133; *Charadrius mongolus*, 136; *Larus novaehollandiae*, 163.

Microphallus vaginosus Deblock & Pearson, 1969.

Pluvialis dominica, 133.

Microphallus sp. Deblock & Pearson, 1969.

Charadrius mongolus, 136.

Family RENICOLIDAE Dollfus, 1939

Renicola sp.

Eudyptula minor, 11; *Puffinus tenuirostris*, 33; *P. gavia*, 34; *Pelecanus conspicillatus*, 37;

Leucocarbo fuscescens, 43; *Phalacrocorax varius*, 45; *P.* sp., 48; *Egretta alba*, 55.

Family **OPISTHORCHIIDAE** Looss, 1899

- *Opisthorchis obsequens* Nicoll, 1914b.
  - *Threskiornis spinicollis*, 66; *Falco berigora*, 104.
- *Opisthorchis* sp.
  - *Circus approximans*, 99.
- *Pachytrema calculus* Looss, 1907.
  - *Larus novaehollandiae*, 163; *Chlidonias hybrida*, 164.
- *Pachytrema* sp., S.J. Smith, pers. comm.
  - *Poliocephalus poliocephalus*, 4.

Family **HETEROPHYIDAE** Ciurea, 1924

- Heterophyidae, unidentified.
  - *Egretta alba*, 55; *Limosa lapponica*, 154; *Calidris ruficollis*, 158; *Hydroprogne caspia*, 166.
- *Ascocotyle* sp.
  - *Pelecanus conspicillatus*, 37.
- *Cryptocotyle* sp.
  - *Puffinus tenuirostris*, 33.
- *Galactosomum angelae* Pearson, 1973.
  - *Eudyptula minor*, 11; *Sula serrator*, 38; *Larus novaehollandiae*, 163; *Hydroprogne caspia*, 166; *Sterna bergii*, 171.
- *Galactosomum bearupi* Pearson, 1973.
  - *Larus novaehollandiae*, 163; *Hydroprogne caspia*, 166; *Sterna fuscata*, 168; *Sterna bengalensis*, 172; *Anous minutus*, 174.
- *Galactosomum renincolum* Pearson, 1973.
  - *Puffinus pacificus*, 31; *Sterna fuscata*, 168; *Anous minutus*, 174.
- *Galactosomum sinuilacte* Pearson, 1973.
  - *Leucocarbo fuscescens*, 43; *Phalacrocorax varius*, 45.
- *Galactosomum ussuriense* Oshmarin, 1963.
  - *Larus novaehollandiae*, 163; *Hydroprogne caspia*, 166; *Sterna fuscata*, 168.
- *Galactosomum* sp.
  - *Leucocarbo fuscescens*, 43; *Hydroprogne caspia*, 166.
- *Haplorchis paravanissimus* Pearson & Ow-Yang, 1982, syn. *H. vanissimus* of Pearson, 1964, in part, not Africa, 1938.
  - *Pelecanus conspicillatus*, 37; *Phalacrocorax sulcirostris*, 46; *Nycticorax caledonicus*, 60; *Haliastur sphenurus*, 91.
- *Haplorchis pumilio* (Looss, 1896).
  - *Phalacrocorax melanoleucos*, 47; *Egretta intermedia*, 57.
- *Haplorchis sprenti* Pearson, 1964, syn. *Haplorchis* sp., Pearson, 1960.
  - *Pelecanus conspicillatus*, 37; *Phalacrocorax sulcirostris*, 46; *P. melanoleucos*, 47; *Ardea novaehollandiae*, 53; *Egretta alba*, 55; *E. intermedia*, 57.
- *Haplorchis vanissimus* Africa, 1938.
  - *Pelecanus conspicillatus*, 37; *Leucocarbo fuscescens*, 43; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *Nycticorax caledonicus*, 60; *Haliastur sphenurus*, 91.
- *Haplorchis yokogawai* (Katsuka, 1932).
  - *Haliastur sphenurus*, 91.
- Heterophyinae, unidentified.
  - *Sterna bergii*, 171.
- *Heterotestophyes* sp.
  - *Larus novaehollandiae*, 163.
- *Procerovum varium* Onji & Nishio, 1916.
  - *Pelecanus conspicillatus*, 37; *Ardea novaehollandiae*, 53; *Egretta alba*, 55; *E. intermedia*, 57; *Nycticorax caledonicus*, 60; *Haliastur sphenurus*, 91.
- *Procerovum* sp., Pearson, 1960.
  - *Pelecanus conspicillatus*, 37; *Phalacrocorax melanoleucos*, 47.
- *Scaphanocephalus australis* S.J. Johnston, 1917, syn. *S.* sp., S.J. Johnston, 1914.
  - *Haliaeetus leucogaster*, 95.
- *Stellantchasmus aspinosus* Pearson, 1964, syn. *S. falcatus* of Pearson, 1960, not Onji & Nishio, 1916.
  - *Phalacrocorax melanoleucos*, 47.
- *Stellantchasmus falcatus* Onji & Nishio, 1916.
  - *Nycticorax calendonicus*, 60; *Haliastur sphenurus*, 91.
- *Stictodora caballeroi* Martin, 1955.
  - *Pelecanus conspicillatus*, 37.
- *Stictodora diplacantha* T.H. Johnston, 1942a.
  - *Leucocarbo fuscescens*, 43; *Phalacrocorax varius*, 45; *P. sulcirostris*, 46; *P.* sp., 46; *Larus novaehollandiae*, 163.
- *Stictodora lari* Yamaguti, 1939a.
  - *Larus novaehollandiae*, 163.
- *Stictodora manilensis* Africa & Garcia, 1935.
  - *Sterna albifrons*, 169.
- *Stictodora* sp., Bearup, 1958.
  - *Larus novaehollandiae*, 163.
- *Stictodora* sp., Pearson, 1960.
  - *Sterna albifrons*, 169.

Family **CLINOSTOMIDAE** Lühe, 1901

- *Clinostomum australiense* S.J. Johnston, 1917.
  - *Anhinga melanogaster*, 42.
- *Clinostomum complanatum* (Rudolphi, 1814), syn. *C. hornum*, Nicoll, 1914b.
  - *Nycticorax caledonicus*, 60; *Botaurus poiciloptilus*, 62.
- *Clinostomum* sp.
  - *Pelecanus conspicillatus*, 37.

Family **DIPLOSTOMIDAE** Poirier, 1866

- Diplostomidae, unidentified.
  - *Phalacrocorax sulcirostris*, 46; *Anas superciliosa*, 77; *Falco peregrinus*, 101.
- *Bolbophorus confusus* (Krause, 1914).
  - *Pelecanus conspicillatus*, 37.
- *Bolbophorus* sp., T.H. Johnston & Angel, 1942a.
  - *Pelecanus conspicillatus*, 37.
- *Diplostomum amygdalum* Dubois & Pearson, 1965.
  - *Egretta garzetta*, 56; *E. intermedia*, 57; *Nycticorax caledonicus*, 60.
- *Diplostomum auriculosum* Dubois & Pearson, 1967.
  - *Anhinga melanogaster*, 42.

Diplostomum galaxiae Smith & Hickman, 1983a.

Ardea novaehollandiae, 53.

Diplostomum parvulum Dubois & Angel, 1972.

Pelecanus conspicillatus, 37; *Hydroprogne caspia*, 166.

Diplostomum podicipinum Kozicka & Niewiadomska, 1960.

Podiceps cristatus, 3.

Diplostomum spathaceum (Rudolphi, 1819), syn. *Diplostomum murrayense* T.H. Johnston & Cleland, 1938.

Haliastur sphenurus, 91; *Larus novaehollandiae*, 163; *Chlidonias hybrida*, 164.

Diplostomum triangulare (S.J. Johnston, 1904), syn. *Hemistomum triangulare* S.J. Johnston, 1904.

Dacelo novaeguineae, 253.

Diplostomum sp.

Pelecanus conspicillatus, 37; *Larus novaehollandiae*, 163.

Hysteromorpha plataleae Dubinina & Dubinin, 1940.

Threskiornis aethiopica, 65.

Hysteromorpha triloba (Rudolphi, 1819), syn. *Diplostomum granulosum* Goss, 1940.

Leucocarbo fuscescens, 43; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *P. melanoleucos*, 47.

Neodiplostomum sp. Dubois & Angel, 1972.

Grallina cyanoleuca, 425.

Neodiplostomum brachyurum (Nicoll, 1914a), syn. *Hemistomum brachyurum* Nicoll, 1914a.

Ninox novaeseelandiae, 242; *Tyto alba*, 244.

Neodiplostomum lanceolatum Dubois & Angel, 1972.

Ninox novaeseelandiae, 242.

Neodiplostomum pricei Krull, 1934.

Larus novaehollandiae, 163.

Neodiplostomum spathula (Creplin, 1829), syn. *Neodiplostomum australiense* Dubois, 1937a, Strigeidae, unidentified, Munday & Green, 1972.

Aviceda subcristata, 89; *Haliastur sphenurus*, 91; *Accipiter cirrhocephalus*, 93; *Haliaeetus leucogaster*, 95; *Aquila audax*, 96; *Circus approximans*, 99; *Falco subniger*, 100; *F. peregrinus*, 101; *Tyto alba*, 244.

Neodiplostomum subaequipartitum Dubois & Pearson, 1967.

Haliastur sphenurus, 91.

Neodiplostomum sp.

Falco peregrinus, 101.

Posthodiplostomum australe Dubois, 1937a.

Pelecanus conspicillatus, 37; *Phalacrocorax sulcirostris*, 46; *P. melanoleucos*, 47; *P.* sp., 48; *Ardea novaehollandiae*, 53; *Egretta alba*, 55; *Nycticorax caledonicus*, 60; *Botaurys poiciloptilus*, 62; *Hydroprogne caspia*, 166.

Posthodiplostomum oblongum Dubois, 1937a.

Botaurus poiciloptilus, 62.

Family STRIGEIDAE Railliet, 1919

Strigeidae, unidentified.

Phalacrocorax varius, 45; *Falco peregrinus*, 101.

Apatemon gracilis (Rudolphi, 1819).

Anas superciliosa, 77.

Apatemon intermedius (S.J. Johnston, 1904), syn. *Hemistomum intermedium* S.J. Johnston, 1904.

Cygnus atratus, 72; *Oxyura australis*, 86; *Accipiter fasciatus*, 92.

Apatemon vitelliresiduus Dubois & Angel, 1972.

Biziura lobata, 87.

Apharyngostrigea simplex (S.J. Johnston, 1904), syn. *Holostomum simplex* S.J. Johnston, 1904.

Ardea novaehollandiae, 53; *Egretta garzetta*, 56; *E. intermedia*, 57.

Apharyngostrigea sp.

Egretta alba, 55.

Cardiocephaloides hillii (S.J. Johnston, 1904), syn. *Holostomum hillii* S.J. Johnston, 1904.

Larus novaehollandiae, 163.

Cardiocephaloides musculosus (S.J. Johnston, 1904), syn. *Holostomum musculosum* S.J. Johnston, 1904.

Chlidonias hybrida, 164; *Hydroprogne caspia*, 166; *Sterna bergii*, 171.

Cardiocephaloides ovicorpus Dubois & Angel, 1972.

Phalacrocorax varius, 45.

Cotylurini, unidentified.

Anas superciliosa, 77.

Cotylurus magniacetabulus Dubois & Angel, 1972.

Cygnus atratus, 72.

Parastrigea repens (Chase, 1921), syn. *Holstomum repens* Chase, 1921.

Ardea novaehollandiae, 53; *Circus approximans*, 99.

Parastrigea sp., Dubois & Angel, 1972.

Threskiornis aethiopica, 65.

Schwarzitrema novaehollandiae Dubois & Pearson, 1967.

Anhinga melanogaster, 42.

Schwarzitrema pandubi (Pande, 1939).

Podiceps cristatus, 3; *Poliocephalus poliocephalus*, 4; *Tachybaptus novaehollandiae*, 5; *Pelecanus conspicillatus*, 37; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *P. melanoleucos*, 47; *Ardea novaehollandiae*, 53; *Botaurus poiciloptilus*, 62; *Platalea flavipes*, 68.

Strigea baylisi Dubois, 1937a.

Threskiornis aethiopica, 65; *T. spinicollis*, 66; *Platalea flavipes*, 68.

Strigea flosculus Nicoll, 1914a.

Podargus strigoides, 246.

Strigea glandulosa Dubois, 1937a, syn. *Strigea falconis*, Dubois, 1937b.

Haliastur sphenurus, 91; *Aquila audax*, 96; *Circus approximans*, 99; *Falco subniger*, 100; *F. berigora*, 104.

Strigea nicolli Dubois, 1937a, syn. *Strigea suttoni* Dubois, 1937a.

Burhinus magnirostris, 128; *Grallina cyanoleuca*, 425; *Gymnorhina tibicen*, 434.

Strigea promiscua Nicoll, 1914a.

Ninox strenua, 241; *N. novaehollandiae*, 242.

Strigea sp.

Falco berigora, 104.

Family PROHEMISTOMIDAE Lutz, 1935

Mesostephanus haliasturis Tubangui & Masilungan, 1941, syn. *Mesostephanus minor* Dubois & Pearson, 1965.
Pelecanus conspicillatus, 37; *Anhinga melanogaster*, 42; *Haliastur sphenurus*, 91.

Family FELLODISTOMIDAE Nicoll, 1909

Fellodistomidae, unidentified, syn. *Steringophoridae*, unidentified, Goss, 1940.
Phalacrocorax varius, 45.

Family ALLOCREADIIDAE Looss, 1902

Allocreadiidae, unidentified.
Haliastur sphenurus, 91.

Family CEPHALOGONIMIDAE Looss, 1899

Cephalogonimus sp.
Poliocephalus poliocephalus, 4.

Family GYLIAUCHENIDAE Fukui, 1929

Gyliauchen sp.
Botaurus poiciloptilus, 62.

Family ANGIODICTYIDAE Looss, 1902

Hexangium sp.
Botaurus poiciloptilus, 62.

'Trematoda', including *'Distoma'* sp. not further identified have not been included in this list.

PHYLUM PLATYHELMINTHES
Class Cestoda
Order Trypanorhyncha

Trypanorhyncha, unidentified.
Phalacrocorax varius, 45.

Order Proteocephalidea

Ophiotaenia hylae T.H. Johnston, 1912e.
Dendrocygna arcuata, 70.

Order Pseudophyllidea

Plerocercoids, unidentified.
Dacelo novaeguineae, 253.

Order Cyclophyllidae

Cyclophyllidea, unidentified, Munday & Green, 1972.
Diomedea melanophrys, 13.
Cyclophyllidae, unidentified.
Cygnus atratus, 72; *Biziura lobata*, 87.

Family TETRABOTHRIIDAE Linton, 1891

Tetrabothriidae, unidentified.
Aptenodytes patagonicus, 7; *Eudyptula minor*, 11; *Puffinus tenuirostris*, 33; *Sula serrator*, 38.
Tetrabothrius diomedeae (Fuhrmann, in Shipley, 1900), syn. *Prosthecocotyle diomediae* Fuhrmann, 1900.
Diomedea exulans, 12.
Tetrabothrius lutzi (Parona, 1901).
Eudyptula minor, 11.
Tetrabothrius polyorchis Nybelin, 1917.
Fregata ariel, 50.
Tetrabothrius sp., T.H. Johnston, 1912b.
Diomedea exulans, 12; *D. melanophrys*, 13; *Fregata minor*, 49.
Tetrabothrius sp.
Eudyptula minor, 11; *Diomedea exulans*, 12; *D. melanophrys*, 13; *D. chlororhynchus*, 16; *Phoebetria palpebrata*, 18; *Macronectes giganteus*, 19; *Pterodroma brevirostris*, 24; *Pachyptila vittata*, 25; *Puffinus griseus*, 32; *Larus novaehollandiae*, 163; *Sterna bergii*, 171.

Family ANOPLOCEPHALIDAE Cholodkovsky, 1902
Subfamily Anoplocephalinae Blanchard, 1891

Paronia trichoglossi (Linstow, 1888), syn. *Moniezia trichoglossae* (Linstow, 1888), *Taenia trichoglossae* Linstow, 1888.
Trichoglossus haematodus, 199.
Hemiparonia bancrofti (T.H. Johnston, 1912c), syn. *Dilepis bancrofti* T.H. Johnston, 1912c.
Platycercus elegans, 212; *P. eximius*, 213; *P.* sp., 217; *Barnardius barnardi*, 218.
Hemiparonia cacatuae (Maplestone, 1922b), syn. *Schizotaenia cacatuae* Maplestone, 1922b, *Hemiparonia merotomochaeta* Woodland, 1930.
Cacatua leadbeateri, 195; C. *galerita*, 196.
Hemiparonia sp.
Cacatua roseicapilla, 191.

Family DAVAINEIDAE Fuhrmann, 1907
Subfamily Davaineinae Braun, 1900

Cotugnia collini Fuhrmann, 1909.
Dromaeus novaehollandiae, 1.
Cotugnia brotogerys Meggitt, 1915.
Platycercus eximius, 213.
Cotugnia platycerci Weerekoon, 1944.
Platycercus icterotis, 216.
Cotugnia polytelidis Burt, 1940.
Polytelis anthopeplus, 206.
Cotugnia seni Meggitt, 1926.
Platycercus eximius, 213.
Cotugnia sp.
Dromaius novaehollandiae, 1.
Davainea himantopodis T.H. Johnston, 1911.
Himantopus leucocephalus, 142.

Davainea sp., T.H. Johnston, 1910.
Himantopus leucocephalus, 142.

Davainea sp., T.H. Johnston, 1912b.
Leucosarcia melanoleucus, 187; *Corvus coronoides*, 438.

Davainea sp.
Alectura lathami, 107; *Himantopus leucocephalus*, 142; *Cladorhynchus leucocephalus*, 143; *Recurvirostra novaehollandae*, 144; *Leucosarcia melanoleucus*, 187; *Corcorax melanorhamphus*, 423.

Raillietina australis (Krabbe, 1869), syn. *Davainea australis* (Krabbe, 1869), *Taenia australis* Krabbe, 1869.
Dromaius novaehollandiae, 1.

Raillietina cacatuina (T.H. Johnston, 1913), syn. *Davainea cacatuina* T.H. Johnston, 1913.
Cacatua galerita, 196.

Raillietina conopophilae (T.H. Johnston, 1913), syn. *Davainea conopophilae* T.H. Johnston, 1913.
Philemon citreogularis, 358; *Entomyzon cyanotis*, 359; *Conopophila albogularis*, 384.

Raillietina corvina (Fuhrmann, 1905).
Corvus orru, 442.

Raillietina leipoae T.H. Johnston & Clark, 1948.
Leipoa ocellata, 106.

Raillietina leptosoma (Diesing, 1850), syn. *Davainea leptosoma* Diesing, 1850.
Cacatua roseicapilla, 191; *Platycercus eximius*, 213.

Raillietina paucitesticulata (Fuhrmann, 1908).
Cacatua galerita, 196.

Raillietina polychalix (Kotlan, 1921).
Platycercus sp. 217; *Neophema petrophila*, 229.

Raillietina sphecotheridis (T.H. Johnston, 1914a), syn. *Davainea sphecotheridis* T.H. Johnston, 1914a.
Sphecotheres viridis, 415.

Raillietina sp., Hall Exped. Report, 1974.
Sphecotheres viridis, 415.

Raillietina sp., T.H. Johnston & Clark, 1948b.
Leipoa ocellata, 106.

Raillietina sp.
Dromaius novaehollandiae, 1; *Alectura lathami*, 107; *Neophema splendida*, 231.

Subfamily Idiogeninae Fuhrmann, 1932

Idiogenes sp.
Ardeotus australis, 126.

Family DILEPIDIDAE Fuhrmann, 1907

Dilepididae, unidentified.
Tachybaptus novaehollandiae, 5; *Emblema picta*, 403; *Poephila bichenovii*, 407; *P. cincta*, 410; *Gymnorhina tibicen*, 434.

Subfamily Dilepidinae Fuhrmann, 1907

Dilepis maxima Goss, 1940.
Phalacrocorax varius, 45.

Dilepis sp.
Phalacrocorax melanoleucos, 47; *Anthochaera carunculata*, 350.

Angularella australis (Maplestone, 1921b), syn. *Angularia australis* Maplestone, 1921b.
Anseranas semipalmata, 69; *Burhinus magnirostris*, 128.

Angularella sp.
Vanellus miles, 131.

Anomotaenia accipitris T.H. Johnston, 1913.
Accipiter cirrhocephalus, 93.

Anomotaenia asymmetrica T.H. Johnston, 1913.
Egretta alba, 55.

Anomotaenia hydrochelidonis Dubinina, 1954.
Larus novaehollandiae, 163.

Baerbonia parvitaeniunca (Baer & Bona, 1960), syn. *Valipora parvitaeniunca* Baer & Bona, 1960.
Egretta sacra, 58.

Bancroftiella sp.
Botaurus poiciloptilus, 62.

Clelandia parva T.H. Johnston, 1909b.
Xenorhynchus asiaticus, 63.

Cyclorchida omalancristrota (Wedl, 1856).
Platalea regia, 67.

Dendrouterina australiensis Baer & Bona, 1960.
Ardea novaehollandiae, 53.

Dendrouterina sp.
Sphecotheres viridis, 415.

Lapwingia adelaidae Schmidt, 1972.
Vanellus miles, 131

Paradilepis minima (Goss, 1940), syn. *Dilepis minima* Goss, 1940.
Phalacrocorax sulcirostris, 46; *P. melanoleucos*, 47

Paradilepis patriciae Baer & Bona, 1960.
Platalea flavipes, 68.

Paradilepis scolecina (Rudolphi, 1819).
Leucocarbo fuscescens, 43; *Phalacrocorax carbo*, 44.

Paradilepis urceina Bona, 1975.
Ardea novaehollandiae, 53; *Threskiornis aethiopica*, 65.

Paradilepis sp., Clark, 1957.
Phalacrocorax melanoleucos, 47.

Paradilepis sp.
Leucocarbo fuscescens, 43.

Paricterotaenia chlamyderae (Krefft, 1873), syn. *Taenia chlamyderae* Krefft, 1873.
Chlamydera maculata, 419.

Paricterotaenia zoniferae (T.H. Johnston, 1912c), syn. *Choanotaenia zoniferae* T.H. Johnston, 1912c.
Vanellus tricolor, 132.

Paricterotaenia sp.
Burhinus magnirostris, 128.

Parvitaenia ardeae (T.H. Johnston, 1913), syn. *Bancroftiella ardeae* T.H. Johnston, 1913.
Ardea novaehollandiae, 53; *Nycticorax caledonicus*, 60.

Parvitaenia clavipera Baer & Bona, 1960, syn. *Bancroftiella glandularis* of T.H. Johnston 1912b, in part, not (Fuhrmann, 1905).
Ardea novaehollandiae, 53.

Parvitaenia glandularis (Fuhrmann, 1905), syn. *Bancroftiella glandularis* (Fuhrmann, 1905).

Egretta alba, 55.

Parvitaenia paracyclorchida Baer & Bona, 1960, syn. *Bancroftiella glandularis* (Fuhrmann, 1905).

Ardea novaehollandiae, 53.

Trichocephaloides sp.

Calidris acuminata, 157.

Subfamily Dipylidiidae Stiles, 1896

Choanotaenia fieldingi (Maplestone & Southwell, 1923), syn. *Monopylidium fieldingi* Maplestone & Southwell, 1923.

Cracticus torquatus, 432.

Choanotaenia southwelli Fuhrmann, 1932, syn. *Monopylidium macracanthus* of Maplestone and Southwell, 1932, not Fuhrmann, 1907.

Vanellus miles, 131.

Choanotaenia taylori T.H. Johnston, 1912c.

Malurus cyaneus, 318.

Choanotaenia sp.

Burhinus magnirostris, 128; *Anthochoera chrysoptera*, 352; *Emblema guttata*, 404; *Poephila bichenovii*, 407.

Pseudochoanotaenia meliphagidarum (T.H. Johnston, 1911), syn. *Choanotaenia meliphagidarum* T.H. Johnston, 1911; *C.* sp., THJ, 1910).

Meliphaga lewini, 363; *Lichenostoma leucotis*, 367; *L. plumula*, 372; *Phylidonyris novaehollandiae*, 380; *P. nigra*, 381; *Myzomela sanguinolenta*, 390.

Similuncinus dacelonis T.H. Johnston, 1909a.

Dacelo novaeguineae, 253.

Subfamily Paruterinae Fuhrmann, 1907

Paruterinae, unidentified.

Pomatostomus temporalis, 310; *P. superciliosus*, 311.

Anonchotaenia arhyncha Fuhrmann, 1918.

Pardalotus striatus, 399.

Anonchotaenia globata (Linstow, 1879), syn. 'unidentified cestode' Cleland, 1922.

Entomyzon cyanotis, 359.

Biuterina sp.

Anseranas semipalmata, 69; *Sphecotheres viridis*, 415.

Paruterina rauschi Freeman, 1957.

Tringa stagnatilis, 150; *Tyto alba*, 244.

Sphaeruterina punctata T.H. Johnston, 1914b.

Pachycephalus rufiventris, 293.

Zosteropicola clelandi T.H. Johnston, 1912c.

Zosterops lateralis, 400.

Family HYMENOLEPIDIDAE Railliet & Henry, 1909

Hymenolepididae, unidentified.

Threskiornis aethiopica, 65; *Philemon citreogularis*, 358; *Entomyzon cyanotis*, 359; *Corcorax melanorhamphus*, 423; *Strepera graculina*, 435.

Subfamily Hymenolepidinae Ransom, 1909

Armadoskrjabinia globosa (Szpotanska, 1931), syn. *Hymenolepis globosa* Szpotanska 1931.

Cygnus atratus, 72.

Australiolepis southwelli (Szpotanska, 1931), syn. *Hymenolepis southwelli* Szpotanska, 1931; *Echinorhynchotaenia nana* Mapleston & Southwell, 1922b.

Cygnus atratus, 72.

Cloacotaenia megalops (Nitzsch in Creplin, 1829), syn. *Hymenolepis megalops* Nitzsch in Creplin, 1829.

Anseranas semipalmata, 69; *Dendrocygna arcuata*, 70; *Cygnus atratus*, 72; *Anas superciliosa*, 77; *A. castanea*, 79.

Cloacotaenia sp.

Cygnus atratus, 72; *Stictonetta naevosa*, 73; *Anas rhynchotis*, 80; *Aythya australis*, 82.

Diorchis flavescens (Krefft, 1873), syn. *Taenia flavescens* Krefft, 1873.

Dendrocygna arcuata, 70; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. castanea*, 79; *A. rhynchotis*, 80; *Aythya australis*, 82; *Himantopus leucocephalus*, 142; *Cladorhynchus leucocephalus*, 143.

Diorchis spiralis Szpotanska, 1931.

Cygnus atratus, 72.

Diorchis stefanski Czaplinski, 1955.

Cygnus atratus, 72.

Diorchis sp.

Stictonetta naevosa, 73; *Anas castanea*, 79.

Dicranotaenia coronula Dujardin, 1845.

Cygnus atratus, 72.

Diplogynea oligorchis (Maplestone, 1922a), syn. *Cotugnia oligorchis* Maplestone, 1922a, *Diploposthe laevis* of T.H. Johnston, 1913, not (Bloch, 1782).

Dendrocygna arcuata, 70; *Aythya australis*, 82.

Diploposthe laevis (Bloch, 1782), syn. *Taenia tuberculata* Krefft, 1873.

Anas superciliosa, 77; *A. castanea*, 79; *Aythya australis*, 82.

Capiuterilepis australiensis Schmidt, 1972.

Anthochaera carunculata, 350; *Anthochaera* sp. 353.

Capiuterilepis meliphagicola Schmidt, 1972.

Philemon corniculatus, 357.

Drepanidotaenia bisacculina Szpotanska, 1931.

Cygnus atratus, 72.

Drepanidotaenia lanceolata (Bloch, 1782).

Cygnus atratus, 72; *Anas superciliosa*, 77.

Drepanidotaenia rapida (Szpotanska, 1931), syn. *Hymenolepis rapida* Szpotanska, 1931.

Cygnus atratus, 72.

Drepanidotaenia sp.

Cygnus atratus, 72.

Haploparaxis australis (T.H. Johnston, 1913), syn. *Aploparaksis australis* T.H. Johnston, 1913.

Tringa hypoleucos, 148; *Gallinago hardwicki*, 152; *G. megala*, 153.

Haploparaxis veitchi Baylis, 1934b.

Anas gibberifrons, 78.

Microsomacanthus collaris (Batsch, 1786), syn. *Hymenolepis collaris* (Batsch, 1786), *Taenia bairdii* Krefft, 1873.
Anas superciliosa, 77; *A. castanea*, 79.
Microsomacanthus cormoranti (Ortlepp, 1938), syn. *Hymenolepis cormoranti* Ortlepp, 1938.
Phalacrocorax melanoleucos, 47.
Monosaccanthes curiosa (Szpotanska, 1931), syn. *Hymenolepis curiosa* Szpotanska, 1931.
Cygnus atratus, 72.
Monosaccanthes kazachstanica (Maksinova, 1963).
Cygnus atratus, 72.
Monosaccanthes sp.
Cygnus atratus, 72
Parabisaccanthes bisacculina (Szpotanska, 1931), syn. *Drepanidotaenia bisacculina* Szpotanska, 1931.
Cygnus atratus, 72.
? *Passerilepis stylosa* (Rudolphi, 1810).
Anseranas semipalmata, 69.
? *Passerilepis zosteropis* (Fuhrmann, 1918).
Dendrocygna arcuata, 70.
Sobolevicanthus terraereginae (T.H. Johnston, 1913), syn. *Hymenolepis terraereginae* T.H. Johnston, 1913.
Anseranas semipalmata, 69.
Sobolevicanthus sp.
Cereopsis novaehollandiae, 74; *Aythya australis*, 82; *Biziura lobata*, 87.
Staphylepis lamellata (Woodland, 1930), syn. *Hymenolepis lamellata* Woodland, 1930.
Tadorna tadornoides, 75; *Anas gibberifrons*, 78.
Tschertkovilepis krabbei (Kowalewski, 1895).
Cygnus atratus, 72.
Woodlandia phalacrocoracis (Woodland, 1929), syn. *Hymenolepis phalacrocoracis* Woodland, 1929.
Phalacrocorax melanoleucos, 47.
Hymenolepis chenopis Palmer, 1981.
Cygnus atratus, 72.
Hymenolepis ellisi T.H. Johnston & Clark, 1948a.
Pelecanus conspicillatus, 37.
'Hymenolepis eurystomi Maplestone'.
Eurystomus orientalis, 261.
Hymenolepis ibidis T.H. Johnston, 1913.
Threskiornis spinicollis, 66; *Platalea flavipes*, 68; *Dendrocygna arcuata*, 70.
Hymenolepis jaenschi T.H. Johnston & Clark, 1948a.
Pelecanus conspicillatus, 37.
Hymenolepis liophallus (Krabbe, 1869).
Cygnus atratus, 72.
Hymenolepis micrancristrota (Wedl, 1855), *Taenia micrancristrota* Wedl, 1855.
Cygnus atratus, 72.
Hymenolepis murrayensis T.H. Johnston & Clark, 1948a.
Pelecanus conspicillatus, 37.
Hymenolepis robertsi Baylis, 1934b.
Anas gibberifrons, 78.
'*Hymenolepis variabilis* Maplestone'.
Cygnus atratus, 72.
Hymenolepis sp., T.H. Johnston, 1910.
Himantopus leucocephalus, 142; *Petroica goodenovii*, 281.
Hymenolepis sp., T.H. Johnston, 1912b.
Nycticorax caledonicus, 60; *Anas superciliosa*, 77.
Hymenolepis sp., Southwell, 1916.
Cygnus atratus, 72.
Hymenolepis sp.
Pelecanus conspicillatus, 37; *Nycticorax caledonicus*, 60; *Threskiornis spinicollis*, 66; *Platalea flavipes*, 68; *Cygnus atratus*, 72; *Tadorna tadornoides*, 75; *Anas superciliosa*, 77; *Fulica atra*, 123; *Recurvirostra novaehollandiae*, 144; *Anthochaera* sp., 353; *Lichenostoma virescens*, 366; *Pardalotus striatus*, 399; *Chlamydera maculata*, 419; *Grallina cyanoleuca*, 425; *Corvus mellori*, 440; *C.* sp., 443.

Subfamily Fimbriariinae Wolffhügel, 1899

Fimbriaria fasciolaris (Pallas, 1871), syn. *Taenia pediformis* Krefft, 1873.
Anas superciliosa, 77; *A. castanea*, 79.
Fimbriaria sp.
Anas superciliosa, 77; *Aythya australis*, 82.
Fimbriarioides intermedia (Fuhrmann, 1913), syn. *Fimbriaria intermedia* Fuhrmann, 1913.
Cereopsis novaehollandiae, 74.

Family ACOLEIDAE Ransom, 1909

Acoleus hedleyi T.H. Johnston, 1910, syn. *Taenia rugosa* Krefft, 1873.
Himantopus leucocephalus, 142.

Family DIPLOPOSTHIDAE Poche, 1926

Diplposthe laevis (Bloch, 1782), syn. *Taenia tuberculata* Krefft, 1873.
Anas superciliosa, 77; *A. castanea*, 79; *Aythya australis*, 82.

Family DIOECOCESTIDAE Southwell, 1930

Subfamily Dioecocestinae Southwell, 1930

Dioecocestus novaehollandiae (Krefft, 1873), syn. *Taenia novaehollandiae* Krefft, 1873, *T. paradoxa* Krefft, 1873.
Tachybaptus novaehollandiae, 5.
Dioecocestus sp.
Poliocephalus poliocephalus, 4.

Subfamily Gyrocoelinae Yamaguti, 1959

Gyrocoelia australiensis (T.H. Johnston, 1910), syn. *Gyrocoelia* sp., T.H. Johnston, 1914a, *Dilepis australiensis* T.J. Johnston, 1910, *Taenia coronata* Krefft, 1873.
Vanellus miles, 131; *Himantopus leucocephalus*, 142.
Gyrocoelia sp.
Poliocephalus poliocephalus, 4; *Vanellus miles*, 131; *Cladorhynchus leucocephalus*, 143.
Infula burhini Burt 1939, syn. '*Shipleya lobivanellus* Maplestone'.
Vanellus miles, 131; *Himantopus leucocephalus*, 142.

Family **TAENIIDAE** Ludwig, 1886

Cladotaenia feuta Meggitt, 1933.
  Circus assimilis, 98.
Cladotaenia sp.
  Circus assimilis, 98; *C. approximans*, 99; *Falco subniger*, 100.

Family **NEMATOPARATAENIIDAE** Poche, 1926

Nematoparataenia paradoxa Maplestone & Southwell, 1922b.
  Cygnus atratus, 72
Gastrotaenia sp.
  Cygnus atratus, 72; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. rhynchotis*, 80; *Aythya australis*, 82; *Biziura lobata*, 87.

PHYLUM NEMATODA
Order Enoplida

Superfamily DIOCTOPHYMATOIDEA

Eustrongylides phalacrocoracis T.H. Johnston & Mawson, 1941c.
  Leucocarbo fuscescens, 43; *Phalacrocorax carbo*, 44; *P. melanoleucos*, 47.
Eustrongylides plotinus T.H. Johnston & Mawson, 1941e.
  Anhinga melanogaster, 42.
Eustrongylides sp.
  Pelecanus conspicillatus, 37; *Phalacrocorax carbo*, 44; *P. sulcirostris*, 46; *Nycticorax caledonicus*, 60.

Superfamily STRONGYLOIDIDAE

Strongyloides sp.
  Anas gibberifrons, 78.

Superfamily TRICHUROIDEA

Capillaria anatis (Schrank, 1790).
  Cygnus atratus, 72; Anas castanea, 79.
Capillaria convolutor Fourment, 1885.
  Diomedea melanophrys, 13; *Macronectes giganteus*, 19.
Capillaria ellisi T.H. Johnston & Mawson, 1945b.
  Cygnus atratus, 72.
Capillaria grallinae T.H. Johnston & Mawson, 1945a.
  Grallina cyanoleuca, 425.
Capillaria graucalina T.H. Johnston & Mawson, 1941d.
  Coracina novaehollandiae, 271.
Capillaria gymnorhinae T.H. Johnston & Mawson, 1947.
  Gymnorhina tibicen, 434.
Capillaria jaenschi T.H. Johnston & Mawson, 1945b.
  Pelecanus conspicillatus, 37; *Leucocarbo fuscescens*, 43; *Phalacrocorax carbo*, 44; *P. varius*, 45; *P. sulcirostris*, 46; *P. melanoleucos*, 47; *Larus novaehollandiae*, 163; *Chlidonias hybrida*, 164.
Capillaria laricola Wassilikova & Gushanskaya, 1930.
  Larus novaehollandiae, 163.
Capillaria obsignata Madsen, 1945.
  Cygnus atratus, 72.
Capillaria pomatostomi T.H. Johnston & Mawson, 1945b.
  Pomatostomus superciliosus, 311.
Capillaria recurvirostrae Mawson, 1968b.
  Recurvirostra novaehollandiae, 144.
Capillaria thomascameroni Mawson, 1969.
  Larus novaehollandiae, 163.
Capillaria triloba Linstow, 1875.
  Vanellus miles, 131; *Himantopus leucocephalus*, 142; *Recurvirostra novaehollandiae*, 144.
Capillaria sp., Munday & Green, 1972.
  Rallus pectoralis, 115.
Capillaria sp., T.H. Johnston & Mawson, 1945a.
  Leucocarbo fuscescens, 43.
Capillaria sp., T.H. Johnston & Mawson, 1949.
  Podiceps cristatus, 3.
Capillaria sp.
  Poliocephalus poliocephalus, 4; *Tachybaptus novaehollandiae*, 5; Podicepididae, unidentified, 6; *Botaurus poiciloptilus*, 62; *Threskiornis aethiopica*, 65; *Threskiornis spinnicollis*, 66; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. castanea*, 79; *A. rhynchotis*, 80; *Malacorhynchus membranaceus*, 81; *Aythya australis*, 82; *Oxyura australis*, 86; *Haliastur sphenurus*, 91; *Haliaeetus leucogaster*, 95; *Circus approximans*, 99; *Falco berigora*, 104; *Alectura lathami* 107; *Turnix pyrrhothorax*, 112; *Rallus pectoralis*, 115; *Porzana pusilla*, 116; *P. fluminea*, 117; *Gallinula mortierii*, 119; *G. tenebrosa*, 121; *Porphyrio porphyrio*, 122; *Charadrius bicincta*, 137; *C. ruficapillus*, 139; *Sterna bergii*, 171; *Melopsittacus undulatus*, 209; *Neophema splendida*, 231; *Cuculus flabelliformis*, 234; *Ninox novaeseelandiae*, 242; *Tyto novaehollandiae*, 245; *Podargus strigoides*, 246; *Eurystomus orientalis*, 261; *Colluricincla harmonica*, 294; *Cinclosoma cinnamomeum*, 309; *Pomatostomus ruficeps*, 312; *Malurus leucopterus*, 322; *Acanthagenys rufogularis*, 354; *Manorina melanocephala*, 361; *M. flavigula*, 362; *Lichenostomus virescens*, 366; *Lichmera indistincta*, 378; *Cracticus torquatus*, 432; *Corvus tasmanicus*, 439; *C. mellori*, 440.

Order Strongylida

Superfamily STRONGYLOIDEA
Family SYNGAMIDAE Leiper, 1912

Syngamus trachea (Montagu, 1811).
  Calyptorhynchus funereus, 188; *Gymnorhina tibicen*, 434.
Syngamus sp.
  Alectura lathami, 107.
'? Hookworm'
  Threskiornis aethiopica, 65.

Superfamily TRICHOSTRONGYLOIDEA

Amidostomum acutum (Lundahl, 1848), syn. *A. chevreuxi* Seurat, 1918.

Stictonetta naevosa, 73; *Tadorna radjah*, 76; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. rhynchotis*, 80; *Himantopus leucocephalus*, 142.

Amidostomum anseris (Zeder, 1800).
Anseranas semipalmata, 69; *Cereopsis novaehollandiae*, 74.

Amidostomum biziurae T.H. Johnston & Mawson, 1947
Biziura lobata, 87.

Amidostomum cygni Wehr, 1933.
Cygnus atratus, 72.

Amidostomum fulicae (Rudolphi, 1819).
Fulica atra, 123.

Amidostomum tribonyx Mawson, 1980.
Gallinula ventralis, 120.

Amidostomum sp.
Cygnus atratus, 72; *Stictonetta naevosa*, 73; *Anas superciliosa*, 77; *Chenonetta jubata*, 83; *Biziura lobata*, 87; *Gallinula tenebrosa*, 121.

Dromaeostrongylus bicuspis Lubimov, 1933.
Dromaius novaehollandiae, 1.

Epomidiostomum uncinatus (Lundahl, 1848).
Anas gibberifrons, 78.

Epomidiostomum sp.
Anseranas semipalmata, 69; *Cygnus atratus*, 72; *Tadorna tadornoides*, 75; *Anas superciliosa*, 77; *A. gibberifrons*, 78; *A. castanea*, 79; *Chenonetta jubata*, 83; *Oxyura australis*, 86.

Pseudamidostomum sp.
Cygnus atratus, 72; *Chenonetta jubata*, 83.

Trichostrongylus incertus T.H. Johnston & Mawson, 1941e.
Hydroprogne caspia, 166.

Trichostrongylus tenuis (Mehlis, 1864).
Dromaius novaehollandiae, 1.

Ornithostrongylinae, unidentified.
Podargus strigoides, 246.

Order Ascaridida

Superfamily ASCARIDOIDEA
Family ANISAKIDAE Railliet & Henry, 1912

Anisakidae, unidentified, Munday & Green, 1972
Diomedea melanophrys, 13.

Anisakidae, unidentified.
Eudyptes chrysocome, 8.

Anisakis diomedeae (Linstow, 1888), syn. *Stomachus* sp., Munday & Green, 1972, *Contracaecum diomedeae* (Linstow, 1888).
Diomedea exulans, 12; *D. melanophrys*, 13; *D. chrysostoma*, 15; *D. chlororhynchos*, 16; *D. cauta*, 17; *Macronectes giganteus*, 19; *Daption capense*, 21; *Pachyptila desolata*, 27.

Anisakis sp., T.H. Johnston & Mawson, 1942a.
Eudyptula minor, 11.

Anisakis sp., T.H. Johnston & Mawson, 1942c.
Pachyptila desolata, 27.

Anisakis sp., T.H. Johnston & Mawson, 1942d.
Pterodroma lessoni, 23.

Anisakis sp., syn. *Stomachus* sp. auctt.
Pterodroma macroptera, 22; *Pachyptila belcheri*, 28; *Sterna bergii*, 171; *Anous minutus*, 174.

Contracaecum ceylanicum (Linstow, 1904).
Haliastur sphenurus, 91.

Contracaecum clelandi T.H. Johnston & Mawson, 1941c.
Pelecanus conspicillatus, 37.

Contracaecum eudyptulae T.H. Johnston & Mawson, 1942a.
Eudyptula minor, 11.

Contracaecum magnicollare T.H. Johnston & Mawson, 1941c.
Diomedea cauta, 17; *Puffinus griseus*, 32; *P. tenuirostris*, 33; *Sula serrator*, 38; *Anous stolidus*, 173; *A. minutus*, 174.

Contracaecum microcephalum (Rudolphi, 1809).
Nycticorax caledonicus, 60; *Botaurus poiciloptilus*, 62; *Anas superciliosa*, 77.

Contracaecum micropapillatum (Stossich, 1890), syn. *C. bancrofti* T.H. Johnston & Mawson, 1941c.
Pelecanus conspicillatus, 37.

Contracaecum nycticoracis T.H. Johnston & Mawson, 1941c.
Nycticorax caledonicus, 60.

Contracaecum pelagicum T.H. Johnston & Mawson, 1942d.
Diomedea melanophrys, 13; *D. chlororhyncha*, 16.

Contracaecum podicipitis T.H. Johnston & Mawson, 1949.
Podiceps cristatus, 3; *Tachybaptus novaehollandiae*, 5.

Contracaecum praestriatum Mönnig, 1923.
Poliocephalus poliocephalus, 4.

Contracaecum rodhaini (Gedoelst, 1916).
Anhinga melanogaster, 42.

Contracaecum sinulabiatum T.H. Johnston & Mawson, 1941c, syn. *Ascaris spiculigerum* (Rudolphi, 1809) of T.H. Johnston, 1914a.
Anhinga melanogaster, 42; *Phalacrocorax carbo*, 44; *P. melanoleucos*, 47.

Contracaecum spiculigerum (Rudolphi, 1809), syn. *Ascaris spiculigerum* Rudolphi, 1809; *Ascaris* sp. T.H. Johnston, 1912b.
Eudyptula minor, 11; *Pelecanus conspicillatus*, 37; *Leucocarbo fuscescens*, 43; *Phalacrocorax carbo*, 44; *P. varius*, 45; *P. sulcirostris*, 46; *P. melanoleucos*, 47; *Ardea pacifica*, 52; *A. novaehollandiae*, 53; *Nycticorax caledonicus*, 60; *Botaurus poiciloptilus*, 62; *Plegadis falcinellus*, 64.

Contracaecum tricuspe (Gedoelst, 1916), syn. *Ascaris spiculigerum* (Rud.) of T.H. Johnston 1912b, *A.* sp., Krefft, 1873.
Anhinga melanogaster, 42.

Contracaecum sp., T.H. Johnston & Mawson, 1941c.
Ardea novaehollandiae, 53; *Egretta alba*, 55; *Xenorhynchus asiaticus*, 63.

Contracaecum sp., T.H. Johnston & Mawson, 1947.
Chlidonias hybrida, 164.

Contracaecum sp., Mawson, 1968b.
Himantopus leucocephalus, 142.

Contracaecum sp.
Eudyptes pachyrhynchus, 9; *Diomedea exulans*, 12; *Phoebetria palpebrata*, 18; *Sula serrator*, 38; *Fregata minor*, 49; *Phaethon rubricauda*, 51;

Ardea novaehollandiae, 53; *Egretta alba*, 55; *Butorides striatus*, 59; *Ixobrychus minutus*, 61; *Botaurus poiciloptilus*, 62; *Platalea flavipes*, 68; *Falco peregrinus*, 101; *Halcyon chloris*, 258.

Phocascaris sp., T.H. Johnston & Mawson, 1942d.

Macronectes giganteus, 19.

Family ASCARIDIDAE Baird, 1853

Baylisascaris sp.

Nymphicus hollandicus, 208.

Porrocaecum angusticolle (Molin, 1860).

Falco berigora, 104.

Porrocaecum circinum T.H. Johnston & Mawson, 1941b.

Elanus notatus, 88; *Accipiter novaehollandiae*, 94; *Hieraaetus morphnoides*, 97; *Circus assimilis*, 98.

Porrocaecum clelandi T.H. Johnston & Mawson, 1941d, syn. 'nematode', Cleland, 1922.

Anthus novaeseelandiae, 270; *Zoothera dauma*, 276; *Cinclosoma punctatum*, 307.

Porrocaecum crassum (Deslongchamps, 1824).

Anas superciliosa, 77.

Porrocaecum ensicaudatum (Zeder, 1800).

Porzana fluminea, 117.

Porrocaecum lobibicis Mawson, 1968b.

Vanellus miles, 131.

Porrocaecum menurae T.H. Johnston & Mawson, 1942b.

Menura novaehollandiae, 264.

Porrocaecum reticulatum (Linstow, 1889).

Ardea pacifica, 52; *Egretta alba*, 55.

Porrocaecum serpentulum (Rudolphi, 1809), syn. *Ascaris serpentula* Rudolphi, 1809.

Grus rubicundus, 124.

Porrocaecum streperae T.H. Johnston & Mawson, 1941d.

Gymnorhina tibicen, 434; *Strepera graculina*, 435; *S. versicolor*, 437.

Porrocaecum wui Hsü, 1933.

Gymnorhina tibicen, 434.

Porrocaecum sp., T.H. Johnston & Mawson, 1941d.

Manorina flavigula, 362.

Porrocaecum sp.

Ardea novaehollandiae, 53; *Circus approximans*, 99; *Merops ornatum*, 260; *Pitta versicolor*, 263; *Malurus leucopterus*, 322; *Corvus mellori*, 440.

Superfamily SEURATOIDEA
Family SEURATIDAE Hall, 1916

Rictularina spinosa T.H. Johnston & Mawson, 1941d.

Myiagra rubecula, 299.

Skrjabinura magna (T.H. Johnston & Mawson, 1941d), syn. *Seuratinema magnum* T.H. Johnston & Mawson 1941d.

Dacelo novaeguineae, 253.

Skrjabinura pomatostomi (T.H. Johnston & Mawson, 1941d), syn. *Seuratinema pomatostomi* T.H. Johnston & Mawson, 1941d.

Pomatostomus superciliosus, 311.

Skrjabinura brevicaudatum (T.H. Johnston & Mawson, 1941b), syn. *Seuratinema brevicaudatum* (T.H. Johnston & Mawson, 1941b).

Ninox connivens, 243; *Pomatostomus temporalis*, 310.

Skrjabinura sp., syn. *Seuratinema* sp., Ogden, 1967.

Podargus strigoides, 246; *Eopsaltria pulverulenta*, 283.

Family SCHNEIDERNEMATIDAE Freitas, 1936

Inglisonema typos Mawson, 1968a.

Pitta versicolor, 263.

Superfamily HETERAKOIDEA
Family HETERAKIDAE Railliet & Henry, 1912

Heterakis chenonettae T.H. Johnston, 1912a.

Cereopsis novaehollandiae, 74; *Chenonetta jubata*, 83.

Heterakis circumvallata (Linstow, 1906b).

Cygnus atratus, 72.

Heterakis dispar (Schrank, 1790).

Cereopsis novaehollandiae, 74.

Heterakis gallinarum (Schrank, 1788), syn. *Heterakis gallinae* (Gmelin, 1790).

Cacatua leadbeateri, 195.

Heterakis vesicularis (Froelich, 1791), syn. *H. papillosa* (Bloch, 1782), *H. caudata* (Linstow, 1906).

Cygnus atratus, 72; *Cereopsis novoehollandiae*, 74.

Heterakis sp.

Anseranas semipalmata, 69; *Northiella haematogaster*, 224; *Ninox novaeseelandiae*, 242.

Odontoterakis bancrofti (T.H. Johnston, 1912a), syn. *Heterakis bancrofti* T.H. Johnston, 1912a.

Alectura lathami, 107; *Leucosarcia melanoleuca*, 187.

Family ASCARIDIIDAE Travassos, 1919

Ascaridia catheturina (T.H. Johnston, 1912a), syn. *Heterakis catheturina* T.H. Johnston, 1912a.

Alectura lathami, 107.

Ascaridia columbae (Gmelin, 1790).

Phaps chalcoptera, 180; *Eclectus roratus*, 197; *Alisterus scapularis*, 203; *Polytelis alexandriae*, 207; *Melopsittacus undulatus*, 209; *Lathamus discolor*, 210; *Barnardius barnardi*, 218; *B. zonarius*, 219; *Neophema bourkei*, 226.

Ascaridia galli (Schrank, 1788).

Chrysococcyx lucidus, 236; *Centropus phasianus*, 239.

Ascaridia lineata (Schneider, 1866).

Centropus phasianus, 239.

Ascaridia platyceri Hartwich & Tscherner, 1979, syn. *Ascaridia sprenti* Mines, 1979.

Calocephalon fimbriatum, 190; *Alisterus scapularis*, 203; *Aprosmictus erythropterus*, 204; *Polytelis swainsoni*, 205; *P. anthopeplus*, 206; *P. alexandrae*, 207; *Nymphicus hollandicus*, 208;

Melopsittacus undulatus, 209; *Lathamus discolor*, 210; *Platycercus elegans*, 212; *P. eximius*, 213; *P.* sp., 217; *Barnardius barnardius*, 218; *B. zonarius*, 219; *Psephotus haematonotus*, 220; *P. varius*, 221; *P. chrysopterygius*, 222; *P. dissimilis*, 223; *Northiella haematogaster*, 224; *Neophema bourkii*, 226; *N. elegans*, 228; *N. pulchella*, 230; *N. splendida*, 231.

Ascaridia stroma (Linstow, 1899).

Grus rubicundus, 124; *G. antigone*, 125.

Ascaridia sp.

Geopelia humeralis, 178; *Cacatua roseicapilla*, 191; *Polyteles anthopeplus*, 206; *Nymphicus hollandicus*, 208; *Melopsittacus undulatus*, 209; *Platycercus* sp., 217; *Centropus phasianus*, 239.

Superfamily SUBULUROIDEA
Family SUBULURIDAE Travassos, 1914

Allodapa differens (Sonsino, 1890), syn. *Subulura differens* (Sonsino, 1890).

Centropus phasianus, 239.

Allodapa suctoria (Molin, 1860), syn. *Subulura clelandi* T.H. Johnston & Mawson, 1941d.

Scythrops novaehollandiae, 238; *Ninox novaeseelandiae*, 242; *Podargus strigoides*, 246; *Eurostopodus mystaculis*, 249; *Caprimulgus argus*, 250.

Allodapa sp., syn. *Subulura* sp., T.H. Johnston & Mawson, 1941b.

Ninox strenua, 241.

Allodapa sp.

Podargus strigoides, 246.

Leipoanema ellisi T.H. Johnston & Mawson, 1942a.

Leipoa ocellata, 106.

Superfamily OXYUROIDEA

Oxyuridae, unidentified.

Ninox novaeseelandiae, 242; *Tyto alba*, 244.

Order Spirurida

Spirurida, unidentified, T.H. Johnston & Mawson, 1941e.

Pomatostomus superciliosus 311.

Spirurida, unidentified, Munday & Green, 1972.

Daption capense, 21; *Pterodroma macroptera*, 22.

Spirurida, unidentified.

Pelecanoides urinatrix, 36; *Accipiter fasciatus*, 92; *A. cirrhocephalus*, 93; *Falco peregrinus*, 101; *F. longipennis*, 102; *Erythrogonys cinctus*, 134; *Charadrius ruficapillus*, 139; *Chlidonias hybrida*, 164; *Eudynamys scolopacea*, 237; *Tyto alba*, 244; *T. novaehollandiae*, 245; *Ceyx azurea*, 252; *Dacelo novaeguineae*, 253; *Halcyon chloris*, 258; *Petroica goodenovii*, 281; *Pachycephala pectoralis*, 291; *Myiagra alecto*, 300; *Pomatostomus superciliosus*, 311; *Acanthiza pusilla*, *336; Climacteris leucophaea*, 346; *Philemon argenticeps*, 356; *Entomyzon cyanotis*, 359; *Artamus cyanopterus*, 430; *Cracticus nigrogularis*, 433; *Gymnorhina tibicen*, 434; *Corvus tasmanicus*, 439; *C. mellori*, 440.

Superfamily ?, Family ?

Bancroftinema dentatum T.H. Johnston & Mawson, 1941b.

Falco berigora, 104.

Superfamily CAMALLANOIDEA
Family CAMALLANIDAE Railliet & Henry, 1915

Procamallanus murrayensis T.H. Johnston & Mawson, 1940b.

Phalacrocorax carbo, 44.

Superfamily PHYSALOPTEROIDEA
Family PHYSALOPTERIDAE (Railliet, 1893)

Physaloptera alata Baylis, 1925.

Falco longipennis, 102.

Physaloptera hieracidiae T.H. Johnston & Mawson, 1941b.

Falco berigora, 104.

Physaloptera sp., T.H. Johnston & Mawson, 1941c.

Threskiornis spinicollis, 66; *Anas superciliosa*, 77.

Physaloptera sp.

Plegadis falcinellus, 64; *Accipiter cirrhocephalus*, 93; *Falco peregrinus*, 101; *Ninox novaeseelandiae*, 242, *Cracticus nigrogularis*, 433.

Superfamily THELAZIOIDEA
Family THELAZIIDAE Skrjabin, 1915

Thelazia aquilina Baylis, 1934a.

Accipiter novaehollandiae, 94; *Haliaeetus leucogaster*, 95; *Aquila audax*, 96; *Falco berigora*, 104.

Thelazia dacelonis (Breinl, 1913b), syn. *Filaria dacelonis* Breinl, 1913b.

Dacelo leachii, 254.

Thelazia pittae T.H. Johnston & Mawson, 1941c, syn 'nematode', Cleland, 1922.

Pitta erythrogaster, 262.

Thelazia sp.

Egretta alba, 55.

Oxyspirura anthochaerae (T.H. Johnston, 1912a), syn. *Ceratospira anthochaerae* T.H. Johnston, 1912a; *Ascaris* sp., Krefft, 1873.

Anthochaera carunculata, 350.

Oxyspirura bancrofti T.H. Johnston & Mawson, 1941d.

Philemon citreogularis, 358.

Oxyspirura streperae T.H. Johnston & Mawson, 1941a.

Gymnorhina tibicen, 434; *Strepera graculina*, 435; *S. fuliginosa*, 436.

Oxyspirura sp.

Ninox novaeseelandiae, 242.

Superfamily SPIRUROIDEA
Family GONGYLONEMATIDAE Hall, 1916

Gongylonema alecturae T.H. Johnston & Mawson, 1942a.

Alectura lathami, 107.

Protospirura sp.
Dacelo novaeguineae, 253.

Family HARTERTIIDAE Quentin, 1970

Alainchabaudia aegotheles (T.H. Johnston & Mawson, 1941e), syn. *Habronema aegotheles* T.H. Johnston & Mawson, 1941c.
Aegotheles cristatus, 248.
Alainchabaudia alcedinis Mawson, 1968c.
Dacelo novaeguineae, 253; *Halcyon sancta*, 257.
Hartertia sp.
Ardeotis australis, 126; *Ninox novaeseelandiae*, 242.

Superfamily HABRONEMATOIDEA
Family HABRONEMATIDAE Chitwood & Wehr, 1932

Habronematinae, unidentified, Mawson, 1969.
Geochelidon nilotica, 165.
Cyrnea colini Cram, 1927.
Coturnix ypsilophora, 109.
Excisa biloba Mawson, 1968d.
Ninox novaeseelandiae, 242; *Podargus strigoides*, 246; *P. ocellatus*, 247.
Excisa dentifera (T.H. Johnston & Mawson, 1941d), syn. *Cyrnea dentifera* T.H. Johnston & Mawson, 1941d.
Ardeotis australis, 126.
Excisa excisiformis (Yamaguti, 1935).
Podargus strigoides, 246.
Procyrnea dollfusi (Mawson, 1968d), syn. *Cyrnea dollfusi* Mawson, 1968d.
Ninox novaeseelandiae, 242.
Procyrnea falco (Mawson, 1968d), syn. *Cyrnea falco* Mawson, 1968d.
Falco longipennis, 102; *F. berigora*, 104; *F. cenchroides*, 105.
Procyrnea incerta (A.J. Smith, 1908), syn. *Spiroptera incerta* A.J. Smith, 1908.
Melopsittacus undulatus, 209; *Platycercus eximius*, 213; *Barnardius barnardi*, 218.
Procyrnea mansioni (Seurat, 1914), syn. *Cyrnea mansioni* (Seurat, 1914).
Milvus migrans, 90; *Haliastur sphenurus*, 91; *Accipiter novaehollandiae*, 94; *Circus assimilis*, 98; *Falco berigora*, 104.
Procyrnea paraleptoptera (T.H. Johnston & Mawson, 1941b), syn. *Cyrnea paraleptoptera* T.H. Johnston & Mawson, 1941b.
Falco cenchroides, 105.
Procyrnea sp., ? *leptoptera* (Rudolphi, 1819).
Accipiter novaehollandiae, 94; *Falco berigora*, 104.
Hadjelia acuariana (Gushanskaya, 1937).
Podargus strigoides, 246.
Hadjelia truncata (Creplin, 1825).
Eurystomus orientalis, 261.
Viguiera chabaudi Mawson, 1968d.
Podargus strigoides, 246.
Viguiera chibiae Mawson, 1968d.
Dicrurus hottentottus, 416.
Viguiera longicollis Mawson, 1968d.
Microeca leucophaea, 287; *Colluricincla harmonica*, 294; *Anthochaera carunculata*, 350.
Viguiera sp.
Cinclosoma cinnamomeum, 309; *Malurus leucopterus*, 322; *Corcorax melanorhamphus*, 423.
Stellocaronema glareolae Mawson, 1968b.
Calidris ruficollis, 158; *Stiltia isabella*, 162.
Stellocaronema charadrii Mawson, 1968b.
Charadrius rubricollis, 135.
Torquatoides balanocephala (Gendre, 1922), syn. *Torquatella balanocephala* (Gendre, 1922).
Merops ornatus, 260.
Torquatoides sp., ? *T. torquata* (Gendre, 1922), syn. *Torquatella* sp., Mawson, 1968d.
Centropus phasianus, 239.

Family TETRAMERIDAE Travassos, 1914

Geopetitia chibiae Mawson, 1966.
Dicrurus hottentottus, 416.
Geopetitia falco Mawson, 1966.
Falco longipennis, 102.
Geopetitia streperae Mawson, 1966.
Strepera versicolor, 437.
Geopetitia sp.
Anthochaera carunculata, 350.
? *Microhadjelia spiralis* (Mawson, 1968d), syn. *Cyrnea spiralis* Mawson, 1968d.
Chrysococcyx basalis, 235; *Coracina novaehollandiae*, 271; *Lalage sueurii*, 274; *Pachycephala pectoralis*, 291; *Cinclosma cinnamomeum*, 309; *Philemon argenticeps*, 356; *Entomyzon cyanotis*, 359; *Lichenostomus plumulus*, 372; *Oriolus sagittatus*, 414.
Microtetrameres aegotheles Mawson, 1977.
Aegotheles cristatus, 248.
Microtetrameres cacomantis Mawson, 1977.
Cuculus variolosus, 233; *C. flabelliformis*, 234.
Microtetrameres circi Mawson, 1977.
Circus assimilis, 98.
Microtetrameres coracinae Mawson, 1977.
Cuculus pallidus, 232; *Coracina novaehollandiae*, 271; *C. papuensis*, 272.
Microtetrameres cractici Mawson, 1977.
Cracticus torquatus, 432.
Microtetrameres egretes Rasheed, 1960.
Ardeola ibis, 54.
Microtetrameres eopsaltriae Mawson, 1977.
Eopsaltria australis, 284.
Microtetrameres gymnorhinae Mawson, 1977.
Gymnorhina tibicen, 434.
Microtetrameres helix Cram, 1927, syn. *Microtetrameres* sp., Munday & Green, 1972.
Corcorax melanorhamphos, 423; *Corvus coronoides*, 438; *C. tasmanicus*, 439; *C. mellori*, 440; *C. bennetti*, 441; *C. orru*, 442.
Microtetrameres meliphagidae Mawson, 1977
Anthochaera carunculata, 350; *A. chrysoptera*, 352; *A.* sp., 353; *Acanthagenys rufogularis*, 354; *Manorina melanocephala*, 361; *M. flavigula*, 362; *Lichenostomus virescens*, 366; *L. leucotis*, 367; *Philidonyris albifrons*, 382.

Microtetrameres mirafrae Mawson, 1977.

Mirafra javanica, 265; *Microeca leucophaea*, 287.

Microtetrameres ninoctis Mawson, 1977.

Ninox novaeseelandiae, 242.

Microtetrameres oriolus Petrov & Tschertkova, 1950.

Oriolus sagittatus, 414.

Microtetrameres paraccipiter Mawson, 1977.

Accipiter fasciatus, 92; *Aquila audax*, 96.

Microtetrameres pelecani (T.H. Johnston & Mawson, 1942e), syn. *Tetrameres pelecani* T.H. Johnston & Mawson, 1942c.

Pelecanus conspicillatus, 37.

Microtetrameres philemon Mawson, 1977.

Philemon argenticeps, 356; *P. citreogularis*, 358; *Entomyzon cyanotis*, 359.

Microtetrameres raptoris Mawson, 1977.

Falco peregrinus, 101; *F. longipennis*, 102; *F. berigora*, 104; *F. cenchroides*, 105; *Ninox novaeseelandiae*, 242.

Microtetrameres sphecotheres Mawson, 1977.

Sphecotheres viridis, 415.

Microtetrameres streperae Mawson, 1977.

Strepera versicolor, 437.

Microtetrameres tytonis Mawson, 1977.

Tyto alba, 244.

Microtetrameres sp., Mawson, 1977.

Accipiter cirrhocephalus, 93; *Cuculus flabelliformis*, 234; *Lalage sueurii*, 274; *Oreoica gutturalis*, 296; *Ptiloris paradiseus*, 422.

Microtetrameres sp.

Accipiter fasciatus, 92; *Chrysococcyx lucidus*, 236; *Anthus novaeseelandiae*, 270; *Pachycephala inornata*, 290; *Lichenostomus ornatus*, 371; *Struthidea cinerea*, 424.

Tetrameres anseranas Mawson, 1979.

Anseranus semipalmata, 69.

Tetrameres australis T.H. Johnston & Mawson, 1941e.

Cygnus atratus, 72.

Tetrameres biziurae T.H. Johnston & Mawson, 1941e.

Biziura lobata, 87.

Tetrameres calidris Mawson, 1968b.

Calidris canutus, 155.

Tetrameres certa (Leidy 1886), syn. *D. diomedeae* T.H. Johnston & Mawson, 1942d.

Diomedea chlororhynchus, 16; *D. cauta*, 17.

Tetrameres cladorhynchi Mawson, 1968b.

Cladorhynchus leucocephalus, 143.

Tetrameres dacelonis Mawson, 1979.

Dacelo novaeguineae, 253.

Tetrameres fissispina (Diesing, 1861).

Anseranas semipalmata, 69; *Anas superciliosa*, 77; *A. castanea*, 79.

Tetrameres globosa (Linstow, 1879), syn. *Tetrameres* sp. Munday & Green, 1972.

Porzana pusilla, 116; *P. fluminea*, 117; *P. tabuensis*, 118; *Gallinula mortierii*, 119; *Porphyrio porphyrio*, 122.

Tetrameres greeni Mawson, 1980, syn. *T. pelecani* T.H. Johnston & Mawson, 1942e, in part.

Pelecanus conspicillatus, 37.

Tetrameres gubanovi Shigin, 1957.

Podiceps cristatus, 3; *Tachybaptus novaehollandiae*, 5.

Tetrameres lobibicis Mawson, 1968b.

Vanellus miles, *131*.

Tetrameres nouveli (Seurat, 1914).

Charadrius ruficapillus, 139; *Himantopus leucocephalus*, 142; *Recurvirostra novaehollandiae*, 144.

Tetrameres scolopacidis Mawson, 1968b.

Tringa glareola, 146; *Calidris acuminata* 157; *C. ruficollis*, 158.

Tetrameres sp., Munday & Green, 1972.

Gallinula mortierii, 119; *Vanellus miles*, 131; *Charadrius ruficapillus*, 139.

Tetrameres sp., Mawson, 1969.

Geochelidon nilotica, 165

Tetrameres sp., T.H. Johnston & Mawson, 1942e.

Anas gibberifrons, 78.

Tetrameres sp.

Phalacrocorax melanoleucos, 47; *Ardea novaehollandiae*, 53; *Stictonetta naevosa, 73; Tadorna tadornoides, 75;* *Cygnus atratus*, 72; *Anas gibberifrons*, 78; *A. rhynchotis*, 80; *Falco longipennis*, 102; *F. berigora*, 104; *Coturnix ypsilophora*, 109; *Calidris ruficollis*, 158; *Larus novaehollandiae*, 163; *Chlidonias hybrida*, 164; *Ninox novaeseelandiae*, 242; *Malurus lamberti*, 320.

Superfamily ACUARIOIDEA Sobolev, 1949

Family ACUARIIDAE Railliet, Henry & Sisoff, 1912

Acuariidae, unidentified, T.H. Johnston & Mawson, 1941e.

Hydroprogne caspia, 166.

Acuariidae, unidentified.

Anas rhynchotis, 80; *Malacorhynchus membranaceus*, 81; *Turnix velox*, 111; *Porzana fluminea*, 117; *Erythrogonys cinctus*, 134; *Anous minutus*, 174; *Ephthianura albifrons*, 393; *Emblema picta*, 402.

Subfamily Acuariinae Railliet, Henry & Sisoff, 1912

Acuaria anthuris (Rudolphi, 1819), syn. *Acuaria corvicola T.H. Johnston & Mawson, 1941a.*

Corvus coronoides, 438; *C. tasmanicus*, 439; *C. mellori*, 440; *C. bennetti*, 441; *C. orru*, 442.

Acuaria colluricinclae Mawson, 1972.

Pachycephala rufiventris, 293; *Colluricincla harmonica*, 294.

Acuaria microeca Mawson, 1972.

Microeca leucophaea, 287; *Malurus leucopterus*, 322.

Acuaria mirafrae Mawson, 1972.

Mirafra javanica, 265.

Acuaria petterae Mawson, 1972.

Lalage leucomela, 275; *Drymodes brunneopygia*, 278; *Oreoica gutturalis*, 296; *Myiagra inquieta*, 301; *Cinclosoma cinnamomeum*, 309; *Anthochaera* sp., 353; *Acanthagenys rufogularis*, 354; *Lichenostomus virescens*, 366; *L. plumulus*, 372; *Artamus cinereus*, 429; *Cracticus nigrogularis*, 433; *Gymnorhina tibicen*, 434.

Acuaria skrjabini Ozerskaya, 1926.

Erythrura trichroa, 412.

Acuaria streperina T.H. Johnston & Mawson, 1941d.

Strepera graculina, 435; *S. fuliginosa*, 436; *S. versicolor*, 437.

Acuaria sp., T.H. Johnston & Mawson, 1941e.

Chlidonias hybrida, 164.

Cheilospirura gruveli (Gendre, 1913).

Coturnix ypsilophora, 109.

Chevreuxia australis T.H. Johnston & Mawson, 1941b.

Charadrius melanops, 140; *Chlidonias hybrida*, 164.

Chevreuxia revoluta (Rudolphi, 1819).

Himantopus leucocephalus, 142; *Recurvirostra novaehollandiae*, 144.

Chevreuxia sp.

Phalacrocorax melanoleucos, 47.

Cosmocephalus jaenschi T.H. Johnston & Mawson, 1941c.

Pelecanus conspicillatus, 37; *Leucocarbo fuscescens*, 43; *Phalacrocorax carbo*, 44; *Chlidonias hybrida*, 164; *Sterna bergii*, 171.

Echinuria heterobrachiata Wehr, 1937.

Charadrius ruficapillus, 139; *Cladorhynchus leucocephalus*, 143; *Recurvirostra novaehollandiae*, 144; *Calidris ruficollis*, 158.

Echinuria squamata (Linstow, 1883).

Phalacrocorax carbo, 44.

Echinuria uncinata (Rudophi, 1819), syn. *Echinuria querquedulae* T.H. Johnston & Mawson, 1942c.

Cygnus atratus, 72; *Tadorna tadornoides*, 75; *Anas gibberifrons*, 78; *A. castanea*, 79; *Nettapus pulchellus*, 85.

Echinuria sp.

Anas superciliosa, 77.

Pectinospirura argentata Wehr, 1933.

Larus novaehollandiae, 163.

Skrjabinocerca sp.

Sterna bergii, 171.

Skrjabinoclava decorata (Solonitzin, 1928).

Tringa terek, 151.

Skrjabinoclava horrida (Rudolphi, 1809), syn. *Skrjabinoclava* sp., Munday & Green, 1972.

Tachybaptus novaehollandae, 5; *Charadrius rubricollis*, 135; *C. ruficapillus*, 139.

Skrjabinoclava sp., cf. *alii* Ali, 1968.

Threskiornis aethiopica, 65.

Skrjabinoclava sp., Munday & Green, 1972.

Charadrius ruficapillus, 139.

Skrjabinoclava sp.

Pachyptila vittata, 25; *P. turtur*, 29; *Threskiornis aethiopica*, 65; *Tringa brevipes*, 147; *Calidris ruficollis*, 158.

Syncuaria contorta (Molin, 1858).

Threskiornis aethiopica, 65.

Syncuaria sp.

Podiceps cristatus, 3; *Tachybaptus novaehollandiae*, 5.

Synhimantus affinis (Seurat, 1916).

Ninox strenua, 241.

Synhimantus falco Mawson, 1982.

Falco berigora, 104; *F. cenchroides*, 105; *Philidonyris novaehollandiae*, 380.

Synhimantus flindersi (T.H. Johnston & Mawson, 1941b), syn. *Acuaria flindersi* T.H. Johnston & Mawson, 1941b; 'nematode', Cleland, 1922.

Falco berigora, 104.

Synhimantus fieldingi (Baylis, 1934a), syn. *Acuaria fieldingi* Baylis, 1934a.

Accipiter novaehollandiae, 94.

Synhimantus laticeps (Rudolphi, 1819).

Ninox novaeseelandiae, 242; *Podargus strigoides*, 246.

Synhimantus lichenostomi Mawson, 1982.

Meliphaga lewini, 363; *Lichenostomus penicillatus*, 374.

Synhimantus podargi Mawson, 1982.

Podargus strigoides, 246.

Synhimantus sirry Khalil, 1931, syn. *Dispharynx pelecani* T.H. Johnston & Mawson, 1942c.

Pelecanus conspicillatus, 37.

Synhimantus sp., T.H. Johnston & Mawson, 1941e.

Anhinga melanogaster, 42.

Synhimantus sp., T.H. Johnston & Mawson 1942c.

Phalacrocorax melanoleucos, 47.

Synhimantus sp., syn. *Dispharynx* sp.

Phalacrocorax carbo, 44; *P. melanoleucos*, 47; *Stictonetta naevosa*, 73; *Accipiter cirrhocephalus*, 93; *Haliaeetus leucogaster*, 95; *Ninox novaeseelandiae*, 242; *Petroica phoenica*, 279; *Malurus cyaneus*, 318; *Corvus* sp., 443.

Willmottia australis Mawson, 1982.

Malurus cyaneus, 318.

Xenocordon patonae Mawson, 1982.

Phylidonyris novaehollandiae, 380.

Xenocordon gymnorhinis (de Chaneet & Robertson, 1983), syn. *Cheilospirura gymnorhinis* de Chaneet & Robertson, 1983.

Gymnorhina tibicen, 434.

Subfamily Seuratiinae Chitwood & Wehr, 1932

Cheilonematodum halcyonis T.H. Johnston & Mawson, 1941d.

Halcyon sancta, 257.

Seuratia shipleyi (Stossich, 1900), syn. *Seuratia marina* T.H. Johnston & Mawson, 1941e.

Diomedea exulans, 12; *D. melanophrys*, 13; *D. bulleri*, 14; *D. chrysostoma*, 15; *D. chlororhyncha*, 16; *Phoebetria palpebrata*, 18; *Macronectes giganteus*, 19; *Fulmarus glacialoides*, 20; *Daption capense*, 21; *Pterodroma macroptera*, 22; *P. lessoni*, 23; *P. brevirostra*, 24; *Pachyptila vittata*, 25; *P. salvini*, 26; *P. belcheri*, 28; *P. turtur*, 29; *Puffinus pacificus*, 31; *P. tenuirostris*, 33; *Pelagodroma marina*, 35; *Sula leucogaster*, 41; *Fregata minor*, 49; *F. ariel*, 50; *Sterna fuscata*, 168; *Anous stolidus*, 173.

Stegophorus diomedeae (T.H. Johnston & Mawson, 1942d), syn. *Paryseria diomediae* T.H. Johnston & Mawson, 1942d.

Diomedea exulans, 12; *D. melamophrys*; 13; *D. chrysostoma*, 15; *D. cauta*, 17.

Stegophorus macronectes (T.H. Johnston & Mawson, 1942d), syn. *Paryseria macronectes T.H. Johnston & Mawson, 1942d.*

Diomedea chrysostoma, 15; *Macronectes giganteus*, 19; *Pterodroma lessoni*, 23; *P. brevirostris*, 24.

Stegophorus pachyptilae (T.H. Johnston & Mawson, 1942d), syn. *Paryseria pachyptilae* T.H Johnston & Mawson 1942d.

Daption capense, 21; *Pachyptila vittata*, 25; *P. salvini*, 26; *P. desolata*, 27; *P. turtur*, 29; *Puffinus griseus*, 32; *P. tenuirostris*, 33.

Stegophorus stellaepolaris (Parona, 1901).

Puffinus tenuirostris, 33.

Stegophorus sp.

Diomedea exulans, 12; *Sterna bergii*, 171.

Streptocara crassicauda (Creplin, 1829).

Anseranas semipalmata, 69; *Tadorna tadornoides*, 75; *Anas rhynchotis*, 80; *Aythya australis*, 82; *Oxyura australis*, 86; *Vanellus miles*, 131; *Charadrius bicinctus, 137; C. ruficapillus, 139.*

Streptocara formosensis Sugimoto, 1930.

Biziura lobata, 87.

Streptocara pectinifera Neumann, 1900.

Hydroprogne caspia, 166.

Streptocara recta (Linstow, 1879).

Poliocephalus poliocephalus, 4; *Ptachybaptus novaehollandiae*, 5; *Phalacrocorax sulcirostris*, 46; *P. melanoleucos*, 47; *Biziura lobata*, 87; *Chlidonias hybrida*, 164.

Streptocara sp., T.H. Johnston & Mawson, 1942e.

Anas gibberifrons, 78.

Streptocara sp., Munday & Green, 1972.

Aythya australis, 82; *Charadrius ruficapillus*, 139.

Streptocara sp.

Tachybaptus novaehollandiae, 5; *Anas gibberifrons*, 78; *A. rhynchotis*, 80; *Vanellus miles*, 131; *Limosa lapponica*, 154.

Subfamily Schistorophinae Travassos, 1918

Ancyracanthopsis sp.

Halcyon sancta, 257.

Schistogendria sp. 1.

Falcunculus frontatus, 288; *Psophodes olivaceus*, 305; *Lichenostomus penicillatus*, 374.

Schistogendria sp. 2.

Halcyon sancta, 257.

Schistogendria sp. 3.

Halcyon sancta, 257.

Schistogendria sp.

Colluricincla harmonica, 294.

Schistorophus cornutus Sobolev, 1943

Tringa terek, 151.

Schistorophus limosae Mawson, 1968b.

Limosa lapponica, 154.

Schistorophus longicornis (Hemprich & Ehrenberg, 1866).

Calidris canutus, 155.

Schistorophus sp.

Dacelo leachii, 254.

Sciadocara umbellifera (Molin, 1860).

Calidris canutus, 155.

Sciadocara sp.

Haematopus fuliginosus, 130.

Viktorocara limosae Mawson, 1968a.

Tringa terek, 151; *Limosa lapponica*, 154.

Viktorocara schejkini Gushanskaya, 1950.

Tringa terek, 151.

Viktorocara sp., Mawson, 1968b.

Calidris canutus, 155.

Superfamily DIPLOTRIAENOIDEA
Family DIPLOTRIAENIDAE Skrjabin, 1916

Diplotriaena alpha T.H. Johnston & Mawson, 1940a, syn. '*Filaria* sp.', Cleland, 1922.

Sericornis fuliginosus, 333; *Strepera graculina*, 435.

Diplotriaena beveridgei Bain & Mawson, 1981.

Corvus orru, 442.

Diplotriaena clelandi (T.J. Johnston, 1912b), syn. *Filaria clelandi* T.H. Johnston, 1912b.

Gymnorhina tibicen, 434.

Diplotriaena delta T.H. Johnston & Mawson, 1940a.

Malurus lamberti, 320; *Amytornis goyderi*, 324.

Diplotriaena epsilon T.H. Johnston & Mawson, 1940a.

Cracticus torquatus, 432.

Diplotriaena falconis (Connal, 1912).

Falco berigora, 104.

Diplotriaena flabellata (Linstow, 1888), syn. *Diplotriaena beta* T.H. Johnston & Mawson, 1940a.

Corvus orru, 442.

Diplotriaena golvani Anderson, 1959.

Colluricincla harmonica, 294.

Diplotriaena halli Ogden, 1967.

Monarcha trivirgata, 297; *Malurus lamberti*, 320.

Diplotriaena pungens (Schneider, 1866).

Sphecotheres viridis, 415.

Diplotriaena smithi Bain & Mawson, 1981, syn. *Diplotriaena* sp., Mackerras, 1962.

Acanthagenys rufogularis, 354; *Philemon corniculatus*, 357.

Diplotriaena spratti Bain & Mawson, 1981.

Oreoica gutturalis, 296.

Diplotriaena tricuspis (Fedschenko, 1874).

Coracina papuensis, 272; *Cisticola exilis*, 315.

Diplotriaena tridens (Molin, 1858).

Sphecotheres viridis, 415.

Diplotriaena zeta T.H. Johnston & Mawson, 1940a.

Acanthagenys rufogularis, 354.

Diplotriaena sp., Mackerras, 1962.

Dicrurus hottentottus, 416.

Diplotriaena sp., Munday & Green, 1972.

Anthochaera paradoxa, 351.

Diplotriaena sp., Ogden, 1967.

Arses kaupi, 298; *Zosterops lateralis*, 400.

Diplotriaena sp.

Coracina papuensis, 272; *Microeca leucophaea*, 287; *Colluricincla megarhynchus*, 295; *Malurus cyaneus*, 318; *M. lamberti*, 320; *Pardalotus striatus*, 399; *Zosterops lateralis*, 400; *Dicrurus hottentottus*, 416; *Strepera fuliginosus*, 436; *Corvus orru*, 442.

Hamatospiculum chibiae T.H. Johnston & Mawson, 1941a.
Dicrurus hottentottus, 416.

Hamatospiculum halcyonis T.H. Johnston & Mawson, 1941a.
Halcyon pyrrhopygius, 256; *H. sancta*, 257.

Hamatospiculum howense T.H. Johnston & Mawson, 1940a, syn. *Filaria* sp., T.H. Johnston, 1912b.
Halcyon sancta, 257.

Hamatospiculum mcneilli T.H. Johnston & Mawson, 1941b, syn. 'nematode' Cleland, 1922. *Ninox rufa*, 240; *N. novaeseelandiae*, 242.

Hamatospiculum sp., cf. *quadridens* (Molin, 1858).
Falco hypoleucos, 103.

Hamatospiculum sp., T.H. Johnston & Mawson, 1941b.
Accipiter cirrhocephalus, 93.

Hamatospiculum sp.
Halcyon pyrrhopygius, 256.

Serratospiculum guttatum (Schneider, 1866), syn. *Serratospiculum attenuatum* (Rudolphi, 1803); *Filaria guttata* Schneider, 1866.
Accipiter cirrhocephalus, 93; *Falco peregrinus*, 101; *F.* longipennis, 102; *F. hypoleucos*, 103; *F. berigora*, 104.

Serratospiculum tendo (Nitzsch in Giebel, 1857), syn. *S. guttatum* (Schneider, 1966) in part.
Accipiter cirrhocephalus, 93; *Falco subniger*, 100; *F. peregrinus*, 101; *F. longipennis*, 102.

Superfamily APROCTOIDEA
Family APROCTIDAE Yorke & Maplestone, 1926

Aproctidae, unidentified, Munday & Green, 1972.
Petroica multicolor, 280; *P. goodenovii*, 281.

Aprocta australis (T.H. Johnston & Mawson, 1942a), syn. *Vagrifilaria australis* T.H. Johnston & Mawson, 1942a.
Centropus phasianus, 239.

Aprocta bakeri Bain & Mawson, 1981.
Corvus coronoides, 438; *C. mellori*, 440; *C. orru*, 442.

Aprocta boulengeri Bain & Mawson, 1981.
Strepera graculina, 435.

Aprocta corvicola T.H. Johnston & Mawson, 1940a.
Corvus orru, 442.

Aprocta vestibulata (T.H. Johnston & Mawson, 1940a), syn. *Austrofilaria vestibulata* T.H. Johnston & Mawson, 1940a.
Aphelocephala nigricincta, 344.

Aprocta sp.
Cacatua sp., 193.

Lissonema brevicaudata (Chow, 1939), syn. *Aprocta brevicaudata* Chow, 1939.
Ninox novaeseelandiae, 242.

Lissonema rotundatum (Linstow, 1903), syn. *Aprocta rotundata* Linstow, 1903.
Centropus phasianus, 239.

Lissonema sp., Bain & Mawson, 1981.
Ninox novaeseelandiae, 242.

Lissonema sp.
Alectura lathami, 107.

Mawsonfilaria rhipidurae (T.H. Johnston & Mawson, 1952), syn. *Austrofilaria rhipidurae*, T.H. Johnston & Mawson, 1952.
Rhipidura leucophrys, 304.

Pseudaprocta copemani Bain & Mawson, 1981, syn. *Aproctidae*, unidentified, Munday & Green, 1972.
Petroica multicolor, 280; *Pachycephala pectoralis*, 291.

Pseudaprocta myzanthae T.H. Johnston & Mawson, 1940a, syn. 'nematode', Cleland, 1922.
Manorina flavigula, 362.

Desmidocercella sp.
Phalacrocorax sulcirostris, 46; *P. melanoleucos*, *47; Ardea* pacifica, 52; Nycticorax caledonicus, *60; Ixobrychus minutus*, 61.

Diomedenema diomediae T.H. Johnston & Mawson, 1952.
Diomedea chrysostoma, 15; *D. cauta*, 17.

Superfamily FILARIOIDEA

Unidentified filarial worms cited by:

Bancroft, 1889.
Anthochaera chrysoptera, 352; *Manorina melanocephala*, 361; *Cracticus torquatus*, 432; *Corvus orru*, 442.

Cleland, 1922.
Falco longipennis, 102; *Petroica phoenica*, 279; *Malurus cyaneus*, 318; *Geoffroyus geoffroyi*, 1981.

T.H. Johnston, 1912a.
Philemon citreogularis, 358.

T.H. Johnston, 1912b.
Ninox novaeseelandiae, 242; *Coracina papuensis*, 272; *Acanthagenys rufogularis*, 354.

T.H. Johnston & Mawson, 1940a.
Nymphicus hollandicus, 208; *Acanthagenys rufogularis*, 354.

T.H. Johnston & Mawson, 1941a.
Malurus leucopterus, 322.

Mackerras, 1962.
Ardea pacifica, 52; *Corvus bennetti*, 442.

Plimmer, 1912.
Ailuroedus melanotis, 420.

Unidentified filarial worms:
Eudyptula minor, 11; *Pelecanus conspicillatus*, 37; *Larus novaehollandiae*, 163; *Ninox connivens*, 243; *Myiagra rubeculus*, 299; *M. inquieta*, 301; *Ailuroedus crassirostris*, 421.

Family ONCHOCERCIDAE Leiper, 1911

Onchocercidae, unidentified.
Sphecotheres viridis, 415.

Cardiofilaria dubia (T.H. Johnston & Mawson, 1940a), syn. *Carinema dubia* T.H. Johnston & Mawson, 1940a, 'Filarial' worms, Cleland, 1922.
Geoffroyus geoffroyi, 198 .

Eufilaria sp., Mawson, 1969.
Larus novaehollandiae, 163.

Paralemdana clelandi T.H. Johnston & Mawson, 1940a.
Strepera graculina, 435.

Pelecitus fulicaeatrae (Diesing, 1861).
Fulica atra, 123.
Pseudaproctella sp., Mawson, 1968b.
Vanellus miles, 131.
Splendidofilaria sp.
Struthidia cinerea, 424.
Splendidofilariinae, unidentified.
Falco longipennis, 102; *Platycercus venustus*, 215; *Gymnorhina tibicen*, 434.
Microfilaria gymnorhinae Gilruth, Sweet & Dodd, 1910.
Gymnorhina tibicen, 434.
Microfilaria sp.
Ptilonorhynchus violaceus, 417.

Microfilaria sp. have been recorded by the following:
Bancroft, 1889.
Trichoglossus haematodus, 199; *Podargus strigoides*, 246; *Eurystomus orientalis*, 261; *Myiagra rubeculus*, 299; *Pomatostomus temporalis*, 310; *Anthochaera chrysoptera*, 352; *Entomyzon cyanotis*, 359; *Manorina melanocephala*, 361; *Oriolus sagittatus*, 414; *Dicrurus hottentottus*, 416; *Sericulus chrysocephalus*, 418; *Cracticus torquatus*, 432; *Gymnorhina tibicen*, 434; *Strepera graculina*, 435; *Corvus orru*, 442.
Breinl, 1913a.
Falco hypoleucos, 103; *Pitta versicolor*, 263.
Cleland, 1915.
Podargus strigoides, 246; *Eurystomus orientalis*, 261; *Colluricincla harmonica*, 294; Myzomela sanguinolenta, *390*.
Cleland, 1922.
Philemon citreogularis, 358.
Cleland & T.H. Johnston, 1910.
Anthochaera chrysoptera, 352; *Gymnorhina tibicen*, 434; *Corvus orru*, 442.
Cleland & T.H. Johnston, 1912.
Phalacrocorax melanoleucos, 47; *Accipiter cirrhocephalus*, 93; *Glossopsitta pusilla*, 202; *Podargus strigoides*, 246; *Eurystomus orientalis*, 261; *Psophodes olivaceus*, 305; *Plectorhyncha lanceolata*, 355; *Entomyzon cyanotis*, 359; *Manorina melanocephala*, 361; *Lichenostomus fuscus*, 373; *Lichmera indistincta*, 378; *Myzomela sanguinolenta*, 390; *Pardalotus striatus*, 399; *Oriolus sagittatus*, 414; *Corcorax melanorhamphos*, 423; *Struthidea cinerea*, 424; *Artamus leucorhynchus*, 426; *A. cinerea*, 429; *A. cyanopterus*, 430; *Cracticus torquatus*, 432; *C. nigrogularis*, 433; *C. orru*, 442.
T.H. Johnston, 1910.
Zoothera dauma, 276; *Anthochaera chrysoptera*, 352.
T.H. Johnston, 1912a.
Anhinga melanogaster, 42; *Phalacrocorax sulcirostris*, 46.
T.H. Johnston, 1916.
Aegotheles cristatus, 248.
Mackerras, 1962.
Phalacrocorax carbo, 44; *Haliastur sphenurus*, 91; *Accipiter cirrhocephalus*, 93; *Vanellus miles*, 131; *Cacatua sanguinea*, 194; *C. galerita*, 196; *Glossopsitta concinna*, 200; *Platycercus adsictus*, 214; *Coracina novaehollandiae*, 271; *Climacteris melanura*, 349; *Anthochaera chrysoptera*, 352; *Entomyson cyanotis*, 359; *Melithreptus albogularis*, 376; *Zosterops lateralis*, 400; *Sphecotheres viridis*, 415; *Dicrurus hottentottus*, 416; *Ptilonorhynchus violaceus*, 417; *Corcorax melanorhamphus*, 423; *Grallina cyanoleuca*, 425; *Artamus personatus*, 427; *A. cyanopterus*, 430; *Cracticus torquatus*, 432; *Gymnorhina tibicen*, 434.
Plimmer, 1912.
Geophaps plumifera, 184; *Platycercus icterotis*, 216; *Entomyzon cyanotis*, 359; *Manorina melanocephala*, 361; *Gymnorhina tibicen*, 434; *Strepera fuliginosa*, 436.
Plimmer, 1914.
Geophaps plumifera, 184; *Platycercus icterotis*, 216.
Plimmer, 1915.
Poephila bichenovii, 407.
Plimmer, 1916.
Artamus superciliosa, 428.
Scott, 1926.
Larus novaehollandiae, 163; *Poephila personata*, 408.
Scott, 1927.
Eurystomus orientalis, 261.

Nematoda not further identified are not included in this list.

PHYLUM ACANTHOCEPHALA
Order Echinorhynchidea

Family FILICOLLIDAE Petroschenko, 1956

Filicollis sphaerocephalus (Bremser, 1819).
Haematopus fuliginosus, 130; *Larus novaehollandiae*, 163.

Family PLAGIORHYNCHIDAE Golvan, 1960

Plagiorhynchus charadrii (Yamaguti, 1939b), syn. *Prosthorhynchus charadrii* Yamaguti, 1939b.
Charadrius rubricollis, 135; *C. ruficapillus*, 139.
Plagiorhynchus menurae (T.H. Johnston, 1912b), syn. *Prosthorhynchus menurae* (T.H. Johnston, 1912b), *Echinorhynchus menurae* T.H. Johnston, 1912b.
Menurae novaehollandiae, 264.
Plagiorhynchus sp.
Pachyptila turtur, 29.

Family POLYMORPHIDAE Meyer, 1931

Polymorphus biziurae T.H. Johnston & Edmonds, 1948.
Pelecanus conspicillatus, 37; *Threskiornis aethiopicus*, 65; *Platalea flavipes*, 68; *Biziura lobata*, 87.

Polymorphus sp.
Cygnus atratus, 72.
Corynosoma clavatum Goss, 1940.
Leucocarbo fuscescens, 43; *Phalacrocorax varius*, 45; *P. sulcirostris*, 46; *P. melanoleucos*, 47.
Corynosoma sp.
Eudyptula minor, 11; *Cygnus atratus*, 72.
Arhythmorhynchus brevis van Cleave, 1916.
Botaurus poiciloptilus, 62.
Arhythmorhynchus johnstoni Golvan, 1960, syn. *Arhythmorhynchus frassoni* of T.H. Johnston & Edmonds, 1950 not (Molin, 1858).
Numenius madagascariensis, 145.
Arhythmorhynchus limosae Edmonds, 1971.
Limosa lapponica, 154.
Arhythmorhynchus sp.
Numenius madagascariensis, 145.

Order Gigantorhynchidea

Family CENTRORHYNCHIDAE van Cleave, 1916

Centrorynchus asturinus (T.H. Johnston, 1913), syn. *Echinorhynchus bazae* Southwell & Macfie, 1925; syn. *Gigantorhynchus asturinus T.H. Johnston, 1913.*
Aviceda subcristata, 89; *Accipiter fasciatus*, 92; *A. cirrocephalus*, 93; *A. novaehollandiae*, 94; *Circus approximans*, 99; *Falco berigora*, 104; *F. cenchroides*, 105.
Centrorhynchus bancrofti (T.H. Johnston & Best, 1943), syn. *Gordiorhynchus bancrofti* T.H. Johnston & Best, 1943.
Ninox strenua, 241; *N. novaeseelandiae*, 242.
Centrorhynchus falconis (T.H. Johnston & Best, 1943), syn. *Gordiorhynchus falconis* T.H. Johnston & Best, 1943.
Falco berigora, 104.
Centrorhynchus horridus (Linstow, 1898a).
Dacelo novaeguineae, 253; *Halcyon sanctus*, 257.
Centrorhynchus sp. T.H. Johnston, 1918b.
Ninox novaeseelandiae, 242
Centrorhynchus sp.
Phalacrocorax sulcirostris, 46.

Family GIGANTORHYNCHIDAE Hamman, 1892

Mediorhynchus alecturae (T.H. Johnston & Edmonds, 1947), syn. *Empodius alecturae* T.H. Johnston & Edmonds 1947.
Alectura lathami, 107.
Mediorhynchus corcoracis T.H. Johnston & Edmonds, 1951, syn. *Echinorhynchus* sp. Cleland 1922.
Corcorax melanorhamphus, 423; *Corvus tasmanicus*, 439; *C. mellori*, 440; *C. bennetti*, 441; *Corvus* sp., 443.
Mediorhynchus garruli (Yamaguti, 1939b).
Grallina cyanoleuca, 425.
Mediorhynchus sp.
Colluricincla harmonica, 294; *Rhipidura leucophrys*, 304; *Anthochoera chrysoptera*, 352; *Acanthagenys rufogularis*, 354; *Grallina cyanoleuca*, 425; *Corvus* sp., 443.

Family OLIGACANTHORHYNCHIDAE Southwell & Macfie, 1925

Oncicola pomatostomi (T.H. Johnston & Cleland, 1912) (encysted stage), syn. *Echinorhynchus pomatostomi* T.H. Johnston & Cleland, 1912; syn. *Oligacanthorhynchus pomatostomi* (T.H. Johnston & Cleland, 1912).
Turnix castanota, 110; *T. velox*, 111; *Pedionomus torquatus*, 113; *Anthus novaeseelandiae*, 270; *Lalage leucomela*, 275; *Zoothera dauma*, 276; *Melanodryas cucullata*, 282; *Microeca leucophaea*, 287; *Pachycephala inornata*, 290; *P. rufiventris*, 293; *Colluricincla harmonica*, 294; *Oreoica gutturalis*, 296; *Cinclosoma castanotum*, 308; *C. cinnamomeum*, 309; *Pomatostomus temporalis*, 310; *P. superciliosus*, 311; *P. ruficeps*, 312; *Amytornis purnelli*, 326; *Sericornis pyrrhopygius*, 330; *S. cautus*, 331; *S. brunneus*, 332; *S. fuliginosus*, 333; *Acanthiza chrysorrhoa*, 341; *Aphelocephala leucopsis*, 343; *Daphoenositta chrysoptera*, 345; *Climacteris leucophaea*, 346; *C. picumnus*, 347; *C. melanura*, 349; *Anthochoera carunculata*, 350; *Manorina flavigula*, 362; *Lichenostomus virescens*, 366; *L. plumulus*, 372; *Poephila cincta*, 410; *Grallina cyanoleuca*, 425; *Artamus cinereus*, 429; *Gymnorhina tibicen*, 434.

Family PROSTHORHYNCHIDAE Petroschenko, 1956

Porrorchis hylae (T.H. Johnston, 1914b), syn. *Echinorhynchus bulbocaudatus* Southwell & Macfie, 1925, syn. *Gordiorhynchus hylae* (T.H. Johnston, 1914b), syn. *Pseudoporrorchis hylae* (T.H. Johnston, 1914b).
Centropus phasianinus, 239; *Podargus strigoides*, 246. 131.
Prosthorhynchus cylindraceus (Goeze, 1782).
Gymnorhina tibicen, 434.
Prosthorhynchus sp.
Haematopus longirostris, 129; *Vanellus miles*, 131.

LIST 3. INDEX TO BIRD FAMILIES REFERRED TO IN THIS CHECKLIST

In this list the number of bird species listed by Schodde *et al.* (1978) for each family is given after the family name, followed by the number of birds from which helminths have been recorded. Introduced species are omitted.

LIST 4. INDEX TO BIRD SPECIES REFERRED TO IN THIS CHECKLIST

LIST 5. INDEX TO HELMINTHS

In this section the helminths are arranged in alphabetical order within each of the taxa Trematoda, Cestoda, Nematoda, and Acanthocephala.

Species names cited in List 1 as junior synonyms of other species are included in this index in their alphabetical sequence. The number(s) following each helminth name is that of the host(s) in which it has been found. As these are consecutive in the host-parasite list (List 1) the bird name may easily be found.

Class Trematoda

Strigeidae, unidentified, Munday & Green, 1972: 93
Strigeidae, unidentified: 45, 101
Tanaisiinae, unidentified: 440
Trichobilharzia australis Blair & Islam, 1983: 77
Trichobilharzia sp., Bearup, 1957: 78
Trichobilharzia sp., Bearup & Langsford, 1966: 142
Trichobilharzia sp., Blair & Otteson, 1979: 77
Trichobilharzia sp., T.H. Johnston, 1941: 72
Trichobilharzia sp.,: 142, 209
Typhlocoelum reticulare S.J. Johnston, 1913: 69
Typhlocoelum sp.: 77, 78
Urotocus sp.: 360
Vermatrema longitestis (Verma, 1936): 72
Trematodes, unidentified, Ratcliffe, 1933: 196
Trematodes, unidentified: 46, 53, 62, 65, 72, 78, 81, 87, 115, 121, 134, 142, 156, 157, 158, 245, 294, 319, 341, 353, 399, 422, 434.

Class Cestoda

Acoleus hedleyi T.H. Johnston, 1910: 142
Angularella australis (Maplestone, 1921b): 69, 128
Angularella sp.: 131
Angularia australis Maplestone, 1921b: 128
Anomotaenia accipitris T.H. Johnston, 1913: 93
Anomotaenia asymmetrica T.H. Johnston, 1913: 55
Anomotaenia hydrochelidonis Dubinina, 1954: 163
Anonchotaenia arhyncha Fuhrmann, 1918: 399
Anonchotaenia globata (Linstow, 1879): 359
Aploparaksis australis T.H. Johnston, 1913: 152
Armadoskrjabinia globosa (Szpotanska, 1931): 72
Ascometra sp.: 126
Australiolepis southwelli (Szpotanska, 1931): 72
Baerbonia parvitaeniunca (Baer & Bona, 1960): 58
Bancroftiella ardeae T.H. Johnston, 1913: 53, 60
Bancroftiella glandularis (Fuhrmann, 1905): 55
Bancroftiella glandularis of T.H. Johnston, 1912b, not (Fuhrmann, 1905): 53
Bancroftiella sp.: 62
Biuterina sp.: 69, 415
Capiuterilepis australiensis Schmidt, 1972: 350, 353
Capiuterilepis meliphagicola Schmidt, 1972: 357
Choanotaenia fieldingi (Maplestone & Southwell, 1923): 432
Choanotaenia meliphagidarum T.H. Johnston, 1911: 363, 367, 372, 380, 381
Choanotaenia southwelli Fuhrmann, 1932: 131
Choanotaenia taylori T.H. Johnston, 1912c: 318
Choanotaenia zoniferae T.H. Johnston, 1912c: 132
Choanotaenia sp. T.H. Johnston, 1910: 363, 367, 372, 380, 381
Choanotaenia sp.: 128, 352, 404, 407
Cladotaenia feuta Meggitt, 1933: 98
Cladotaenia sp.: 98, 99, 100
Clelandia parva T.H. Johnston, 1909b: 63
Cloacotaenia megalops (Nitzsch in Creplin, 1829): 69, 70, 72, 77, 78, 79
Cloacotaenia sp.: 82
Cotugnia brotogerys Meggitt, 1915: 213
Cotugnia collini Fuhrmann, 1909: 1
Cotugnia oligorchis Maplestone, 1922a: 70
Cotugnia platycerci Weerekoon, 1944: 216
Cotugnia polytelidis Burt, 1940: 206
Cotugnia seni Meggitt, 1926: 213
Cotugnia sp.: 1
Cyclophyllidea, unidentified, Munday & Green, 1972: 13
Cyclophyllidea, unidentified: 72, 87
Cyclorchida omalancristrota (Wedl, 1856): 67
Davainea australis (Krabbe, 1869): 1
Davainea cacatuina T.H. Johnston, 1913: 196
Davainea conopophilae T.H. Johnston, 1913: 358, 359, 384
Davainea himantopodis T.H. Johnston, 1911: 142
Davainea leptosoma Diesing, 1850: 191
Davainea sphecotheridis T.H. Johnston, 1914a: 415
Davainea sp., T.H. Johnston, 1910: 142
Davainea sp., T.H. Johnston, 1912b: 187, 438
Davainea sp.: 107, 142, 143, 187, 423
Dendrouterina australiensis Baer & Bona, 1960: 53
Dendrouterina sp.: 415
Dicranotaenia coronula (Dujardin, 1845): 72
Dilepididae, unidentified: 403, 407, 410, 434
Dilepis australiensis T.H. Johnston, 1912d: 142
Dilepis bancrofti T.H. Johnston, 1912c: 213
Dilepis maxima Goss, 1940: 45
Dilepis minima Goss, 1940: 46, 47
Dilepis sp.: 46, 350
Dioecocestus novaehollandiae (Krefft, 1873): 5
Dioecocestus sp.: 4
Diorchis flavescens (Krefft, 1873): 70, 77, 78, 79, 80, 82, 142, 143
Diorchis spiralis Szpotanska, 1931: 72
Diorchis stefanski Czaplinski, 1955: 72
Diorchis sp.: 73, 79
Diplogynea oligorchis (Maplestone, 1922a): 70
Diplogynea sp.: 82
Diploposthe laevis (Bloch, 1782): 77, 79, 82
Diploposthe laevis of T.H. Johnston, 1913, not (Bloch, 1782): 70
Drepanidotaenia bisacculina Szpotanska, 1931: 72
Drepanidotaenia lanceolata (Bloch, 1782): 72, 77
Drepanidotaenia rapida (Szpotanska, 1931): 72
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Echinorhynchotaenia nana Mapleston & Southwell, 1922b: 72
Fimbriaria fasciolaris (Pallas, 1871): 77, 79
Fimbriaria intermedia Fuhrmann, 1913: 74
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Gyrocoelia australiensis (T.H. Johnston, 1910): 131, 142
Gyrocoelia sp., T.H. Johnston 1914a: 131
Gyrocoelia sp.: 4, 131, 143
Haploparaxis australis (T.H. Johnston, 1913): 148, 152, 153
Haploparaxis veitchi Baylis, 1934b: 78
Hemiparonia bancrofti (T.H. Johnston, 1912c): 212, 213, 217, 218
Hemiparonia cacatuae (Maplestone, 1922b): 195, 196
Hemiparonia merotomochaeta Woodland, 1930: 195
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Hymenolepis colluris (Batsch, 1786): 77, 79

Macgillivray, 1917: 1
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Acuaria corvicola T.H. Johnston & Mawson, 1941a: 442
Acuaria fieldingi Baylis, 1934a: 94
Acuaria flindersi T.H. Johnston & Mawson, 1941b: 104
Acuaria microeca Mawson, 1972: 287, 322
Acuaria mirafrae Mawson, 1972: 265
Acuaria petterae Mawson, 1972: 275, 278, 296, 301, 309, 353, 354, 366, 372, 429, 433, 434
Acuaria skrjabini Ozerskaya, 1926: 412
Acuaria streperina T.H. Johnston & Mawson, 1941d: 435, 436, 437
Acuaria sp., T.H. Johnston & Mawson, 1941c: 164
Acuaria sp.: 248
Acuariidae, unidentified. T.H. Johnston & Mawson, 1941c: 166
Acuariidae, unidentified: 80, 81, 111, 117, 134, 174, 393, 402
Alainchabaudia aegotheles (T.H. Johnston & Mawson, 1941e): 248
Alainchabaudia alcedinis Mawson, 1968c: 253, 257
Allodapa differens (Sonsino, 1890): 239
Allodapa suctoria (Molin, 1860): 238, 242, 246, 249, 250
Allodapa sp., T.H. Johnston & Mawson, 1941b: 241
Allodapa sp.: 246
Amidostomum acutum (Lundahl, 1848): 73, 76, 77, 78, 80, 142
Amidostomum anseris (Zeder, 1800): 69, 74
Amidostomum biziurae T.H. Johnston & Mawson, 1947: 87
Amidostomum chevreuxi Seurat, 1918: 142
Amidostomum cygni Wehr, 1933: 72
Amidostomum fulicae (Rudolphi, 1819): 123
Amidostomum tribonyx Mawson, 1980: 120
Amidostomum sp.: 72, 77, 78, 83
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Anisakidae, Munday & Green, 1972: 13
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Anisakis sp., T.H. Johnston & Mawson, 1942c: 27
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Aprocta bakeri Bain & Mawson, 1981: 438, 440, 442
Aprocta boulengeri Bain & Mawson, 1981: 435
Aprocta brevicaudata Chow, 1939: 242
Aprocta corvicola T.H. Johnston & Mawson, 1940a: 442
Aprocta rotundata (Linstow, 1903): 239
Aprocta vestibulata (T.H. Johnston & Mawson, 1940a): 344
Aprocta sp.: 193
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Ascaridia columbae (Gmelin, 1790): 180, 197, 203, 207, 209, 210, 218, 219, 226
Ascaridia galli (Schrank, 1788): 236, 239
Ascaridia lineata (Schneider, 1866): 239
Ascaridia platyceri Hartwich & Tscherner, 1979: 190, 203, 204, 205, 206, 207, 208, 209, 210, 212, 213, 217, 218, 219, 220, 221, 222, 223, 224, 226, 228, 230, 231
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Ascaris sp., Krefft, 1873: 42, 350
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Austrofilaria rhipidurae T.H. Johnston & Mawson, 1952: 304
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Bancroftinema dentatum T.H. Johnston & Mawson, 1941b: 104
Baylisascaris sp.: 208
Capillaria anatis (Schrank, 1790): 72
Capillaria convolutor Fourment, 1885: 13, 19
Capillaria ellisi T.H. Johnston & Mawson, 1945b: 72
Capillaria grallina T.H. Johnston & Mawson, 1945a: 425
Capillaria graucalina T.H. Johnston & Mawson, 1941d: 271
Capillaria gymnorhinae T.H. Johnston & Mawson, 1947: 434
Capillaria jaenschi T.H. Johnston & Mawson, 1945b: 37, 43, 44, 45, 46, 47, 163, 164
Capillaria laricola Wassilikova, 1930: 163
Capillaria obsignata Madsen, 1945: 72
Capillaria pomatostomi T.H. Johnston & Mawson, 1945b: 311
Capillaria recurvirostrae Mawson, 1968b: 144
Capillaria thomascameroni Mawson, 1969: 163
Capillaria triloba Linstow, 1875: 131, 142, 144

Synhimantus fieldingi (Baylis, 1934a): 94
Synhimantus laticeps (Rudolphi, 1819): 242, 246
Synhimantus lichenostomi Mawson, 1982: 363, 374
Synhimantus podargi Mawson, 1982: 246
Synhimantus sirry Khalil, 1931: 37
Synhimantus sp., T.H. Johnston & Mawson, 1941e: 42
Synhimantus sp., T.H. Johnston & Mawson, 1942e: 47
Synhimantus sp.: 44, 47, 73, 93, 95, 242, 279, 318, 443
Tetrameres anseranas Mawson, 1979: 69
Tetrameres australis T.H. Johnston & Mawson, 1941e: 72
Tetrameres biziurae T.H. Johnston & Mawson, 1941e: 87
Tetrameres calidris Mawson, 1968b: 155
Tetrameres certa (Leidy, 1886): 16, 17
Tetrameres cladorhynchi Mawson, 1968b: 143
Tetrameres dacelonis Mawson, 1979: 253
Tetrameres diomedeae T.H. Johnston & Mawson, 1942d: 16
Tetrameres fissispina (Diesing, 1861): 69, 77, 79
Tetrameres globosa (Linstow, 1879): 116, 117, 118, 119, 122
Tetrameres greeni Mawson, 1980: 37
Tetrameres gubanovi Shigin, 1957: 3, 5
Tetrameres lobibicis Mawson, 1968b: 131
Tetrameres nouveli (Seurat, 1914): 139, 142, 144
Tetrameres pelecani T.H. Johnston & Mawson, 1942c: 37
Tetrameres scolopacidis Mawson, 1968b: 146, 157, 158
Tetrameres sp., T.H. Johnston & Mawson, 1942e: 78
Tetrameres sp., Munday & Green, 1972: 119, 131, 139
Tetrameres sp., Mawson, 1969: 165
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Thelazia aquilina Baylis, 1934a: 94, 95, 96, 104
Thelazia dacelonis (Breinl, 1913b): 254
Thelazia pittae T.H. Johnston & Mawson, 1941e: 262
Thelazia sp.: 55
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Trichostrongylus tenuis (Mehlis, 1864): 1, 72
Vagrifilaria australis T.H. Johnston & Mawson, 1942a: 239
Viktorocara limosae Mawson, 1968a: 151, 154
Viktorocara schejkini Gushanskaya, 1950: 151
Viktorocara sp., Mawson, 1968b: 155
Viguiera chabaudi Mawson, 1968d: 246
Viguiera chibiae Mawson, 1968d: 416
Viguiera longicollis Mawson, 1968d: 287, 294, 350
Viguiera sp.: 309, 322, 423
Willmottia australis Mawson, 1982: 318
Xenocordon patonae Mawson, 1982: 380
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Arhythmorhynchus frassoni of T.H. Johnston & Edmonds, 1951, not (Molin, 1858): 145
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Arhythmorhynchus limosae Edmonds, 1971: 154
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Centrorhynchus bancrofti (T.H. Johnston & Best, 1943): 241, 242
Centrorhynchus falconis (T.H. Johnston & Best, 1943): 104
Centrorhynchus horridus (Linstow, 1898a): 253, 257
Centrorhynchus sp., T.H. Johnston, 1918: 242
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Corynosoma clavatum Goss, 1940: 43, 45, 46, 47
Corynosoma sp.: 11, 72
Echinorhynchus bazae Southwell & Macfie, 1925: 89
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Echinorhynchus menurae T.H. Johnston, 1912b: 264
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Filicollis sphaerocephalus (Bremser, 1819): 130, 163
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Gordiorhynchus bancrofti T.H. Johnston & Best, 1943: 241
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RECORDS OF THE SOUTH AUSTRALIAN MUSEUM

VOLUME 19 NUMBERS 16–19 NOVEMBER 1986

SOUTH AUSTRALIAN MUSEUM
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ANATOMICAL NOTES ON THE LAND SNAIL BOTHRIEMBRYON (PULMONATA: BULIMULIDAE) FROM SOUTH AUSTRALIA AND WESTERN AUSTRALIA

BY RON C. KERSHAW

Summary

Comparative notes on the anatomy of the South Australian land snail Bothriembryon mastersi (Cox, 1867) from different localities are presented. Comparisons are also made with Bothriembryon barretti Iredale, 1930 (Nullarbor Plain), Bothreimbryon melo (Quoy & Gaimard, 1832) type of the genus (Western Australia), Bothreimbryon tasmanicus (Pfeiffer, 1853) (Tasmania) and seven other Western Australian species. Features of the anatomy together with the protoconch sculpture of B. mastersi and B. tasmanicus suggest a clinal distribution pattern. Therefore the recognition of a subgenus Tasmanembryon Iredale, 1933 (Breure, 1979) is here suggested to be unjustified.

ANATOMICAL NOTES ON THE LAND SNAIL *BOTHRIEMBRYON* (PULMONATA: BULIMULIDAE) FROM SOUTH AUSTRALIA AND WESTERN AUSTRALIA

by

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(Manuscript accepted 20 June 1985)

ABSTRACT

KERSHAW, R. C. 1986. Anatomical notes on the land snail *Bothriembryon* (Pulmonata: Bulimulidae) from South Australia and Western Australia. *Rec. S. Aust. Mus.* 19(16): 327-337.

Comparative notes on the anatomy of the South Australian land snail *Bothriembryon mastersi* (Cox, 1867) from different localities are presented. Comparisons are also made with *Bothriembryon barretti* Iredale, 1930 (Nullarbor Plain), *Bothriembryon melo* (Quoy & Gaimard, 1832) type of the genus (Western Australia), *Bothriembryon tasmanicus* (Pfeiffer, 1853) (Tasmania) and seven other Western Australian species. Features of the anatomy together with the protoconch sculpture of *B. mastersi* and *B. tasmanicus* suggest a clinal distribution pattern. Therefore the recognition of a subgenus *Tasmanembryon* Iredale, 1933 (Breure, 1979) is here suggested to be unjustified.

INTRODUCTION

Specimens of the snail *Bothriembryon mastersi* (Cox, 1867) collected by members of the Malacological Society of South Australia from St Francis Island (Nuyts Archipelago: 32°31'S, 133°18'E) and Venus Bay (33°11'S, 134°40'E) were dissected and compared with specimens of this species from Port Lincoln and Flinders Island, South Australia.

Study of the Nullarbor Plain species *Bothriembryon barretti* Iredale, 1930 from two localities together with *Bothriembryon melo* (Quoy & Gaimard, 1832) (Albany, Western Australia), seven other Western Australian species and the Tasmanian species *Bothriembryon tasmanicus* (Pfeiffer, 1853) has enabled presentation of comparative notes on the anatomy and relationships within the genus.

SEM micrographs taken by Dr A. Solem of the Field Museum of Natural History, Chicago of the shell protoconch sculpture of *B. mastersi* and *B. tasmanicus* provide new information on the nature of this feature.

The recent evaluation by Breure (1979, pp. 91-96) of the status of generic level taxa suggested recognition of *Bothriembryon* Pilsbry, 1894 and *Tasmanembryon* Iredale, 1933 as subgenera on the basis of differences in the spermathecal duct and the protoconch sculpture. The anatomical and protoconch data presented in this paper permit further comment on the status of *Tasmanembryon*.

The holotype of *Bothriembryon mastersi* (Cox, 1867) described from Port Lincoln, Eyre Peninsula, South Australia, has not been located, but an apparent syntype from Flinders Island, 170 km to the north west within the Great Australian Bight, is preserved in the South Australian Museum (D.11341). The status of another Eyre Peninsula species *Bothriembryon angasianus* (Pfeiffer, 1864) which predates *B. mastersi* has yet to be determined; matter, however, beyond the scope of this paper. Full study on the South Australian species and their shells must depend on future research.

Very little has been published on the anatomy of *Bothriembryon*. Early comments and illustrations of genitalia and buccal organs were presented by Semper (1870) and Hedley (1889). Pilsbry (1946) gave more detail and discussed the affinities of *Bothriembryon* with New World taxa. Breure (1978b, 1979) revising the Bulimulinae, has provided some descriptive and illustrative information. Breure (1978a) provided illustrations of part of the radula of both *B. melo* and *B. tasmanicus*.

The following abbreviations have been used in this paper: SAM, South Australian Museum, Adelaide; NMV, Museum of Victoria, Melbourne; TM, Tasmanian Museum, Hobart; QVM, Queen Victoria Museum, Launceston; FMNH, Field Museum of Natural History, Chicago; AE, anterior oesophagus; AG, albumen gland; BM, buccal mass; DI, digestive gland; E, prostate; EP, epiphallus; F, flagellum; GA, genital atrium; HD, hermaphrodite duct; I, intestine; KD, kidney; O, free oviduct; P, penis; PC, pericardium; PM, penial muscle; PV, pulmonary vein; R, rectum; RM, penial retractor; S, stomach; SD, bursa duct; SL, salivary gland; SO, spermoviduct; SP, bursa copulatrix; T, talon; U, uterus; V, vagina; VD, vas deferens; XB, site of bursa copulatrix.

MATERIALS AND METHODS

This work is based on study of more than 200 South Australian and 100 Western Australian specimens from the collections of the Museum of Victoria, the Tasmanian Museum and the Queen Victoria Museum. One "fossil" specimen of *Bothriembryon barretti* Iredale, 1930, collected by Miss Karen Gowlett at Petrel Cove, St Francis Island, 22 January 1982, from a sand layer in the south-west cliff, is in Miss Gowlett's collection.

Selected Tasmanian specimens are included for comparative purposes from a study of *Bothriembryon tasmanicus* (Pfeiffer, 1853) (Kershaw, unpublished). The results from dissections presented are taken from the following material:

Bothriembryon mastersi (Cox, 1867)

St Francis Island, Nuyts Archipelago (32°31'S, 133°18'E); collected 24 January 1982 by K. Gowlett and R. Brown, 2 live and 12 dead specimens; deposited as follows: SAM D 17089, 1 spirit; D 17091, 6 dry specimens; QVM 1 spirit, 4 dry specimens.

Venus Bay, West Coast, Eyre Peninsula (33°11'S, 134°40'E); collected January 1982 by R. Brown, 14 live specimens; deposited as follows: SAM D 18090, 8 spirit specimens; QVM 6 spirit specimens.

Flinders Island, west coast Eyre Peninsula (33°43'S, 134°30'E); collected T. Castle, 6 March 1968, 5 spirit specimens; deposited: SAM D 17089.

Port Lincoln, Eyre Peninsula (34°44'S, 135°52'E) west side Spalding Cove; collected by B. J. Smith, 5 November 1969; NMV series spirit specimens.

Bothriembryon barretti Iredale, 1930

Wilson Bluff, Nullarbor Plain (31°40'S, 129°06'E); collected by T. A. Darragh, March 1969, deposited: NMV series spirit specimens.

Eyre Highway 44 miles east of SA-WA border (30°35'S, 129°20'E); collected by T. A. Darragh, 9 November 1973; deposited: NMV series spirit specimens.

Bothriembryon melo (Quoy & Gaimard, 1832)

Near Albany Western Australia (35°02'S, 117°43'E); 6 animals collected by G. W. Kendrick, 22 January 1972: author's collection courtesy S. Slack-Smith.

Bothriembryon bulla (Menke, 1843)

Clarence, Western Australia (and other localities); 8 specimens collected by G. W. Kendrick, 15 May 1971: T. M. Dartnall collection.

Bothriembryon glauerti Iredale, 1939

Bluff Knoll, Stirling Range north from Albany; 6 specimens collected by B. R. Wilson, 28 May 1971: T. M. Dartnall collection.

Bothriembryon indutus (Menke, 1843)

Walyunga National Park, Darling Range; 4 specimens: T. M. Dartnall collection.

Bothriembryon serpentinus Iredale, 1939

Bickley, Darling Range; 7 specimens collected by G. W. Kendrick, 10 July 1971: T. M. Dartnall collection.

Bothriembryon sayi (Pfeiffer, 1847)

Kudadup 200 m south of Jewel and Moondyne Caves, 8 km north of Augusta; collected by Anne Paterson, 6 July 1971; 6 specimens: T. M. Dartnall collection.

Bothriembryon leeuwinensis (Smith, 1894)

Kudadup near Jewel and Moondyne Caves, 8 km north of Augusta; collected by Anne Paterson, 6 July 1971: 6 specimens: T. M. Dartnall collection.

Bothriembryon kendricki Hill, Johnson and Merrifield, 1983

Booragoon west side of Blue Gum Swamp; collected by G. W. Kendrick, 13 June 1971; several specimens in T. M. Dartnall collection.

Bothriembryon kingii (Gray, 1825)

East of Wilson Inlet (35°00'S, 117°28'E); collected by R. C. Kershaw, 12 May 1978; 3 live and many dead specimens: QVM.

Bothriembryon tasmanicus (Pfeiffer, 1853)

Maria Island (42°38'S, 148°05'E); collected by R. H. Green, 1 May 1969: QVM.

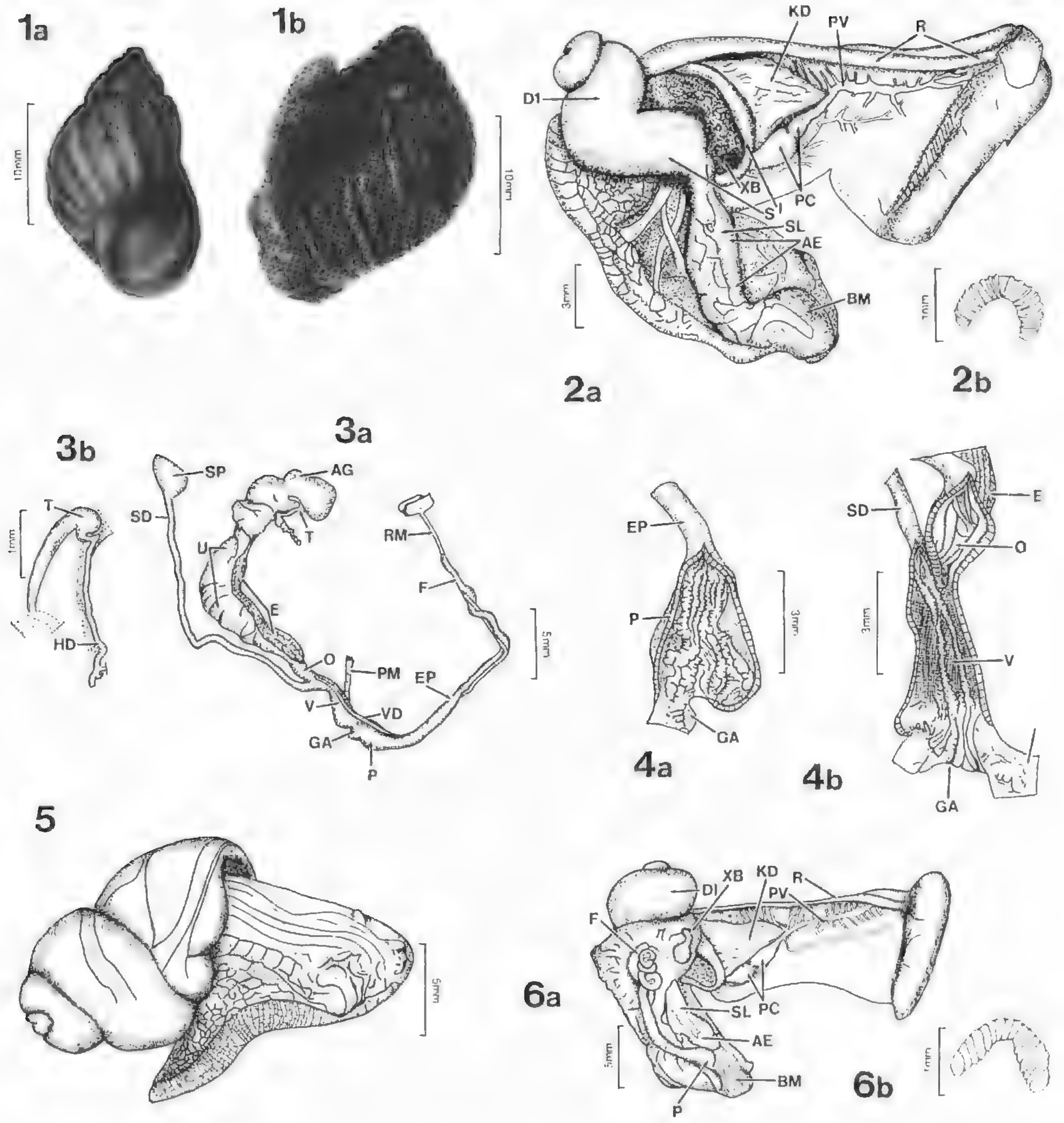
Cooks Beach (42°13'S, 148°18'E); collected by B. Moore, 27 May 1971: TM E 8914.

All dissections were done by the author using a Zeiss dissecting microscope and a Wild dissecting microscope with drawing arm. The drawings and photographs are by the author. Scanning electron micrographs were done by Dr Alan Solem (FMNH). The specimens selected from the listed collections, were coated with a 150 Angstrom units gold coating in a sputter coater and then studied with a Cambridge SR-10 stereoscan microscope. These specimens are stored as follows: St Francis I. and Venus Bay: QVM; Maria I.: QVM; Bicheno: TM E 13642; Near Eagle Hawk Neck: NMV.

The dissection data are presented on a species and locality basis within South Australia by comparison with *B. mastersi* from St Francis I. and between all other species and the South Australian species using the St Francis I. morph as the basic concept.

OBSERVATIONS

While the distribution of *B. mastersi* (Cox) is confined within South Australia that of *B. barretti* Iredale extends into Western Australia on the Nullarbor Plain. Both South Australian species have an elongate pallial structure (Figs 2, 6, 11, 17) which does not differ significantly from the generic features as described by Breure (1979). Each species has a pale orange jaw with 16 transverse ribs usually of darker orange colour (Figs 2, 17). Apart from gross size differences there are no important external body features requiring comment in this paper.



FIGS. 1-6. *Bothriembryon mastersi* (Cox, 1867); 1, shell: (a) St Francis Island (natural size 21 mm), (b) Venus Bay (natural size 17 mm); 2. St Francis Island, (a) pallial anatomy, (b) jaw; 3, St Francis Island, (a) whole genitalia, (b) detail of talon; 4, St Francis Island, (a) view of lower female tract, (b) internal view of penis; 5, Venus Bay, animal; 6, Venus Bay, (a) pallial anatomy, (b) jaw.

Bothriembryon mastersi (Cox, 1867)

Shell (Figs 1, 9)

Measurements of many specimens failed to reveal more than minor racial differences in the adult from the several localities. The sculpture and superficial appearance is as describd by Cox (1867) and Iredale (1937). The dimensions of shells from the dissected animals are presented in Table 1.

Protoconch (Figs 24a, b)

The sculpture is usually described as pitted or pit-reticulate. The optical microscope suggests ridges crossing obliquely. Anastomosing results in some irregularity of the pattern. Shells from Port Lincoln, Elliston, Wallanippie, Fowlers Bay, Streaky Bay, Venus Bay and St Francis I. provided minor differences. In some cases the basic wrinkled pattern as seen in *B. tasmanicus* can be seen near sutures.

Genital Anatomy

St Francis Island Material (Figs 3, 4).

Hermaphroditic duct thin, coiled, cream in colour, expanded slightly before entering the talon laterally.

Talon (Fig. 3b) 0.5 mm long, 0.3 mm wide, resting on albumen gland surface, then descending into albumen anteriorly to join with albumen gland duct and enter uterine passage. Albumen gland pale orange, ca 7 mm long. Spermoviduct with uterus translucent greyish amber in colour, prostate cream coloured slightly brownish near free oviduct. Latter short, 1.5 mm long, inflated, internally with wide fleshy ridges entering uterus. Vagina (Fig. 4a), ca 6 mm long, internally with broad low ridges just above atrium, apically becoming low rounded ridges crossed by transverse lines of pustules which continue as thin raised ridges into bursa duct. Free oviduct opening into bursa-vaginal channel is small and laterally oriented. Bursa duct ca 22 mm long, the bursa copulatrix 3×2 mm, somewhat globular, elongated and embedded above pallial apex next to albumen gland, kidney and digestive gland lobes.

Prostate narrowing to form thin, white tube of vas deferens (Fig. 3a) which emerges from free oviduct to vagina surface to atrial region then ascending partly free of penis to epiphallus to enter at base of flagellum. Latter short with a speckled grey surface. Chamber of penis (Fig. 4b) with 5 high subrounded folded longitudinal ridges modified into epiphallus. Atrium narrow with relatively very small lobes.

Dimensions and relative sizes presented in Table 2.

Venus Bay Material (Figs 5, 7, 8).

Apparently at a similar stage of maturity the anatomy closely resembles St Francis I. animal. Talon larger, 0.5 mm long, 0.5 mm wide, albumen gland less developed, 6.5 mm long of deep cream colour, uterus translucent pale yellowish cream. Free oviduct longer, 2.2 mm, vagina shorter, 4.5 mm. Internally the latter (Fig. 8a) has fine tightly folded ridges passing into bursa duct. Similar oblique lines of raised pustules are present.

Elongate globular bursa copulatrix appressed to uterine lobes (Fig. 6a) adjacent dorsal crop surface, not embedded as in the St Francis I. animal. This is the only instance observed of this nature in South or Western Australian animals and the degree of incidence or relationship to maturity is not known. The bursa duct coils through the uterine lobes normally.

The penial chamber (Fig. 8a) has 7 broad tightly folded longitudinal ridges abruptly very thin with epiphallus. Vas deferens appressed to penis-epiphallus throughout.

Dimensions and relative sizes presented in Table 2. The complexly folded distinctly everted atrium has two large white lobes visible (Fig. 8b).

Flinders Island Material (Figs 14, 15).

A more mature larger animal (Fig. 14) with some differences (Table 2). Talon (Fig. 15b) large, 0.9 mm long, 0.6 mm wide, albumen gland ca 6 mm long greyish in colour, uterus translucent greyish but prostate as in St Francis I. animal. Free oviduct short, 1.5 mm with internal fleshy ridges, vagina short, 3 mm, with internal folds entering bursa duct as very fine close pustulose ridges. Bursa duct and bursa copulatrix as in St Francis I. animal.

TABLE 1. DIMENSIONS OF MALE AND FEMALE GENITALIA OF DISSECTED SPECIES (MEASUREMENTS OF MALE ORGANS AND SPERMOVIDUCT IN MM, PROPORTIONS OF FEMALE ORGANS EXPRESSED AS PERCENTAGE OF SPERMOVIDUCT).

Species	Male genitalia			Female genitalia			
	P	EP length	F	SO length	SD %	O %	V %
B. mastersi							
St Francis I.	3.0	20.0	3.5	24.5	90	6	24.5
Venus Bay	2.5	15.0	3.0	26.5	79	8	17.0
Flinders I.	2.5	10.5	4.5	31.5	70	5	9.5
Port Lincoln	2.5	14.0	3.0	21.0	81	12	15.0
B. barretti							
Wilson Bluff	10.0	14.0	9.0	28.0	128	11	12.5
Eyre Highway	8.0	13.0	7.0	31.0	123	13.5	10.0
B. melo	3.0	22.0	3.5	23.0	139	15	15.0
B. bulla	6.0	26.8	3.2	22.0	191	14	9.0
B. glauerti	6.0	28.0	16.0	30.0	180	7	13.0
B. indutus	3.5	18.5	10.0	32.5	111	9	5.0
B. serpentinus	4.0	16.0	11.0	23.0	61	9	6.5
B. sayi	2.0	8.0	8.0	22.0	82	7	7.0
B. leeuwinensis	6.0	27.0	10.0	42.0	100	6	5.0
B. kingii	10.0	17.5	4.5	31.5	83	11	13.0
B. tasmanicus							
Maria I.	5.0	19.0	6.5	19.0	53	8	13.0
Cooks Beach	5.0	26.5	9.0	21.0	81	14	10.0

Penis chamber ornament of broad flatly convex ridges variably folded similar to Venus Bay animal. The somewhat longer flagellum is normally very tightly coiled. Dimensions in Table 2.

Port Lincoln Material (Figs 12, 13).

Animal of similar size and maturity to St Francis I. specimen. Talon (Fig. 12b) 0.5 mm long, 0.4 mm wide, coloured pale cream, albumen gland 6 mm long, uterus translucent off white, free oviduct longer, 2.5 mm, than in the other animals but only 1.7 mm fleshy inflated.

Vagina, 3.2 mm, short as in Flinders I. animal, the internal pustulose ornament (Fig. 13) passing into the bursa duct which, at 17 mm length, is relatively longer than in the other animals.

Penial chamber ornament (Fig. 13) high rounded tightly folded ridges resembling the St Francis I. specimen.

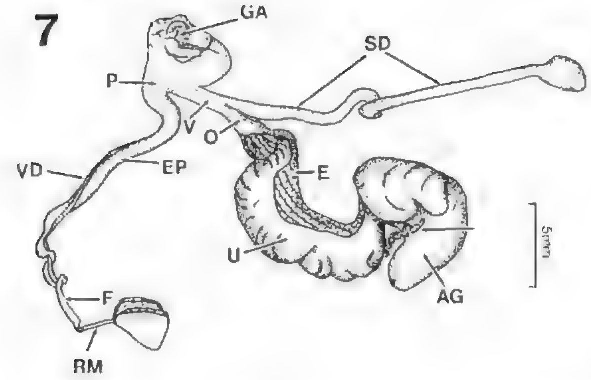
Dimensions and relative sizes presented in Table 2.

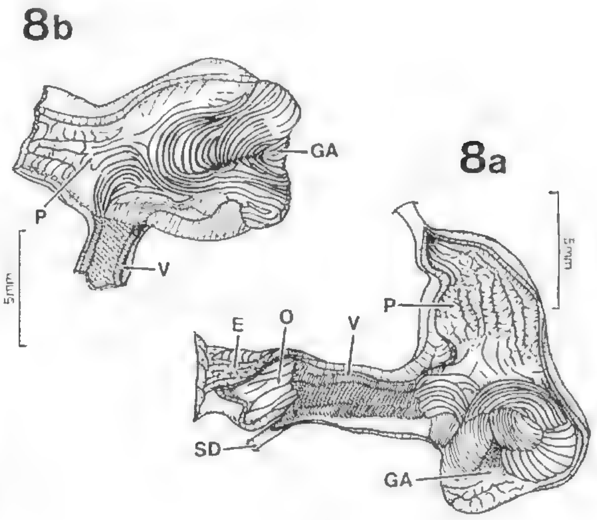
Bothriembryon barretti Iredale, 1930

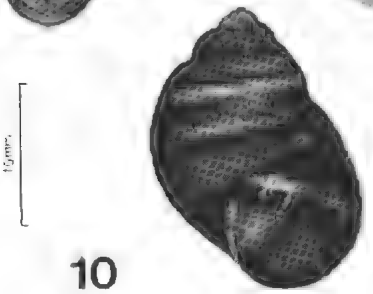
Shell (Fig. 16)

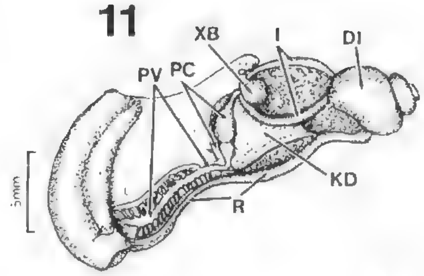
This is a large species with a distribution on the Nullarbor Plain just west of Fowlers Bay in South Australia, possibly as far as Balladonia in Western Australia, 360 km from Eucla and Wilson Bluff at the border. The young shell has a very thin very pale brown epidermis usually lost in the adult. Descriptions are provided by Iredale (1930, 1937, 1939).

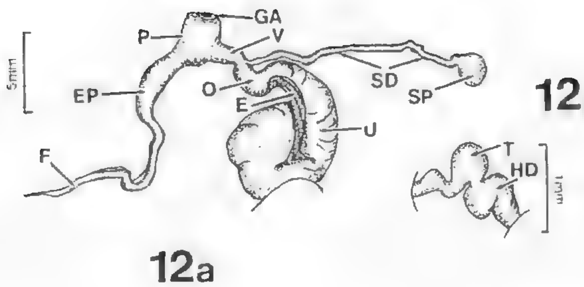
The "fossil" specimen (Fig. 16b) collected by Miss Gowlett on St Francis I. appears to be very similar to

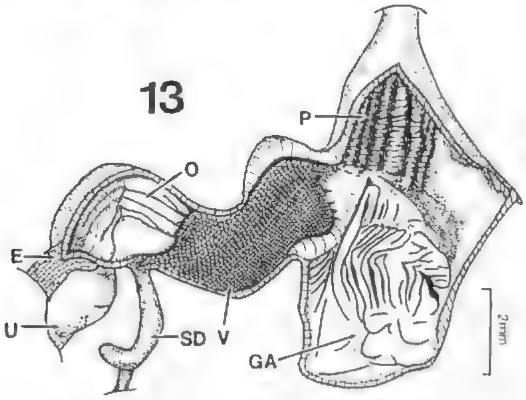












FIGS. 7-9. *Bothriembryon mastersi* (Cox, 1867); 7, Venus Bay, whole genitalia; 8, Venus Bay, (a) internal view of terminal genitalia, (b) atrial complex, detail of folding; 9, Port Lincoln, shell (natural size 16 mm).

FIG. 10. *Bothriembryon angasianus* (Pfeiffer, 1864), Port Lincoln; shell (natural size 21 mm).

FIGS. 11-13. *Bothriembryon mastersi* (Cox, 1867), Port Lincoln; 11, pallial anatomy; 12, (a) terminal genitalia, (b) detail of talon; 13, internal view of terminal genitalia.

this species, the aperture proportions being almost identical with the holotype figure (Iredale 1930). The age of the specimen is unknown. Its appearance suggests early Recent (subfossil?) or possibly Late Pleistocene age. If correctly identified the range of the species formerly extended further east than is now apparent. The dimensions of this specimen and the shells of dissected animals are presented in Table 1.

Protoconch

The optical microscope reveals radial oblique ridges crossed by vertical or oblique ridges resulting in somewhat squared pits. Descriptions (Iredale 1930) refer to pits not distinguished notably from *B. mastersi* (Cox).

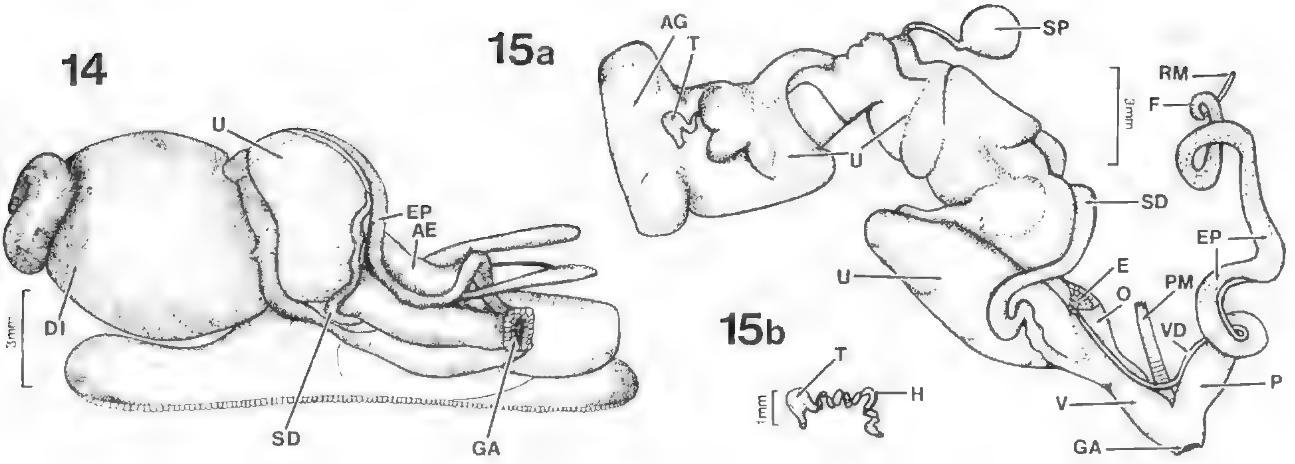
Genital Anatomy

Wilson Bluff Material (Figs 18, 19).

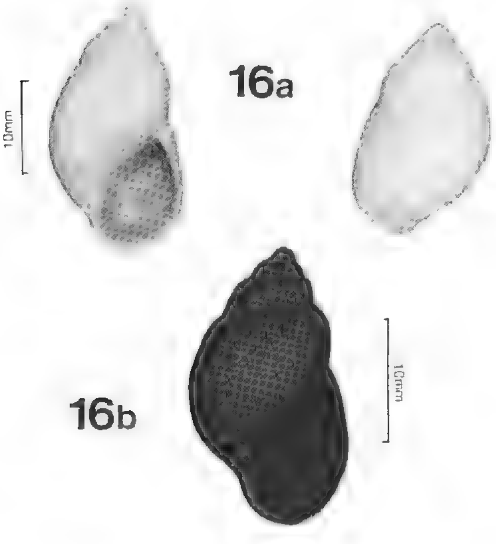
Talon (Fig. 18b) somewhat elongate, 0.7 mm long, 0.4 mm wide, the elongate cream-coloured albumen gland ca 12 mm long, uterus translucent off-white, prostate cream. Free oviduct short, 3 mm, with internal swollen fleshy ridges through half the length, vagina

14

15a



16a



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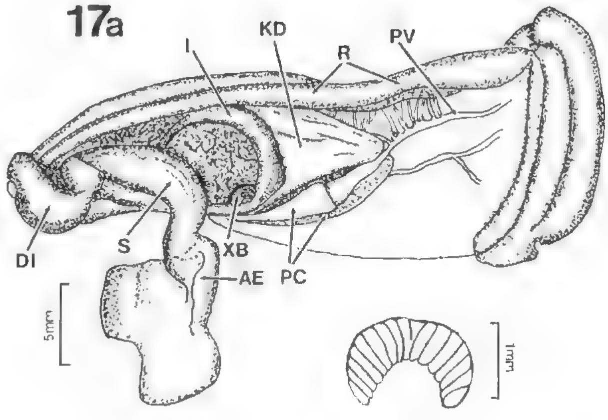

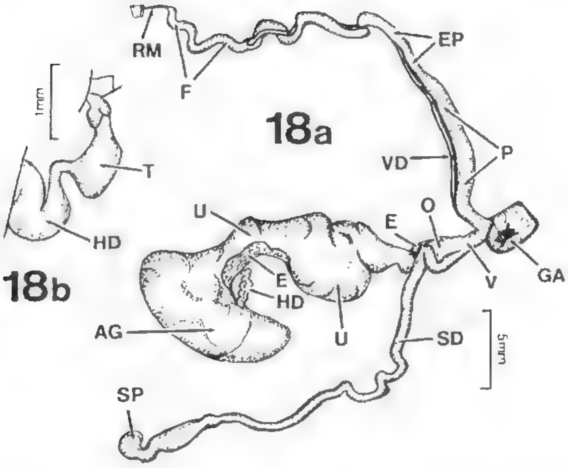

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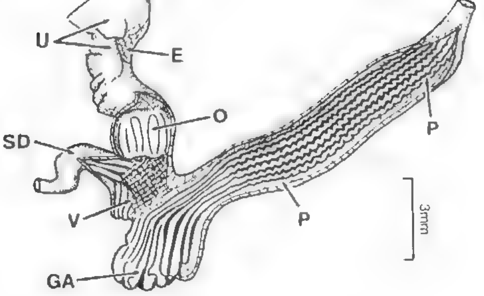


FIGS. 14-15. *Bothriembryon mastersi* (Cox, 1867), Flinders Island; 14, animal showing genitalia *in situ*; 15, (a) whole genitalia, (b) detail of talon.

FIG. 16. *Bothriembryon barretti* Iredale, 1930; (a) Wilson Bluff near Eucla (natural size 30 mm), (b) St Francis Island "fossil" (natural size 29.6 mm).

FIGS. 17-19. *Bothriembryon barretti* Iredale, 1930 Wilson Bluff; 17, (a) pallial anatomy, (b) jaw; 18, (a) whole genitalia, (b) detail of talon; 19, internal view of terminal genitalia.

(Fig. 19) slightly longer, 3.5 mm, with usual raised pustular ornament together with fine ridges entering bursa duct.

The bursa copulatrix is embedded above the pallial apex as in *B. mastersi* from St Francis I. (Fig. 2a) and Port Lincoln (Fig. 11) but the bursa duct is longer, 36 mm, not shorter than the spermoviduct.

Penis (Fig. 18a) very long, almost as long as epiphallus without a clear junction. The clearly constricted region (Fig. 19) between the atrium and penis, much more evident than in *B. mastersi*, is internally lined with thin folds. Penial chamber (Fig. 19) ornament bold rounded raised weakly folded ridges become thinner within epiphallus. The vas deferens emerges from free oviduct wall rather than at vagina junction as in *B. mastersi*, and is then appressed through to flagellum base. Flagellum, 9 mm, proportionately much longer than in *B. mastersi* (Table 2).

Eyre Highway Material (Figs 20, 21).

Talon (Fig. 20b) rounded, 0.6 mm long, 0.6 mm wide, with relatively short hermaphrodite duct entering 3 mm from apex, the narrowed exit duct passing deeply into pale cream-coloured 7.5 mm long albumen gland. Spermoviduct closely resembling Wilson Bluff animal but free oviduct shorter, 3 mm, vagina longer. Vas deferens (Fig. 21) within free oviduct narrows from prostate to form a ridge continuous with one of fleshy free oviduct ridges. Vagina (Fig. 21) internal pustular ornament is very close packed and becomes elongate entering the bursa duct. The latter, 34 mm long, is not coiled within the uterine lobes in the usual manner.

The penis-epiphallus dimensions are shorter than the Wilson Bluff animal but the proportions are similar.

Dimensions and relative sizes in both these animals are presented in Table 2.

Bothriembryon melo (Quoy & Gaimard, 1832)

Shell

This shell is clearly described by Kendrick & Wilson (1975) and no additional comment is needed. The genital anatomy is described on a comparative basis with dimensional data of this and other Western Australian species tabulated (Table 2).

Genital Anatomy (Figs 22, 23).

This specimen is considered representative of the several dissections made. Talon, 0.6 mm long, 0.5 mm wide, differs in appearance from *B. mastersi* with hermaphrodite duct entering relatively basally. Albumen gland short, ca 5 mm, cream-coloured, uterus very pale translucent greyish white, prostate very pale cream, free oviduct (Fig. 23), at 3.5 mm to 4.5 mm in length, relatively long with small fleshy ridges lining most of the chamber internally. Vagina (Fig. 23), 3.5 mm, short compared to St Francis I. *B. mastersi* but longer than some Western Australian species. The internal ornament of oblique irregular low elongate pustular lines becoming fine ridges in bursa duct, resembles *B. mastersi*.

Bursa duct (Fig. 22) much longer than spermoviduct but globular bursa copulatrix embedded exactly as in *B. mastersi* from St Francis I. (Fig. 2a) and Port Lincoln (Fig. 11).

Penis (Fig. 22) short, its chamber (Fig. 23) lined with about 6 close rounded folded ridges reducing in number and size within relatively long epiphallus. Vas deferens (Fig. 22) free from vagina surface in part and penis, becomes appressed at epiphallus. Penial complex proportions resemble those of *B. mastersi* but the oviduct and bursa duct are similar to *B. barretti* (Table 2).

The most significant feature noted in the other Western Australian species dissected is that the bursa duct length varies from 61% (*B. serpentinus*) to 191% (*B. bulla*) of the spermoviduct (Table 2).

Breure has figured the genitalia of *B. indutus* (Menke) (Darling Range) (1978a, Fig. 5; 1978b, Fig. 346), *B. glauerti* Iredale (Darling Range) (1978b, Fig. 345) and *B. onslowi* (Cox) (Shark Bay) (1978b, Fig. 350).

Bothriembryon tasmanicus (Pfeiffer, 1853)

Shell

Complete animal and shell descriptions will be presented elsewhere (Kershaw, unpublished). Selected dimensions are presented in Table 1.

Protoconch (Figs 24e-f).

The optical microscope reveals oblique wrinkles as noted by Breure (1979). Spiral lines were reported by Breure (1979, p. 95) but not by Pilsbry (1900, pl. 4). These spiral lines have not been detected in very many examples studied and their absence is supported by the micrographs figured. It is suggested that the spiral increment observed is due to the spirals observed in the adult sometimes having a visible origin usually low on the last protoconch whorl.

Genital Anatomy

The spermoviduct (Breure 1978a, Fig. 6; 1978b, Fig. 351) is broadly similar to the South Australian and Western Australian species. The essential differences are seen in the internal free oviduct and vagina ornament with fleshy glandular development greatly reduced in *B. tasmanicus*. The vagina has no pustular ornament and that of the free oviduct is distinct. The bursa duct is shorter than various Western Australian species and *B. barretti*, but it is not shorter than that of *B. mastersi* nor that of *B. serpentinus* (Table 2).

In Tasmania the range in length expressed as a proportion of spermoviduct length of 40% to 100%, can also include *B. sayi* and *B. kingii*. These data were unknown to Breure (1979) whose Tasmanian material

TABLE 2. SHELL MEASUREMENTS (MM) OF SOUTH AUSTRALIAN AND TASMANIAN SPECIES

Species	Whorl Number	Height	Diameter	Aperture Height
B. mastersi (Cox)				
St Francis I.				
dissected sp.	4.75	15.2	11.3	10.1
largest seen	5.375	21.0	13.9	11.8
Venus Bay	4.75	16.8	12.1	10.1
Flinders I.	5.0	20.0	12.5	10.0
Port Lincoln	4.875	16.0	10.0	9.2
B. barretti Iredale				
Wilson Bluff				
dissected sp.	5.875	29.0	15.0	14.3
largest seen	6.00	31.2	16.8	16.0
Eyre Highway	5.75	24.1	14.4	14.2
St Francis I.				
fossil sp.	5.5	29.6	16.9	15.9
B. tasmanicus (Pfeiffer)				
Maria I.	4.75	22.4	13.7	14.1
Cooks Beach	4.75	21.0	12.5	13.0

came from Coles Bay. Six specimens from this locality have a mean of 53% of spermoviduct length.

The significant distinguishing feature of the female genitalia and spermoviduct is that the bursa copulatrix is always appressed to the uterus adjacent the base of the albumen gland. It is never embedded above the pallial apex as in the southern and Western Australian species. Only the one specimen from Venus Bay has any resemblance.

Compared with *B. melo* and *B. mastersi* the penis is longer and the internal penial ornament is not folded. The flagellum is longer than in those species but is comparable with *B. barretti* and other species (Table 2).

B. tasmanicus has a rounded pallial region compared with the elongate western forms. The shallow atrium has no constriction preceding the penial lumen. The species does form a very distinct entity but the features suggest a long period of isolation rather than consistent subgeneric features. Of the features used by Breure to define *Tasmanembryon* only the radula may be consistent.

DISCUSSION

The basic data on variation in the material studied are summarized in Table 1. Shell dimensions of the South Australian species are given in Table 2. The dimension of the largest specimen seen in each species is also given for comparison. From these data it can be seen that the shell of *B. mastersi* compare in size to *B. tasmanicus* but the aperture of the latter is nearer to *B. barretti*. Despite differences in shell height, however, there is surprising similarity in spermoviduct length. The most obvious differences are in the proportionate lengths of the bursa duct and secondly in the penial complex.

Genital Anatomy

B. barretti and *B. kingii* both have a much enlarged penis but the flagellum differs. *B. mastersi*, *B. melo*, *B. indutus*, *B. serpentinus* and *B. sayi* all have a small penis but the flagellum in the first two is rather short such as that found in *B. bulla*. *B. tasmanicus* and others tend to be intermediate. The bursa duct is significantly longer than other species in *B. barretti*, *B. melo*, *B. bulla* and *B. glauerti*.

The South Australian *B. mastersi* from the localities studied, has a duct length (mean of 80%) that is intermediate between the long ducts (mean 118%) of several Western Australian species (see also Breure 1978b, pp. 203-209; 1979, pp. 92-96) and the duct of *B. tasmanicus* (mean 63%). The length of the duct in the latter species varies considerably (Kershaw, unpublished) the range in different morphs as already noted being inclusive of that noted for *B. mastersi* and other species.

The South Australian *B. mastersi* is thus not strongly differentiated from the Western Australian species with which it shows clear affinity but could be part of a clinal gradient across southern Australia. More species need study to allow further evaluation of this theme; but the similarities observed in *B. tasmanicus* together with the relative dimensions given appear to support the concept.

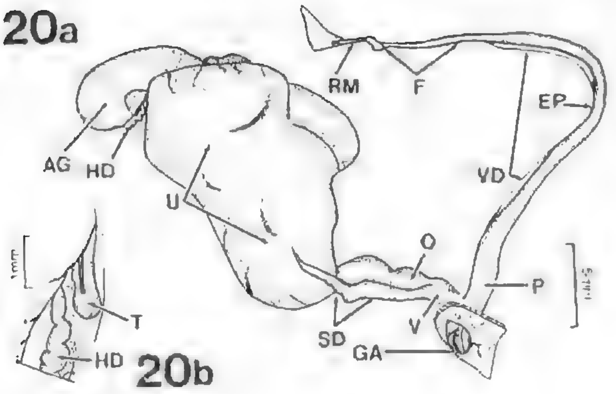
Protoconch

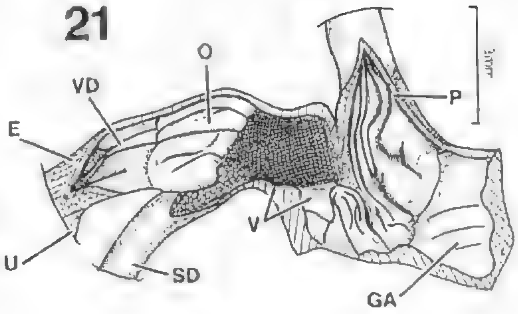
Few scanning electron micrographs have been published of bulimulid species. Breure (1978a, 1979, Pls 1-3) has provided several including *B. tasmanicus* and *B. onslowi* (Cox). He does not include micrographs of other genera he considers related to *Bothriembryon* nor does he expand on his data other than to separate *Tasmanembryon* from *Bothriembryon*. Since the structural details are complex, subject to change because of surface wear, and difficult to illustrate optically, more detailed study is desirable.

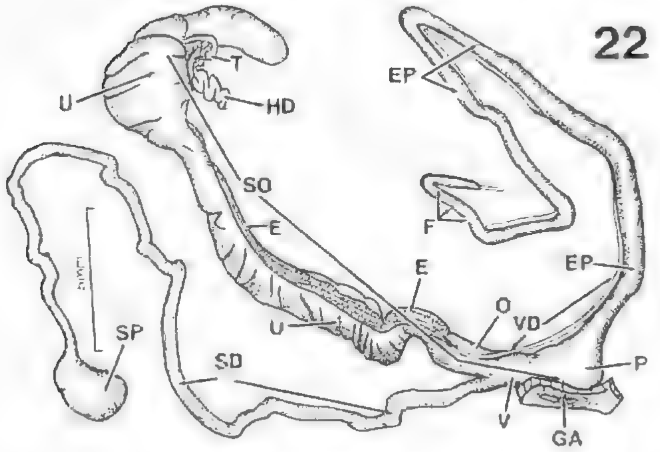
The photographs presented here of *Bothriembryon mastersi* and *B. tasmanicus* are the first to enable comparison both on a species and locality basis (Figs 24a-f) together with some different parts of the protoconch. Breure's (1979, Pl. 2) very useful work illustrated only part of one specimen of each of *B. tasmanicus* and *B. onslowi*.

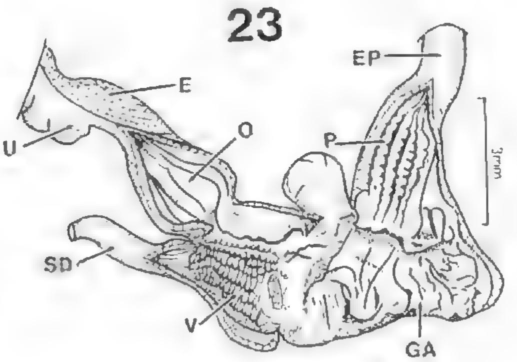
The specimen of *B. mastersi* from Venus Bay is unworn, with both apical and post apical sculpture well defined (Fig. 24a). Note that the radial ribs on the apex are mostly continuous, with only a few anastomosing, or are interrupted along their length. In the worn specimen from St Francis Island (Fig. 24b) note that the apical sculpture is absent just above the periphery and the lower part of the first whorl has the sculpture worn down into minute "pits", although the typical sculpture can be seen on the right margin of the photograph. The post-apical sculpture is similarly degraded in comparison with that of Venus Bay specimen (Fig. 24a).

The specimen from Maria Island (Figs 24c, d), the probable type locality of *B. tasmanicus*, is unworn. The apical sculpture consists of generally continuous radial ribs with some anastomosing (Fig. 24d) at the sutures, while the post-apical sculpture is relatively inconspicuous on the upper spire. Another unworn specimen









FIGS. 20-21. *Bothriembryon barretti* Iredale, 1930 Eyre Highway; 20, (a) whole genitalia, (b) detail of talon; 21, internal view of terminal genitalia.

FIGS. 22-23. *Bothriembryon melo* (Quoy & Gaimard, 1832) Albany; 22, whole genitalia; 23, internal view of terminal genitalia.

from Bicheno (Fig. 24e) shows interruptions in the apical radials, more frequent anastomosing, and much more prominent early spire sculpture. A worn example from just north of Eagle Hawk Neck, south-eastern Tasmania, shows increased irregularity of the apical radials and more interruptions (Fig. 24f).

None of the Tasmanian specimens examined with the SEM show the spiral sculpture as claimed by Breure (1979, p. 92). It is possible that the points of irregularity visible (Figs 24e, f) in these specimens could be misinterpreted as spiral lines during optical viewing. The effect is noticeable above the suture in the Bicheno specimen (Fig. 24e). But Breure's figure of *B. tasmanicus*, presumably from Coles Bay, does show some trace of spiral joining of irregularity points on the lower part of the whorl (1979, pl. 2, Fig. 4). The possibility that adult spirals sometimes develop in the lower protoconch and sometimes do not has been suggested in comment on the species above.

In addition the illustration of *B. onslowi* (Breure 1979, Pl. 2, Fig. 3) shows traces of the irregular radials near the suture seen in some South Australian specimens. The apical sculpture is otherwise as seen in the western species.

Since the dissections reported on above show an apparent clinal variation in proportionate bursa duct length, and the SEM photographs of South Australian and Tasmanian species of *Bothriembryon* illustrate apical shell sculpture composed of the same basic elements rather than distinctive elements, the evidence does not support subgeneric distinction. Thus Breure's (1979) suggestion of subgeneric status for *Tasmanembryon* Iredale, 1933 requires further evidence if it is to be supported. The present evidence suggests that only one generic unit, *Bothriembryon* Pilsbry, 1894, is recognizable for the Australian Bulimulidae.

ACKNOWLEDGMENTS

This report was made possible by the provision of specimens from St Francis Island and Venus Bay for which gratitude is due to Miss K. Gowlett and Messrs N. J. C. Holmes and R. Brown. Gratitude is also due for specimens and loan of collections which contributed to the full study. Mrs Shirley Slack-Smith provided specimens of *B. melo* collected by Mr G. Kendrick and Mr Wolfgang Zeidler (South Australian Museum) loaned specimens from Flinders Island. Collections studied were provided by Dr B. J. Smith (Museum of Victoria), Miss Alison Green and Mrs E. Turner (Tasmanian Museum), Messrs C. B. Tassell and R. H. Green (Queen Victoria Museum). Dr A. J. and

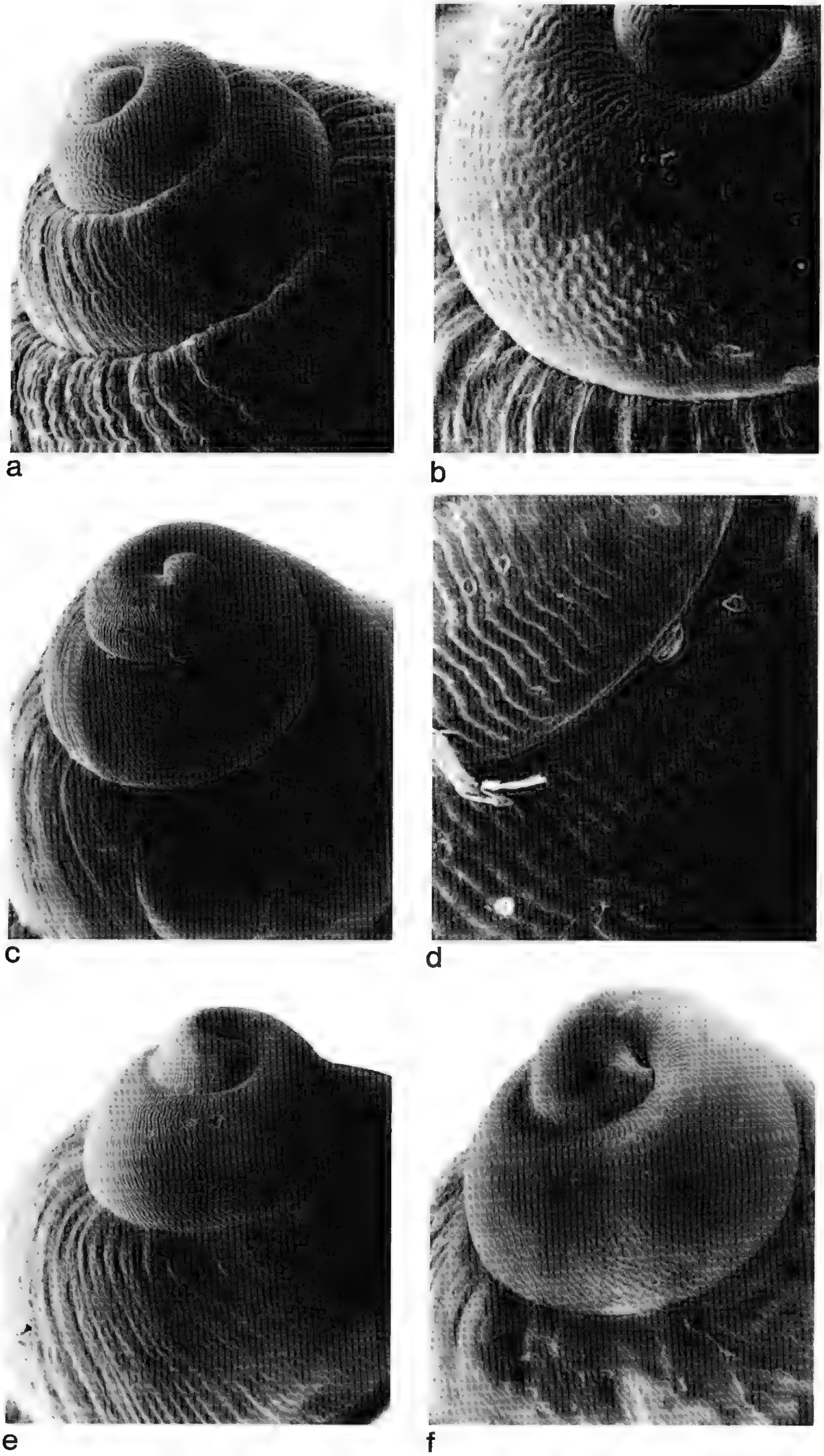


FIG. 24. Scanning electron micrographs of *Bothriembryon* apical sculpture. (a) *B. mastersi*, Venus Bay, whole apex × 15.7; (b) *B. mastersi*, St Francis Island, worn sculpture × 48.8; (c) *B. tasmanicus*, Maria Island, whole apex × 17.4; (d) *B. tasmanicus*, Maria Island, whole first stage × 88.5; (e) *B. tasmanicus*, Bicheno, whole apex × 18.1; (f) *B. tasmanicus*, near Eagle Hawk Neck, whole apex × 20.1.

Mrs J. A. Dartnall kindly made available material, drawings and manuscripts through the courtesy of the Tasmanian Museum.

Dr Alan Solem (Field Museum of Natural History, Chicago) made the SEM photographs used and provided very valuable discussion on the results. He also made valuable comments on earlier drafts of this manuscript and suggested an outline for the present approach. Dr Brian Smith provided many suggestions and discussion during the study and commented on the manuscript. Gratitude is due to reviewers for encouragement and some useful comment on presentation. The Science and Industry Endowment Fund has provided equipment and support critical to the success of my research for which gratitude is expressed to the Trustees.

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ADDENDUM

Since the above text was written Ludbrook (1984: pp. 301-302, Fig. 82) ("Quaternary Molluscs of South Australia". Department of Mines and Energy, South Australia, Handbook No. 9) has described and figured fossil *Bothriembryon barretti barretti* Iredale from the Semaphore Sand Formation and the Upper Member Bridgewater Formation. The St Francis Island specimen resembles her Figure 82a and b in form and boldness of sculpture, but appears to be an older specimen.

THE EPHEMEROPTERA (MAYFLIES) OF SOUTH AUSTRALIA

BY P. J. SUTER

Summary

In a study of the Ephemeroptera of South Australia, thirteen species have been recognised. All species have been described from both adult and nymphal material and keys enabling their identification are included. Five new species have been recognised, Atalophlebia auratus sp. nov., Nousia pilosa sp. nov., Ulmerophlebia pipinna sp. nov., Cloeon paradieniensis sp. nov., and Centroptilum elongatum sp. nov.; and one species transferred from each genus Atalophlebia and Atalonella to Nousia. (Nousia inconspicua (Eaton) comb. Nov. and Nousia fuscula Tinnyard comb. Nov.). The first associated nymphal descriptions of five previously described species Nousia inconspicua (Eaton), N. fuscula (Tillyard), Baetis soror Ulmer, Cloeon fluviatile Ulmer, and Tasmanocoenis tillyardi (Lestage) are also made. Two species have been redescribed from South Australian material; Atalophlebia australis (Walker), and A. australasica (Pictet) and one species of Tasmanophlebia is described but not formally named.

THE EPHEMEROPTERA (MAYFLIES) OF SOUTH AUSTRALIA

by

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(Manuscript accepted 2 July 1985)

ABSTRACT

SUTER, P. J. 1986. The Ephemeroptera (Mayflies) of South Australia. *Rec. S. Aust. Mus.* 19(17): 339-397.

In a study of the Ephemeroptera of South Australia, thirteen species have been recognised. All species have been described from both adult and nymphal material and keys enabling their identification are included. Five new species have been recognised, *Atalophlebia auratus* sp. nov., *Nousia pilosa* sp. nov., *Ulmerophlebia pipinna* sp. nov., *Cloeon paradieniensis* sp. nov., and *Centroptilum elongatum* sp. nov.; and one species transferred from each genus *Atalophlebia* and *Atalonella* to *Nousia*, (*Nousia inconspicua* (Eaton) comb. nov. and *Nousia fuscula* Tillyard comb. nov.). The first associated nymphal descriptions of five previously described species *Nousia inconspicua* (Eaton), *N. fuscula* (Tillyard), *Baetis soror* Ulmer, *Cloeon fluviatile* Ulmer, and *Tasmanocoenis tillyardi* (Lestage) are also made. Two species have been redescribed from South Australian material; *Atalophlebia australis* (Walker), and *A. australasica* (Pictet) and one species of *Tasmanophlebia* is described but not formally named.

INTRODUCTION

The first species of mayfly in South Australia was recorded by Eaton in 1871 when *Leptophlebia inconspicua* was described from Adelaide. In subsequent papers 1883-1888 Eaton placed this species into the new genus *Atalophlebia*. Since that date only two other records of the Ephemeroptera in South Australia have been made. Harker (1954) recorded *Atalophlebia australasica* from Tillyard's 1934 collection near Mount Gambier; and Timms (1974) recorded a "*Caenis sp.*" in Valley Lake, Mount Gambier, and L. Edward near Millicent. Both Williams (1968) and Rick (1970) acknowledge the presence of mayflies in South Australia, but neither mention any specific families or genera.

With the exception of the species described by Eaton (1871) the other records of Ephemeroptera are from the wet South East of South Australia. It appears that because South Australia is the driest State in Australia, the existence of freshwater in regions other than the South East had been ignored, leaving a large gap in our knowledge of Australian freshwater invertebrates, and zoogeographical relationships of these animals.

Preliminary collections from the Fleurieu Peninsula, the Mount Lofty Ranges and the Flinders Ranges showed that mayflies were abundant in all permanent freshwater streams, waterholes and in many dams and reservoirs. Further collections from the freshwater habitats in South Australia have led to the recognition of 13 species of Ephemeroptera, all but one of which have nymph and adult associations confirmed in the laboratory or in the field.

All 13 species have been described from both adult and nymphal material and keys to their identification are included. Five new species have been recognised, *Atalophlebia auratus*, *Nousia pilosa*, *Ulmerophlebia pipinna*, *Cloeon paradieniensis* and *Centroptilum elongatum*; one species transferred from each genus *Atalophlebia* and *Atalonella* to *Nousia* (*Nousia inconspicua* (Eaton) comb. nov. and *Nousia fuscula* (Tillyard) comb. nov.) and the first associated nymphal descriptions of five previously described species; *Nousia inconspicua* (Eaton), *N. fuscula* (Tillyard), *Baetis soror* Ulmer, *Cloeon fluviatile* Ulmer and *Tasmanocoenis tillyardi* (Lestage) made. Enlarged descriptions of *Atalophlebia australis* (Walker), and *A. australasica* (Pictet) are also given. A single species of *Tasmanophlebia* was also recorded and is described, but since a revision of the Siphlonuridae is being prepared by Dr I. C. Campbell material has been sent to him to include in his more detailed studies of this group.

MATERIALS AND METHODS

Collection of nymphs was by dip-net with mesh-pore size of 500 μm, or by hand of nymphs clinging to the under-surface of rocks or bark in streams. Adults were collected by beating the vegetation along river banks with an insect net, or by sweeping the net through a swarm. Specimens were preserved in 70% ethyl alcohol with 5% glycerol.

Specimens for study were dissected under a Wild M5 stereoscopic microscope, and the appendages (legs and wings of adults; legs, mouth-parts and gills in nymphs) were mounted on glass slides using "Euparal" or Polyvinyl lacto-phenol mounting media. The sterna, and nymphal abdominal terga, were prepared using the techniques of Tsui and Peters (1972, 1975), and the

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nymphal tentoria were studied by the methods given by Hudson (1951).

Genitalia and eggs were either mounted on slides or prepared for the Scanning Electron Microscope (S.E.M.) using critical-point drying which eliminated both shrinkage and distortion. They were then mounted and coated with Au/Pd and examined using an E.T.E.C. Autoscan with an operating voltage of 5, 10, or 20 KV.

Illustrations of wings and body colour-patterns were made using a Wild M3 or M5 stereoscopic microscope with an attached drawing head. Legs, mouthparts, gills and high magnification ($>100\times$) illustrations were drawn using a Wild compound microscope and camera lucida.

Wing venation terminology is based on Tillyard's (1932) scheme, and as illustrated in Figures 1a and 1b used by Peters & Edmunds (1964, 1970, 1972) and Edmunds, Jensen & Berner (1976). Each segment of the fore, middle and hind legs of the nymph and male imago is compared to the length of the femur, and is expressed as a ratio. The absolute length of the femur is given last in parenthesis.

In figures of the labium the method used by Peters & Edmunds (1964, 1970, 1972) is followed, with the ventral surface shown on the right hand side of the illustration, and the dorsal surface on the left. Comparative measurements of the segments of the labial palpi and maxillary palpi are expressed as ratios, compared with the proximal segment length, which is given in parenthesis. All measurements are given in millimetres.

KEYS TO THE SOUTH AUSTRALIAN EPHEMEROPTERA

The following keys will serve to distinguish the male imago and mature nymphs of the species of Ephemeroptera recorded in South Australia. Figures are included with each couplet to give illustrated examples of the key characters, although occasionally these are not required (e.g. "terminal filament present" as compared with "terminal filament absent").

The key to the imagos is primarily for male specimens because species identification of the female imagos is often very difficult as external morphological characteristics of the female show generic, rather than specific affinities. Only direct association with nymphs can allow accurate identification of females, using external characters. However, with the limited South Australian mayfly fauna, the females have also been included in the key and can be distinguished by external morphological characters in all genera with the exception of *Nousia*. The external characteristics are useful to distinguish this genus, but species separation is difficult without direct nymphal association, or a study of the morphology of fertilized eggs. Identification of subimagos is not as successful. Generic segregating characters are present in subimagos, and generic identification can be made using the imago key. For specific identification it is necessary to refer to the subimago characteristics listed in the description of each species.

KEY TO SOUTH AUSTRALIAN ADULT EPHEMEROPTERA

1a Hind wings comparatively large, about half as long as the fore wing (Figs 28a, b). Male penes long and tubular (Figs 30a, b) .... Siphlonuridae
Only one representative in South Australia: *Tasmanophlebia sp.*

1b Hind wings small or entirely absent 2

2a(1) Fore wings with many cross-veins; hind wings small, also with many cross-veins (Figs 1a, b; 3a, b; 5a, b; 8a, b; 10a, b; 12a, b, c; 17a, b) .... Leptophlebiidae 3

2b Fore wings with few cross-veins, clear open appearance, hind wings present or absent, if present reduced, with cross-veins few or absent (Figs 21a, b; 23a, b; 25a; 31a, g) 9

3a(2) Tarsal claws of each pair similar, elongate, slender, hooked distally (Figs 1g; 3g; 5h; 8g; 10g; 12f); fore wings $<3.5\times$ longer than wide (Figs 1a; 3a; 5a; 8a; 10a; 12a) 4

3b Tarsal claws of each pair dissimilar, one elongate, slender, hooked distally, one blunt with a distal tooth, club shaped (Fig. 17h); fore wings $>3.5\times$ longer than wide. Male genitalia (Figs 17c; 19a, b) .... *Ulmerophlebia*
Only one species in South Australia: *U. pipinna* sp. nov.

4a(3) Large species, body length $>$ 8 mm; fore wing 7-13 mm; Sc of hind wing reaches wing margin at 9/10 wing length (Figs 1b; 3b; 5b) ... *Atalophlebia* 5

4b Small species, body length $<$ 8 mm; fore wing 5-8.5 mm; Sc of hind wing reaches wing margin at 3/4 of wing length (Figs 8b; 10b; 12b) ...... *Nousia* 7

5a(4) Males and females with terminal filament; body colour yellow-brown (orange); female with ninth abdominal sternite deeply incised (Figs 1e; 5i) . 6

5b Males without terminal filament (present in females); body colour black. Male genitalia (Figs 3c, d; 7c, d); female with ninth abdominal sternite with shallow incision (Fig. 3e) ...... *Atalophlebia australasica*

6a(5) Fore wings with darker pterostigmatic region, cross-veins of costal and subcostal spaces shaded with black; hind wings and rest of fore wings hyaline (Fig. 1a, b); body yellow with black thorax. Apices of penes widely separated and divergent (Figs 1c, d; 7a, b) .... *A. australis*

6b Fore wings tinged entirely with yellow, pterostigmatic region darker than rest of wing; hind wing grey-brown, darker than fore wing (Fig. 5a, b). Apices of penes convergent (Figs 5c, d; 7e, f) .... *A. auratus* sp. nov.

7a(4) Two halves of penes distinctly separated forming a U-shape (Figs 10c, d; 15c, d); with a small triangular spine on inner margin (visible using transmitted light, Fig. 10c) .... *Nousia fuscula*

7b Two halves of penes held close together, without spine 8

8a(7) Penes with two ventral lobes near apex (Figs 8a; 15a, b) .... *N. inconspicua* comb. nov.

8b Penes without ventral lobes (Figs 12d, e; 15e, f) .... *N. pilosa* sp. nov.

9a(2) Males with turbinate eyes (females without dorsal compound eyes); marginal intercalaries short, developed between the ends of the main veins (Figs 21a; 23a; 25a, g); hind wings present or absent . . . . Baetidae 10

9b Males and females with small lateral eyes, dorsal compound eyes absent; no marginal intercalaries present (Fig. 31a); hind wings absent. Penes fused with apical indentation, forceps strongly bowed (Figs 30c; 31d) . . . . Caenidae
Only one species in South Australia: *Tasmanocoenis tillyardi*

10a(9) Hind wings present 11

10b Hind wings absent . . . . *Cloeon* 12

11a(10) Marginal intercalaries of fore wing paired (Fig. 21a). Male genitalia (Fig. 19c; 21d) . . . . *Baetis*
Only one species in South Australia: *B. soror*

11b Marginal intercalaries of fore wing single (Fig. 23a). Male genitalia (Figs 19d; 23d) . . . . . *Centroptilum*
Only one species in South Australia: *C. elongatum* sp. nov.

12a(10) Males with turbinate eyes, yellow; terminal segment of forceps triangular (Figs 19f; 25i); females with costal and subcostal spaces of wings shaded red/brown; body length > 7 mm . . . . *Cloeon paradieniensis* sp. nov.

12b Males with turbinate eyes, sepia; terminal segment of forceps small and globular (Figs 19e; 25d); females with costal and subcostal spaces of wings opaque, milky; body length < 5 mm . . . . *C. fluviatile*

KEY TO THE NYMPHS OF SOUTH AUSTRALIAN EPHEMEROPTERA

1a Head prognathous; tail filaments with whorls of setae at apex of each segment, body dorso-ventrally flattened. Families Leptophlebiidae; Caenidae . . 2

1b Head hypognathous; tail filaments fringed laterally with long fine setae, body usually cylindrical. Families Baetidae; Siphlonuridae 9

2a(1) Seven pairs of gills inserted laterally on abdomen, each gill consisting of a pair of lamellae 3

2b Six pairs of gills, 1st very small mono filament, 2nd enlarged to form an elytriform gill cover, remaining pairs bearing long tracheal filaments (Figs 32b, c, d) . . . . Caenidae: *Tasmanocoenis*
Only one species in South Australia: *T. tillyardi*.

3a(2) Gill base broad with one apical filament, lined with fine setae (Fig. 18c), legs and body covered with long fine setae (Fig. 20) . . . . *Ulmerophlebia*
Only one species in South Australia: *U. pipinna* sp. nov.

3b Gills lanceolate or linear, with one apical filament (Figs 9e; 11e; 13e), apex with multiple tracheal filaments (Figs 2c; 4c), body not covered with long fine setae 4

4a(3) Gills lanceolate or linear, not branched at apex into tracheal filaments (Figs 9e; 11e; 13e) . . *Nousia* 5

4b Gills broad at apex, with each lamella subdivided into tracheal filaments (Figs 2c; 4c) . *Atalophlebia* 7

5a(4) Gills lanceolate (Figs 9e; 13e); proximal segment of labial palpi narrow, 2 × longer than wide (Figs 9g; 13g) 6

5b Gills linear (Fig. 11e); proximal segment of labial palpi broad, 1.67 × longer than wide (Fig. 11g); prostheca of left mandible robust with serrated apex (Fig. 11i); dorsal abdominal markings irregular black and white (Fig. 14e) . . . . *N. fuscula*

6a(5) Dorsal abdominal marking with a broad median light stripe (Fig. 14d); labrum rectangular, 2 × wider than long (Fig. 9d); femora with few fine setae (Fig. 9a) . . . . *N. inconspicua* comb. nov.

6b Dorsal abdominal marking with narrow light regions on segments 4-10 (Fig. 14f); labrum almost square 1.5 × wider than long (Fig. 13d); femora lined with numerous long fine setae (Fig. 13a) . . . . *N. pilosa* sp. nov.

7a(4) Apex of gills with each lamella trifurcate (Fig. 2c) . . . . *Atalophlebia australis*

7b Apex of gills multifurcate with more than three tracheal filaments (Fig. 4c) 8

8a(7) Ninth abdominal segment with only one backward pointing spine (Fig. 14c); no dark markings on legs (Fig. 6a) . . . . *A. auratus* sp. nov.

8b Ninth abdominal segment with two backward pointing spines (Fig. 14b); femur and tibia with broad bands of black (Fig. 4a) . . . . *A. australasica*

9a(1) Four pairs of gills present, first pair elytriform, covering last three pairs. Postero-lateral margins of abdominal segments produced into backward pointing spines (Fig. 28g) . . . . Siphlonuridae: *Tasmanophlebia*
Only one species in South Australia: *Tasmanophlebia sp.*

9b Seven pairs of gills present, postero-lateral margins of abdominal segments not produced into backward pointing spines . . . . Baetidae 10

10a(9) Gill lamellae double on abdominal segments 1-6, single on 7th (Figs 26e; 27e); hind wing sheaths absent . . . . *Cloeon* 11

10b Gill lamellae single on abdominal segments 1-7 (Figs 21i; 24d); hind wing sheaths present 12

11a(10) Paraprocts with 27-30 spines (Fig. 27d); maxillary palpi with terminal spines on distal segment (Fig. 28f); without definite abdominal colour pattern . . . . *Cloeon paradieniensis* sp. nov.

11b Paraprocts with 17-22 spines (Fig. 26d); maxillary palpi without terminal spines on distal segment (Fig. 26i); abdominal pattern as in Fig. 26e . . . . *C. fluviatile*

12a(10) Labrum with deep median V-shaped concavity with a tooth on each side of the lateral margins of the concavity, near the apex (Fig. 24e); tarsal claws very long and slender (Fig. 24a) . . . . *Centroptilum elongatum* sp. nov.

12b Labrum rounded, with shallow U-shaped concavity (Fig. 21j); tarsal claw short (Fig. 21f) *Baetis soror*

FAMILY LEPTOPHLEBIIDAE

Peters and Edmunds (1964, 1970) recorded the systematic history of the family and listed characterizations based on Ethiopian and Eastern Hemisphere material.

GENUS *ATALOPHLEBIA* Eaton 1881

Burmeister, 1839: 800 (In *Baetis*); Pictet, 1843: 189-191 (In *Baetis*) *B. australasica;* Walker, 1853: 538 (In *Ephemera*) *E. australis;* 1853: 559-561 (In *Baetis*) *B. australasica, B. costalis;* Eaton, 1871: 78-81 (In *Leptophlebia*); 1881: 193-194 (Type species *A. australis*); 1884: 83-91; Ulmer, 1908: 40-46; 1916: 2-17; 1919: 16-23; Needham & Murphy, 1924: 34-36; Tillyard, 1926: 63-64; 1934: 1-16; 1936: 30-49; Harker, 1950: 8-17; 1954:

243-252; 1957: 63-68; Kimmins, 1960: 294; Riek, 1970: 239; Tsui & Peters, 1975: 542-544.

Type Species: Atalophlebia australis (Walker).

Detailed characteristics of the genus are given in Suter (1980).

Atalophlebia australis (Walker) 1853

Ephemera australis Walker, 1853: 538; *Leptophlebia australis* Eaton, 1871: 78; *Atalophlebia australis* Eaton, 1881: 193-194; 1884: 86; Tillyard, 1934: 1-16.

This species was fully described by Tillyard (1934) in a study of the type species of *Atalophlebia*. Therefore much of the detailed description is unnecessary, but measurements and ratios have been included. A transparency of the genitalia of the lectotype designated by Tillyard (held in the British Museum of Natural History) has been examined, but the actual specimen has not been seen. The following description is based on South Australian representatives, and includes measurements not recorded by Tillyard.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	10.69	1.38	14	8.80-12.50
Notal Length	3.65	0.39	15	3.20- 4.20
Mesonotal Width	1.93	0.27	15	1.52- 2.28
Pronotal Width	1.50	0.16	5	1.24- 1.64
Fore Wing Length	11.84	0.87	9	9.92-12.48
Hind Wing Length	3.45	0.37	10	2.52- 3.72
Cerci Length	28.00	2.86	5	25.00-32.60
Terminal Filament Length	23.35	1.40	4	22.00-25.00

Thorax: Fore leg femur length 1.18 × middle leg femur length, and 1.07 × hind leg femur length. Ratios of leg segments (Note: in middle and hind legs, second ratio is tibia + T_1 length: femur length): fore leg 1.00 : 1.34 : 0.11 : 0.51 : 0.44 : 0.34 : 0.21 (2.34 mm); middle leg 1.00 : 1.00 : - : 0.11 : 0.10 :0.09 : 0.19 (1.99 mm); hind leg 1.00 : 1.04 : - : 0.10 :0.09 : 0.08 : 0.17 (2.18 mm). Mesosternum: basisternum length 1.13 × width, 0.62 × furcasternum length, furcasternum length 0.77 × width, posterior margin with a short triangular indentation, lateral margins of furcasternum strongly sclerotized and dark brown.

Wings: Fore wing 2.75 × longer than wide. Hind wing (Fig. 1b) 1.62 × longer than wide.

Abdomen: yellow with dark brown markings dorsally (Fig. 1h). Segments 8, 9, 10 yellow-brown, ventrally yellow with light brown markings (Fig. 1i).

Genitalia: (Figs 1c, d) forceps yellow-brown. Penes broad, with a V-shaped median indentation, ventral sperm duct openings obvious (Figs 7a, b).

Mature Male Nymph (Fig. 14a)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	2.22	0.06	7	2.12- 2.28
Notal Length	3.21	0.07	7	3.12- 3.34
Pronotal Width	2.14	0.18	7	1.80- 2.30
Mesonotal Width	2.42	0.09	7	2.24- 2.48
Cerci Length	16.03	0.86	4	15.05-17.10
Terminal Filament Length	13.54	0.96	5	12.31-14.54

Thorax: Pronotum width 0.96 × head width. Mesonotum 1.09 × wider than head. Legs (Fig. 2a) yellow-brown with brown bands on each segment. Tarsal claws short and curved with 20-25 peg-like ventral denticles (Fig. 2b). Femora of fore and middle leg equal in length, hind leg longest, 1.12 × fore femur length. Ratios of leg segments: fore leg 1.00 : 1.05 : 0.53 (1.88 mm); middle leg 1.00 : 0.97 : 0.43 (1.90 mm); hind leg 1.00 : 1.02 : 0.43 (2.10 mm). Femur length to width ratios: fore leg 3.16, middle leg 3.26, hind leg 3.54. Sternum: prosternum width equal to anterior width of mesobasisternum. Mesosternum: basisternum length equal to or slightly longer than furcasternum, sternacostal suture present. Metasternum: basisternum 4-5 × wider than long, width slightly less than mesofurcasternum.

Abdomen: (Fig. 14a) posterior margins of tergites with large singular spines, with smaller spines basally. Cerci well developed, longer than terminal filament. Gills, seven pairs, each consisting of a pair of lamellae with three tracheal filaments per lamella (Fig. 2c).

Mouthparts: labrum (Fig. 2d) 2.78 × wider than long, mid-anterior indented, rugose, with 4-5 rounded tubercles (Fig. 2e). Left mandible (Fig. 2h): outer incisors with four teeth, inner with three, prostheca robust (Fig. 2i). Right mandible (Fig. 2j): outer incisors with three apical teeth, with five serrations on inner margin of third tooth, inner incisors with two teeth, inner lateral margin with up to five spines, prostheca long and slender with four spines along length (Fig. 2k). Hypopharynx (Fig. 2f). Maxillae (Fig. 2l): proximal segment of palp 2.24 × longer than wide, segment ratios: 1.00 : 1.22 : 0.66 (0.32 mm). Labium (Fig. 2g): proximal segment of papl 1.81 × longer than wide, segment ratios: 1.00 : 0.80 : 0.60 (0.37 mm).

Female Imago

Colour similar to male, ninth abdominal sternite with deeply incised posterior margin (Fig. 1e), seventh sternite produced posteriorly, slightly hooked when viewed laterally (Fig. 1f). Fore legs shorter than in male. Sternum broader than male, mesobasisternum length 0.85 × width, mesofurcasternum 0.65 × width.

Subimago

Black to dark brown, wings shaded grey with hyaline lambda (λ) marking complete (see Tillyard, 1934).

Female Nymph

Similar to but larger than male, lacking dorsal compound eyes.

Diagnostic Characteristics

1. Genitalia of male imago (Figs 1c, d and Figs 7a, b).
2. Distinctive yellow-brown (orange) colour described by Walker (1853) and Tillyard (1934) as "red", and "rufopiceous above; venter dull light burnt-umber, approaching rusty brown" by Eaton (1884).
3. Distinctive pattern of subimago.
4. Nymphal gills with trifurcate filaments (Fig. 2e).
5. Form and shape of mandibles, incisors and prostheeae (Figs 2h, i, j, k).

History and Discussion

In 1853 Walker briefly described *Ephemera australis* from Dr Hooker's 1842 collection from Tasmania. This species was later placed in the genus *Leptophlebia* (Eaton 1871) and subsequently (Eaton 1881) was designated the genotype for the new genus *Atalophlebia.* Walker referred to the "red" abdomen, and Eaton referred to rufo-piceous coloration, "an unusual character for this genus" (Tillyard 1934). Tillyard's extensive descriptions of the male imago, subimago and nymph of *A. australis* enable relatively easy recognition of all stages of this species, but the coloration in the living material differs from that of dry pinned specimens. Newly caught and alcohol-preserved adults have a distinctive orange colour, not red, as is the case in dry specimens.

Material Examined

SOUTH AUSTRALIA. South East: Brown Lake, Bakers Range Drain, Eastern Division Diversion Drain, Mt. Hope Drain, Reedy Creek Drain, Sutherlands Drain and Valley Lake. Mt. Lofty Ranges; Marne R., Para R., Torrens R. Southern Flinders Ranges: Back Creek, Julia Creek, Rocky River.

VICTORIA. Clunes, Tarango Dam, Neerin, Lake west of Harrow, L. Hattah, L. Wendouree, Ballarat, Konongwootong Reservoir, Rocklands Reservoir, Surrey R.

TASMANIA. Break O'Day R., Lagoon of Islands, L. Leake.

Atalophlebia australasica (Pictet) 1843

Baetis australasica Pictet, 1843: 189-190; Walker, 1853: 559: *Leptophlebia australasica* Eaton, 1871: 78-79; *Atalophlebia australasica* Eaton, 1884: 86-87; Ulmer, 1916: 2-3; Harker, 1950: 28; 1954: 248-249.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	10.10	0.86	26	8.60-11.46
Notal Length	3.13	0.24	8	2.84- 3.60
Pronotal Width	1.09	0.10	8	2.84- 3.60
Mesonotal Width	1.54	0.13	8	1.44- 1.80
Fore Wing Length	10.33	1.10	18	9.23-12.83
Hind Wing Length	3.02	0.41	18	2.40- 3.96
Cerci Length	28.20	2.72	8	24.00-31.00

Head: dark brown to black. Dorsal compound eyes dark red-grey, lateral eyes dark grey.

Thorax: shiny black. Pronotum narrower than head. Mesonotum without markings. Legs: fore legs black with two darker bands on femur, one mid-, one distally, T_1 partially fused to tibia. Middle and hind legs shorter than fore leg, light yellow-brown with two black bands on femora, one mid, one distal, tibiae with one proximal band, T_1 fused to tibia with joint apparent. Fore leg femur length 1.20 × middle leg femur length, and 1.06 × hind leg femur length. Ratios of leg segments: fore leg 1.00 : 1.39 : 0.13 : 0.53 : 0.48 : 0.39 : 0.20 (2.26 mm); middle leg 1.00 : 0.93 : 0.08 : 0.11 : 0.09 : 0.08 : 0.16 (1.88 mm); hind leg 1.00 : 1.01 : 0.08 : 0.09 : 0.08 : 0.07 : 0.15 (2.13 mm). Mesosternum: basisternum length 1.12 × width, 0.66 × furcasternum length, lateral margins anteriorly expanded, posterior margin truncated, furcasternum length 0.71 × width, posterior margin with a triangular indentation.

Wings: fore wing (Fig. 3a) 2.77 × longer than wide, pterostigmal region brown, costal and subcostal cross-veins broadly shaded with black, bulla in Sc surrounded by black marking. Hind wing (Fig. 3b) 1.60 × longer than wide, costal space with 1-3 proximal and 6-10 distal cross-veins.

Abdomen: light brown with darker markings dorsally (Fig. 3h) ventrally grey with light patches on segments 3-9 (Fig. 3i). Cerci stout, black-brown with the last 3-5 mm buff, terminal filament absent.

Genitalia: (Figs 3c, d): penes broad at base, with concave lateral margins and bulbous distal region, fused, centrally, giving a triangular apex (Figs 7c, d).

Mature Male Nymph (Fig. 14b)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	2.38	0.11	9	2.28- 2.60
Notal Length	3.41	0.41	9	3.00- 4.32
Pronotal Width	2.44	0.15	9	2.28- 2.76
Mesonotal Width	2.70	0.22	9	2.48- 3.12
Cerci Length	12.74	—	2	12.14-13.34
Terminal Filament Length	12.82	0.35	3	12.42-13.40

Head: dark brown-black. Dorsal compound eyes red-black, lateral eyes black. Antennae yellow-brown, longer than head is wide.

Thorax: dark brown with pale mid-longitudinal line. Pronotum wider or narrower than head (geographically variable). Mesonotum 1.11 × wider than head. Legs yellow brown with black bands on each segment, femora with two bands (one mid-, one distal), tibiae with two bands (one proximal, one distal), tarsi with a broad band covering proximal half (Fig. 4a). Fore femur 1.05 × longer than middle femur, hind femur 1.15 × longer than fore femur. Tarsal claws short, curved, with 15-20 peg like denticles (Fig. 4b). Ratios of leg segments: fore leg 1.00 : 1.02 : 0.50 (2.24 mm); middle leg 1.00 : 0.98 : 0.37 (2.21 mm); hind leg 1.00 : 1.06 : 0.36 (2.42 mm). Femur length to width ratios:

fore leg 3.18, middle leg 3.42, hind leg 3.61. Mesosternum: basisternum length equal to furcasternum length, sternacostal suture present. Metasternum: basisternum 3.7-5 × wider than long, width equal to width of mesofurcasternum.

Abdomen: brown, patterned (Fig. 14b), lateral flange of segment 9 with two spines, outer largest, inner rounded; posterior margin of tergum with spines arranged singularly. Cerci well developed, terminal filament longer than lateral filaments. Gills: multifurcate (Fig. 4c), each gill consisting of a pair of lamellae with 8-20 tracheal filaments per lamella.

Mouthparts: labrum (Fig. 4d) 3.41 × wider than long, mid-anterior margin indented, rugose (Fig. 4e). Left mandible (Fig. 4h): outer incisors with three large teeth, inner with three large teeth, prostheca robust, crenulated with 6-8 blunt teeth (Fig. 4i). Right mandible (Fig. 4j): outer incisors with five teeth, inner incisors with two teeth and four small spines on inner lateral margin, prostheca, slender, with crenulations on outer margin of 2-4 tubercles, distally with a long spine (Fig. 4k). Hypopharynx (Fig. 4f). Maxillae (Fig. 4l): proximal segment of palp 2.80 × longer than wide, segment ratios, 1.00 : 1.19 : 0.69 (0.41 mm). Labium (Fig. 4g): proximal segment of palp long and broad, 1.97 × longer than wide, segment ratios 1.00 : 0.67 : 0.68 (0.42 mm).

Female Imago

Larger than male, similar colour and dorsal markings, 9th abdominal sternite with shallow incision on posterior margin, 7th sternite produced posteriorly forming a bulbous projection (Figs 3e, f). Fore legs shorter than in male, sternum and thorax broader than male, mesobasisternum length of 0.81 × width, 0.63 × furcasternum length, furcasternum length 0.61 × width. Terminal filament present.

Subimago

Dull, black-brown, wings uniformly shaded grey, no "lambda" pattern, terminal filament present.

Diagnostic Characteristics

1. Genitalia of male imago (Figs 3c, d; 7c, d).
2. Lack of terminal filament in adult male.
3. Subimago with uniform grey wings.
4. Nymphs with multifurcate tracheal gill filaments (Fig. 4c).
5. 9th abdominal segment with two spines on the posterolateral margin.
6. Form and shape of mandibles, incisors and prosthecae (Figs 4h-k).

History and Discussion

Atalophlebia australasica, originally described by Pictet (1843), has been redescribed by Eaton (1871, 1884), by Ulmer (1916) and Harker (1954). The description given by Pictet was not extensive enough to enable recognition of this species as more Australian species were described. Eaton (1871, 1884) redescribed this species and illustrated the wings and genitalia. Ulmer (1916) designated material from northern Queensland as *A. australasica,* and described the male and female imagos, and the subimago. Ulmer noted differences in the venation of the hind wing of these specimens when compared with Eaton's (1884) illustration, but did not comment on the apparent differences in the genitalia as illustrated by Eaton. Harker (1950) recorded that Ulmer (1919) had placed *A. australasica* as a synonym of *A. costalis* (Burmeister). In 1954, Harker noted, after examining material in the British Museum, that *A. australasica* as designated by Eaton was distinctly different from *A. costalis* as determined by Tillyard, and redescribed all stages of the species.

Although the male imago description is of the holotype (as inferred by the statement "fore legs are missing in holotype and paratypes"), Harker included a record of a well-developed terminal filament. Pictet's (1843) description included only one caudal filament measurement, consistent with the accompanying illustration, and of descriptions of species lacking the terminal filament. Eaton (1871, 1884) also included only one measurement. Ulmer (1916) recorded only the lateral cerci "Die Schwanzborsten (2 beim ♂) sind schwarzbraun . . ." but recorded the presence of the terminal filament in the male subimago. Harker (1954) also noted that material examined from Mt Gambier (from Tillyard's 1934 collection) was consistent with her recognition of this species. Adult males of *A. australasica* from south-east South Australia and the Fleurieu Peninsula lack the terminal filament, consistent with the type description. Harker's record mentions no variability of expression of the terminal filament (as described for *A. australis* by Tillyard 1934). Therefore, since subsequent collections, as well as the type material all lack this filament, its presence as indicated by Harker must be suspect.

A comparison of Figs 3c, and 7c, with the illustration of the *A. australasica* genitalia by Harker (1954) shows little resemblance. The South Australian material of this species, examined in this study, was initially considered different from previously described species. However, a comparison of an air-dried specimen and a critical-point dried specimen revealed two different penes characteristics. The air-dried specimen closely resembles the illustration presented by Harker, from a dry, pinned preparation. The lateral lobes of air-dried specimens curl in towards the mid-line, producing a long narrow structure. The critical-point dried specimens represent more closely the living, or alcohol-preserved, characteristics of the genitalia, with the lateral lobes of the penes maintaining their lateral position.

Material Examined

SOUTH AUSTRALIA. South East: Cress Ck, Deep Ck, Eight Mile Ck, Hitchcock Drain, Jerusalem Ck. Mt. Lofty Ranges: Blackfellow Ck, Brownhill Ck, Bull Ck, Cudlee Ck, Currency Ck, Dam at Carey's Gully, Dam at Ashton, Deep Ck, First Ck, Fourth Ck, Little Para R., Morialta Ck, Onkaparinga R., Sturt R., Torrens R., Wakefield R. Fleurieu Peninsula: Carrickalinga Ck, Coolawang Ck, The Deep Ck, (Delamere), Finnis R., Gold Digging Swamp, Hindmarsh R., Inman R., Kangarilla Ck, Myponga Ck, No Where Else Ck, Tookayerta Ck, Yankalilla R. Kangaroo Island: Breakneck R., De Mole R., Middle R., Rocky R., South West R.
VICTORIA. Crawford R., Eumarella R., Fitzroy R., Glenelg R., Shaw R.

Atalophlebia auratus sp. nov.

Holotype Male Imago

Body Length	7.95 mm
Notal Length	2.60 mm
Pronotal Width	1.04 mm
Mesonotal Width	1.27 mm
Fore Wing Length	7.44 mm
Hind Wing Length	2.23 mm
Cerci Length	19.67 mm
Terminal Filament Length	15.57 mm

General colour yellow-brown, fore wings yellow, hind wings grey.

Head: dark brown. Antennae short, basal segment 0.12 mm long, 1.5 × longer than wide, 2nd segment 0.1 mm long, 2.5 × longer than wide, flagellum 0.24 mm long. Dorsal compound eyes pink-brown, lateral eyes dark grey. Ocelli dark brown laterally, white anteriorly.

Thorax: shiny black. Pronotum narrower than head. Legs: fore legs long, femur and tibia dark brown, tarsal segments dark brown, no banding on any segment, T_1 partially fused to tibia. Middle and hind legs shorter, light brown without banding, tarsal segments 1-4 with distal spine, T_1 fused to tibia, join visible. Fore leg femur length 1.03 × middle leg femur length, and 0.95 × hind leg femur length. Ratios of leg segments: fore leg 1.00 : 1.14 : 0.09 : 0.40 : 0.40 : 0.28 : 0.19 (1.84 mm); middle leg 1.00 : 0.77 : - : 0.10 : 0.08 : 0.16 (1.78 mm); hind leg 1.00 : 0.98 : - : 0.08 : 0.10 : 0.07 : 0.17 (1.94 mm). Sternum dark black-brown. Prosternum triangular, longer than wide. Mesosternum: basisternum length 1.17 × width, 0.78 × furcasternum length 0.89 × width, lateral margins of median longitudinal invagination divergent, posterior margin concave (Fig. 5e).

Wings: fore wing (Fig. 5a) tinged throughout with yellow-brown, veins yellow-brown, pterostigma darker than rest of wing, cubital region shaded grey, length 3.35 × width, pterostigmatic cross-veins forked in left wing, simple, not forked in right wing, cross-veins present in proximal half of costal region. Hind wing (Fig. 5b) grey-brown, darker than fore wing, shaded completely, length 2.06 × width, costal hump not large, costal space with nine cross-veins.

Abdomen: yellow-brown dorsally, lighter yellow ventrally, dorsal tergites with dark brown-black markings laterally, and light mid-longitudinal stripe along all segments (Fig. 5f). Sternites yellow-grey, with light red-brown circular markings on mid-line (Fig. 5g). Cerci long, terminal filaments well developed but not as long or robust as cerci.

Genitalia (Figs 5c, d; 7e, f): forceps with long proximal segment, broadest proximally, narrows half way along length, 2nd segment short, globular, distal segment longer, ovoid, rounded apically. Penes broad at base, tapering towards apex with apices held close together, curving upwards in profile.

Mature Female Nymph (Fig. 14e)

Body Length	9.20 mm
Head Width	2.03 mm
Notal Length	2.22 mm
Pronotal Width	1.90 mm
Mesonotal Width	2.19 mm
Cerci Length	15.20 mm
Terminal Filament Length	14.66 mm

General colour brown.

Head: brown. Lateral eyes black, ocelli black. Tentorial body almost square, length 0.95 × width. Antennae 4.8 mm long.

Thorax: pronotum brown without markings, width 0.95 × head width, 2 stout spine setae on anterior margin, no setae on lateral margin. Mesonotum brown, broad, width 1.08 × head. Legs light brown without banding (Fig. 6a). Tarsal claws with 31-35 peg-like denticles (Fig. 6b), segment ratios: fore leg 1.00 : 0.98 : 0.49 (1.81 mm); middle leg 1.00 : 0.96 : 0.48 (1.81 mm); hind leg 1.00 : 0.96 : 0.47 (1.97 mm). Femur length to width ratios; fore leg 3.77, middle leg 4.11, hind leg 4.48. Sternum: prosternum, length 0.73 × width, wider than anterior margin of mesosternum. Mesosternum: basisternum rectangular, width 0.68 × length. Metasternum: basisternum short, width 5.71 × length.

Abdomen: brown dorsally with black patches on lateral flanges of segments 1-7, segments 1-5 otherwise brown without markings, segments 6, 7, 8, 9 with central light stripe, segment 10 light brown (Fig. 14e). Segment 9 with a single postero-lateral spine. Cerci and terminal filament well developed, cerci longer. Gills: multifurcate, with numerous fine tracheal filaments on each lamella.

Mouthparts: labrum (Fig. 6c) length 0.40 × width, anterior margin with median concavity lined with five rounded tubercles (Fig. 6d). Left mandible (Fig. 6g):

outer incisors with three apparent (four actual) teeth; inner incisors with three teeth, prostheca robust with 8-10 pointed teeth on external margin (Fig. 11h). Right mandible (Fig. 6i): outer incisors with three teeth and a fourth shoulder-like ridge on third tooth, two small tubercles on mesal margin, inner incisors with three teeth, inner most with two small tubercles laterally, prostheca long, narrow with one small external spine and two terminal spines (Fig. 6j). Hypopharynx (Fig. 6e). Maxillae (Fig. 6k). Segment ratios of palp 1.00 : 1.10 : 0.67 (0.30 mm). Labium (Fig. 6f): proximal segment of palp broad, length 1.61 × width, distal segment triangular, segment ratios 1.00 : 0.80 : 0.62 (0.38 mm).

Female Imago

Reared in laboratory. Wing and body coloration resemble male, body robust, filled with eggs. Ninth abdominal segment with a deep ventral cleft (Fig. 5i); sternite of seventh abdominal segment slightly produced posteriorly (Fig. 5j).

Subimago

Similar to male imago, wing colour dull yellow-grey, without marking.

Male Nymph

Smaller than female, head with red-brown compound eyes.

Diagnostic Characteristics

1. Genitalia of male imago; shape of forceps segments two and three and shape of penes (Figs 5c, f; 7e, f).
2. Wing coloration in both fore and hind wings.
3. Lack of banding on legs of adults.
4. Multifurcate gills of nymphs.
5. Only one postero-lateral spine on abdominal segment 9.
6. Shape of mandibles, incisors and prosthecae (Figs 6g-j).
7. Lack of banding on legs of nymphs (Fig. 6a).
8. Dorsal colour pattern of nymph and adults (Fig. 14c; and Fig. 5f).

Type Locality

Bakers Range Drain, west of Penola, South Australia. Grid Reference on 1 : 250 000 map series, Penola Sheet: 357393. Collected 22 November 1977 by D. N. Suter and P. J. Suter.

TABLE 1. COMPARISON OF QUALITATIVE CHARACTERISTICS OF *ATALOPHLEBIA AUSTRALIS*, *A. AUSTRALASICA* AND *A. AURATUS* FROM SOUTH AUSTRALIA

Character	*A. australis*	*A. australasica*	*A. auratus*
Male Imago			
Body colour	Yellow-brown	Black-brown	Yellow-brown
Fore wing colouration	Pterostigma only (yellow)	Pterostigma only (brown)	Totally yellow
Hind wing colouration	Clear	Clear	Grey
Penes	Separate apically	Fused apically with lateral lobes	Fused apically without lateral projections
Legs	Femur banded	Femur banded	No banding
Fusion of tarsal Segment 1 of fore leg	Partial	Partial	Partial
Fusion of tarsal Segment 1 of middle and hind legs	Fused	Fused	Fused
Terminal filament	Present-absent	Absent	Present
Nymph			
Dorsal eye colour ♂♂	Sepia	Red-black	Pink-brown
Lateral eye colour	Black	Black	Black
Legs: banding	Femora 2 bands	2 bands	Absent
	Tibiae 2 bands	2 bands	Absent
	Tarsi 1 band	1 band	Absent
Postero-lateral spines on abdominal segment 9	Single	2 spines	Single
Abdominal tergite spines	Large singular spines with smaller basal spines	Singular spines	Single spines with smaller basal spines
Gills	Trifurcate	Multifurcate	Multifurcate
Left mandible			
Incisors Outer	4	3	4
Incisors Inner	3	3	3
Prostheca	Robust-serrated	Robust-serrated	Robust-serrated
Right mandible			
Incisors Outer	3	5	3
Incisors Inner	2	2	3
Prostheca	Long, slender with 4 spines	Slender-serrated	Long, narrow

Type Specimens

A auratus is only known from the type locality. Holotype male and paratypes are placed in the Museum of Victoria. The wings and legs of the holotype male are mounted on slides, and the mouthparts, legs and gills of the female nymph are also mounted on slides. The genitalia and body of the holotype are maintained in ethanol.

Type Habitat

Near the source of Bakers Range Main Drain, which is a man-made drain, draining the swamps of Bakers Range in the South East of South Australia. The water at the type locality was evaporating rapidly during November 1977, when the type collection was made. *A. australis* was also present at this locality.

Etymology of Specific Epithet

The specific epithet *auratus* (L), ornamented with gold, refers to the golden coloration of the forewings which make this species distinct from all other described *Atalophlebia* species.

Affinities

In adult characters the wing coloration, genitalia and lack of banding of the legs distinguish this species from other described species in the genus *Atalophlebia*. The nymph, however, resembles the nymph of *A. australasica* in possessing multifurcate gills. Although smaller than *A. australasica* (a character to be used with great care) the lack of banding of the legs, the presence of only one postero-lateral spine on the 9th abdominal segment, the mandible incisors and prosthecae all distinguish *A. auratus* from *A. australasica*. A comparison of qualitative characteristics which distinguish the three *Atalophlebia* species found in South Australia is presented in Table 1.

GENUS *NOUSIA* Navás, 1918

Navás, 1918: 213; 1925: 308; Ulmer, 1919: 20 (In *Atalophlebia*); Needham & Murphy, 1924: 35-37; Lestage, 1931: 52; Traver, 1946: 420; Harker, 1950: 30-32; 1954: 242-243; 1957: 69-71; Riek, 1970: 239; Peters & Edmunds, 1972: 1411; Tsui & Peters, 1975: 540-542; Pescador & Peters, 1985: 91-123.

Type Species: Nousia delicata Navás by original designation. Detailed characterisation of this genus is given by Pescador & Peters (1985) and Suter (1980). There has been considerable discussion of the validity of the genus *Atalonella* in Australia (Tsui and Peters 1972; Suter 1980) and following the work of Pescador & Peters (1985) the South Australian species are placed in the genus *Nousia*. Although differences between the South American and Australian species exist (e.g. egg structure) until a full revision is performed all *Atalonella* species should be considered as belonging to the genus *Nousia*.

Nousia inconspicua (Eaton) 1871 comb. nov.

Leptophlebia inconspicua Eaton, 1871: 79-80; *Atalophlebia inconspicua* Eaton, 1884: 87; Ulmer, 1908: 43-44; Tillyard, 1936: 31; Harker, 1950: 28; 1954: 265.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	7.27	0.50	26	6.07- 7.95
Notal Length	2.26	0.15	26	2.02- 2.62
Pronotal Width	0.96	0.09	16	0.84- 1.08
Mesonotal Width	1.19	0.08	26	1.04- 1.32
Fore Wing Length	7.25	0.52	26	5.74- 8.36
Hind Wing Length	1.43	0.14	26	1.20- 1.80
Cerci Length	10.60	0.80	11	9.41-12.14
Terminal Filament Length	12.67	1.01	10	11.11-14.02

General colour black, with light transparent regions between adbominal segments, giving a banded appearance.

Head: black. Dorsal compound eyes light brown, lateral eyes grey

Thorax: dark brown-black. Legs: fore legs dark brown, without banding. Middle and hind legs shorter, light brown, without bands. T_1 fused to tibia, suture apparent. Ratios of leg segments: fore leg 1.00 : 1.46 : 0.14 : 0.48 : 0.45 : 0.33 : 0.17 (2.13 mm); middle leg 1.00 :1.07 : 0.06 : 0.08 : 0.08 : 0.07 : 0.16 (1.44 mm); hind leg 1.00 : 1.13 : 0.06 : 0.08 : 0.08 : 0.07 : 0.16 (1.49 mm).

Wings: fore wings (Fig. 8a) 3.29 × longer than wide, pterostigmal region slightly opaque, with simple cross-veins in distal 1/3 only, proximal region of subcostal space without cross-veins, distal region with very faint cross-veins, cubital and anal regions with few cross-veins. Hind wing (Fig. 8b) 1.55 × longer than wide, 4-5 cross-veins in distal region of costal space, absent in proximal half, subcostal space with 3-5 cross-veins.

Abdomen: black with light central marking dorsally (Fig. 8h), all segments light brown ventrally (Fig. 8i).

Genitalia (Figs 8c, d): distal segment of forceps globular. Penes broad, fused along entire length, extending beyond constriction of proximal segment of forceps, ventral lobes triangular with base separate anteriorly, sperm ducts open on mid line (Figs 15a, b).

Mature Male Nymph (Fig. 14d)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	1.59	0.04	13	1.54-1.70
Notal Length	1.95	0.08	13	1.80-2.12
Pronotal Width	1.50	0.08	13	1.38-1.56
Mesonotal Width	1.58	0.07	13	1.50-1.72
Cerci Length	9.92	—	1	—
Terminal Filament Length	10.77	—	1	—

Head: dark brown. Dorsal compound eyes dark reddish brown.

Thorax: legs brown, no banding (Fig. 9a). Ratios of leg segments: fore leg 1.00 : 0.92 : 0.52 (1.39 mm); middle leg 1.00 : 0.92 : 0.44 (1.39 mm); hind leg 1.00 :

0.98 : 0.36 (1.49 mm). Femur length to width ratio: fore leg 3.17, middle leg 3.20, hind leg 3.35.

Abdomen: brown dorsally with a light stripe down mid-line (Fig. 14d), posterior margins of terga with large singular spines, with smaller spines between them. Gills lanceolate (Fig. 9c), lamellae with numerous tracheal branches.

Mouthparts: labrum (Fig. 9d) 2 × wider than long, median cavity without obvious rounded denticles (Fig. 9e). Left mandible (Fig. 9h): outer incisors with three teeth, inner with three teeth, prostheca long and slender, apically with two rounded teeth (Fig. 9i). Right mandible (Fig. 9j): outer incisors with three teeth, inner with 2-4 teeth, prostheca simple, narrow with one apical spine (Fig. 9k). Hypopharynx (Fig. 9f). Maxillae (Fig. 9l): proximal segment of palp 2.06 × longer than wide, segment ratios 1.00 : 0.92 : 0.80 (0.22 mm). Labium (Fig. 9g): proximal segment of palp 1.98 × longer than broad, distal segment with 3-4 short apical spines, segment ratios; 1.00 : 0.79 : 0.64 (0.35 mm).

Female Imago

More robust than male, uniform brown. Fore wings with cross-veins along entire costal and subcostal spaces. Hind wings with cross-veins in radial, median and cubital sectors. Anal plate with a deep V shaped incision (Fig. 8e), no ovipositor (Fig. 8f). Egg, oval, 0.12 mm long, 0.09 mm wide with a polar cap of two rings of tubular projections on each apex (Fig. 16a).

Subimago

Black with uniformly grey wings.

Diagnostic Characteristics

1. Genitalia: penes shape, broad, fused, with triangular ventral lobes (Figs 8c, d and Figs 15a, b).
2. Lack of cross-veins in proximal regions of C and Sc spaces of fore wings (Fig. 8a).
3. Egg morphology, polar caps with 2 rows of tubular processes (Fig. 16a).
4. Nymphal gills lanceolate (Fig. 9c).
5. Mandibles, incisors and prostheceae shape (Figs 9h-k).
6. Proximal segment of labial palp long and narrow (Fig. 9g).
7. Dorsal white stripe on abdomen (Fig. 14d).

History and Discussion

Until this study *N. inconspicua* had the distinction of being the only species described from South Australia. Eaton (1871) described and placed it in *Leptophlebia*, noting the black and white patterning of the abdomen. His illustration of the genitalia differs from the scanning electromicrograph (Figs 15a, b) as he showed separate penes lobes. This separation of the two lobes of the penes is observed with air-dried specimens, and may occur with slide-mounted material. Living, critical-point dried, and alcohol-preserved specimens possess genitalia with the two lobes held close together as illustrated in the micrograph. The type locality of this species is Adelaide, but the river or stream from which the holotype was collected is unknown. In 1884 Eaton placed *Nousia inconspicua* in the new genus *Atalophlebia* where it has remained until the present study. Ulmer (1908) added to Eaton's description from material from the South-West of Western Australia. He included illustrations of male genitalia, both wet-preserved in alcohol and dried, showing the separation of the paired penes lobes in the dried preparation. From the illustrations of the wings (the presence of cross-veins in the proximal half of the C and Sc regions of the fore wing) and genitalia it is difficult to know if the species described by Ulmer is *N. inconspicua* or a different species.

Tillyard (1936) recognised two groups within the genus *Atalophlebia*, and he included *N. inconspicua* in the group with the smaller species i.e. "smaller species, expanding from one-half to three-quarters of an inch (fore wing from 5 to 8 mm long)". Since this species is not recorded in Tasmania, no description was given, and in fact it is only referred to in the adult key. All the other species from the smaller sized group were later placed in the genus *Atalonella* by Harker (1954), but *N. inconspicua* was left in *Atalophlebia*.

The nymphs and adults of this species, as described above, have characteristics which distinguish them from the genus *Atalophlebia*, but are consistent with the generic characteristics of *Nousia*. Consequently *N. inconspicua* is now formally placed in the genus *Nousia*.

Material Examined

SOUTH AUSTRALIA. Mt. Lofty Ranges: Aldgate Ck, Blackfellow Ck, Brownhill Ck, Bull Ck, Currency Ck, Deep Ck, Fifth Ck, Finnis R., Fourth Ck, Little Para R., Marne R., Morialta Ck, Onkaparinga R., Scott Ck, Sturt R., Torrens R. Southern Flinders Ranges: Back Ck, Nectar Brook Dam, Rocky R., Schumacher Ck, Skillogalee Ck, Spring Ck, Wakefield R. Fleurieu Peninsula: Anacotilla Ck, Carrickalinga Ck, Coolawang Ck, The Deep Creek (Delamere), Gold Digging Swamp, Hindmarsh R., Kangarilla Ck, Myponga Ck, Yankalilla R. Kangaroo Island: Breakneck R., Cygnet R., De Mole R., Grassy/Sheep Ck, Middle R., North East R., Rocky R., South West Bay R., South West R., Stunsail Boom R.

Nousia fuscula (Tillyard, 1936)

Atalophlebia fuscula Tillyard, 1936: 44-47; *Atalophlebia fuscula* Harker, 1950: 28; *Atalonella fuscula* Harker, 1954: 242-243, 264; Scholes, 1961: 31-33.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	6.58	0.32	23	5.82- 7.01
Notal Length	2.02	0.11	21	1.84- 2.20
Pronotal Width	0.87	0.06	10	0.74- 0.92
Mesonotal Width	1.02	0.09	20	0.82- 1.12
Fore Wing Length	6.41	0.28	22	5.90- 6.97
Hind Wing Length	1.29	0.09	23	1.12- 1.40
Cerci Length	10.32	0.62	12	9.23-11.11
Terminal Filament Length	11.67	0.76	8	10.77-13.00

Head: black. Dorsal compound eyes, brown-grey.

Thorax: black. Fore legs black without banding. Middle and hind legs brown without banding. Ratios of leg segments: fore leg 1.00 : 1.29 : 0.14 : 0.49 : 0.44 : 0.28 : 0.16 (1.64 mm); middle leg 1.00 : 1.15 : - : 0.11 : 0.09 : 0.09 : 0.15 (1.38 mm); hind leg 1.00 : 1.20 : - : 0.09 : 0.08 : 0.09 : 0.15 (1.58 mm). Fore leg femur length 1.19 × middle leg femur length, and 1.04 × hind leg femur length.

Wings: fore wing (Fig. 10a) 3.13 × longer than wide, pterostigmal region slightly tinged with brown, cross-veins slanted, simple, costal space proximal to bulla with 3-7 very faint cross-veins, subcostal space with 2-4 cross-veins in proximal half, 7-10 in distal half. Hind wing (Fig. 10b), 1.52 × longer than wide, 3-4 cross-veins in distal region of costal space, absent in proximal half, subcostal space with 4-6 cross-veins.

Abdomen: black, with brown and light brown markings (Fig. 10h); ventral pattern (Fig. 10i).

Genitalia (Figs 10c, d): distal segment of forceps globular. Penes lobes widely separated, cylindrical, constricted near apex, apex rounded, lobes apparently sheathed, inner margin with a small spine hidden within sheath, visible in mounted preparations examined using transmitted light (Fig. 10j), but not in the Scanning Electron Micrographs (Figs 15c, d).

Mature Male Nymph (Fig. 14e)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	1.44	0.06	6	1.36-1.50
Notal Length	1.71	0.07	4	1.64-1.80
Pronotal Width	1.28	0.04	4	1.22-1.32
Mesonotal Width	1.33	0.06	4	1.26-1.40

Cerci and terminal filament damaged in available specimens.

Head: dark brown. Dorsal compound eyes reddish brown.

Thorax: pronotum with spine setae on antero-lateral margins. Legs brown, not banded (Fig. 11a). Ratios of leg segments: fore leg 1.00 : 0.87 : 0.55 (1.18 mm); middle leg 1.00 : 0.84 : 0.39 (1.19 mm); hind leg 1.00 : 0.91 : 0.38 (1.40 mm). Femur length to width ratios, fore leg 2.74, middle leg 2.82, hind leg 3.11.

Abdomen: colour pattern irregular (Fig. 14e). Spines on posterior margins of terga occur either separately or in pairs. Gills (Fig. 11c); linear, lamellae lacking tracheal branches, or, if present, very short

Mouthparts: labrum (Fig. 11d) 2 × wider than long; median cavity with four to six rounded denticles (Fig. 11e). Left mandible (Fig. 11h), outer incisors with three apical teeth, inner incisors with three teeth, prostheca broad, robust, outer and apical margin serrated (Fig. 11i). Right mandible (Fig. 11j): outer incisors with three apical teeth, inner incisors with two teeth, prostheca simple, long and narrow with one apical spine (Fig 11k). Hypopharynx (Fig. 11f). Maxillae (Fig. 11l), proximal segment of palp 2.11 × longer than wide. Segment ratios: 1.00 : 0.71 : 0.78 (0.21 mm). Labium (Fig. 11g): proximal segment of palp 1.57 × longer than broad, segment ratios; 1.00 : 0.71 : 0.69 (0.29 mm).

Female Imago

More robust than male, wings similar, hind wings with more cross-veins in radial, median and cubital sectors. Anal plate with a deep V shaped incision (Fig. 10e), no ovipositor (Fig. 10f). Eggs oval 0.12 mm × 0.09 mm, polar caps with three rings of tubular processes (Fig. 16b).

Subimago

Dull black, wings opaque, dark grey.

Diagnostic Characteristics

1. Male genitalia, lateral lobes of penes widely separate, small spine on mesal margin of lobes (Figs 10c, d and Figs 15c, d).
2. Cross-veins in proximal region of costal and subcostal spaces (Fig. 10a).
3. Egg polar cap with 3 coronae of tubular processes (Fig. 16b).
4. Nymphs have linear gills with few tracheal branches on lamellae (Fig. 11c).
5. Mandibles, shape of incisors and prostheae (Figs 11h-k).
6. Proximal segment of labial palpi broad (Fig. 11g).
7. Abdominal colour pattern irregular (Fig. 14e).

History and Discussion

Tillyard (1936) described the adults (male and female), subimago, and nymph of *N. fuscula* placing it in his distinct group of small species of the genus *Atalophlebia*. Harker (1954) recognisd that all the species Tillyard placed in this second group of small-sized species belonged in the genus *Atalonella*. These species now belong to the genus *Nousia*, and *N. fuscula* is formally included in this genus.

The male genitalia are distinctive in *N. fuscula*, with a small spine on the mesal margins of the penes lobes, but the associated nymph in South Australia differs from the description and illustration given by Tillyard (1936). The gill illustrated by Tillyard shows a more lanceolate lamella with numerous tracheal branches, both shape and tracheation are inconsistent with the associated nymphs of South Australia. Nymphs of Tillyard's description were not found at Tookayerta

Creek (the only locality where *N. fuscula* is present on the Fleurieu Peninsula), but one of a similar description to his was recorded from Deep Creek, east of Port Macdonnell in the South East of South Australia. Similar nymphs from the Grampians, Victoria, were bred through and *N. pilosa* sp. nov. was the associated adult. Field observations suggest that *N. fuscula* emerges before *N. pilosa*, therefore leaving *N. pilosa* nymphs in the stream. This observation was repeated by the author in the South East of South Australia, the Grampians, Victoria, and in Tasmania. The nymphs of *N. fuscula* from Tasmania (collected in February 1978 and associated with adults) were similar to those in South Australia. From these observations it appears that Tillyard indirectly associated the nymph in the stream with the flying adults and emerged subimagos rather than by breeding through the nymphs and directly associating these with the resulting adults.

Material Examined

SOUTH AUSTRALIA. South East: Cress Ck, Deep Ck, Eight Mile Ck. Fleurieu Peninsula: Tookayerta Ck.
VICTORIA. Aire R., Albert R., Beehive Ck, Crawford R., Cumberland Falls (Marysville), Darlots Ck, Genoa Ck, Howqua R., Jimmy's Ck, Little R., McKenzie R., Mt. Zero Channel, Stony Ck (Halls Gap), Tanjil R., Tarwin R., Toorongo Falls (Noojee).
NEW SOUTH WALES. Leatherbarrel Ck, Styx R., Wallagaraugh R.
TASMANIA. Break O'Day R., Dee R., George R., Great Forester R., Isis R., Macquarie R., Rostrevor Ck.

Nousia pilosa sp. nov.

Holotype Male

Body Length	7.50 mm
Notal Length	1.90 mm
Pronotal Width	0.93 mm
Mesonotal Width	1.17 mm
Fore Wing Length	7.67 mm
Hind Wing Length	1.23 mm
Cerci Length	9.05 mm
Terminal Filament Length	12.00 mm

Head: black-brown. Dorsal eyes pink/brown.

Thorax: pronotum black, narrower than head. Fore leg without banding, femur dark brown, tibia and tarsi light brown, T_1 partially fused to tibia; middle and hind legs with dark brown femora each with one black band at 3/4 of length, tibiae and tarsi light brown, T_1 fused to tibia. Ratios of leg segments: fore leg 1.00 : 1.52 : 0.08 : 0.48 : 0.51 : 0.38 : 0.15 (1.92 mm); middle leg 1.00 : 1.22 : - : 0.07 : 0.07 : 0.07 : 0.11 (1.62 mm); hind leg 1.00 : 1.35 : - : 0.09 : 0.08 : 0.07 : 0.13 (1.67 mm).

Wings: fore wing (Fig. 12a) 3.3 × longer than wide, pterostigmal region with simple, slanted cross-veins, proximal 2/3 of costal space without cross-veins, subcostal space without proximal cross-veins, distal region with seven. Hind wing (Fig. 12b, c) 1.52 × longer than wide; 2 cross-veins in distal region of costal space, absent in proximal half, sub costal space with 3 cross-veins.

Abdomen: dark brown with mid-dorsal light brown region on segments 2-7, segments 8-10 dark brown (Fig. 12g); ventrally light brown (Fig. 12h). Base of each segment of caudal filaments tinged with brown giving a banded appearance.

Genitalia (Figs. 12d, e): second segment of forceps short, ovoid, distal segment globular. Penes fused, apex with 2 lobes, ventral surface lacking lobes (Figs 12d, 15e, f).

Mature Male Nymph (Fig. 14f)

Head Width	1.20 mm
Notal Length	2.30 mm
Pronotal Width	1.09 mm
Mesonotal Width	1.31 mm
Caudal Filaments	Damaged in type

Head: light brown, light marking in centre of frons. Dorsal eyes red-brown.

Thorax: pronotum width 0.91 × head width, few spine setae present on antero-lateral margin. Legs light brown, without banding, margins of segments lined with long fine setae (Fig. 13a). Tarsal claws with 12 peg-like teeth (Fig. 13b). Ratios of leg segments: fore leg 1.00 : 0.96 : 0.40 (1.70 mm); middle leg 1.00 : 0.95 : 0.31 (1.77 mm); hind leg 1.00 : 1.01 : 0.29 (1.93 mm). Femur length to width ratios: fore leg 3.13, middle leg 3.39, hind leg 3.70.

Abdomen: dark brown with light central marking (Fig. 14f). Gills (Fig. 13c) lanceolate with single terminal tracheal filament, lamellae with tracheal branches obvious.

Mouthparts: labrum (Fig. 13d) 1.5 × wider than long; anterior margins with a median cavity with six rounded denticles (Fig. 13e), one row of setae behind median cavity. Left mandibles (Fig. 13h); outer incisors with three apical teeth, inner incisors with three apical teeth and two ridges on inner margin, prostheca broad basally, long and slender distally with three terminal teeth (Fig. 13i). Right mandible (Fig. 13j); outer incisors with three apical teeth, inner incisors with two teeth; prostheca slender, elongate with a long terminal spine (Fig. 13k). Hypopharynx (Fig. 13f). Maxillae (Fig. 13l); palpi, proximal segment 1.79 × longer than wide. Segment ratio 1.00 : 0.68 : 0.68 (0.27 mm). Labium (Fig. 13g); palpi, proximal segment 2.26 × longer than broad, distal segment; apex with four short teeth, segment ratios; 1.00 : 0.77 : 0.49 (0.44 mm).

Female Imago

Unknown.

Diagnostic Characteristics

1. Genitalia of male imago (Figs 12d, e and Figs 15e, f).
2. Gills of nymphs lanceolate, similar to *N. inconspicua* (Fig. 13c).

3. Labrum long (width 1.5 × greater than length) (Fig. 13d).
4. Prostheca shape of left and right mandibles (Figs 13i, k).
5. Legs lined with numerous long fine setae (Fig. 13a).

Type Locality

Type material was collected from Second Wannon River on the road from Halls Gap to Dunkeld, Grampian Mountains, Victoria. Grid Reference on 1 : 250 000 map series Ballarat Sheet: 547396. Collected 25 November 1977 by D. N. and P. J. Suter.

Type Specimens

Holotype male, and nymphal exuvium are placed in the Museum of Victoria. The wings and legs of the holotype are mounted on slides, and the body and genitalia are maintained in ethanol. The nymphal exuvium is mounted on slides. Three paratype males, two mature males and three mature female nymphs are included in the type series. Slides of a nymph, and adult male imago from Hitchcock Drain, South East South Australia, are also included.

Type Habitat

The Second Wannon River in the Grampians Mountains, is a moderately fast-flowing stream over cobble-sized rocks.

Etymology of Specific Epithet

The specific epithet *pilosa* (L) for hairy refers to the long, fine setae which line the margins of the legs distinguishing this species from *N. inconspicua* and *N. fuscula*.

Affinities

In the adult characters *N. pilosa* resembles closely *N. inconspicua*, with the penes fused, and lacking spination. *N. fuscula* is distinctly different with V-shaped penes, and internal spines. Although superficially similar, the penes of *N. inconspicua* and *N. pilosa* are distinct, with *N. inconspicua* with obvious ventral lobes, and separated basal halves of the penes (Figs 15a, b). *N. pilosa* lacks the ventral lobes, and the penes are fused along their entire length.

In nymphal characters *N. pilosa* resembles *N. inconspicua*, possessing lanceolate gills, but lacks the obvious dorsal white stripe on the abdomen, characteristic of *N. inconspicua*. The mouthpart structure, especially the labrum (Fig. 13d) and prostheeal structure (Figs 13i, k), and the fine setae on the legs, clearly distinguish *N. pilosa* from both *N. inconspicua* and *N. fuscula*.

A comparison of qualitative characteristics of the three species of *Nousia* from South Australia is given in Table 2.

History and Discussion

As mentioned previously the description of *N. fuscula* nymphs given by Tillyard (1936) is similar to that of *N. pilosa* and the associated nymph of *N. fuscula* differs from the description given by Tillyard. *N. fuscula* and *N. pilosa* appear ecologically separated by the timing of maturation and the imago mating flights. Therefore, it is possible that Tillyard indirectly associated the nymphs and adults collected from the River Shannon, Tasmania. Consequently it appears that the nymph of *N. pilosa* was indirectly ascribed to *N. fuscula*. The present descriptions are based on associated material, and distinguishes the nymphs of these two co-occurring species.

TABLE 2. COMPARISON OF QUALITATIVE CHARACTERISTICS OF *NOUSIA INCONSPICUA*, *N. FUSCULA* AND *N. PILOSA* FROM SOUTH AUSTRALIA

Character	*N. inconspicua*	*N. fuscula*	*N. pilosa*
Male Imago			
Legs: banding	Absent	Absent	Present
Penes	Fused apically Ventral lobes present No internal spines	Separate apically Ventral lobes absent Internal spines present	Fused apically Ventral lobes absent No internal spines
Nymph			
Legs: banding	Uniform brown	Absent	Present
Gills	Broad lanceolate	Linear	Broad lanceolate
Lamellae trachea	Plentiful, branched	Few, simple	Plentiful, branched
Left mandible			
Incisors Outer	3	3	3
Incisors Inner	3	3	3
Right mandible			
Incisors Outer	3	3	3
Incisors Inner	2	2	2
Prostheca Left	Slender, two terminal spines	Robust, apex serrated	Slender with lateral comb
Prostheca Right	Slender, two terminal spines	Slender, two terminal spines	Slender apex with three spines
Labial palpi	Slender	Broad	Slender
Labrum	Width ≑ 2 × length	Width ≑ 2 × length	Width <2 length
Hypopharynx	Not divided	Deeply divided	Not divided

GENUS *ULMEROPHLEBIA* Demoulin 1955

Demoulin 1955: 228-229; Tsui and Peters 1975: 538.

Male Imago

Fore wings 3-3.5 × longer than wide, with numerous cross-veins, those in the subcostal space are upright and parallel. Hind wing with narrow costal region with numerous cross-veins apically, Sc joins wing margin at 3/4 of wing length, MA forked, single intercalary present. Tarsal claws dissimilar, one blunt club-shaped, one long, slender, hooked distally (Fig. 17h). Forceps three-segmented, basal segment very long. Penes much shorter than basal segment of forceps, not reaching narrowing of this segment. Cerci longer than terminal filament.

Type Species: *Ulmerophlebia mjobergi.*

Mature Nymph

Head without tusk-like projections, labrum with a small convex projection on mid-anterior margin. Labial palpi three-segmented. Maxillary palpi three-segmented, distal segment very small. Gills on abdominal segments 1-7 paired, each consisting of a pair of broad, ovate lamellae, with apical tracheal filaments fringed with long fine hairs. Body and legs fringed with long fine setae. Abdominal segments 6-9 with postero-lateral margins produced into backward-pointing projections.

History and Discussion

Ulmerophlebia was described by Demoulin (1955) to include a species described by Ulmer (1916) in the genus *Euphyrus* as *E. mjobergi.* Subsequently Ulmer (1920) placed this species in *Deleatidium* and, Harker (1953) accepted this determination. In 1955, Ulmer noted that the 2ICuA were parallel, the hind wings had an Sc which joined the wing margin at 3/4 of wing length and resembled *Atalonella.* However, the short pointed penes of *D. mjobergi* separated this species from *Deleatidium* and *Atalonella,* and therefore a new generic designation was made. The only generic description is made by Ulmer (1916) in his species description and, therefore the characteristics of the imago are included here.

The nymph of *Ulmerophlebia* has never been formally described and, therefore the generic characteristics are also given here.

In the nymphal characteristics *Ulmerophlebia* resembles very closely nymphs of *Jappa* Harker. The only major distinguishing feature is the lack of frontal horns characteristic of this latter genus. Riek (1970) also made note of this similarity although indirectly, by stating that the eastern states' nymphs of the genus *Jappa* lack frontal horns. Tsui & Peters (1975) examined the thoracic morphology of nymphs of *Ulmerophlebia* and, although the nymphs had not been described or associated with adults they found only 4 of the 16 character states that they examined differed from nymphs of *Jappa.* These, plus the absence of frontal horns are the only differences in the nymph.

In the adults the major differences are the length of the penes, which in *Jappa* are almost equal to the length of the basal segment of the forceps and, the shorter Sc vein in the hind wing which extends almost to the apex of the wing in *Jappa.* Tsui and Peters (1975) recorded 1 of 6 character states that differed.

Clearly *Jappa* and *Ulmerophlebia* are closely related and future research may demonstrate that the two are congeneric. However, on the basis of the limited South Australian material, this is not possible as part of this work.

Ulmerophlebia pipinna sp. nov.

Holotype Male Imago

Body Length	9.44 mm
Notal Length	2.54 mm
Pronotal Width	0.92 mm
Mesonotal Width	1.33 mm
Fore Wing Length	9.31 mm
Hind Wing Length	2.03 mm
Cerci Length	14.10 mm
Terminal Filament Length	11.97 mm

Body colour reddish brown, abdomen darker dorsally.

Head: dark brown, with a white patch between ocelli. Antennae short, 1 mm long, basal segment twice as long as wide, flagella 0.87 mm long.

Thorax: light brown dorsally with white patches on scutoscutellum, laterally with patches of white and pink. Legs light brown, femora with two dark bands, one distally, and one at 2/3 of length, T_1 partially fused to tibia, join apparent. Ratios of leg segments: fore leg 1.00 : 1.74 : 0.07 : 0.65 : 0.60 : 0.47 : 0.19 (1.84 mm); middle leg 1.00 : 1.28 : 0.04 : 0.09 : 0.09 : 0.06 : 0.20 (1.49 mm); hind leg 1.00 : 1.09 : 0.04 : 0.08 : 0.06 : 0.06 : 0.15 (1.80 mm). Sternum dark brown (Fig. 17e). Prosternum with heavily sclerotized base. Mesosternum: basisternum length 1.46 × width, 0.79 × furcasternum length, posterior margin rounded; furcasternum length 0.87 × width, lateral margins of median longitudinal invagination divergent posteriorly, posterior margin slightly concave.

Wings: hyaline. Fore wing (Fig. 17a), length 3.5 × width, cross-veins in pterostigmal region simple, costal cross-veins extending along entire length, slightly shaded with grey, cross-veins of subcostal space also shaded with grey. Hind wing (Fig. 17b), length 2 × width, costal hump not exaggerated, costal space with 5 cross-veins distally. R_1 straight, Rs joins MA in centre of wing, MA straight, MP branched in proximal half of wing, anal region without cross-veins.

Genitalia: forceps light brown, proximal segment long, 0.74 mm, broad at base, narrows approximately half way along length, second segment almost square, distal segment longer, narrow proximally. Penes paired, very short, extending half way to narrowing of proximal segment of forceps, separate, mesal margins divergent, lobes simple (Figs 17c, d; 19a, b).

Mature Female Nymph (Fig. 20)

Head Width	1.96 mm
Notal Length	3.12 mm
Pronotal Width	2.32 mm
Mesonotal Width	2.36 mm
Cerci Length	8.25 mm
Terminal Filament Length	9.71 mm

Head: brown. Lateral eyes black. Antennae 3.08 mm long with whorls of setae at apex of each segment. Tentorial body; width 2.33 × length.

Thorax: brown. Pronotum, brown with black-brown median marking, lateral margins lined with long fine setae. Legs brown, with one mid and one distal black band on femora; tibiae and tarsi not banded (Fig. 18a). Tarsal claws short and curved, with 12-16 small rounded ventral denticles (Fig. 18b). Femora of fore and middle legs almost equal in length, hind leg longest, 1.34 × fore femur length. Ratios of leg segments: fore leg 1.00 : 1.04 : 0.37 (1.66 mm); middle leg 1.00 : 0.94 : 0.33 (1.60 mm); hind leg 1.00 : 0.87 : 0.26 (2.14 mm). Femur length to width ratios: fore leg 2.18, middle leg 2.22, hind leg 2.68. Sternum: prosternum triangular with apex truncated, sternacostal suture absent. Mesosternum: basisternum, almost square, length 0.92 × width, and equal to furcasternum length, sternacostal suture present. Metasternum: basisternum narrower than mesofurcasternum, width 4.75 × length.

Abdomen: dark brown with light central stripe on segments 4-7, segments 8, 9, and 10 dark brown (Fig. 20). All segments with long fine setae dorsally. Caudal filaments well developed, terminal filament longer than cerci. Gills (Fig. 18e).

Mouthparts: labrum (Fig. 18d) 2.12 × wider than long, lateral margins angular lined with long fine setae, mid anterior margin with seven tubercles, three tubercles on each side of a large sharp central projection (Fig. 18e), dorsal surface covered with long setae. Left mandible (Fig. 18h); lateral margin lined with long setae, incisors displaced mesally, outer incisors with two large teeth and four smaller teeth on mesal margin, inner incisors with three apical teeth and one small lateral tubercle, prostheca narrow with six spines (Fig. 18i). Right mandible (Fig. 18j); outer margin lined with long setae, incisors displaced mesally, outer incisors rugose, with three apical teeth, with four lateral tubercles, inner incisors with two apical teeth and one lateral tubercle, prostheca long, spinous (Fig. 18k). Hypopharynx (Fig 18f). Maxillae (Fig. 18l) galeo-lacinia rectangular, row of sixteen rake setae on ventral surface, rake setae also interspersed within apical brush; mesal corner with one large rake spine, inner margin lined with long fine pinnate setae; palpi longer than galeo-lacinia, proximal segment 2.33 × longer than wide, second segment long and broad, 1.88 × longer than wide, distal segment very short, triangular, covered with long setae, apex with two short spines, segment ratios 1.00 : 0.94 : 0.29 (0.36 mm). Labium (Fig. 18g); proximal segment of palpi 1.71 × longer than wide, segment ratios 1.00 : 0.65 : 0.58 (0.41 mm).

Female Imago

Unknown.

Subimago

Unknown.

Male Nymph

Unknown.

Diagnostic Characteristics

1. Genitalia of male imago, penes very short and simple (Figs 17c, d; 19a, b).
2. Wing length 3.5 × width (Fig. 17a).
3. Femora of imago with two black bands.
4. Nymph without frontal lobes (Fig. 20).
5. Labrum with one mid anterior projection and three denticles on each side (Figs 18d, e).
6. Maxillary palpi three segmented (Fig. 18l).
7. Lateral projection of glossae of labium (Fig. 18g).
8. Mandibles, shape and form of incisors and prostheeae (Figs 18h-k).

Type Locality

Second Wannon River, Grampian Mountains, Victoria, Grid Reference on 1 : 250 000 map series Ballarat Sheet: 547396. Collected 25 November 1977 by P. J. and D. N. Suter.

Type Specimens

The holotype male is deposited in the Museum of Victoria. Two paratype imagos are also placed in the Museum of Victoria. The wings and legs of the holotype male are mounted on slides, and the genitalia and body are in ethanol. The female nymph is mounted on slides.

Type Habitat

The Second Wannon River in the Grampian Mountains, is a moderately fast-flowing stream over large cobble-size rocks. The nymphs were collected using a kick-sample technique, and therefore there is no certainty of the habitat being occupied by this species.

Etymology of Specific Epithet

The penes of *U. pipinna* are very short and simple, hence the specific epithet *pipinna* (L) for small penes.

Affinities

The male imago of *U. pipinna* can be distinguished from *U. mjobergi* by the short simple penes. In *U. mjobergi* the penes are short and boot shaped, having a lateral angular projection, absent in *U. pipinna*.

Material Examined

SOUTH AUSTRALIA. South East: Cress Ck, Eight Mile Ck, Hitchcocks Drain.

VICTORIA. Crawford R., Fitzroy R., Fyans Ck, Shaw R., Wannon R., Second Wannon R.

FAMILY BAETIDAE

This family occurs on every continent, and is represented in Australia by the genera *Baetis* Leach, *Bungona* Harker, *Centroptilum* Eaton, *Cloeon* Leach and *Pseudocloeon* Klapálek.

Characterization of the Baetidae can be found in Edmunds, Jensen and Berner (1976).

GENUS *BAETIS* Leach 1815

Leach, 1815: 137; Burmeister, 1839: 800 (*B. costalis* later placed in *Atalophlebia*); Pictet, 1843: 189-191 (*B. australasica* later placed in *Atalophlebia*); Walker, 1853: 559-561 (*B. australasica, B. costalis*); Eaton, 1871: 110; 1881: 196; 1885: 156-158; Ulmer, 1908: 44-45; Tillyard, 1926: 64; 1936: 50-53; Harker, 1950: 21-24, 29; 1954: 263-264, 266; Scholes, 1961: 36-38; Riek, 1970: 235.

Type Species: *Baetis bioculatus* (Linn, Fabr.).

The first record of *Baetis* from Australia was made by Ulmer (1908) when *B. soror* was described from Western Australia. Tillyard (1936) described *B. frater* from Tasmania, and Harker (1950) added two further species *B. baddamsae* and *B. confluens* from New South Wales. In 1954, Harker described *B. sogerensis* from Port Moresby, New Guinea, but this species has not been recorded on the Australian mainland.

Müller-Liebenau (1969, 1973) recorded and discussed the characteristics used in the revision of the European species of *Baetis*; these characteristics have been found to be useful in the present study. The following redescription of the male adult, and the original description of the nymph of *B. soror* Ulmer, include the characteristics which Müller-Liebenau (1969, 1973) found to be species specific.

Baetis soror Ulmer 1908

Baetis soror Ulmer, 1908: 44-45; Tillyard, 1926: 64; Harker, 1950: 29; 1954: 266.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	5.45	0.45	18	4.40- 6.00
Notal Length	1.59	0.21	14	1.36- 2.00
Pronotal Width	0.62	0.08	12	0.54- 0.76
Mesonotal Width	0.88	0.08	12	0.74- 1.00
Fore Wing Length	4.93	0.51	30	4.20- 5.82
Hind Wing Length	1.01	0.16	30	0.80- 1.26
Cerci Length	11.57	0.92	5	10.25-12.50

General colour brown.

Head: dark brown. Dorsal turbinate eyes yellow, oval, lateral eyes black.

Thorax: light brown. Pronotum narrower than head. Legs; buff, slender. Fore legs longer than middle and hind legs, fore leg femur length 1.23 × middle leg femur length, and 1.25 × hind leg femur length, middle and hind legs with four tarsal segments. Ratios of leg segments: fore leg 1.00 : 1.80 : 0.08 : 0.78 : 0.62 : 0.37 : 0.18 (0.93 mm); middle leg 1.00 : 0.98 : 0.16 : 0.13 : 0.07 : 0.20 : - (0.75 mm); hind leg 1.00 : 0.97 : 0.16 : 0.13 : 0.07 : 0.20 : – (0.76 mm). Tarsal claws dissimilar, one blunt, club-shaped, one slender with a terminal hook.

Wings: fore and hind wings hyaline with light brown venation. Fore wing (Fig. 21a) 2.67 × longer than wide, pterostigmal region slightly opaque (milky) with 7-10 cross-veins, anastomosed, branched or incomplete, proximal region of costal space without cross-veins. Hind wing with triangular costal projection, three longitudinal veins, second forked with one intercalary, one proximally located cross-vein in costal space (Fig. 21b).

Abdomen: brown, with black marking (Fig. 21c). Cerci long, terminal filament reduced to a basal stump.

Genitalia: proximal segment of forceps cylindrical, second segment bulbous, fused to third segment, third segment long and slender, distal segment short but 3 × longer than wide, rounded, bulbous distally. Covers of penes broad, extending beyond bulbous second segment of forceps, bluntly pointed with divergent apices (Figs 21d; 19c).

Mature Male Nymph (Fig. 21e)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	0.97	0.07	22	0,86-1.06
Notal Length	1.50	0.14	17	1.30-1.74
Pronotal Width	0.87	0.09	17	0.76-1.00
Mesonotal Width	1.27	0.13	17	1.06-1.46
Cerci Length	3.43	0.50	7	2.60-4,16
Terminal Filament Length	2,29	0.24	7	2.00-2.60

Body cylindrical, light brown.

Head: brown, dorsal compound eyes sepia, lateral eyes black. Antennae long without apical projection on basal segment.

Thorax: mesonotum brown with an oxbow shaped white marking beside mesonotal suture. Legs buff-grey with darker femur-tibia joint (Fig. 21f). Tarsal claws short curved with ventral peg-like denticles (Fig. 21g). Ratios of leg segments: fore leg 1.00 : 0.72 : 0.64 (0.77 mm); middle leg 1.00 : 0.71 : 0.58 (0.79 mm); hind leg 1.00 : 0.68 : 0.54 (0.82 mm). Femur length to width ratios: fore leg 3.15, middle leg 3.45, hind leg 3.70.

Abdomen: brown, without definite markings. Posterior margins of terga with short sharp spines. Paraprocts curved, lined with 17-24 spines (Figs 21h; 22a, b). Gills (Figs. 21i), margins serrated with one fine bristle alternating with each serration (Fig. 21i), first gill small without clear trachea, gills 2-7 with black branched trachea, 3,4,5, largest, ovate, 1,7 narrower, *Mouthparts:* labrum (Fig. 21j) ovoid, length 0.58 × width, with deep concavity in centre of anterior margin (Fig. 21k), two small median denticles within concavity. Left mandible (Fig. 21n) outer incisors with three teeth, outer tooth broad and robust, inner incisors with one long central tooth and three shorter lateral teeth, prostheca robust with one large curved apical tooth with 3-4 spines in concavity of tooth (Fig. 21o). Right mandible (Fig. 21p); outer incisors with first tooth robust with two small inner teeth, inner incisors with 1-2 long central teeth with two (one each side) lateral teeth, prostheca long and narrow with outer margin lined with 6-7 setae (Fig. 21q). Hypopharynx (Fig. 21r). Maxillae (Fig. 21l); galeo-lacinia long and narrow with pointed apex, lined with four stout teeth, ventrally with a line of pinnate setae and a line of curved setae below teeth, palpi longer than galeo-lacinia, three-segmented, segment ratios 1.00 : 1.45 : 0.36 (0.10 mm), distal segment with a short tooth, all segments with short fine setae. Labium (Fig. 21m); palpi, length of proximal segment 2.06 × width, inner margin of second segment produced forming a lobe, segment ratios 1.00 : 0.71 : 0.33 (0.19 mm).

Female Imago

Wings similar, lacking dorsal compound eyes, fore legs shorter than male, body colour cream, abdomen broad.

Female Nymph

Similar to male, lacking dorsal compound eyes, lateral eyes black.

Diagnostic Characteristics

1. Hind wings with three longitudinal veins, second forked (Fig. 21b).
2. Third and fourth segments of forceps elongated (Figs 21d; and Fig. 19c).
3. Dorsal compound eye yellow in imago.
4. Incisors and prostheceae of left and right mandibles (Figs 21n-q).
5. Number of spines on paraprocts (Figs 21h; 22a, b).

History and Discussion

Ulmer (1908) described *Baetis soror* from south-west Western Australia. This species resembles the South Australian species in hind wing venation and forceps structure. Ulmer recorded that "the costal and subcostal region of the fore wings are weakly tanned (browned)" *sic*, translation from Ulmer, 1908, but the South Australian specimens possess a milky costal and subcostal region. Müller-Liebenau (1973) stated "the colour of the pterostigma can be useful, especially when one separates two related species in the same material". This colour difference is usually associated with other character differences (genitalia and hind wing venation) and is not used as a primary specific character. Until further material from Western Australia is made available, it is considered that this single feature which differs from the type description is not enough to validate erection of a new species for the South Australian material. This material is therefore designated as *Baetis soror* Ulmer.

Material Examined

SOUTH AUSTRALIA. South East: Eight Mile Ck; Deep Ck, Jerusalem Ck, Mosquito Ck, Hitchcock Drain. Mt. Lofty Ranges: Deep Ck, Little Para R. Fleurieu Peninsula: The Deep Ck (Delamere), Finnis R., Hindmarsh R., Inman R., Tookayerta Ck, Yankalilla R. Southern Flinders Ranges: Nectar Brook Ck, Spring Ck. Northern Flinders Ranges: Balcanoona Ck, Brachina Ck, Bunyeroo Ck, Elatina Ck, Emu Ck, Wirrealpa Ck.

GENUS *CENTROPTILUM* Eaton 1869

Eaton, 1869: 131-132; 1871: 107-108; 1885: 174-175; Harker, 1957: 75-76; Rick, 1970: 235.

Type Species: *Centroptilum luteolum* Eaton.

Centroptilum is also a cosmopolitan genus, but it was not until Harker (1957) described *C. collendum* from Kuringae Chase, New South Wales, that an Australian species was recognised. A new species *C. elongatum* sp. nov. which is recorded in South Australia, is described from associated material from the Wannon River, Victoria. *C. elongatum* has a limited distribution in South Australia and although many nymphs are present in the collections there are relatively few adult specimens. Consequently the type series was taken from a much larger collection made in Victoria, from which some assessment of variation of character expression could be made.

Centroptilum elongatum sp. nov.

Holotype Male

Body Length	8.20 mm
Notal Length	2.01 mm
Pronotal Width	0.95 mm
Mesonotal Width	1.33 mm
Fore Wing Length	7.05 mm
Hind Wing Length	1.72 mm
Cerci Length	14.02 mm
Terminal Filament absent.	

Head: light brown. Dorsal eyes turbinate with upper portion brown/orange, oval, lateral eyes grey.

Thorax: pronotum brown. Metanotum dark brown with median backward-produced projection (Fig. 23c). Legs; fore leg femur light brown, tibia and tarsal segments darker brown, middle and hind legs light brown, tarsal segments darker brown. T_1 fused to tibia in all legs. Fore leg longer than middle and hind legs, fore leg femur length 1.19 × middle leg femur length, and 1.16 × hind leg femur length. Ratios of leg segments (second value is the combined tibia + T_1

length to femur length): fore leg 1.00 : 1.18 : - : 0.50 : 0.44 : 0.26 : 0.16 (1.60 mm); middle leg 1.00 : 0.75 : - : 0.19 : 0.10 : 0.08 : 0.16 (1.34 mm); hind leg 1.00 : 0.74 : - : 0.19 : 0.10 : 0.07 : 0.16 (1.38 mm). Sternum light brown (Fig. 23e).

Wings: hyaline. Fore wing (Fig. 23a); 2.78 × longer than wide, costal and subcostal spaces shaded with yellow, pterostigma with 10-14 cross-veins, some forked, one faint cross-vein in costal space present or absent, subcostal space with six cross-veins. Hind wing (Fig. 23b); 2.15 × longer than wide, with a curved costal projection, three longitudinal veins, second forked with one intercalary, two cross-veins between first and second longitudinal veins.

Abdomen: brown dorsally with red tinges in patches on segments 2-4 and 6-9, segment 1 dark brown (Fig. 23c). Light brown ventrally with paired brown markings on each side of median line.

Genitalia (Fig. 23d; Fig. 19d): forceps four-segmented, proximal segment rectangular 1.6 × longer than wide, second segment fused to third segment, third segment long and slender, bowed slightly, distal segment shorter, rounded apically. Pene covers paired, rectangular, rounded apically, divergent, extending beyond apex of proximal segment of forceps.

Mature Male Nymph (Fig. 23f)

Body Length	7.68 mm
Head Width	1.32 mm
Notal Length	2.12 mm
Pronotal Width	1.16 mm
Mesonotal Width	1.68 mm
Cerci Length	4.20 mm
Terminal Filament Length	3.44 mm

Body colour brown.

Head: brown. Dorsal compound eyes red-brown.

Thorax: brown. Legs yellow-brown with black patches distally on femur about 2/3 of length (Fig. 24a); tibia and tarsi yellow-brown, not marked. Tarsal claws very long and slender, half tarsal length, lined proximally with 13-20 fine denticles, distal half smooth and tapering. Ratios of leg segments: fore leg 1.00 : 0.63 : 0.66 (1.28 mm); middle leg 1.00 : 0.62 : 0.54 (1.30 mm); hind leg 1.00 : 0.62 : 0.52 (1.30 mm). Femur length width ratios: fore leg 4.92, middle and hind leg 5.42.

Abdomen: brown, with tinges of red-brown, patterned as in Fig. 23f. Posterior margin of tergites with long spines and smaller minute spines between them. Hind margin of sternites similarly lined with long spines and only minute inner basal spines. Paraprocts rounded, with 25 large spines on internal and apical margins (Fig. 24c; Fig. 22d); hind margins of ninth sternite with developing forceps, separated by a concave depression with 24 spines (Fig. 24b; Fig. 22c). Gills with black, branched trachea (Fig. 24d), first gill smallest, half-moon-shaped, fifth and sixth largest, margins serrated with one short fine bristle in each depression.

Mouthparts: labrum rectangular (Fig. 24e), length 0.77 × width, with a broad, deep, V-shaped concavity, with truncated apex, and lateral denticles near apex (Fig. 24f). Left mandible (Fig. 24i), outer incisors with four large teeth apically and four smaller teeth along inner margin, outer margin with one long spine, inner incisors with three large apical teeth and 3-4 small tubercles on inner basal margin, prostheca long, broadest proximally with paired apical projections, one long and slender with one apical spine seta, the other shorter, curved and blunt, with a sharp opposing tooth (Fig. 24j). Right mandible (Fig. 24k): outer incisors with three large teeth, outer margin with one long tapering spine, inner incisors with two contiguous teeth, prostheca strap-like, long and slender with 2-3 minute spines on apex, and two long setae near mid region (Fig. 24l). Hypopharynx simple, median lobe with a large, bulbous, apical tubercle (Fig. 24h). Maxillae (Fig. 24m): palpi three-segmented, longer than galeo-lacinia, basal segment long and slender, 3.67 × longer than wide, lined with short fine setae, segment ratios 1.00 : 0.55 : 1.09 (0.22 mm). Labrum (Fig. 24c); palpi three-segmented proximal segment 2.43 × longer than wide, second segment narrow proximally, broad distally, distal segment short, broad with concave apical margin, segment ratios 1.00 : 0.71 : 0.35 (0.34 mm).

Female Imago

Resembles male, but lacks dorsal turbinate eyes. Body length 7.95 mm, fore wing length 7.45 mm, hind wing length 2.87 mm. Thorax grey, abdomen red-brown. Costal margin of fore wing brown. Fore leg shorter than in male. Sub-anal plate with paraprocts lacking spines.

Female Nymph

Similar to male, lacking dorsal compound eyes, lateral eyes black. Ninth abdominal sternite hind margin square and lined with spines.

Diagnostic Characteristics

1. Genitalia, shape of last segment of forceps (Fig. 23d; Fig. 19c).
2. Hind wing lacks acute costal projection (Fig. 23b).
3. Number of spines on paraprocts of nymphs (Figs 24b, c; Figs 22c, d).
4. Incisors and prostheca of mandibles (Figs 24i-l).
5. Labrum shape (Fig. 24e).
6. Saddle-like colour pattern on abdomen (Fig. 23f).

Type Locality

Wannon River just above Wannon Falls, near Wannon, Western Victoria, Grid reference 1 : 250 000 map series Hamilton Sheet: 353482. Collected 30 October, 1977 by P. and A. Suter and A. Wells.

Type Specimens

The holotype male and nymphal type are located in the Museum of Victoria. Five paratype male imagos and paratype nymphs are also placed in the Museum of Victoria and five paratype male imagos and nymphs are placed in the South Australian Museum.

Type Habitat

The nymphs were found in fast-flowing water about 500 m above the Wannon Falls. Adult males and females were swarming in the afternoon sun above a grass covered bank about 10 m above the water's edge.

The habitat records of this species in South Australia are quite variable, but may reflect only the season and flow conditions of the streams from which the collections were made. Collections from Kangaroo Island, and Mosquito Creek in South East South Australia during spring, indicated that *C. elongatum* nymphs occupied a similar habitat to that observed in Victoria. However, in Carrickalinga Creek on the Fleurieu Peninsula, a collection was made in November 1977 when the creek was in the process of drying, and pools were being formed. It was from one of these stationary *Juncus* lined pools, that the only record of *C. elongatum* on the Fleurieu Peninsula, was made. At times of higher water levels and discharge, *C. elongatum* may be found occupying the faster-flowing waters, rather than the stationary pool habitat recorded in November 1977.

Etymology of Specific Epithet

The specific epithet *elongatum* refers to the elongated distal segment of the forceps of the male imago. This long segment distinguishes *C. elongatum* from *C. collendum* Harker, the only other species in this genus described from Australia.

Affinities

Of the diagnostic features, the genitalia and hind wing characteristics clearly distinguish *C. elongatum* from *C. collendum* Harker. Harker's (1957) description records that the nymphs of *C. collendum* have long tarsal claws: "about equal in length to the tarsus itself". *C. elongatum* has much shorter tarsal claws, being about half the tarsal length. Other differences between the nymphs are not obvious from Harker's description, and the nymphal morphotype of *C. collendum* has not been examined.

Material Examined

SOUTH AUSTRALIA. South East: Mosquito Ck. Fleurieu Peninsula: Carrickalinga Ck. Kangaroo Island: Breakneck R., DeMole R., Rocky R., South West R., Stunsail Boom R., Western R.

VICTORIA. Jimmy's Ck, Mt. Emu Ck, Wannon R.

GENUS *CLOEON* Leach 1815

Leach, 1815: 137; Eaton, 1868: 87-88; 1871: 102; 1885: 179-181; Klapálek, 1905: 106-107; Ulmer, 1916: 17; 1919: 54; Tillyard, 1926: 64; 1936: 53-55; Harker, 1950: 24, 29; 1954: 266; 1957: 72-73; Scholes, 1961: 38-39; Riek, 1970: 236.

Type Species: *Cloeon dipterum* (Linn. Fabr.).

History and Discussion

The genus *Cloeon* was erected in 1815 by Leach, to include *C. dipterum* (Linn. Fabr.). Eaton (1868) noted "A species (1 specimen in British Museum) is reputed to be from S. Australia"., and in 1885 he included Australia in the distribution of this cosmopolitan genus.

The first confirmed record of *Cloeon* in Australia was made by Ulmer (1916) when he recorded *C. virens* Klapálek (incorrectly spelt as *C. viridis* Klap. by Ulmer and later by Tillyard, 1926) from the Kimberley district, N.W. Australia. This species was originally described from Java by Klapálek (1905). A further species *C. fluviatile* Ulmer was described by Ulmer (1919) from New Guinea, and was later recorded at Armidale (N.S.W.) by Harker (1950), who added the description of the egg.

Tillyard (1936) recorded *C. tasmaniae* from the Macquarie R., Tasmania, and described the male and female imagos, and the subimago. Harker (1957) described the first *Cloeon* nymph in her description of *C. nandirum* from Townsville, Queensland.

The present study recognises one new species, and *C. fluviatile* Ulmer from South Australia, and the descriptions include the characteristics used by Müller-Liebenau (1969, 1973) in her revision of *Baetis*. The nymph of *C. fluviatile* is described from South Australian material.

Cloeon fluviatile Ulmer 1919

Cloeon fluviatile Ulmer, 1919: 54-57; Harker, 1950: 24, 29; 1954: 266.

The following description is based on one male imago from the Third Spring on the Oratunga Loop, Flinders Ranges, South Australia, collected 9 April 1977 by P. J. Suter.

Body Length	4.12 mm
Notal Length	1.40 mm
Pronotal Width	0.56 mm
Mesonotal Width	0.80 mm
Fore Wing Length	4.32 mm
Cerci Length	8.53 mm
Terminal Filament absent.	

Head: dark brown. Antennae light brown 0.72 mm long. Dorsal eyes turbinate, upper portion yellow-brown, lateral portion lighter brown.

Thorax: brown, notal sutures black. Legs; buff. T_1 fused in middle and hind tibia, only partially fused in fore tibia. Ratios of leg segments: fore leg 1.00 : 1.76 : 0.07 : 0.68 : 0.49 : 0.27 : 0.20 (0.82 mm); middle leg 1.00 : 0.82 : - : 0.28 : 0.15 : 0.08 : 0.18 (0.78 mm); hind leg 1.00 : 0.86 : - : 0.26 : 0.12 : 0.07 : 0.19 (0.86 mm). Sternum brown (Fig. 25c).

Wings: hyaline. Fore wing (Fig. 25a) length 2.70 × width, costal and subcostal region opaque, cream-coloured, milky in pterostigmal region, pterostigma with 2-4 cross-veins, no cross-veins in proximal region of costal space, subcostal space without cross-veins.

Abdomen: red-brown with light brown median markings on segments 1-7, segments 8, 9, 10 red-brown (Fig. 25b). Light red-grey ventrally. Cerci long, white with red-brown joints every fourth segment, terminal filament absent.

Genitalia (Figs 25d-f; 19e): Forceps proximal segment rectangular, length 0.69 × width, second segment slender, partially fused with third segment which is long and slender, distal segment short, with a basal stalk and globular apex. Penes covers large and obvious, extending to middle of second segment of forceps, separate, rectangular, apices divergent. Subgenital plate with a posterior brown projection which separates proximal segments of forceps.

Mature Male Nymph

Body Length	5.08-5.60
Head Width	1.02-1.08
Notal Length	1.60-1.74
Pronotal Width	0.92-0.98
Mesonotal Width	1.38-1.46
Cerci Length	3.50-5.40
Terminal Filament Length	1.62-3.80

Body cylindrical, general colour light brown.

Head: brown. Dorsal compound eyes red-brown. Antennae long, 3 × longer than head width.

Thorax: pronotum width 0.91 × head width, brown with light markings. Mesonotum width 1.35 × head width, uniformly light brown. Legs cream with brown banding, one band on distal 1/3 of femur, one proximally on tibia, tarsus with one proximal and one distal band (Fig. 26a). Tarsal claws long and slender with two ventral rows of peg like denticles (Fig. 26b). Ratios of leg segments: fore leg 1.00 : 0.73 : 0.63 (1.01 mm); middle leg 1.00 : 0.74 : 0.54 (1.03 mm); hind leg 1.00 : 0.68 : 0.53 (1.16 mm). Femur length-width ratios: fore leg 4.87, middle leg 5.01, and hind leg, 5.27.

Abdomen: brown, with dark brown rectangular patches on each segment, edged with light brown, a central light stripe on each segment (Fig. 26c), lateral flanges of segments 7-10 lined with spines, 1-2 spines on postero-lateral margins. Posterior margins of tergites with large single spines. Paraprocts with 16-22 spines on inner and apical margins, largest spine at apex, smaller mesally (Fig. 26d). Gills (Fig. 26e) with paired lamellae on segments 1-6, single on segment 7, black branched trachea, margins serrated with short fine bristle in each depression.

Mouthparts: labrum (Fig. 26f) rectangular, 1.94 × broader than long with a U-shaped concavity in centre of anterior margin (Fig. 26g). Left mandible (Fig. 26j); robust, outer incisors with 3-4 large teeth, inner incisors with 4-5 teeth, prostheca with three apical denticles and two sharp spines (Fig. 26k). Right mandible (Fig. 26l) robust, outer incisors with three apical teeth, inner incisors with three large and one small teeth, prostheca long and slender, mesal margin near apex with two short spines and one small denticle (Fig. 26m). Hypopharynx (Fig. 26n). Maxillae (Fig. 26i) galeo-lacinia slender, with three well developed apical teeth, lined mesally with 12-15 large spine setae, palpi longer than galeo-lacinia, proximal segment 5.83 × longer than wide, segment ratios; 1.00 : 0.80 : 0.82 (0.15 mm), distal segment lacks apical spines. Labium (Fig. 26h); palpi: length of proximal segment 2.20 × width, apical margin of distal segment concave lined with short spine setae, segment ratios: 1.00 : 0.61 : 0.80 (0.22 mm); glossae shorter than paraglossae.

Female Imago

Lacks dorsal compound eyes, lateral eyes black, fore leg shorter than male, otherwise similar to male imago.

Female Nymph

Similar to male nymph, lacks dorsal compound eyes, lateral eyes black, thorax broad, wider than head.

Diagnostic Characteristics

1. Distal segment of forceps minute, globular (Figs 25d-f; 19e).
2. Turbinate eyes yellow/brown.
3. Incisors and prostheca of left and right mandibles (Figs 26j-m).
4. Distal segment of maxillary palpi without apical spines (Fig. 26i).
5. Paraproct spination (Fig. 26d).

History and Discussion

C. fluviatile was described in 1919 by Ulmer from specimens from New Guinea. Harker (1950) recorded this species from Armidale, New South Wales, and described the egg. Since the type material is held in the Berlin Museum (Ulmer 1919) or the Stockholm Museum (Harker 1950, 1954) it was not available for this study. The South Australian specimens have no features which distinguish them from the species described by Ulmer, and until the type material is examined they are placed as *C. fluviatile* Ulmer.

Material Examined

SOUTH AUSTRALIA. Mt. Lofty Ranges: Torrens R. Southern Flinders Ranges: Ohlenmeyer Reservoir, Rocky R., Wild Dog Ck. Northern Flinders Ranges: Balcanoona Ck, Bendieuta Ck, Brachina Ck, Elatina Ck, Emu Ck, Eregunda Ck, Kanyaka Ck, Marolana Ck, Mt. Chambers Ck, Parachilna Ck, Stubbs Waterhole, Willigan Ck, Creek in Warren Gorge.

Cloeon paradieniensis sp. nov.

Holotype Male

Body Length	7.80 mm
Notal Length	2.96 mm
Pronotal Width	0.92 mm
Mesonotal Width	1.20 mm
Fore Wing Length	7.05 mm
Cerci Length	15.73 mm

Head: brown. Antennae short, 1.02 mm, buff. Dorsal eyes turbinate, yellow dorsally, brown laterally.

Thorax: brown, pronotum narrower than head. Legs: white-cream, fore leg longer than middle and hind legs, fore leg femur length 1.06 × middle leg femur length, and equal to hind leg femur length. T_1 of middle and hind legs fused to tibia. Ratios of leg segments: fore leg 1.00 : 1.68 : 0.05 : 0.70 : 0.50 : 0.28 : 0.18 (1.48 mm); middle leg 1.00 : 1.01 : - : 0.29 : 0.13 : 0.06 : 0.16 (1.40 mm); hind leg 1.00 : 0.99 : - : 0.26 : 0.12 : 0.06 : 0.15 (1.46 mm).

Wings: hyaline (Fig. 25g); 2.89 × longer than wide, veins buff, transparent, pterostigmal region with 3-4 cross-veins, well separated, proximal region of costal space with two cross-veins, sub-costal space with two cross-veins in distal half.

Abdomen: red-brown with a light brown dorsal stripe, segments 8 and 9 dark red-brown, 10 lighter (Fig. 25h). Cerci long, terminal filament reduced to a vestigial stump.

Genitalia (Figs 25i-k; 19f): forceps proximal segment short and broad; second segment short, narrower than proximal segment, almost fused with third segment; third segment long and narrow, bulbous apically; distal segment short and angular, conical. Penes covers broad, extending beyond fusion of second and third segments of forceps, bluntly pointed, apices divergent.

Mature Male Nymph

Head Width	1.31 mm
Notal Length	1.96 mm
Pronotal Width	1.15 mm
Mesonotal Width	1.64 mm
Cerci Length	6.23 mm
Terminal Filament Length	4.59 mm

Body cylindrical, red-brown dorsally, light brown ventrally.

Head: dorsal compound eyes red-brown (sepia). Antennae long, 4.92 mm, proximal and second segment brown, flagellae buff.

Thorax: pronotum width 0.88 × head width, brown with median longitudinal white stripe. Mesonotum width 1.25 × head width, brown with light median longitudinal stripe. Sternum light brown, with little sclerotization. Legs buff without markings (Fig. 27a). Tarsal claws long and slender, with two ventral rows of peg-like denticles. Ratios of leg segments: fore leg 1.00 : 0.67 : 0.58 (1.44 mm); middle leg 1.00 : 0.67 : 0.51 (1.56 mm); hind leg 1.00 : 0.79 : 0.60 (1.68 mm). Femur length to width ratios: fore leg 5.18, middle leg 6.05, hind leg 6.51.

Abdomen: red-brown dorsally, yellow-brown ventrally, without definite colour pattern, overlap of segments darker brown. Lateral margins of segments 7-10 lined with spines, postero-lateral margins with 2-3 spines, posterior margins of tergites with large and small irregularly placed spines. Paraprocts broadly triangular, lined on mesal margin with 27-30 large spines (Fig. 27b). Cerci long, terminal filament shorter, every fourth segment red-brown, giving banded appearance. Gills; lamellae paired on segments 1-6 (Fig. 27e), seventh single, margins of gills serrated with a single fine bristle.

Mouthparts: labrum (Fig. 27c) rectangular, 1.5 × broader than long with a deep concavity in centre of anterior margin (Fig. 27d). Left mandible robust (Fig. 27i), outer incisors with four teeth, inner incisors with 3-4 teeth, prostheca robust with a corrugated apex of 5-6 rounded teeth and two long spines mesally (Fig. 27j). Right mandible (Fig. 27k) robust, outer incisors with four teeth, inner incisors with two large teeth and two smaller teeth, prostheca robust with apex of 6-8 tooth-like ridges (Fig. 27l). Hypopharynx (Fig. 27g) simple, median lobe rounded with a small median bulbous projection. Maxillae (Fig. 27f) galeo-lacinia long and narrow, with three well developed sharp teeth apically, palpi longer than galeo-lacinia, proximal segment 5.33 × longer than wide, segment ratios 1.00 : 0.69 : 0.88 (0.24 mm), distal segment fringed with fine setae, and two small terminal teeth. Labium (Fig. 27h) palpi three segmented, length of proximal segment of palpi 2.74 × width, apical margin of distal segment slightly concave, segment ratios 1.00 : 0.56 : 0.48 (0.33 mm); glossae shorter than paraglossae.

Female Imago

Without dorsal compound eyes, fore legs shorter than male. Fore wing: costal and subcostal spaces shaded with red-brown, twelve cross-veins in costal space. Body colour red-brown.

Female Nymph

Similar to male, lacks dorsal compound eyes, lateral eyes black, thorax broader than male, pronotum wider than head.

Diagnostic Characteristics

1. Distal segment of forceps conical shape (Figs 25i-k; 19f).
2. Turbinate eyes yellow.

3. Female with costal and subcostal spaces shaded red-brown.
4. Incisors and prostheca of left and right mandibles (Figs 27i-l).
5. Paraproct spination (Fig. 27b).
6. Maxillary palpi with terminal spines on distal segment (Fig. 27f).

Type Locality

Little Para River at Paracombe, Mt. Lofty Ranges, South Australia, Grid Reference 1 : 250 000 map series, Adelaide Sheet: 179695. Collected 20 October, 1976 by J. H. Diener and P. J. Suter.

Type Specimens

Holotype male and nymphal type and allotype female are located in the Museum of Victoria. This short type series is because this species is only known from two collections from the type locality, and one is the drain system of the South East. Further material has not been collected.

Type Habitat

The nymphs were found in a non-flowing pool system in a culvert beside the Paracombe road. The pool was overgrown with *Nasturtium* sp. and *Lemna* sp. Adults were raised in the laboratory from mature nymphs collected from the type locality.

Etymology of the Specific Epithet

The specific epithet *paradieniensis* refers to the river (Little Para River), and is in recognition of J. H. Diener whose collection from the Little Para River was the first of this species.

Affinities

Cloeon paradieniensis resembles all the described Australian species, but it can be readily distinguished by the conical shaped distal segment of the forceps of the male imago. The nymph can only be compared with *C. nandirum* Harker and *C. fluviatile* Ulmer, the only Australian species associated with their nymphs. The shape of the labrum clearly distinguish the nymphs of

TABLE 3. TABULATED COMPARISON OF ALL DESCRIBED SPECIES OF *CLOEON* IN AUSTRALIA — DATA COLLECTED FROM THE PRESENT STUDY AND FROM PUBLISHED DESCRIPTIONS BY KLAPÁLEK (1905), ULMER (1919), TILLYARD (1936) AND HARKER (1957)

Character	*Cloeon fluviatile*	*C. paradieniensis*	*C. nandirum*	*C. virens*	*C. tasmaniae*
Male Imago					
Body length (mm)	4.12	7.80	7	6	7
Fore Wing length (mm)	4.32	7.05	4	6	6
Fore Wing width (mm)	1.60	2.44	1.6	2.27	2.4
Cerci length (mm)	8.53	15.73	—	11-12	12
Eye colour	Sepia	Yellow	Orange	—	Buff-pink
Pterostigmal cross-veins	2-4	3-4	5	4-5	5
C/Sc basal cross-veins	0	2-5	0	6	—
Sc/R cross-veins	0	2-6	0	7	—
Costal colouration	Milky	Milky	Milky	Emerald Green in females.	Cream
Genitalia					
Forceps, terminal segment	Short and narrow	Triangular	Long and narrow	Short and narrow	Globular
Penes covers	Rectangular, flat apically	Pointed apically	?	?	?
Nymph					
Body length (mm)	5.08-5.60	—	6	Unknown	Unknown
Head width (mm)	1.02-1.08	1.31	—		
Cerci length (mm)	3.50-5.40	6.23	—		
Terminal filament length	1.62-3.80	4.59	—		
Legs	Banded	Not banded	Not banded		
Left Mandibles					
Outer incisors	3-4 teeth	3-4 teeth	—		
Inner incisors	4-5 teeth	5-6 teeth	—		
Prostheca	3 denticles + 2 sharp spines	5-6 teeth + 2 long spines	—		
Right Mandibles					
Outer incisors	3 teeth	4 teeth	—		
Inner incisors	3 large, 1 small	2 large, 2 small	—		
Prostheca	Long and slender, 2 short spines + 1 denticle apically	Robust, 6-8 tooth-like ridges	—		
Maxillary palpi	No terminal teeth	2 terminal teeth	—		

C. paradieniensis and *C. nandirum*, but as the type material is in the British Museum, and the description given by Harker (1957) was not comprehensive enough, no further character comparisons are possible.

The nymphs of *C. paradieniensis* can be distinguished from *C. fluviatile* Ulmer initially by size, the latter species being less than 6 mm, the former greater than 7.5 mm. The number of spines on the paraprocts, the lack of bands on the femora, spines on the distal segment of the maxillary palpi, and the shape of the prostheca of the right mandible also distinguish the two species found in South Australia. Tabulated comparisons of all Australian *Cloeon* species is given in Table 3, with data taken from the present study, and from published descriptions by Klapálek (1905), Ulmer (1919), Tillyard (1936) and Harker (1957).

FAMILY SIPHLONURIDAE

A full revision of this Family is at present being prepared by Dr I. Campbell, Chisholm Institute of Technology, Victoria.

GENUS *TASMANOPHLEBIA* Tillyard 1921

Tillyard, 1921: 409-412; 1926: 62; 1933: 12-13; 1936: 27; Lestage, 1935a: 132; 1935b: 350-353 (in part as *Tasmanophlebioides*); Harker, 1950: 29; 1954: 267; Riek, 1955: 268-269; 1970: 235; Scholes, 1961: 21-23.

Type Species: *Tasmanophlebia lacustris.*

As mentioned above, Dr I. Campbell is revising the Siphlonuridae and therefore material of the single species of *Tasmanophlebia* recorded in South Australia has been forwarded to him for comparison with other Australian species. No specific designation has been made for the South Australian species.

Tasmanophlebia sp.

The following description is of one male imago from Tookayerta Creek, Fleurieu Peninsula, South Australia. Adult specimens are rare in collections from South Australia, and for this reason the mean, ranges and standard deviations are based on only three animals.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	10.40	1.03	3	9.40-11.46
Fore Wing Length	9.54	0.90	3	8.53-10.26
Fore Wing Width	2.90	0.43	3	2.42- 3.25
Hind Wing Length	4.53	0.61	3	3.86- 5.06
Hind Wing Width	2.51	0.26	3	2.23- 2.74
Cerci Length	4.71	(other cerci damaged)		
Terminal Filament Length	0.24	0.14	3	0.08- 0.32

Head: light brown. Dorsal region of compound eyes burgundy.

Thorax: brown. Fore leg dark brown, longer than middle and hind legs, fore leg femur length 2.11 × middle leg femur length and 1.87 × hind femur length. Middle and hind legs light brown, first tarsal segment fused to tibia. Ratios of leg segments: fore leg 1.00 : 0.67 : 0.63 : 0.47 : 0.52 : 0.47 : 0.28 (2.24 mm); middle leg 1.00 : 0.84 : - : 0.17 : 0.17 : 0.14 : 0.29 (1.06 mm); hind leg 1.00 : 0.80 : - : 0.17 : 0.17 : 0.12 : 0.28 (1.20 mm).

Wings: fore and hind wings hyaline, tinged with yellow, veins brown. Fore wing (Fig. 28a) 3.31 × longer than wide, costal and subcostal region shaded with brown, radial and proximal regions of median, cubital and anal veins tinged with yellow. Hind wing (Fig. 28b); 1.79 × longer than wide, half as long as forewing, subcostal space shaded with brown, costal, subcostal and proximal regions of the radial and anal veins tinged with yellow.

Abdomen: brown, speckled with black, segments 8 and 9 with median black stripe and two convex lateral stripes, segment 10 black (Fig. 28c). Cerci long, dark brown, terminal filament vestigial, of 1-4 segments.

Genitalia (Figs 28d, e; 30a, b); forceps three-segmented, subgenital plate broad forming forceps base, proximal segment very long and narrow, middle segment shorter, but elongated, distal segment just shorter than middle, rounded apically. Penes long, narrow, extending to mid proximal segment of forceps, lobes tubular, almost fused, rounded at apices.

Mature Male Nymph (Fig. 28g)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	1.71	0.12	6	1.52- 1.84
Body Length	12.64	1.00	4	11.18-13.40
Notal Length	2.91	0.21	6	2.58- 3.20
Pronotal Width	1.77	0.12	6	1.58- 1.88
Mesonotal Width	2.26	0.16	6	2.00- 2.44
Cerci Length	5.09	0.29	3	4.71- 5.41
Terminal Filament Length	4.68	0.13	3	4.52- 4.83

Colour mottled sandy brown.

Head: small, light brown. Compound eyes large, red-brown dorsally, black laterally. Antennae 1.30 mm long.

Thorax: pronotum as wide as head, mottled grey-brown. Mesonotum width 1.32 × head width, mottled brown. Legs yellow-brown, femora with a brown patch on posterior margin, joints of tibia and tarsi dark brown, tarsi with brown bands along length, equivalent to tarsal segments of adult (Fig. 29a). Tarsal claws long and slender 0.50-0.71 × length of tarsus, smooth without denticles. Ratios of leg segments: fore leg 1.00 : 0.46 : 0.85 (1.25 mm); middle leg 1.00 : 0.41 : 0.67 (1.30 mm); hind leg 1.00 : 0.44 : 0.74 (1.32 mm). Femur length to width ratios similar; fore leg 3.44, middle leg 3.25, hind leg 3.56.

Abdomen: dorso-ventrally flattened, with medial dorsal crest of curved posteriorly directed projections on segments 1-7; process on segment 1 small, 2, 3, largest, becoming less prominent from segment 4-7 (Fig. 28g). Lateral flanges of each abdominal segment semi-transparent, postero-lateral margin sharply produced. Paraprocts separate, smooth, developing forceps large (Figs 22e, f). Gills: on segments 1-4, first pair broadly ovoid, operculate, other three pairs with paired lamellae, transparent, with well-developed gill lamellae lined with fine setae (Figs 29b-e).

Mouthparts: labrum (Fig. 29f) rectangular, length 0.44 × width, anterior margin smooth (Fig. 29g). Left mandible (Fig. 29k) robust, incisors widely separate, outer group with three apical teeth, and a ventral row of short setae, inner incisors with three apical teeth and a row of short setae, prostheca broad at base, anterior margin tapers to form a long narrow projection with 3-4 short spines (Fig. 29l). Right mandible (Fig. 29m) robust, incisors widely separate, outer group with two apical teeth, and a ventral row of short setae, inner incisors with three apical teeth and a ventral row of short setae, prostheca broad at base, curved, apex divided into two separate lobes, posterior lobe largest (Fig. 29n). Hypopharynx (Fig. 29i): median lobe deeply bifid. Maxillae (Fig. 29j): apical angle of galeo-lacinia with three or four spine setae, palpi three segmented, longer than galeo-lacinia, segment ratios; 1.00 : 0.86 : 0.77 (0.35 mm). Labium (Fig. 29h): palpi three-segmented, length of proximal segment 1.3 × width, segment ratios; 1.00 : 0.86 : 0.51 (0.37 mm); glossae with one small pointed tubercle distally.

Diagnostic Characteristics

1. Genitalia; shape of forceps and penes (Figs 28d, e; 30a, b).
2. Dorsal crest of nymph with curved posteriorly directed projections on abdominal segments 1-7 (Fig. 28g).
3. First abdominal gill ovoid, rounded posteriorly (Fig. 29b).
4. Lateral flanges of abdominal segments narrow.
5. Shape of incisors and prosthecae of mandibles (Figs 29k-m).

Material Examined

SOUTH AUSTRALIA. Fleurieu Peninsula: Tookayerta Ck, Yankalilla R.
VICTORIA. Gawkers Ck, Stokes Ck.

FAMILY CAENIDAE

The Caenidae was recognised as a distinct group of mayflies by Eaton (1883) when he included the genera *Tricorythus, Leptohyphes* and *Caenis* in Section 7 of his Revisional Monograph. Banks (1900) erected the tribe Caenini and Thew (1960) states that "according to the Copenhagen decision of the International Commission on Zoological Nomenclature, Banks should be credited with the authorship of the family."

Lestage (1930, 1938) refers to the Caenidae as the Brachycercidae, but with the exception of Demoulin (1955b), the Brachyceridae has not been recognised by authors working on the Australian Ephemeroptera. Tillyard (1936), Harker (1950, 1954, 1957), Thew (1960), Riek (1970), Soldan (1978) and Suter (1979, 1984) have all recognised the family Caenidae.

In 1978 Soldan described a new genus of caenid from Australia (*Pseudocaenis*) from nymphal material only, but Suter (1984) demonstrated that this genus was a synonym of *Tasmanocoenis*.

GENUS *TASMANOCOENIS* Lestage 1930

Puthz, 1975: 412; Soldan, 1978: 128; Suter, 1979: 82; Suter, 1984: 105.

Type Species: *Tasmanocoenis tonnoiri*.

The genus *Tasmanocoenis* has been reviewed by Suter (1984) and further discussion is not included here. In the present study all caenid material from South Australia was *Tasmanocoenis tillyardi* (Lestage).

Tasmanocoenis tillyardi (Lestage) 1938

Caenis scotti Tillyard, 1936: 56-58; *Coenis tillyardi* Lestage, 1938: 320; *Caenis scotti* Harker, 1950: 24-26, 29; *Caenis tillyardi* Harker, 1954: 266; *Tasmanocoenis tillyardi* Demoulin, 1955b: 4; Harker, 1957: 77; van Bruggen, 1957: 33; Thew, 1960: 202; Scholes, 1961: 39-41; *"Caenis" scotti* Williams, 1968: 169.

Male Imago

	$\bar{x}$	*SD*	*n*	*Range*
Body Length	3.25	0.14	7	3.12- 3.52
Notal Length	1.45	0.07	7	1.32- 1.52
Pronotal Width	0.68	0.06	7	0.55- 0.72
Mesonotal Width	0.84	0.08	7	0.67- 0.90
Fore Wing Length	3.15	0.14	7	2.96- 3.36
Cerci Length	11.30	—	—	—
Terminal Filament Length	12.00	—	—	—

Colour dark black-brown.

Head: brown, with light brown epicranial sutures. Compound eyes lateral, black. Antennal base brown, one-segmented, flagellae long, 0.54 mm.

Thorax: robust, dark black-brown (Fig. 31b). Pronotum narrower than head. Mesonotum wider than head. Legs slender, pale brown-grey; fore legs longer than middle and hind legs, fore leg femur 1.15 × middle leg femur length and 1.28 × hind femur length. Ratios of leg segments: fore leg 1.00 : 1.93 : 0.09 : 0.57 : 0.26 : 0.25 : 0.16 (0.69 mm); middle leg 1.00 : 0.55 : 0.08 : 0.05 : 0.05 : 0.07 : 0.08 (0.60 mm); hind leg 1.00 : 0.61 : 0.08 : 0.05 : 0.05 : 0.07 : 0.08 (0.54 mm). Tarsal claws similar in fore leg, both blunt, club-shaped, dissimilar in middle and hind legs, one blunt club-shaped, one slender and sharp. Sternum (Fig. 31c): prosternum triangular, apex truncated, lateral margins separated anteriorly, slightly longer than broad. Mesosternum dark black-brown, basisternum length 1.19 × maximum width, sterna-costal suture well developed, furcasternum length 0.65 × width, and 0.65 × basisternum length, posterior margin straight.

Wings (Fig. 31a): short and broad, length 1.72 ×

width, hyaline with milky-opaque pterostigma, venation reduced, simple, almost lacking cross-veins, posterior margins may be lined with fine setae.

Abdomen: short, cylindrical, segments 1-5 very short, light brown, and speckled with black, segments 8 and 9 lighter. Cerci long, transparent, terminal filament longer, both tipped with long fine setae.

Genitalia (Figs 31d; 30c): forceps one-segmented, bowed, sharply pointed with ventral mesal groove, penes lobed, fused with a small apical indentation, sclerotized basally.

Mature Male Nymph (Fig. 31e)

	$\bar{x}$	*SD*	*n*	*Range*
Head Width	0.96	0.04	21	0.90-1.04
Notal Length	1.62	0.10	21	1.40-1.76
Pronotal Width	1.00	0.06	21	0.78-1.04
Mesonotal Width	1.14	0.05	21	1.00-1.20
Cerci Length	3.03	0.16	3	2.92-3.22
Terminal Filament Length	3.39	0.18	3	3.28-3.60

Body colour brown.

Head: dark brown. Antennae light brown, basal segment 0.16 mm long, flagellum 1.46 mm (Fig. 32e). Tentorial body rectangular, length 0.79 × width.

Thorax: pronotum brown, lateral flanges lighter, semi-transparent, anterior margins with spine setae, 0.96 × wider than the head. Mesonotum dark brown. Legs light brown, margins lined with spine setae (Fig. 32a). Tarsal claws short, curved with 4-6 small ventral denticles, otherwise smooth. Ratios of leg segments: fore leg 1.00 : 0.73 : 0.65 (0.68 mm); middle leg 1.00 : 0.70 :0.59 (0.68 mm); hind leg 1.00 : 0.76 : 0.60 (0.74 mm). Femur length to width ratios: fore leg 2.81, middle leg 2.86, and hind leg 2.95.

Abdomen: brown, with square patterns of brown on each side of median line. Operculate gill of second segment covers segments 3-5, segment two with median backward-projecting spine, postero-lateral margins produced forming backward pointing projections. Cerci and terminal filament dark brown, well developed. Gills: on segments 1-6, first pair single, filamentous with indistinct segments, lined with fine setae (Fig. 32b), second pair operculate with raised triangular region dorsally, mesal ridge with few setae, outer ridge not reaching posterior margin of gill covers, margins lined with long setae (Figs 32c; 30d); third-sixth pairs laminate with 40-50 tracheal fringes, single or bifid, few trifid, third gill largest (Fig. 32d).

Mouthparts: labrum (Fig. 32f) rectangular, width 2.34 × length, anterior margin with slight median concavity with 2-3 small denticles (Fig. 32g). Left mandible (Fig. 32j): outer incisors with three apical teeth and one shorter mesal tooth, inner incisors with three apical teeth, prostheca robust with apical brush of setae (Fig. 32k). Right mandible (Fig. 32l): outer incisors with 2-3 apical teeth, inner with two, prostheca robust with apical brush of setae (Fig. 32m). Hypopharynx (Fig. 32i) with square median lobe, slightly concave anteriorly. Maxillae (Fig. 32n): galeo-lacinia short and narrow, with 3-4 robust apical spines, mesal margin lined with stout spine setae, palpi three-segmented, longer than galeo-lacinia, segment ratios 1.00 : 0.70 : 1.07 (0.12 mm). Labium (Fig. 32h): palpi three-segmented, proximal segment length 1.47 × width, segment ratios 1.00 : 0.78 : 0.53 (0.13 mm); glossae rectangular.

Female Imago

Similar to male, sternum and notum broader, tarsi four segmented, tarsal claws, each pair dissimilar, one blunt, club-shaped, one curved and sharp.

Female Nymph

Body shape similar to male, more robust than male, i.e. head width of last instar greater than male, wing sheaths longer, second abdominal operculate gill longer, covering segments 3-6, fore, middle and hind femora longer.

Diagnostic Characteristics

1. Genitalia of male with curved sharp forceps and fused penes with a small apical indentation, not extending beyond apices of forceps (Figs 31d; 30c).
2. Labrum rectangular (Fig. 32f).
3. Structure of mandibles, incisors and prostheeae (Figs 32j-m).

History and Discussion

Tillyard (1936) described *Caenis scotti* from the South Esk River at Clarendon, Tasmania. Lestage (1938) noted that *C. scotti* was preoccupied by a species described by Ulmer in 1924 (referred to by Thew, 1960) and renamed the Tasmanian species *Caenis tillyardi.* Harker (1950) apparently was unaware of this name alteration and described a nymph which she assigned to *Caenis scotti.* Subsequently in 1954 she recognised the name change, and maintained the generic recognition as *Caenis.* Demoulin (1955b) reviewed the genus *Tasmanocoenis* and recognised that *Caenis tillyardi* belonged in the genus *Tasmanocoenis,* an observation validated by the review of the Caenidae by Thew (1960).

Williams (1968) noted that *Caenis* and *Tasmanocoenis* in Australia were probably synonymous, and illustrated gills of *"Caenis" scotti* after Harker (1950). Riek (1970) noted, as had Demoulin (1955b) and Thew (1960), that *Tasmanocoenis* was the only Australian genus in the Caenidae but records of nymphs of *Caenis* sp. were made by Timms (1974) in a benthic study of three South Australian volcanic lakes. This record and all others from South Australia belong to the one species, *T. tillyardi.*

Material Examined

SOUTH AUSTRALIA. South East: Drain L, Drain K, Eastern Division Diversion Drain, Eight Mile Ck, Hitchcock Drain, Mosquito Ck, Mt. Hope Drain, Sutherland's Drain. Mt. Lofty Ranges: Deep Ck, Eleanor R., Sturt R., Torrens R., Waite Institute Pond. Fleurieu Peninsula: Anacotilla Ck, Carrakalinga Ck, Deep Ck, Hindmarsh R., Inman R., Kangarilla Ck. Lake Alexandrina: Tookayerta Ck, Yankalilla R. Kangaroo Island: Breakneck R., Cygnet R., Grassy/Sheep Ck, North-East R., Tin Hut/Bullock Ck, South West R., South West Bay R. Southern Flinders Ranges: Broughton R., Nectar Brook Ck, Ohlenmeyer Reservoir, Rocky R., Schumacher Ck, Spring Ck. Northern Flinders Ranges: Arkaba Ck, Arkaroola Ck, Balcanoona Ck, Bendieuta Ck, Brachina Ck, Bunyeroo Ck, Elatina Ck, Emu Ck, Enorama Ck, Eregunda Ck, Hot Springs (Paralana), Kanyaka Ck, Marolana Ck, Mount Chambers Ck, Nepouie Ck, Old Wirrealpa Springs, Oraparina Ck, Oratunga Ck, Parachilna Ck, Stubbs Waterhole, Willigan Ck, Teatree Ck, Warren Gorge C, Wilpena Ck, Wockerawirra Ck, Woodendinna Ck. Eyre Peninsula: Old Woolshed Dam.
VICTORIA. Crawford R., Darlots Ck, Gawkers Ck, Glenelg R., Lake Wendouree (Ballarat), Mount Emu Ck, Pigeon Hole Ck, Rocklands Reservoir, Stoke Ck, Surrey R., Wando R., Wannon R., Wennicott R.
TASMANIA. Elizabeth R., Lagoon of Islands, Macquarie R., Rileys Creek Reservoir, Geeveston.

ACKNOWLEDGMENTS

This work was supported by a Commonwealth of Australia Post Graduate Research Award and by research funds of the Zoology Department, University of Adelaide. Special thanks must go to my supervisor, Dr J. E. Bishop for his valuable advice, encouragement, and constructive criticism throughout this study. Thanks also to Prof. W. D. Williams for his encouragement and guidance, and to all people who assisted in collecting material from throughout South Australia. I would also like to thank my wife, for her support during the study.

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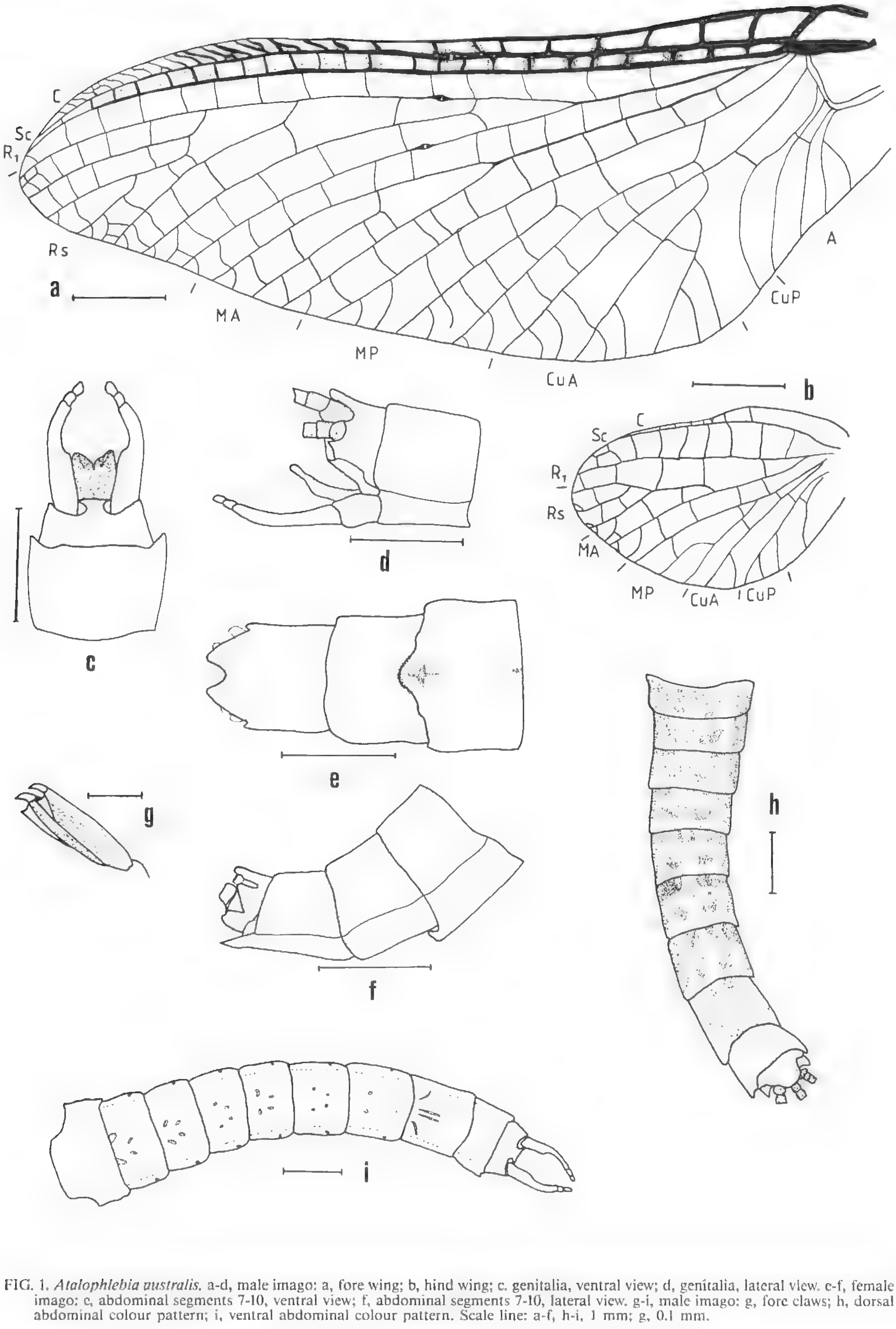

FIG. 1. *Atalophlebia australis.* a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, abdominal segments 7-10, ventral view; f, abdominal segments 7-10, lateral view. g-i, male imago: g, fore claws; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern. Scale line: a-f, h-i, 1 mm; g, 0.1 mm.

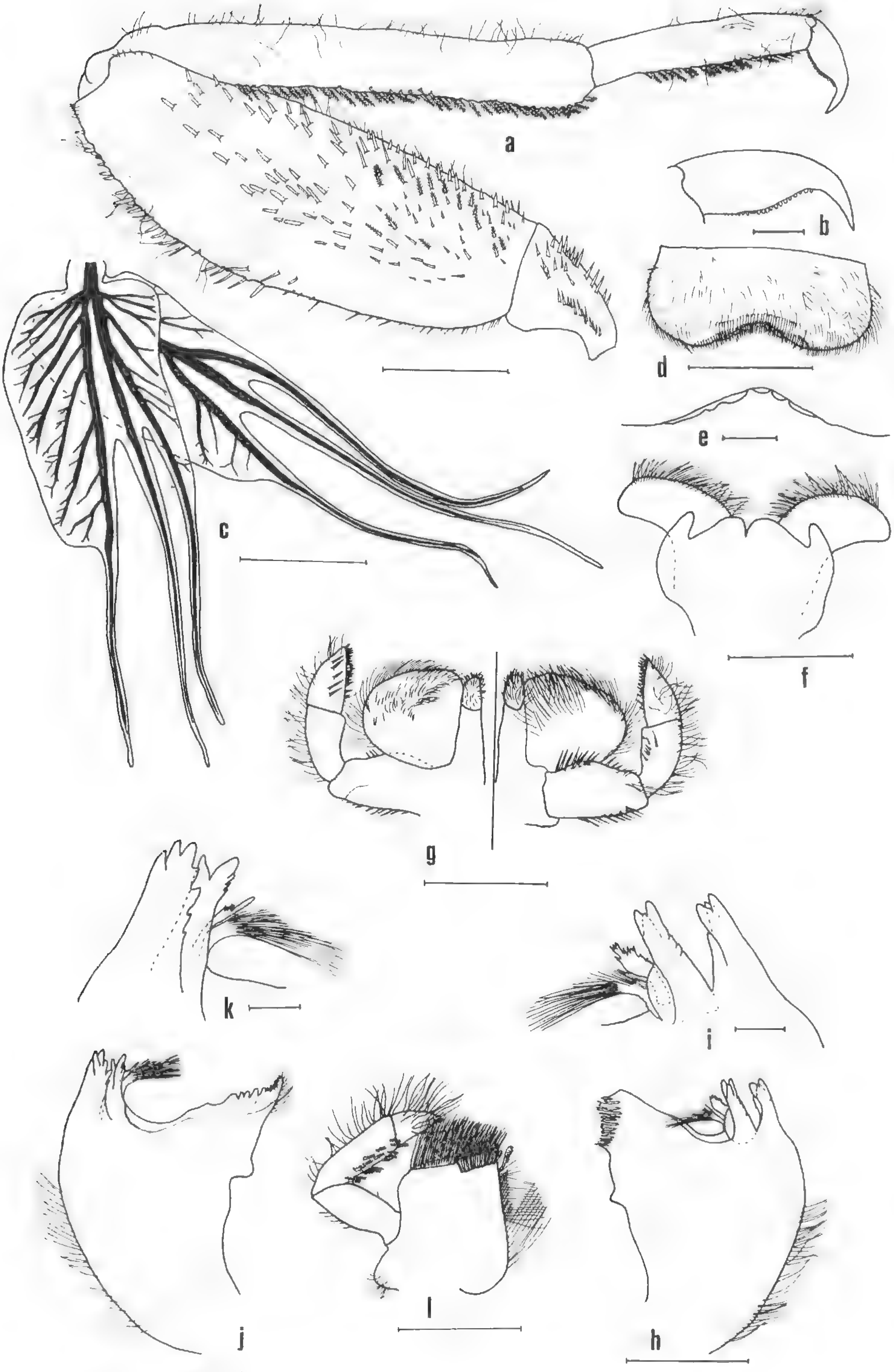

FIG. 2. *Atalophlebia australis*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged; l, right maxilla, ventral view. Scale lines: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm.

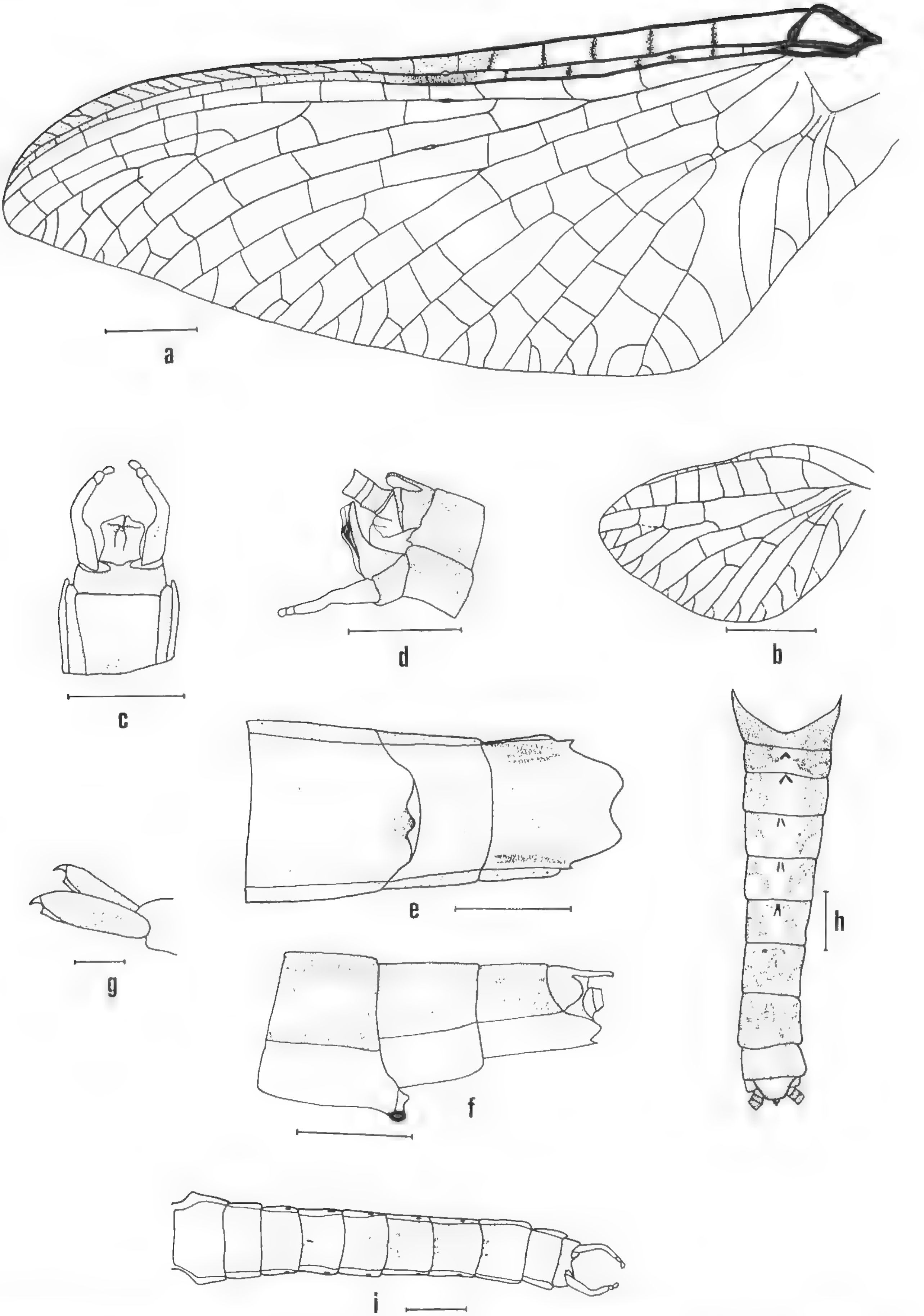

FIG. 3. *Atalophlebia australasica*. a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, abdominal segments 7-10, ventral view; f, abdominal segments 7-10, lateral view. g-i, male imago: g, fore claw; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern. Scale line: a-f, h-i, 1 mm; g, 0.1 mm.

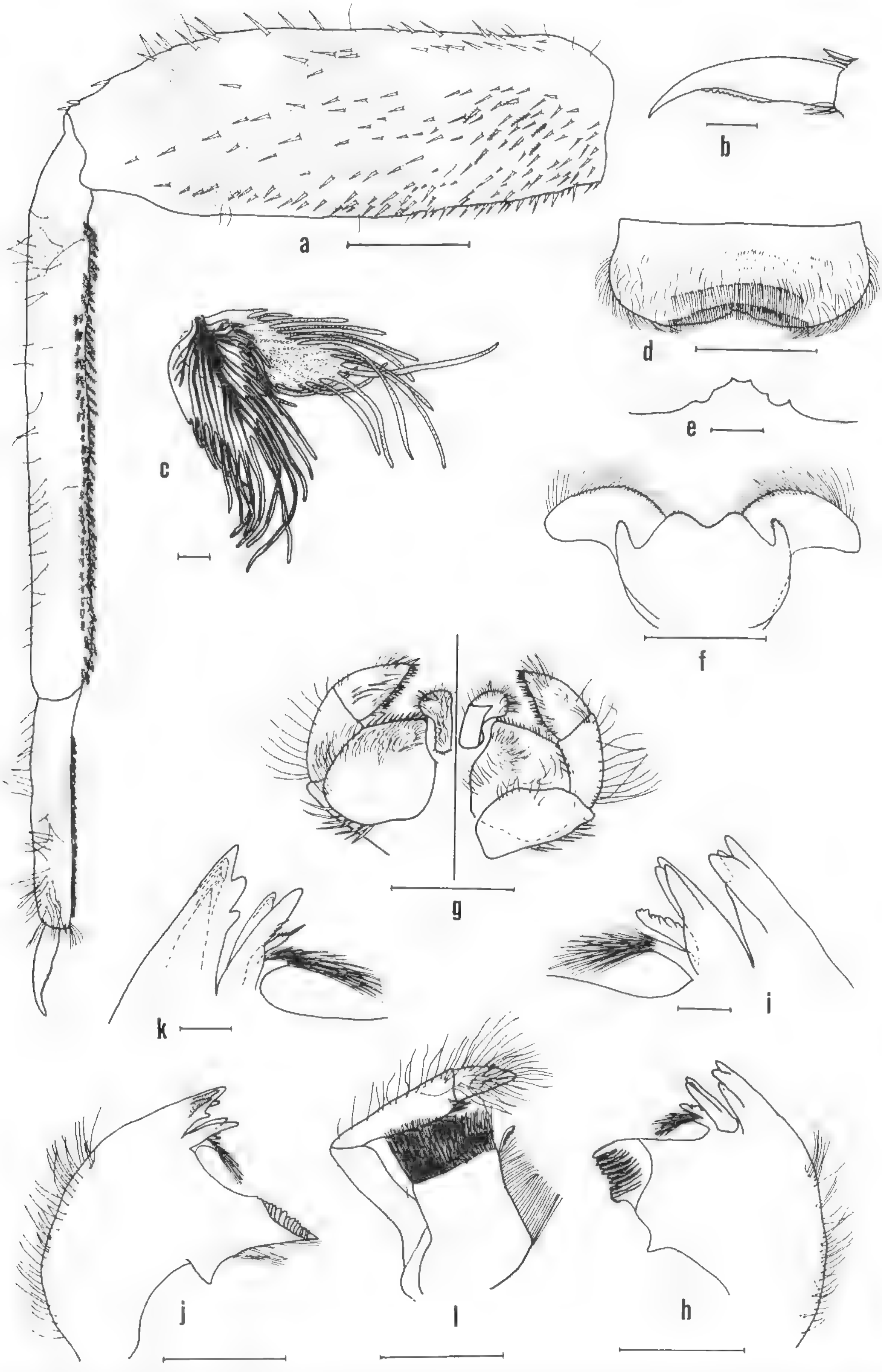

FIG. 4. *Atalophlebia australasica,* mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca enlarged; l, right maxilla, ventral view. Scale line: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm.

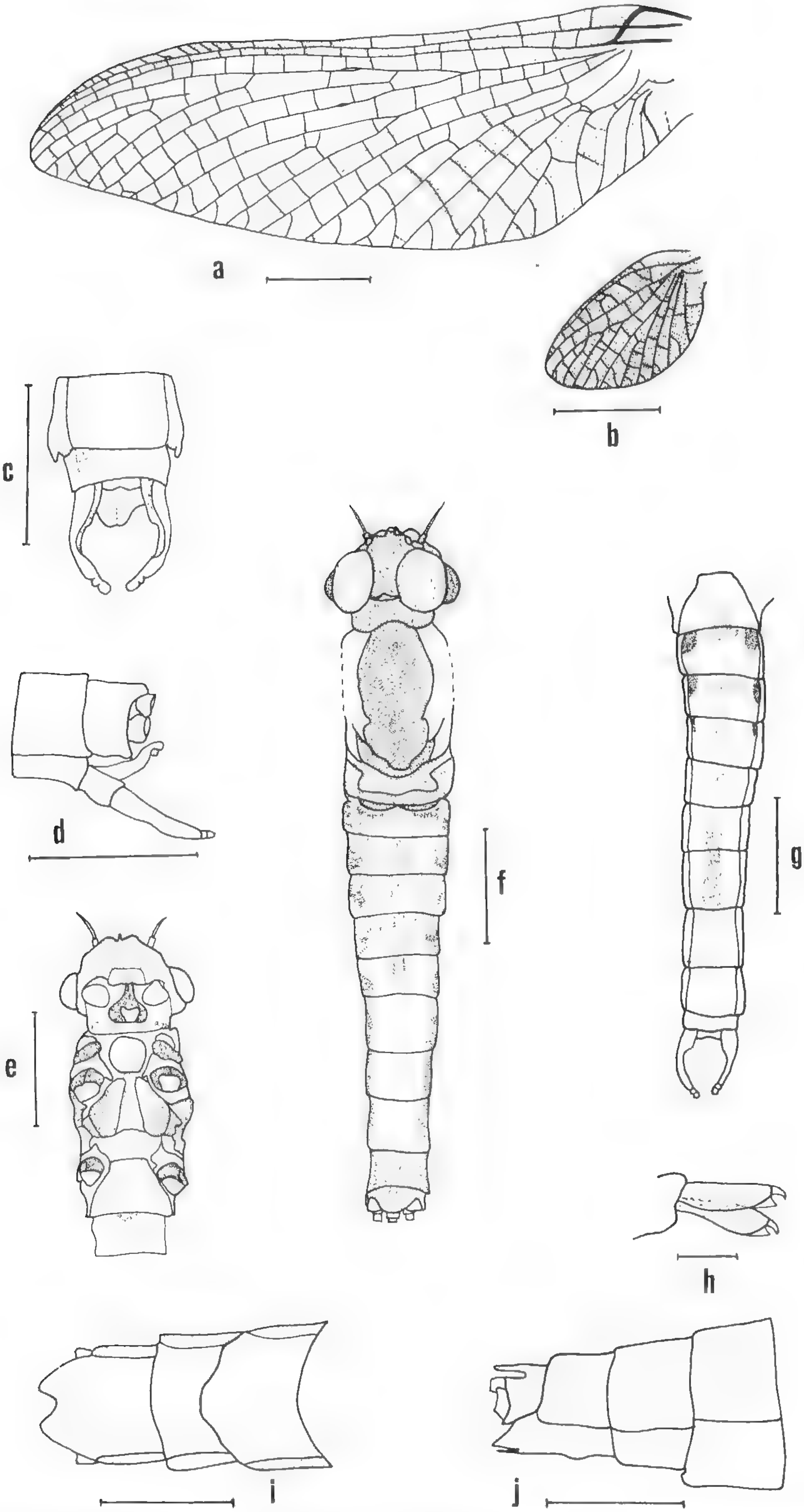

FIG. 5. *Atalophlebia auratus*. a-h, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view; e, thoracic sterna; f, dorsal colour pattern; g, ventral abdominal colour pattern; h, fore claw. i-j, female imago: i, abdominal segments 7-10, ventral view; j, abdominal segments 7-10, lateral view. Scale lines: a-g, i, j, 1 mm; h, 0.1 mm.

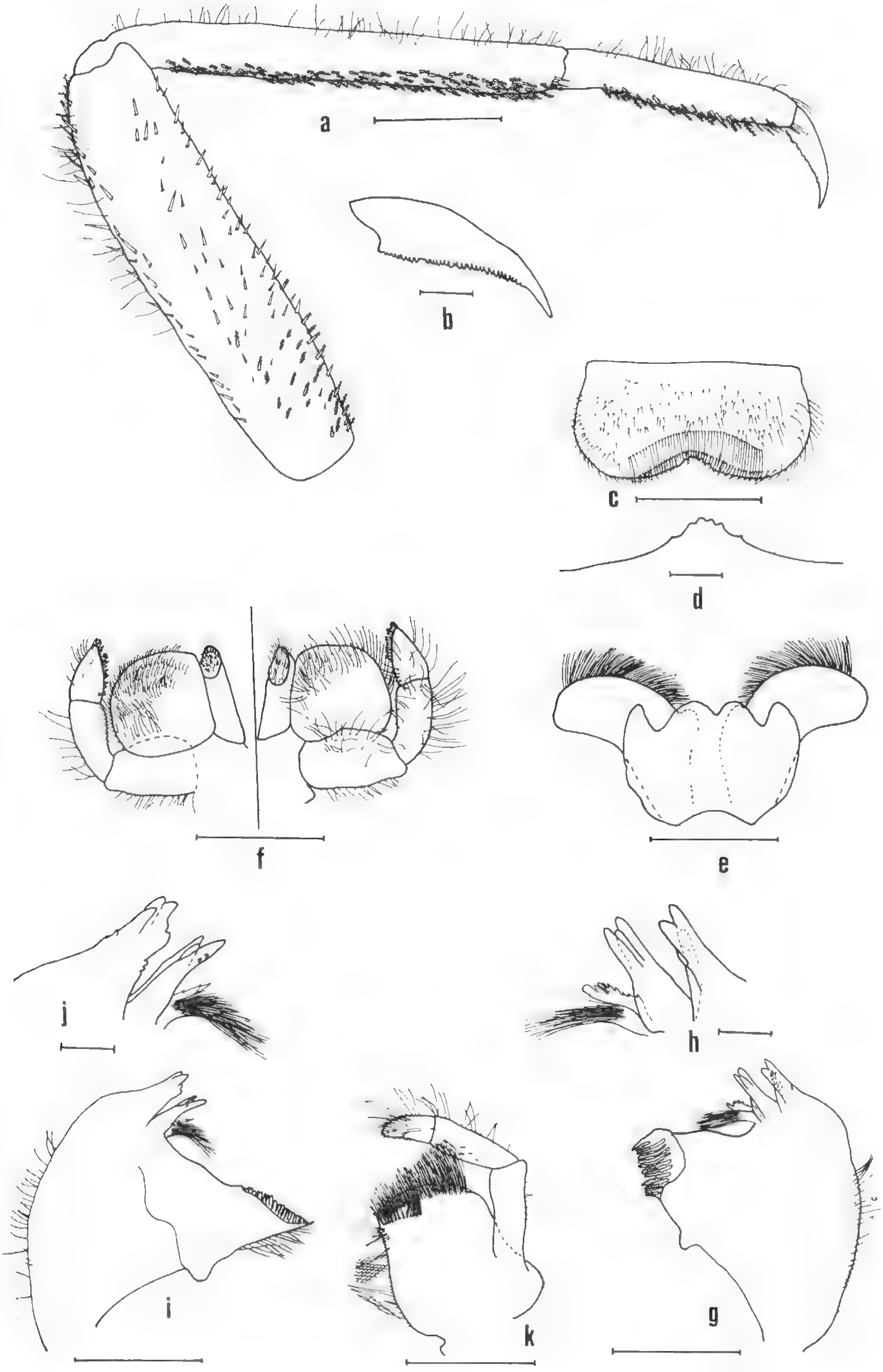

FIG. 6. *Atalophlebia auratus*, mature nymph: a, fore leg; b, fore claw; c, labrum, dorsal view; d, antero-median emargination of labrum, enlarged; e, hypopharnyx; f, labium, dorsal (left) and ventral views; g, left mandible, ventral view; h, left incisors and prostheca, enlarged; i, right mandible, ventral view; j, right incisors and prostheca, enlarged; k, left maxilla, ventral view. Scale lines: a, c, e, f, g, i, k, 0.5 mm; b, d, h, j, 0.1 mm.

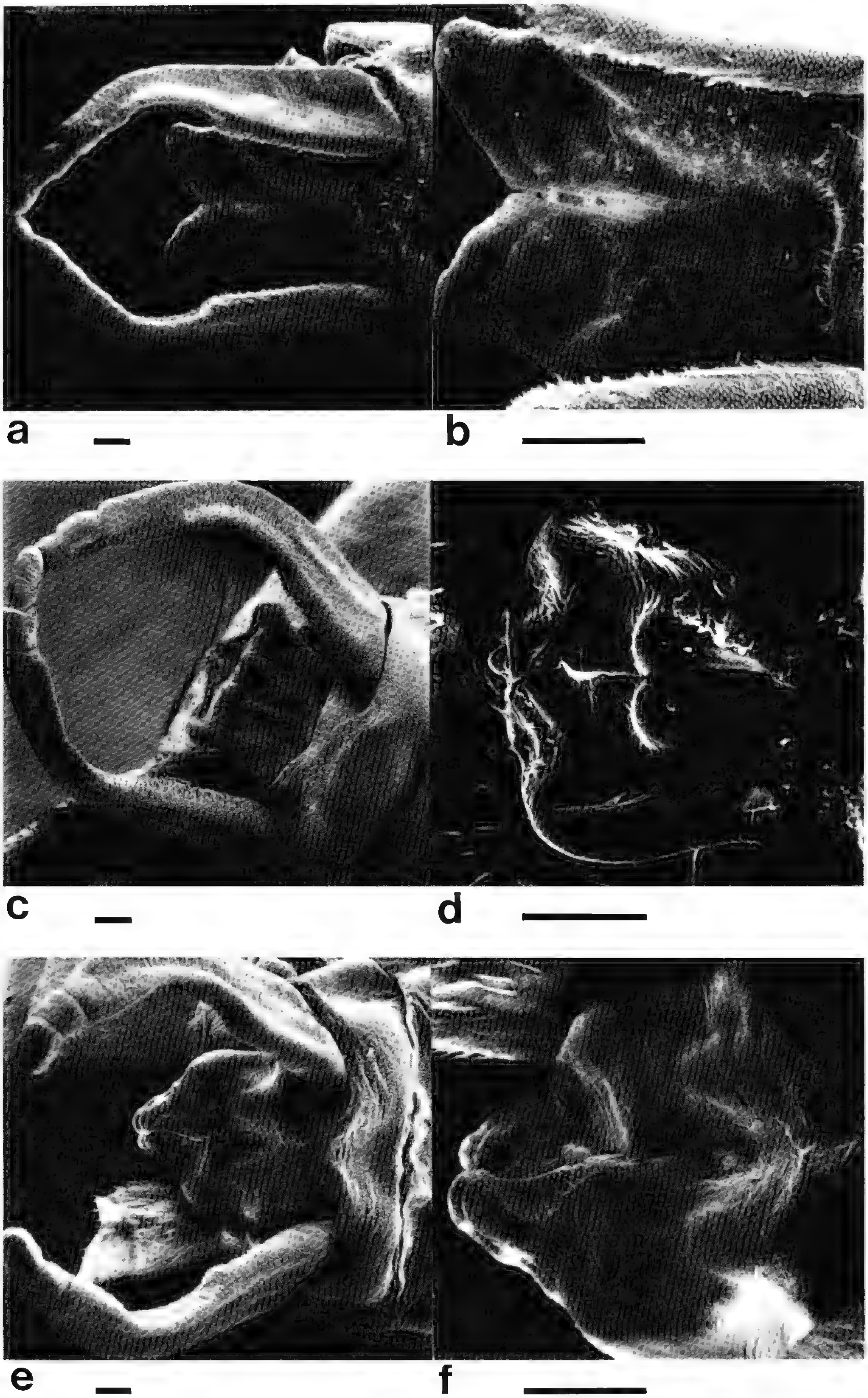

FIG. 7. SEM micrographs of genitalia of *Atalophlebia* male imagos. a-b, *Atalophlebia australis*: a, genitalia, ventral view; b, penes, ventral view, enlarged. c-d, *Atalophlebia australasica*: c, genitalia, ventral view; d, penes, ventral view, enlarged. e-f, *Atalophlebia auratus*: e, genitalia, ventral view; f, penes, ventral view, enlarged. Scale lines: 100 μm.

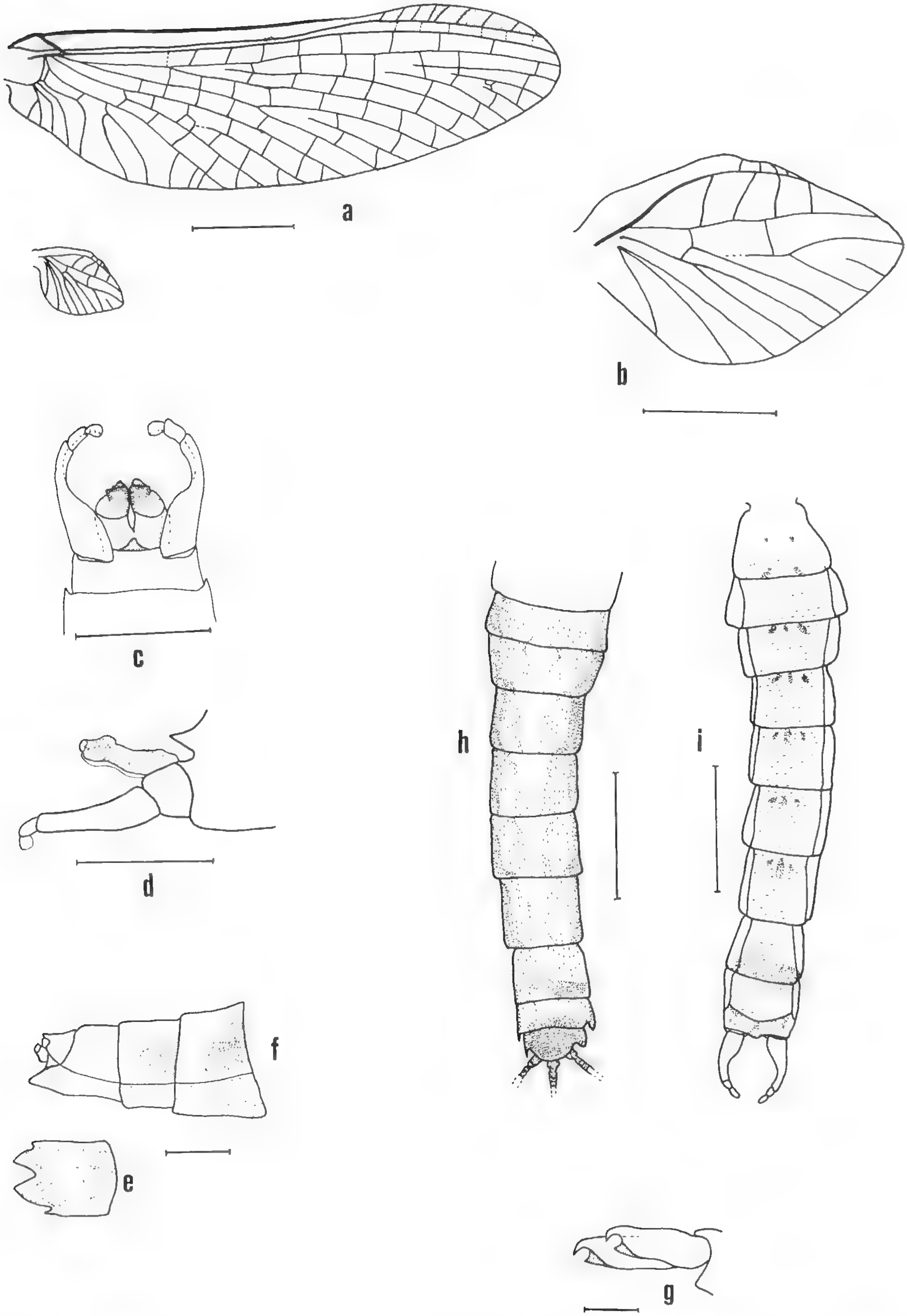

FIG. 8. *Nousia inconspicua.* a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, abdominal segment 10, ventral view; f, abdominal segments 7-10, lateral view. g-i, male imago: g, fore claws; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern. Scale lines: a, h, i, 1 mm; b-f, 0.5 mm; g, 0.05 mm.

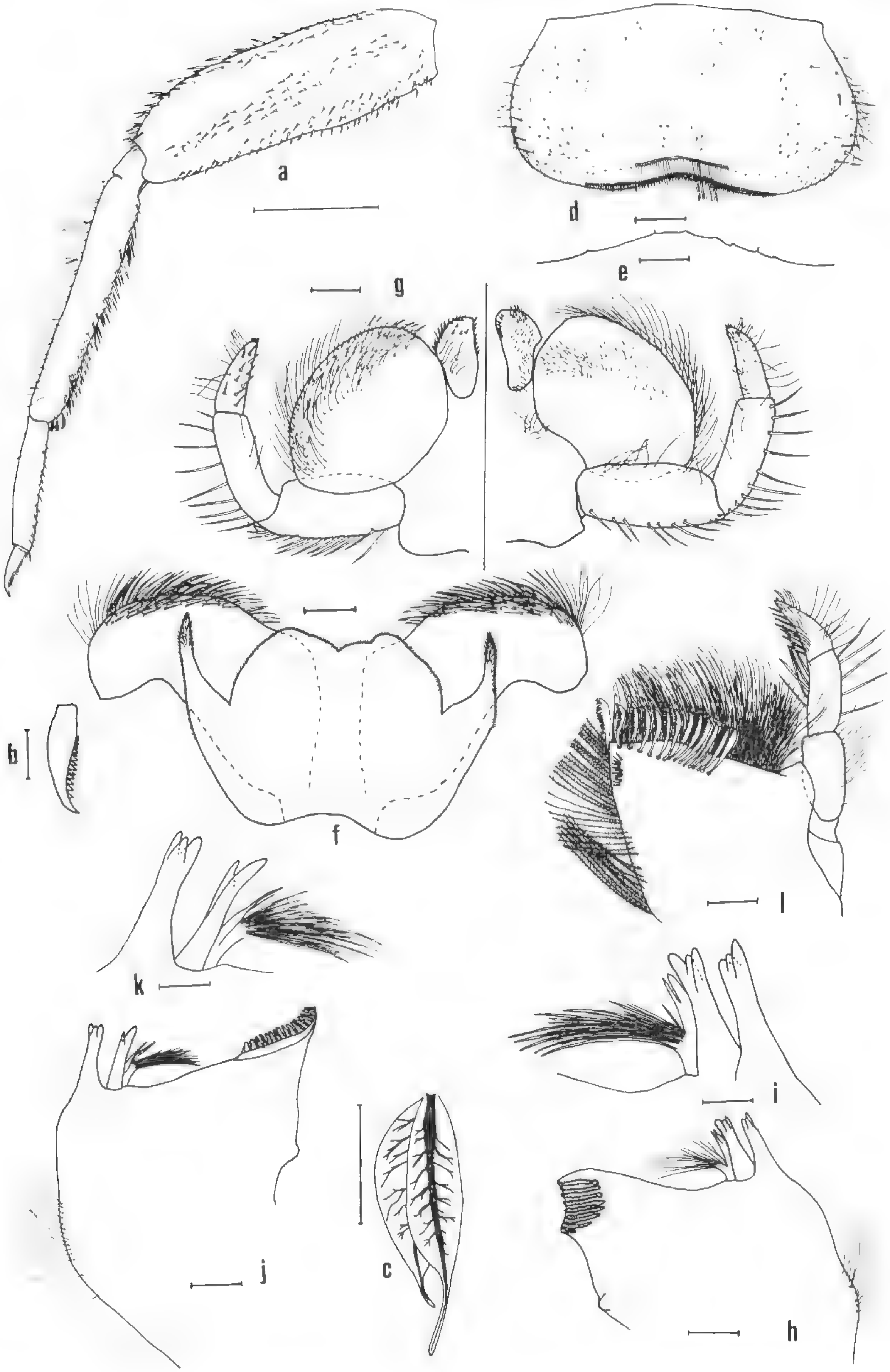

FIG. 9. *Nousia inconspicua,* mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged; l, left maxilla, ventral view. Scale lines: a, c, 0.5 mm; b, d, f, g, h, j, l, 0.1 mm; e, i, k, 0.05 mm.

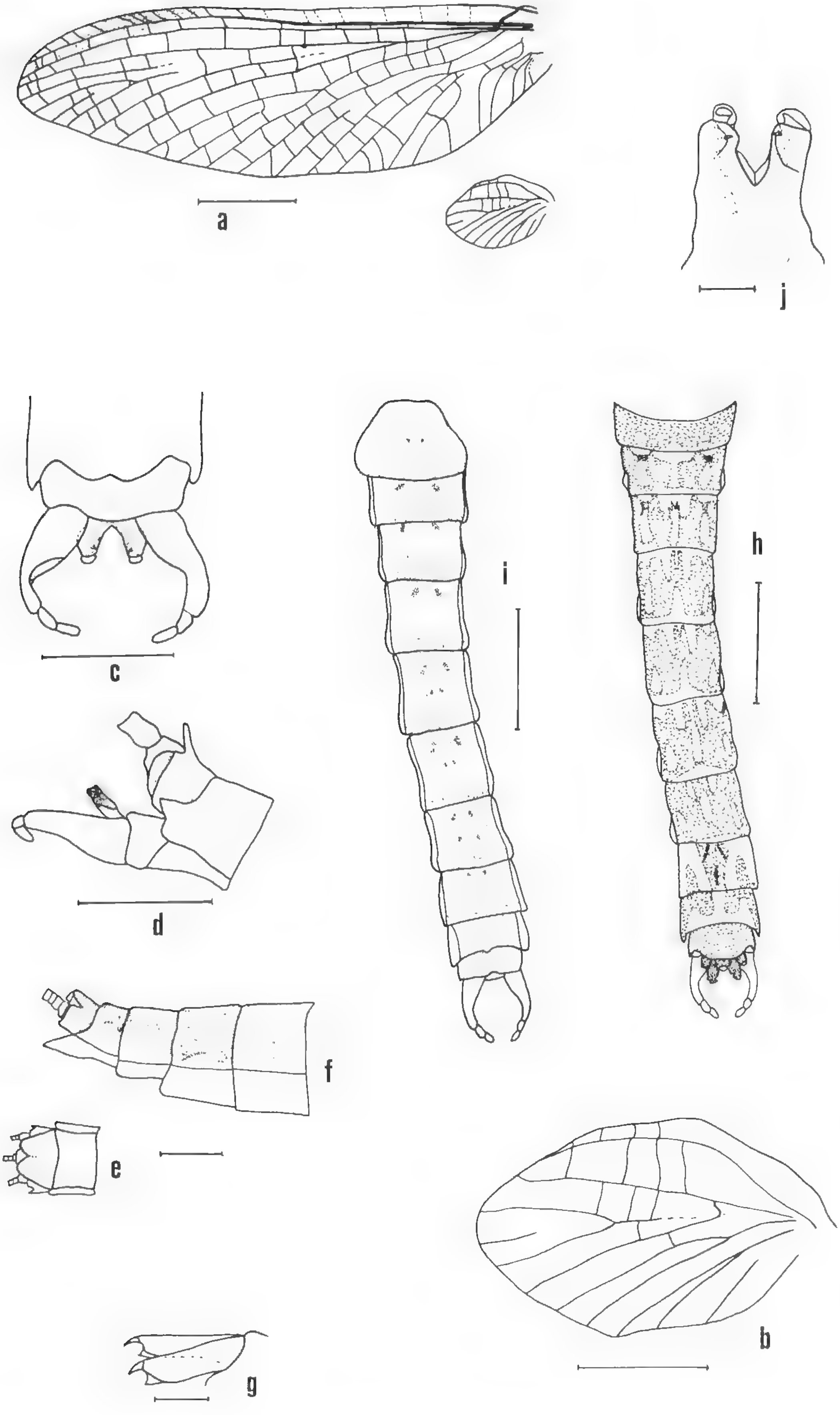

FIG. 10. *Nousia fuscula.* a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, ventral view of abdominal segment 10; f, abdominal segments 6-10, lateral view. g-j, male imago: g, fore claws; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern; j, penes enlarged, ventral view. Scale lines: a, h, i, 1 mm; b, c, d, e, f, 0.5 mm; j, 0.1 mm; g, 0.05 mm.

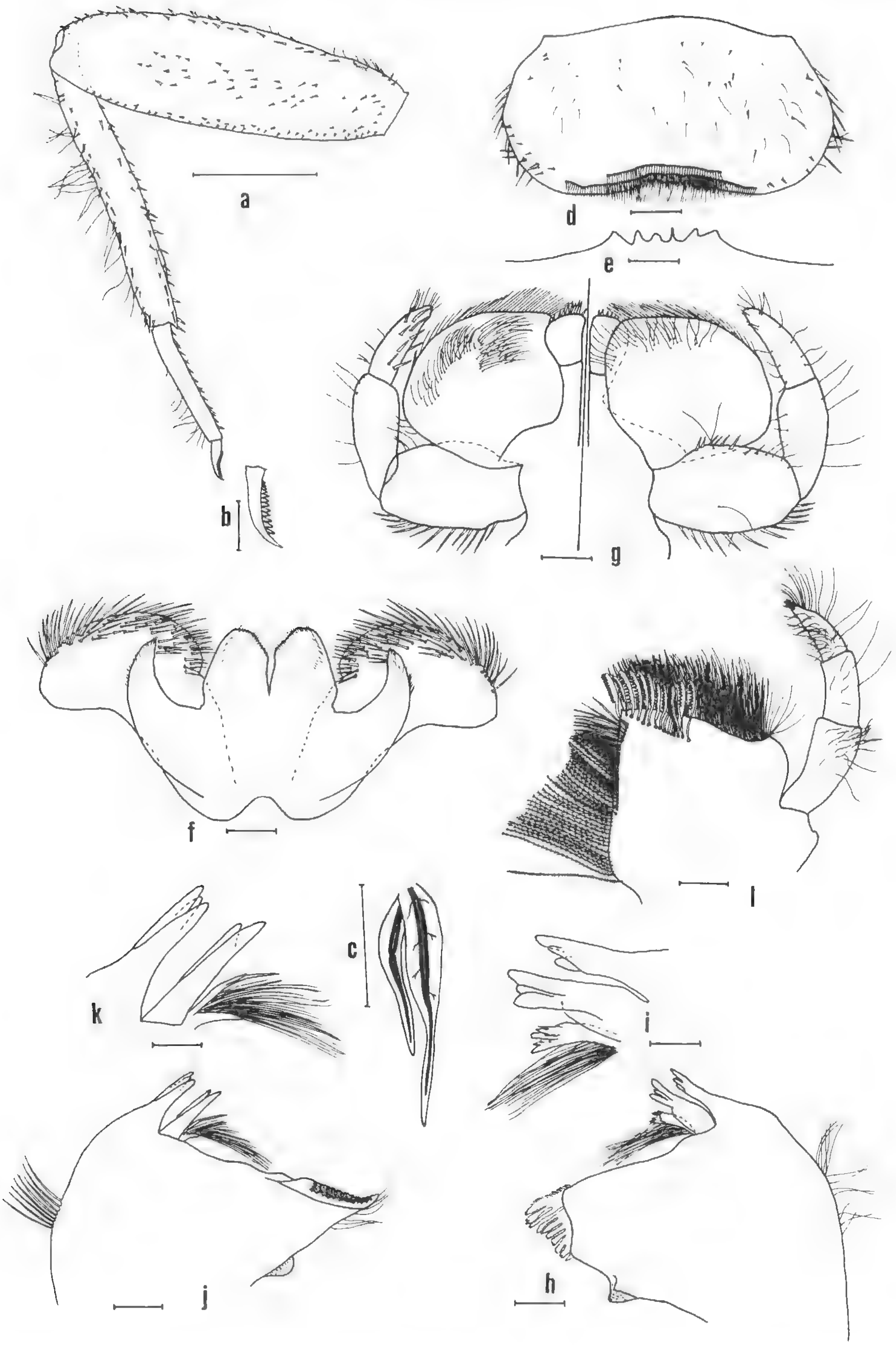

FIG. 11. *Nousia fuscula*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged; l, left maxilla, ventral view. Scale lines: a, c, 0.5 mm; b, d, f, g, h, j, l, 0.1 mm; e, i, k, 0.05 mm.

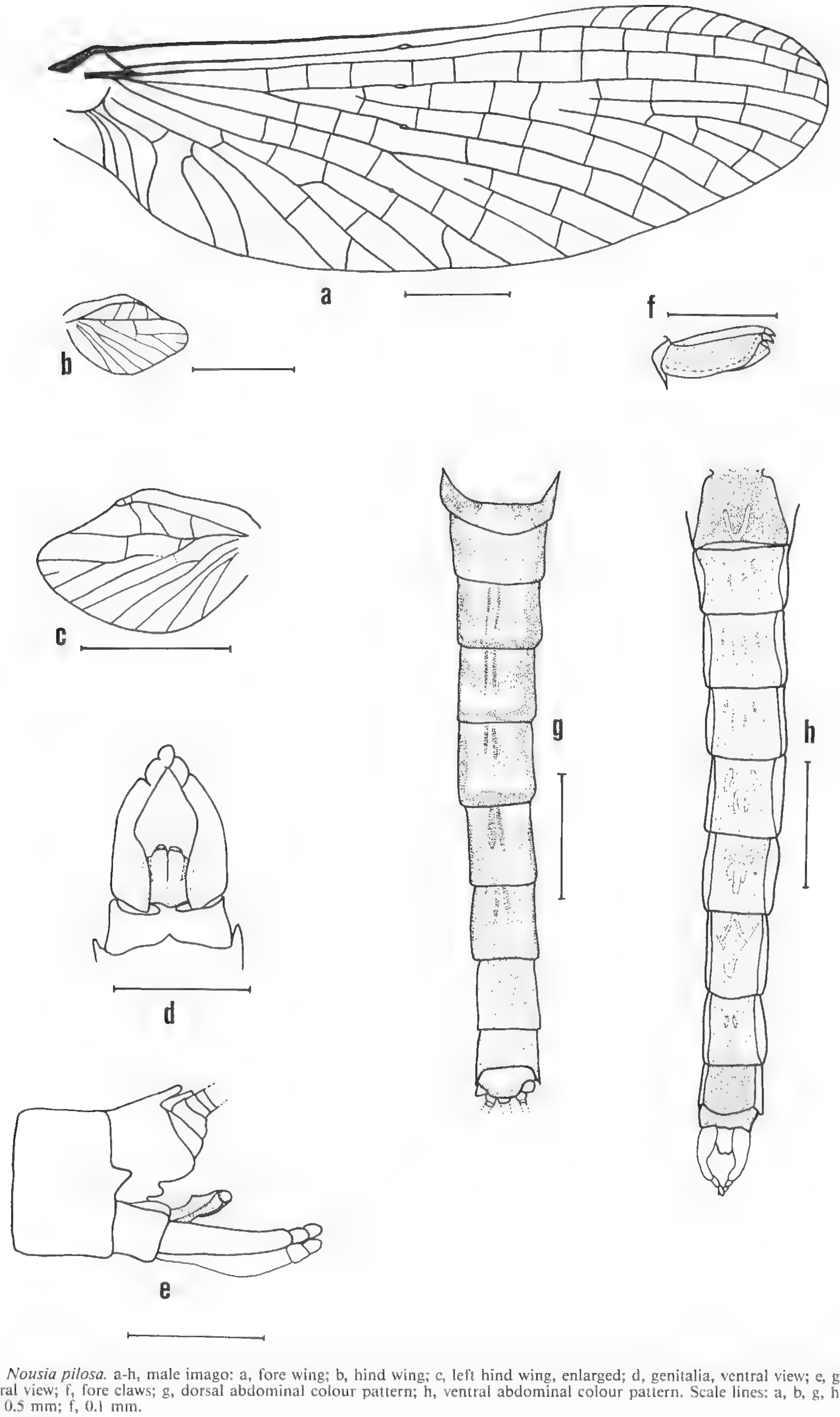

FIG. 12. *Nousia pilosa.* a-h, male imago: a, fore wing; b, hind wing; c, left hind wing, enlarged; d, genitalia, ventral view; e, genitalia, lateral view; f, fore claws; g, dorsal abdominal colour pattern; h, ventral abdominal colour pattern. Scale lines: a, b, g, h, 1 mm; c-e, 0.5 mm; f, 0.1 mm.

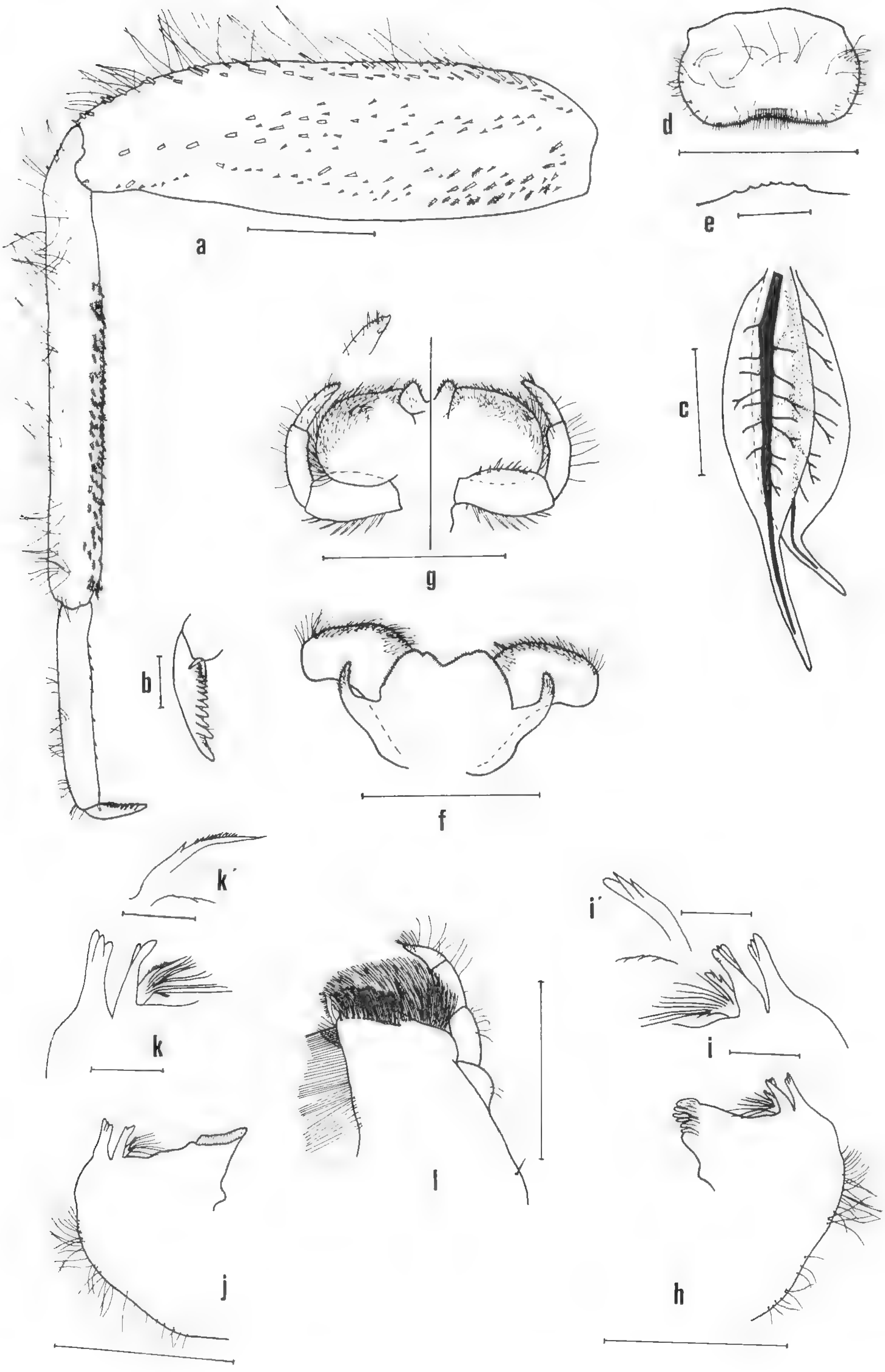

FIG. 13. *Nousia pilosa*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; i′, left prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged; k′, right prostheca, enlarged; l, left maxilla, ventral view. Scale lines: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm; i′, k, 0.05 mm.

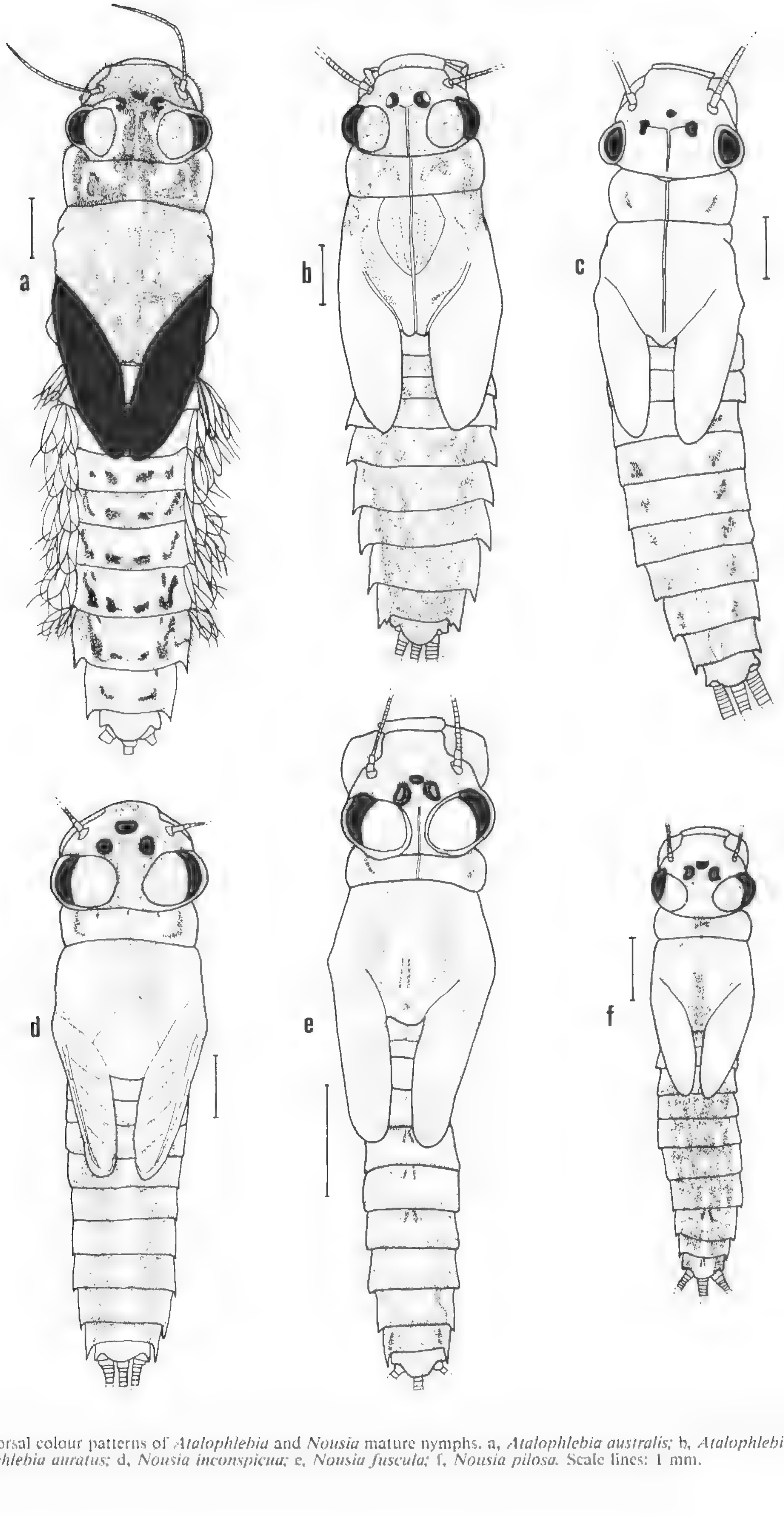

FIG. 14. Dorsal colour patterns of *Atalophlebia* and *Nousia* mature nymphs. a, *Atalophlebia australis;* b, *Atalophlebia australasica;* c, *Atalophlebia auratus;* d, *Nousia inconspicua;* e, *Nousia fuscula;* f, *Nousia pilosa.* Scale lines: 1 mm.

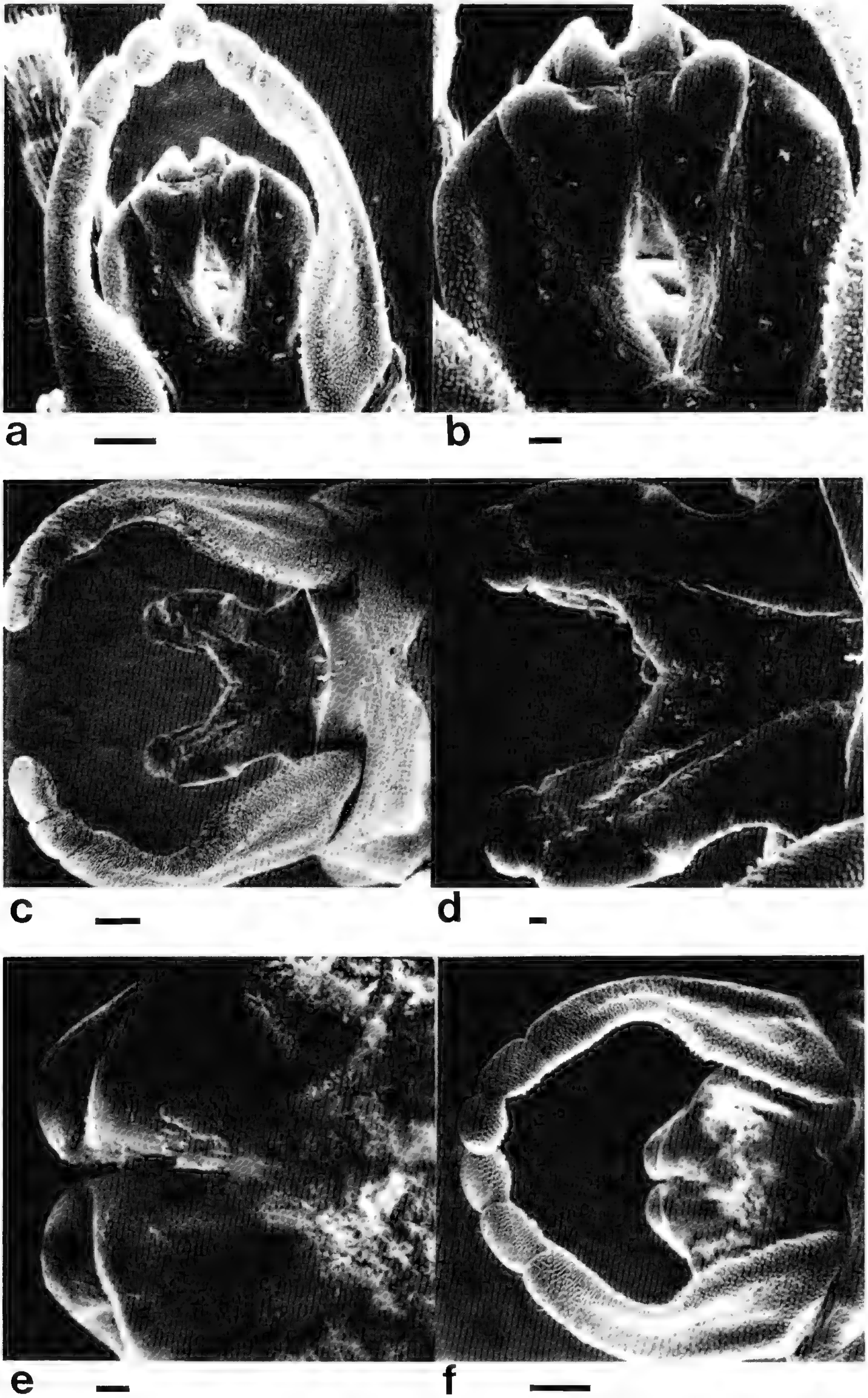

FIG. 15. SEM micrographs of genitalia of *Nousia* male imagos. a-b, *Nousia inconspicua*: a, genitalia, ventral view; b, penes, ventral view, enlarged. c-d, *Nousia fuscula*: c, genitalia, ventral view; d, penes, ventral view, enlarged. e-f, *Nousia pilosa*: e, penes, ventral view, enlarged; f, genitalia, ventral view. Scale lines: a, c, f, 100 μm; b, d, e, 10 μm.

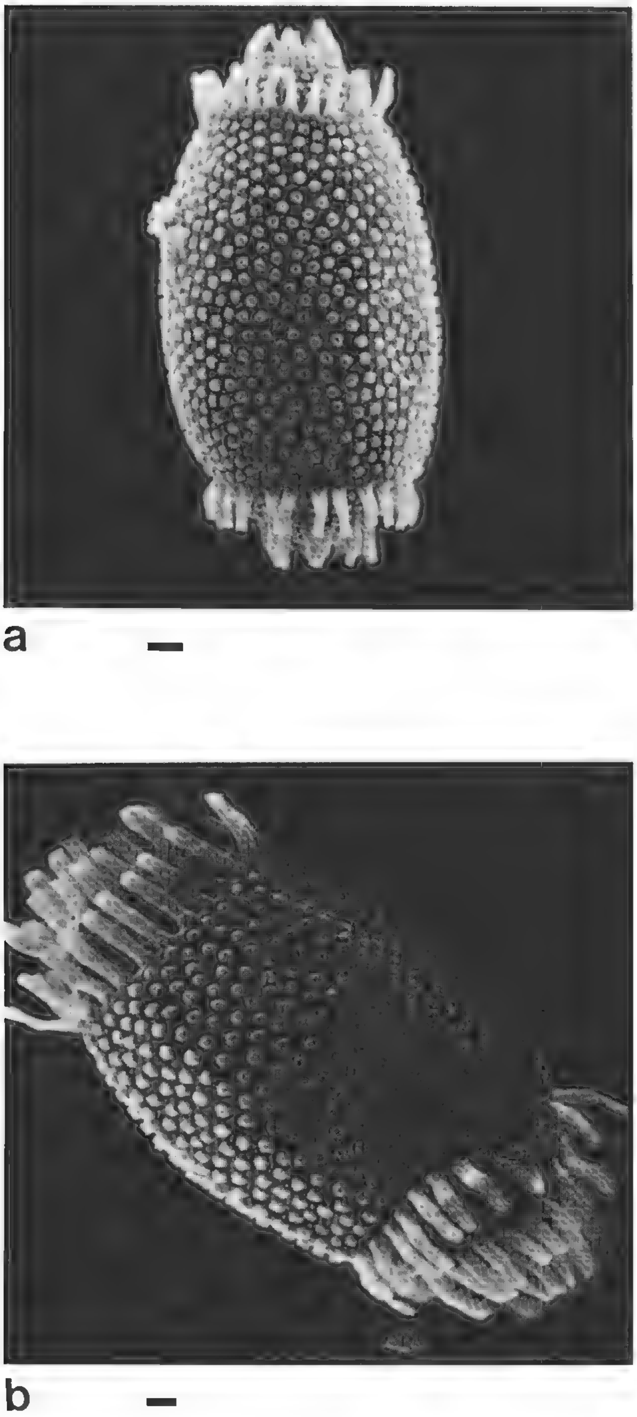

FIG. 16. SEM micrographs of eggs of a, *Nousia inconspicua*; and b, *Nousia fuscula*, illustrating the general similarity of morphology, but distinct polar caps of each species. Scale line: 10 μm.

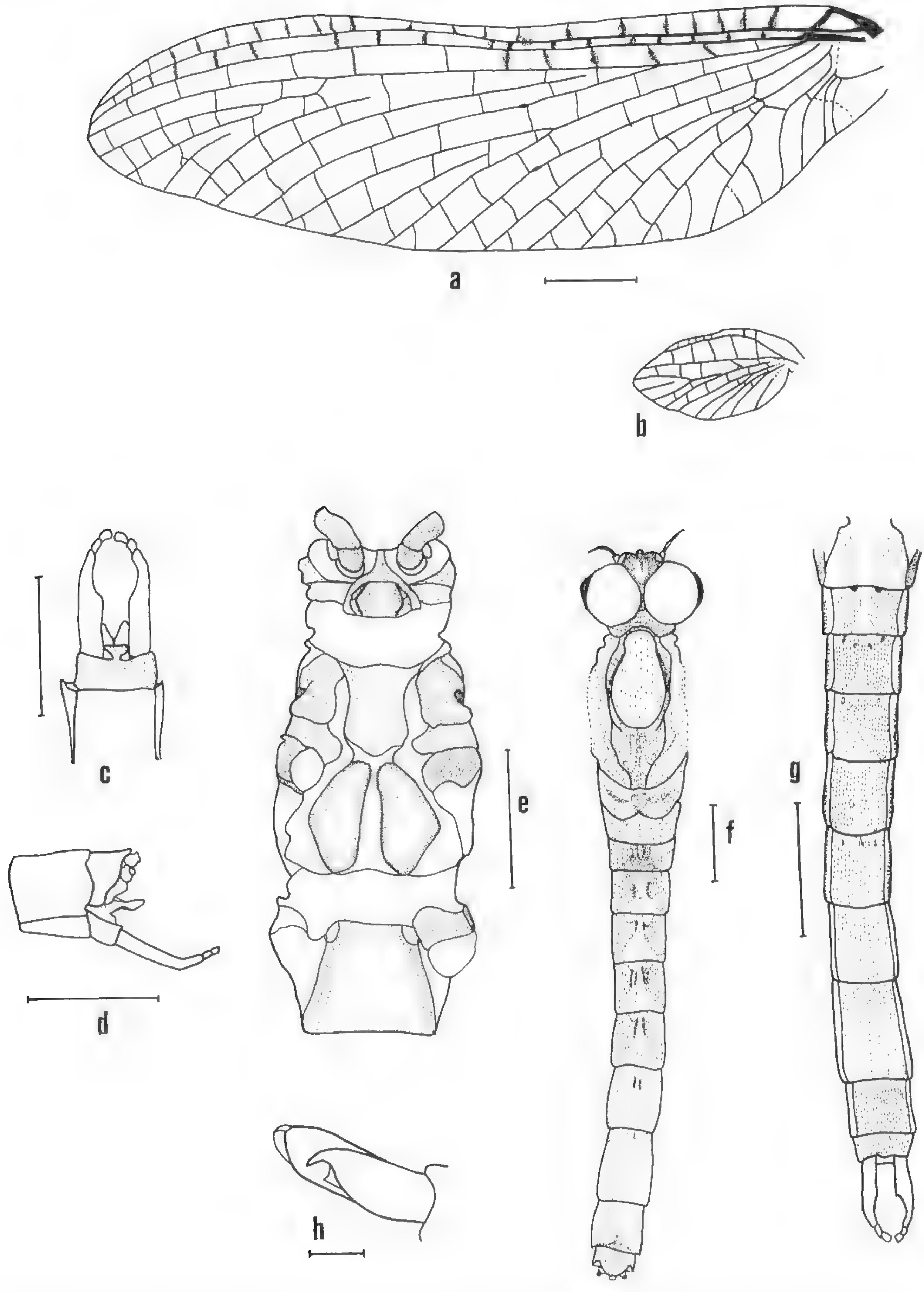

FIG. 17. *Ulmerophlebia pipinna,* male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view; e, thoracic sterna; f, dorsal colour pattern; g, ventral abdominal colour pattern; h, fore claws. Scale lines: a-g, 1 mm; h, 0.5 mm.

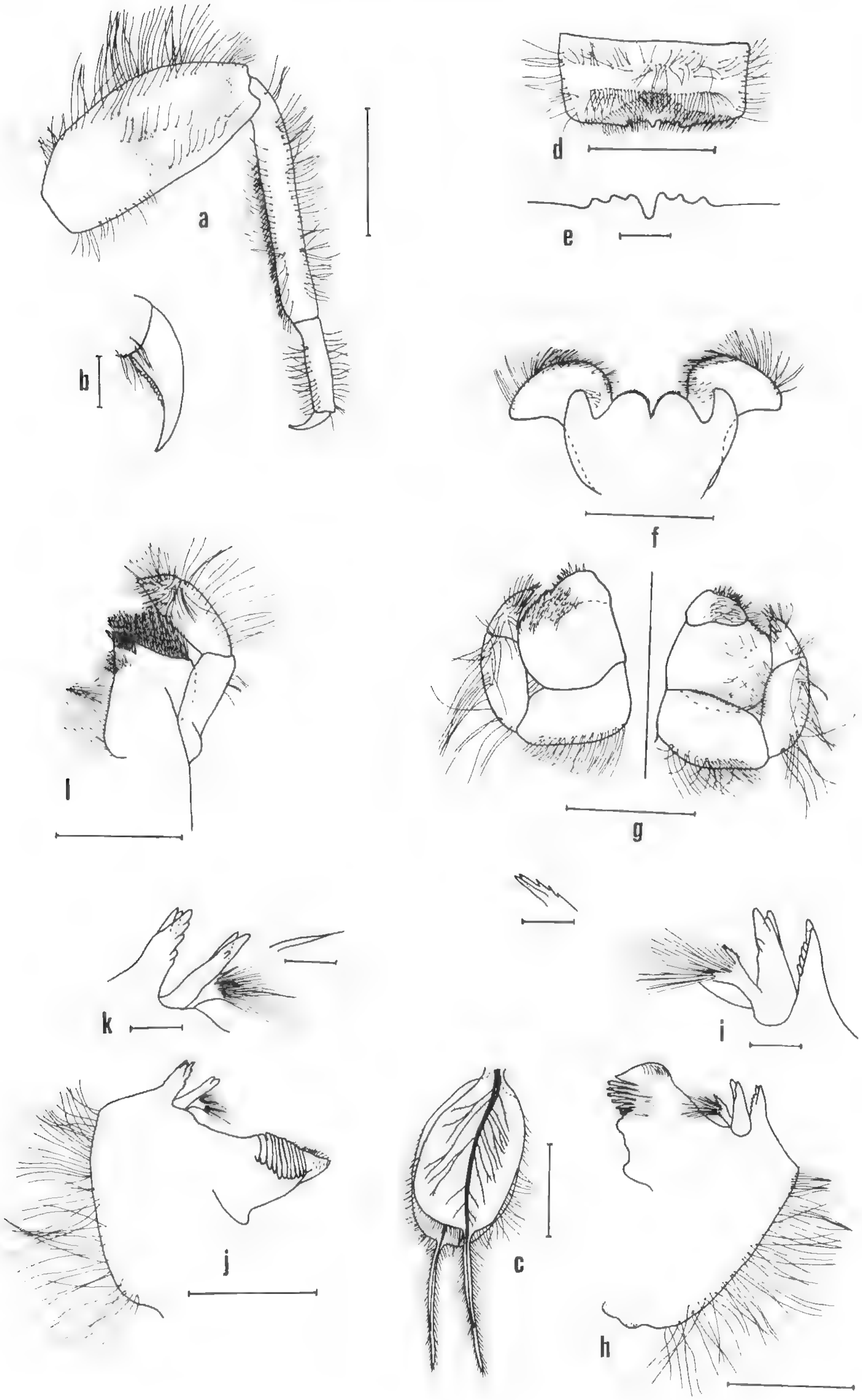

FIG. 18. *Ulmerophlebia pipinna*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged and prostheca, enlarged; l, left maxilla, ventral view. Scale lines: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm; prostheca, 0.05 mm.

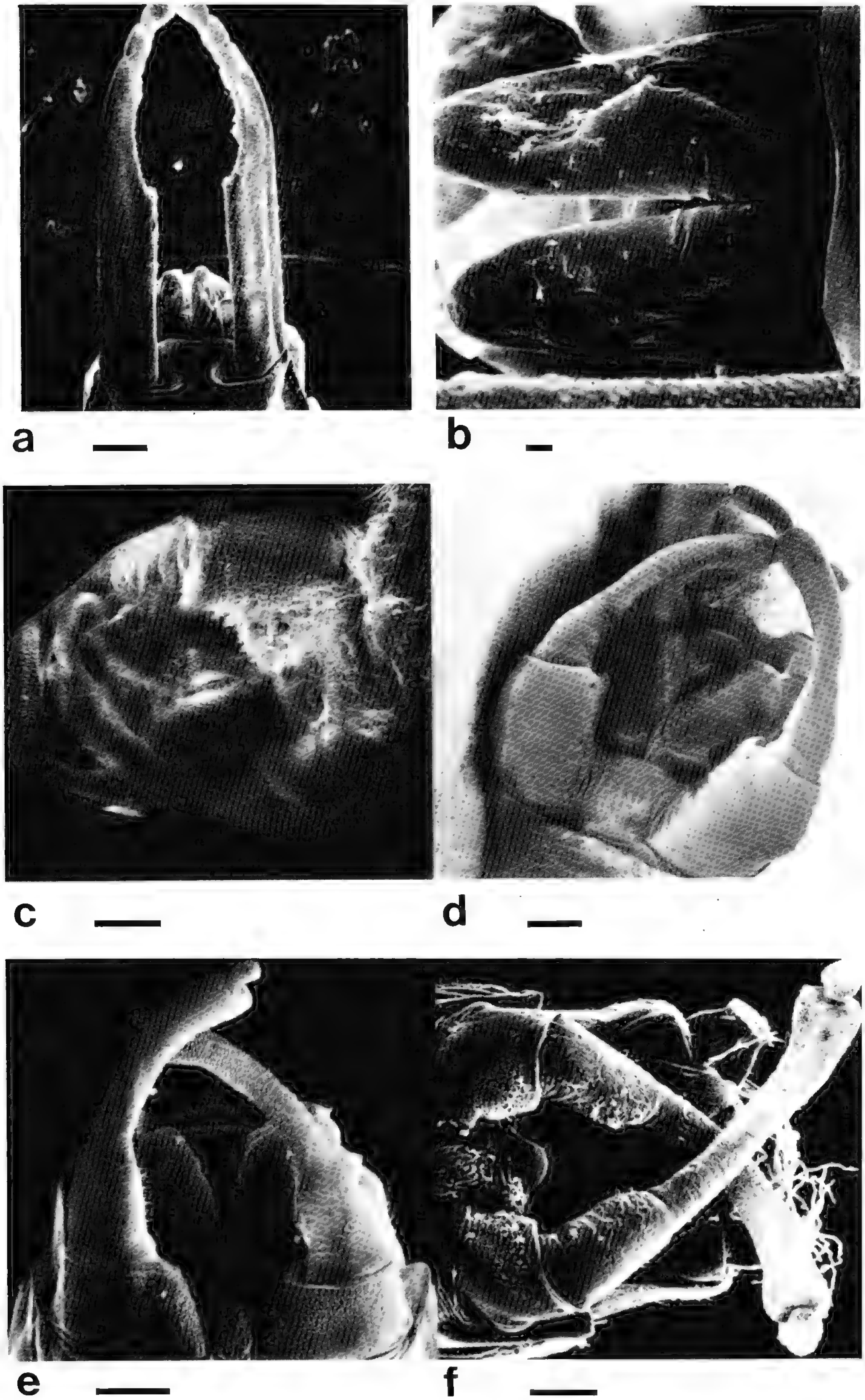

FIG. 19. SEM micrographs of some Australian mayflies. a-b, *Ulmerophlebia pipinna*: a, genitalia, ventral view; b, enlarged ventral view of penes. c-e, ventral view of genitalia of c, *Baetis soror*; d, *Centroptilum elongatum*; e, *Cloeon fluviatile*; f, *Cloeon paradieniensis*. Scale lines: 100 μm.

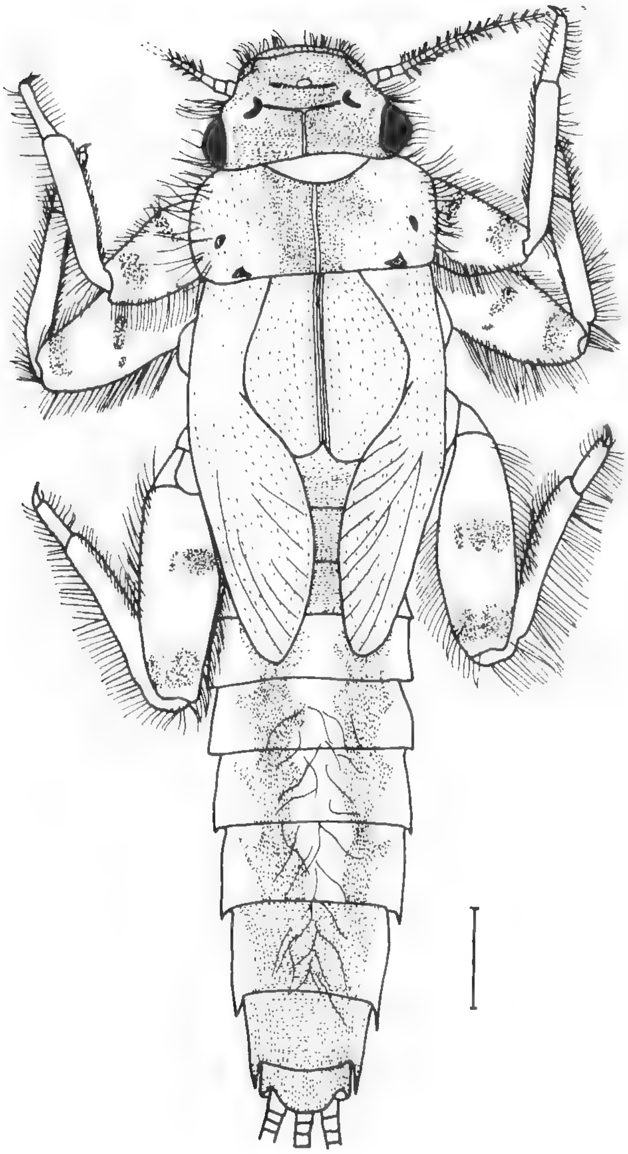

FIG. 20. Dorsal colour pattern of mature female nymph of *Ulmerophlebia pipinna*. Scale line: 1 mm.

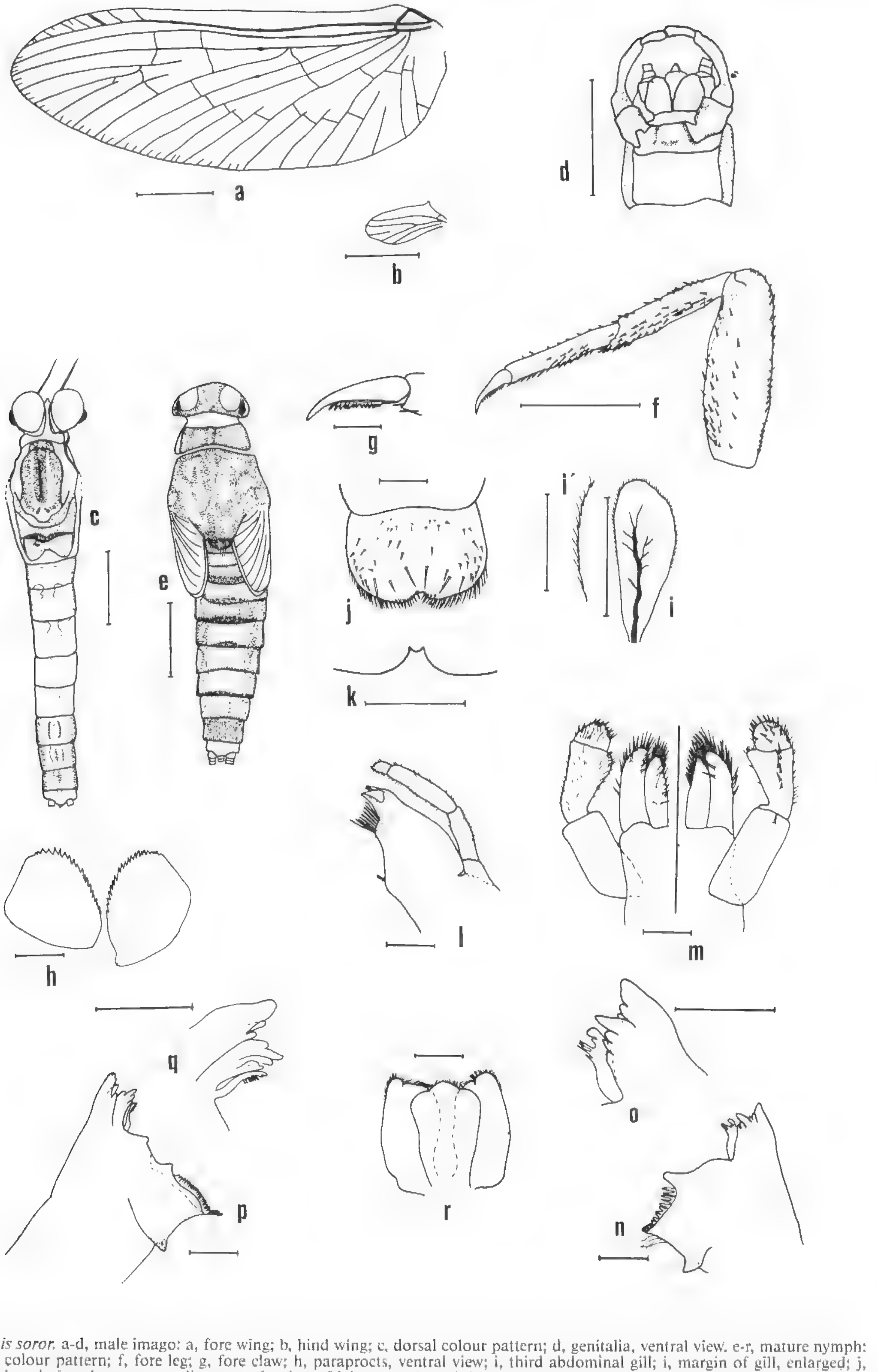

FIG. 21. *Baetis soror.* a-d, male imago: a, fore wing; b, hind wing; c, dorsal colour pattern; d, genitalia, ventral view. e-r, mature nymph: e, dorsal colour pattern; f, fore leg; g, fore claw; h, paraprocts, ventral view; i, third abdominal gill; i, margin of gill, enlarged; j, labrum, dorsal view; k, antero-median emargination of labrum, enlarged; l, left maxilla, ventral view; m, labium, dorsal (left) and ventral views; n, left mandible, ventral view; o, left incisors and prostheca, enlarged; p, right mandible, ventral view; q, right incisors and prostheca, enlarged; r, hypopharynx. Scale lines: a, b, c, e, 1 mm; d, f, i, 0.5 mm; g, h, i, j-r, 0.1 mm.

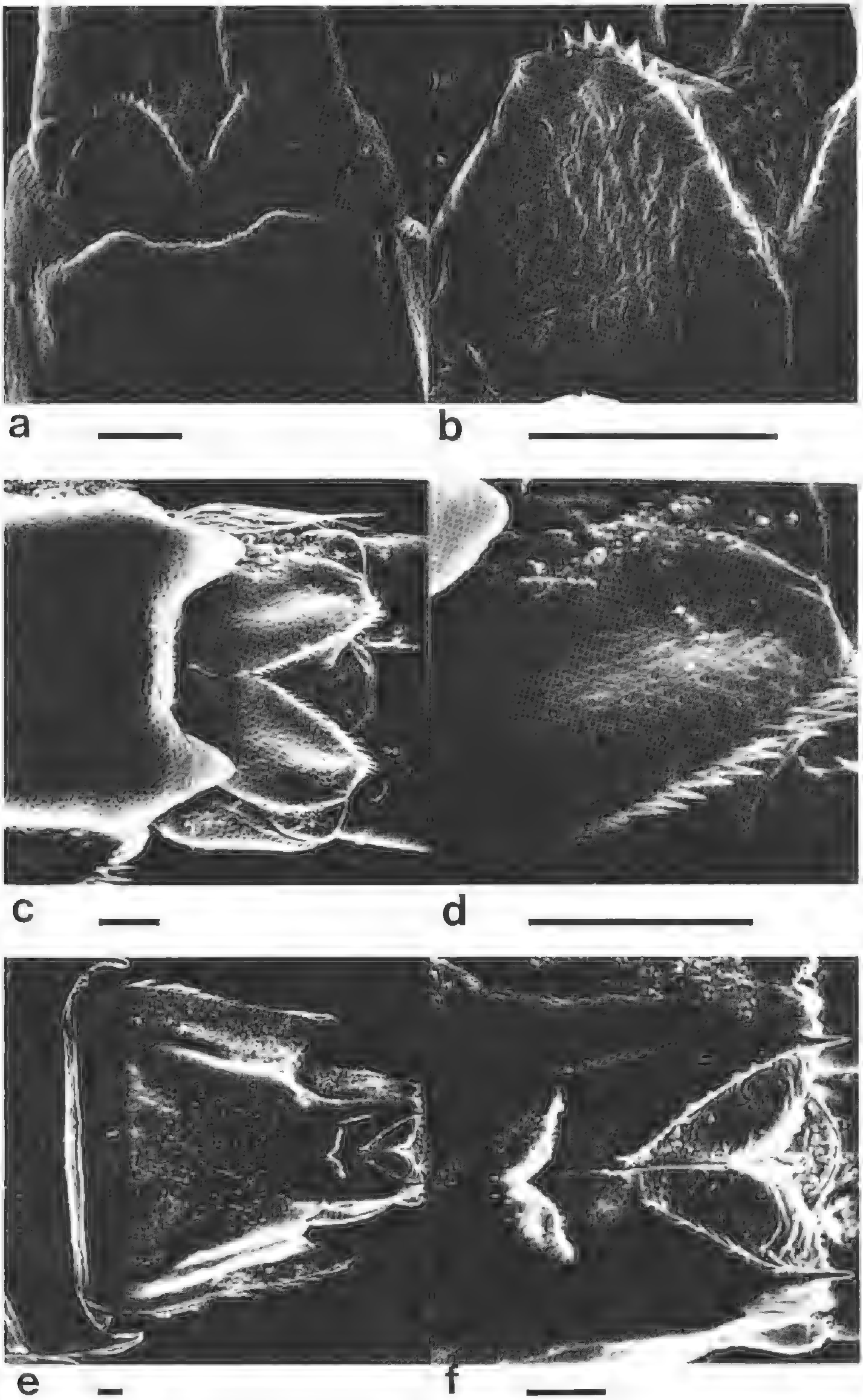

FIG. 22. SEM micrographs of the paraprocts of nymphs of *Baetis soror* (a, b); *Centroptilum elongatum* (c, d) and *Tasmanophlebia* sp. (e, f). Scale lines: 100 μm.

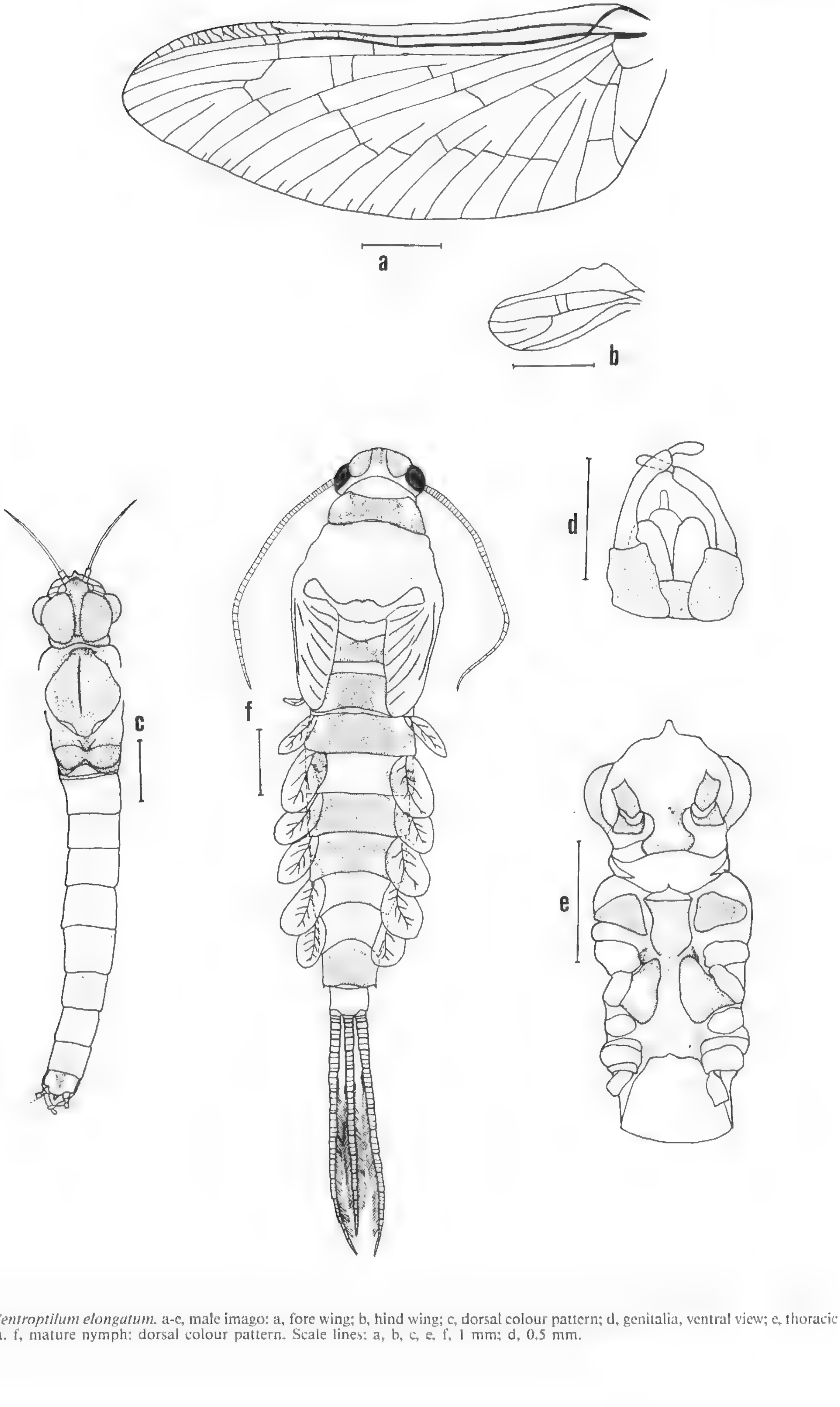

FIG. 23. *Centroptilum elongatum*. a-e, male imago: a, fore wing; b, hind wing; c, dorsal colour pattern; d, genitalia, ventral view; e, thoracic sterna. f, mature nymph: dorsal colour pattern. Scale lines: a, b, c, e, f, 1 mm; d, 0.5 mm.

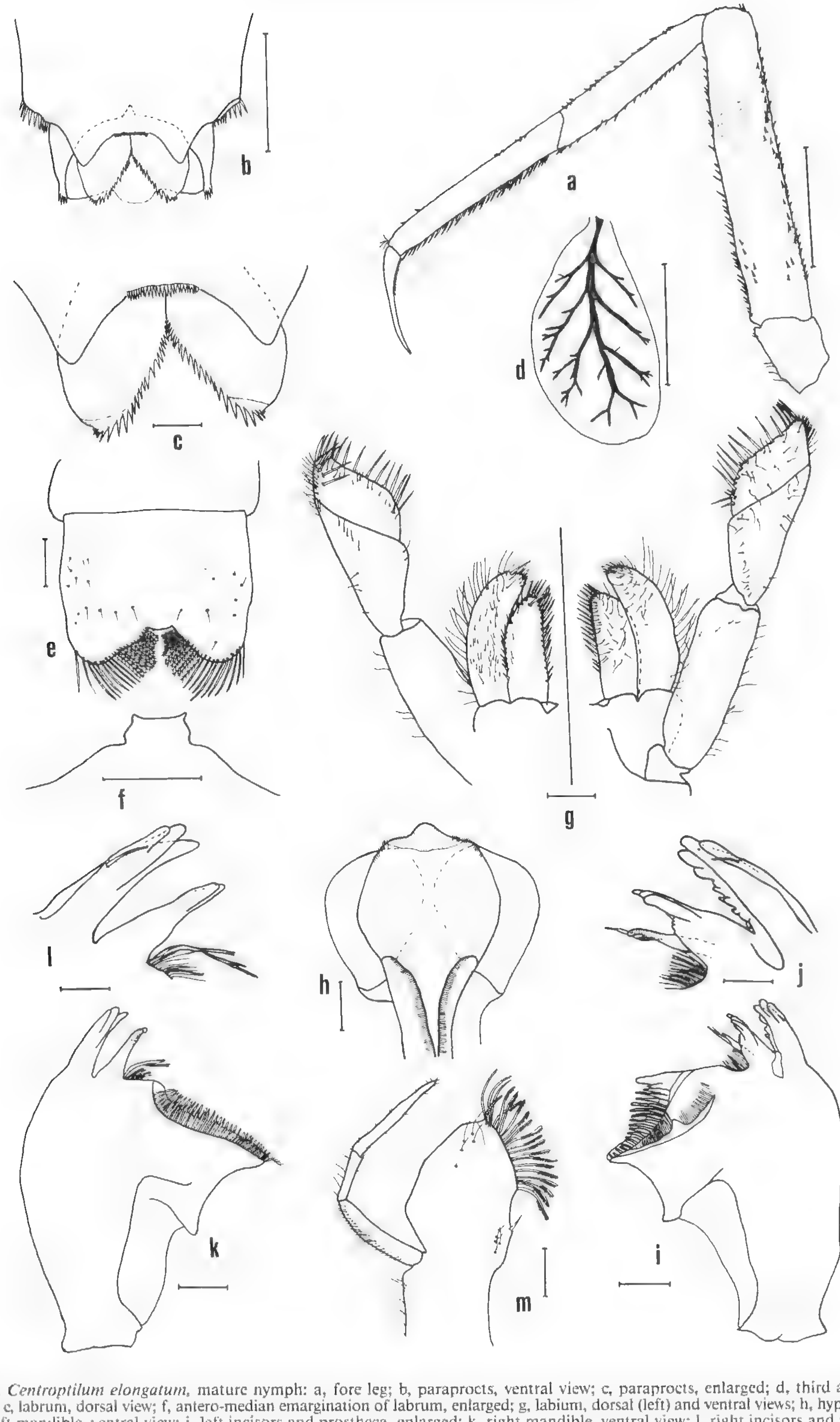

FIG. 24. *Centroptilum elongatum,* mature nymph: a, fore leg; b, paraprocts, ventral view; c, paraprocts, enlarged; d, third abdominal gill; e, labrum, dorsal view; f, antero-median emargination of labrum, enlarged; g, labium, dorsal (left) and ventral views; h, hypopharynx; i, left mandible, ventral view; j, left incisors and prostheca, enlarged; k, right mandible, ventral view; l, right incisors and prostheca, enlarged; m, right maxilla, ventral view. Scale lines: a, b, d, 0.5 mm; c, d, e, f, g, h, i, k, m, 0.1 mm; j, l, 0.05 mm.

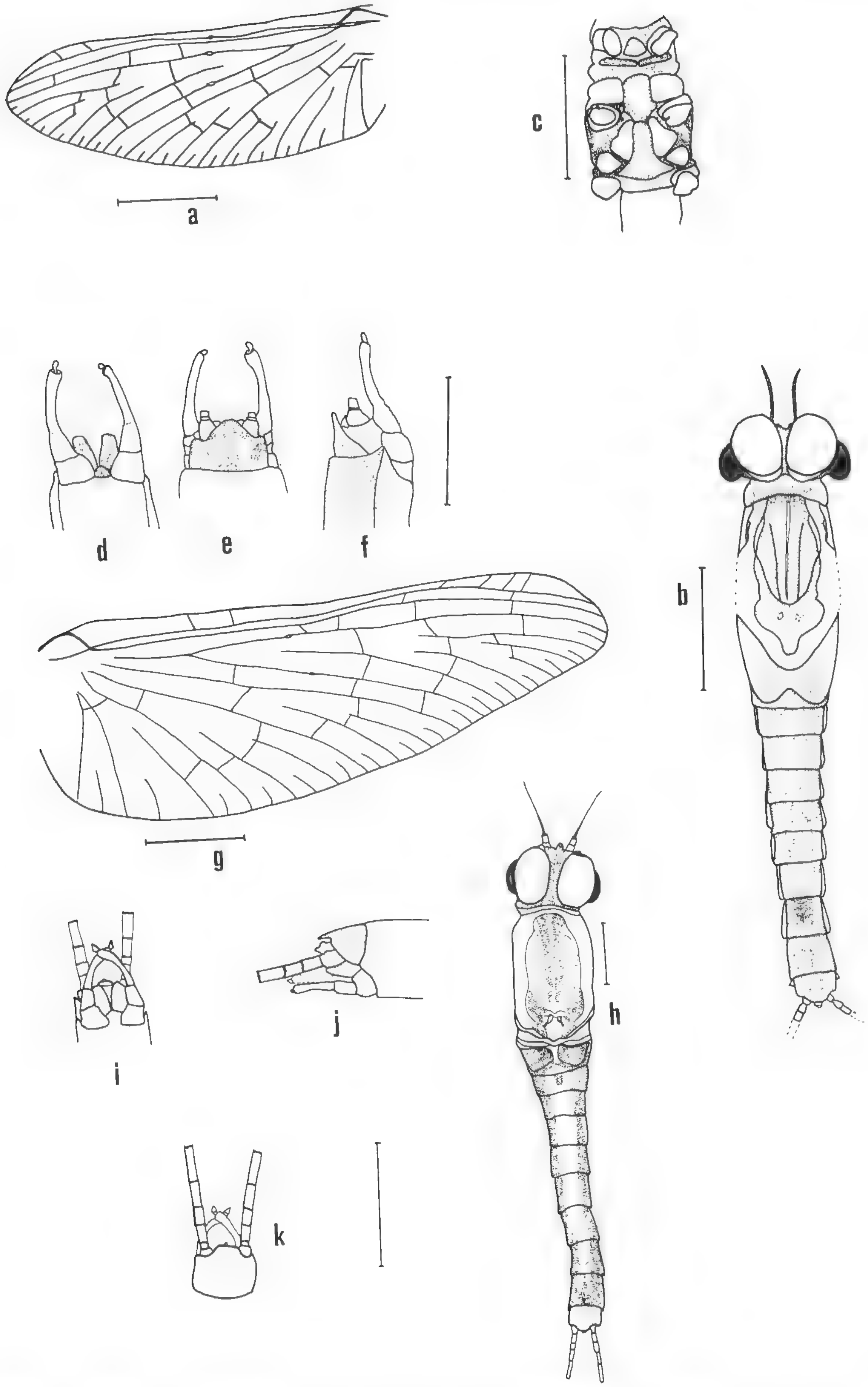

FIG. 25. *Cloeon fluviatile.* a-f, male imago: a, fore wing; b, dorsal colour pattern; c, thoracic sterna; d, genitalia, ventral view; e, genitalia, dorsal view; f, genitalia, lateral view. *Cloeon paradieniensis.* g-k, male imago: g, fore wing; h, dorsal colour pattern; i, genitalia, ventral view; j, genitalia, lateral view; k, genitalia, dorsal view. Scale lines: a, b, c, g-k, 1 mm; d, e, f, 0.5 mm.

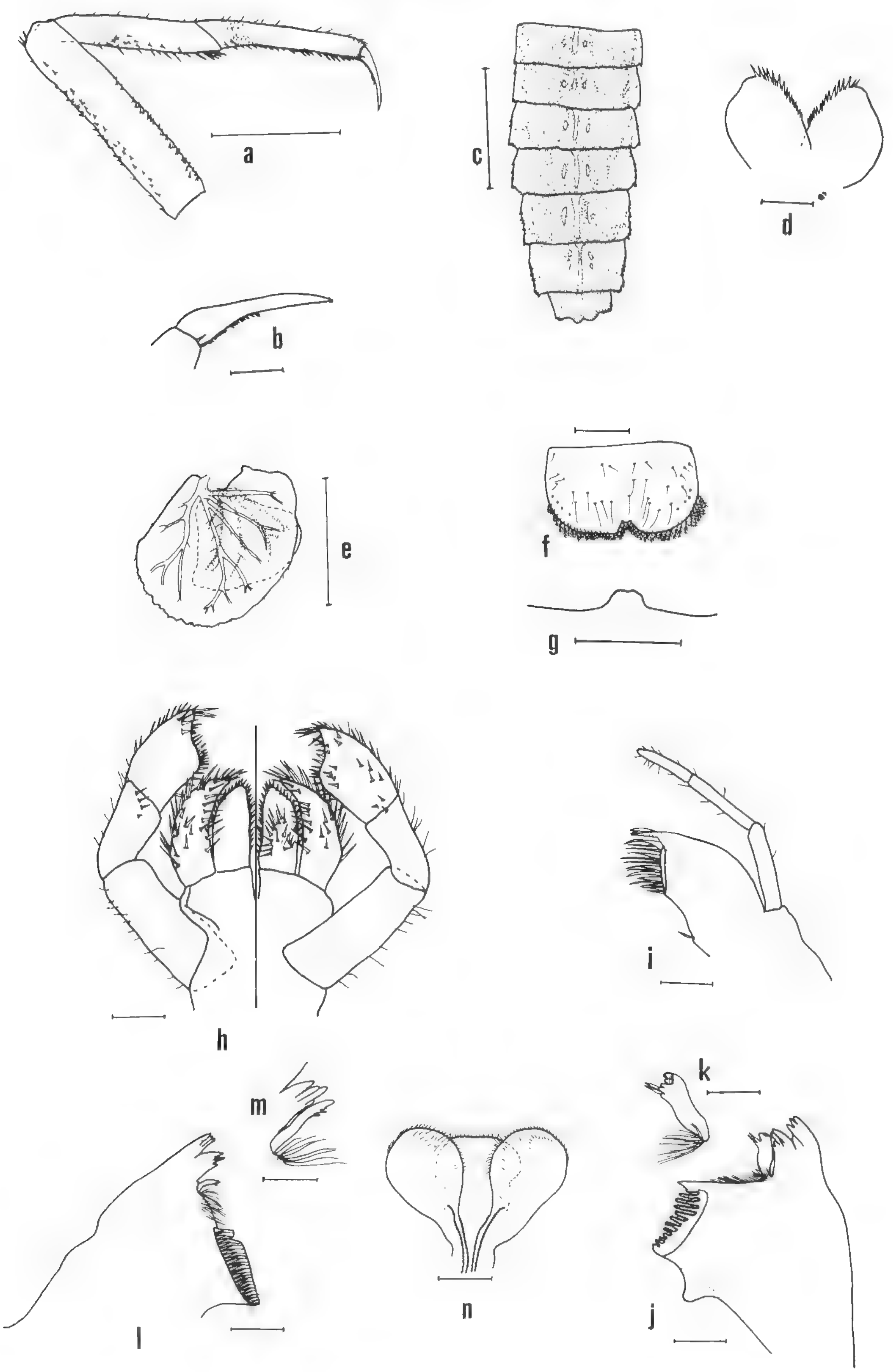

FIG. 26. *Cloeon fluviatile,* mature nymph: a, fore leg; b, fore claw; c, dorsal abdominal colour pattern; d, paraprocts; e, third abdominal gill; f, labrum, dorsal view; g, antero-median emargination of labrum; h, labium, dorsal (left) and ventral views; i, left maxilla, ventral view; j, left mandible, ventral view; k, left prostheca, enlarged; l, right mandible, ventral view; m, left prostheca, enlarged; n, hypopharynx. Scale lines: c, 1 mm; a, e, 0.5 mm; b, d, f-j, l, n, 0.1 mm; k, m, 0.05 mm.

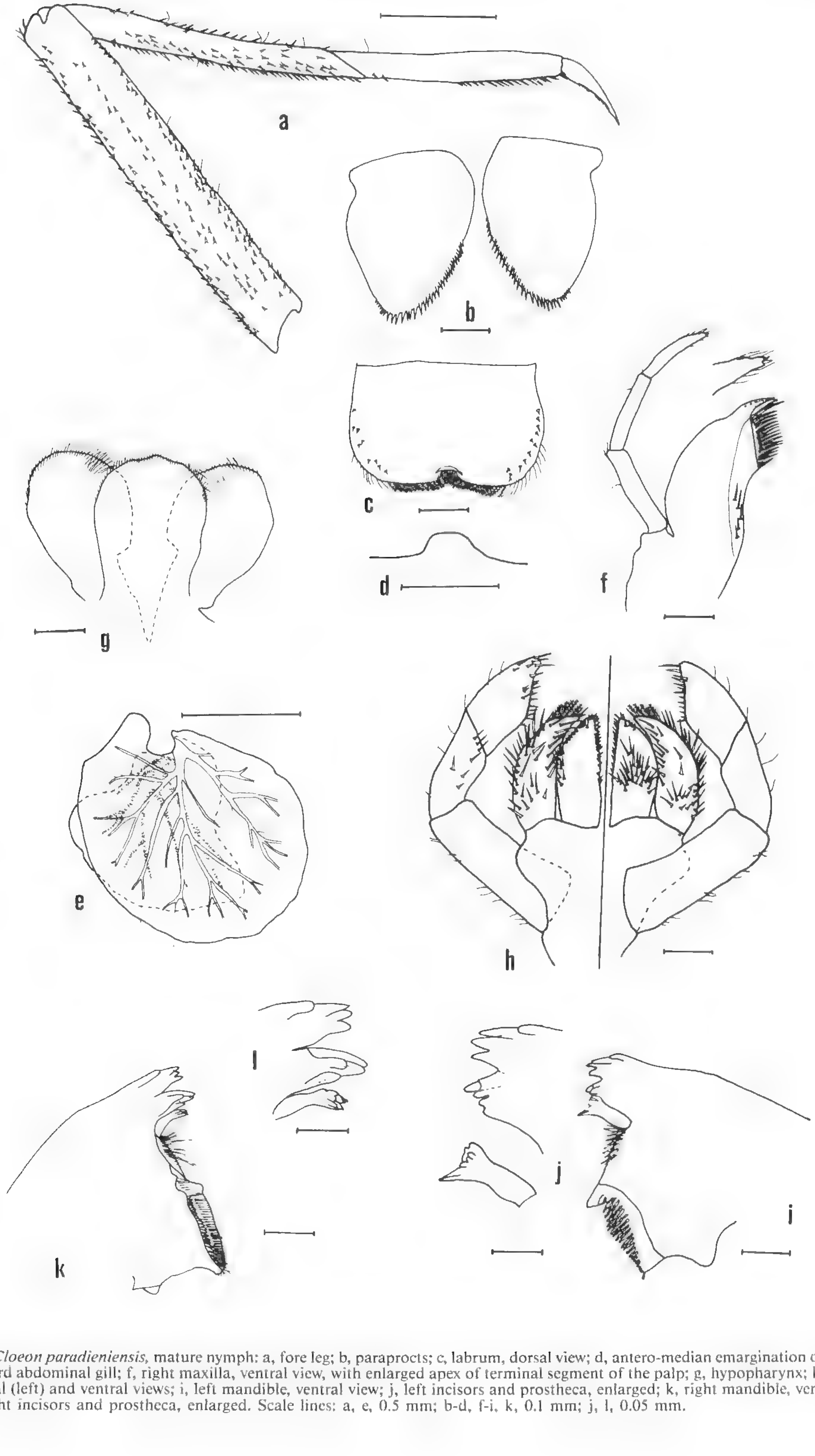

FIG. 27. *Cloeon paradieniensis,* mature nymph: a, fore leg; b, paraprocts; c, labrum, dorsal view; d, antero-median emargination of labrum; e, third abdominal gill; f, right maxilla, ventral view, with enlarged apex of terminal segment of the palp; g, hypopharynx; h, labium, dorsal (left) and ventral views; i, left mandible, ventral view; j, left incisors and prostheca, enlarged; k, right mandible, ventral view; l, right incisors and prostheca, enlarged. Scale lines: a, e, 0.5 mm; b-d, f-i, k, 0.1 mm; j, l, 0.05 mm.

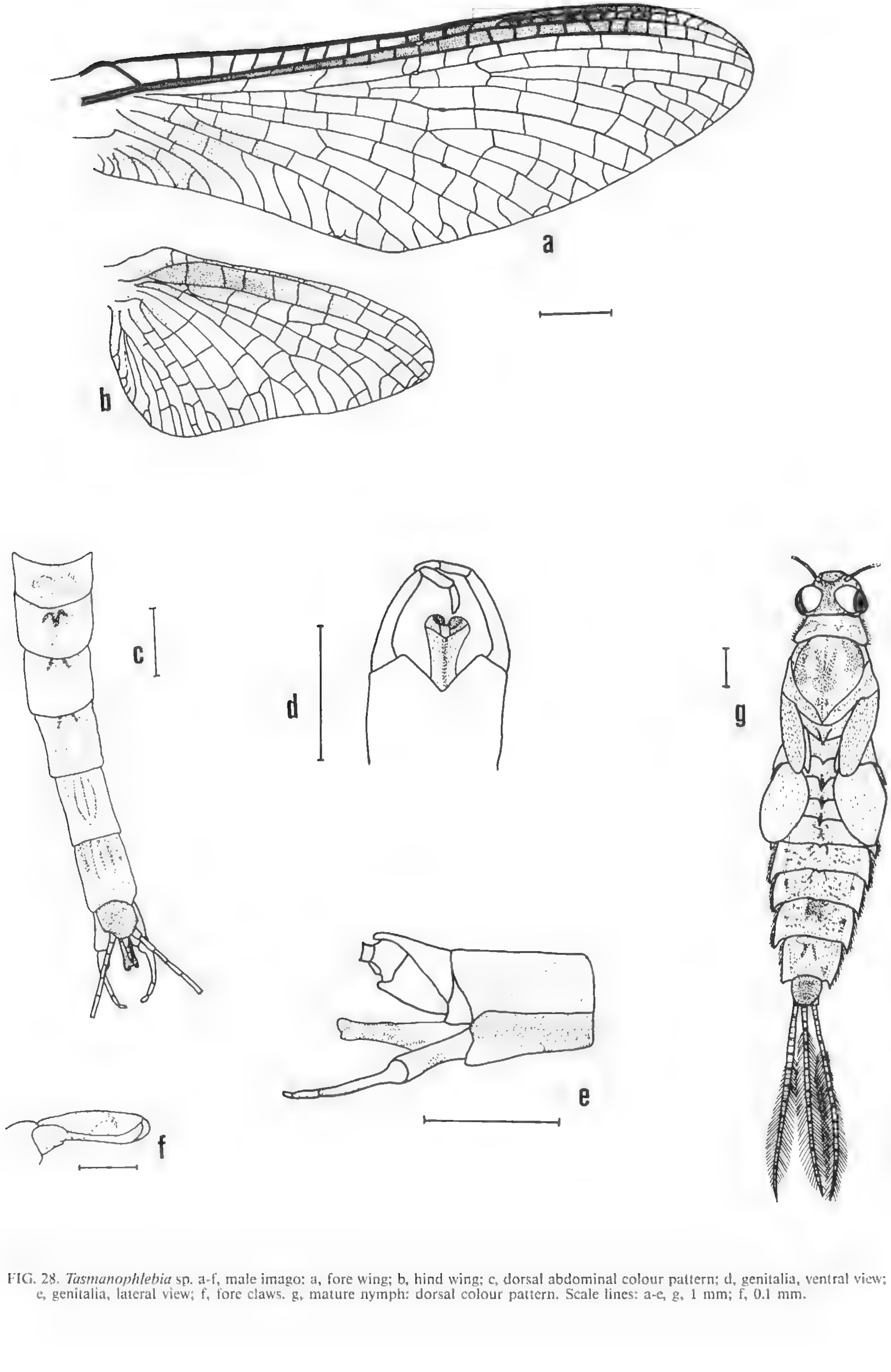

FIG. 28. *Tasmanophlebia* sp. a-f, male imago: a, fore wing; b, hind wing; c, dorsal abdominal colour pattern; d, genitalia, ventral view; e, genitalia, lateral view; f, fore claws. g, mature nymph: dorsal colour pattern. Scale lines: a-e, g, 1 mm; f, 0.1 mm.

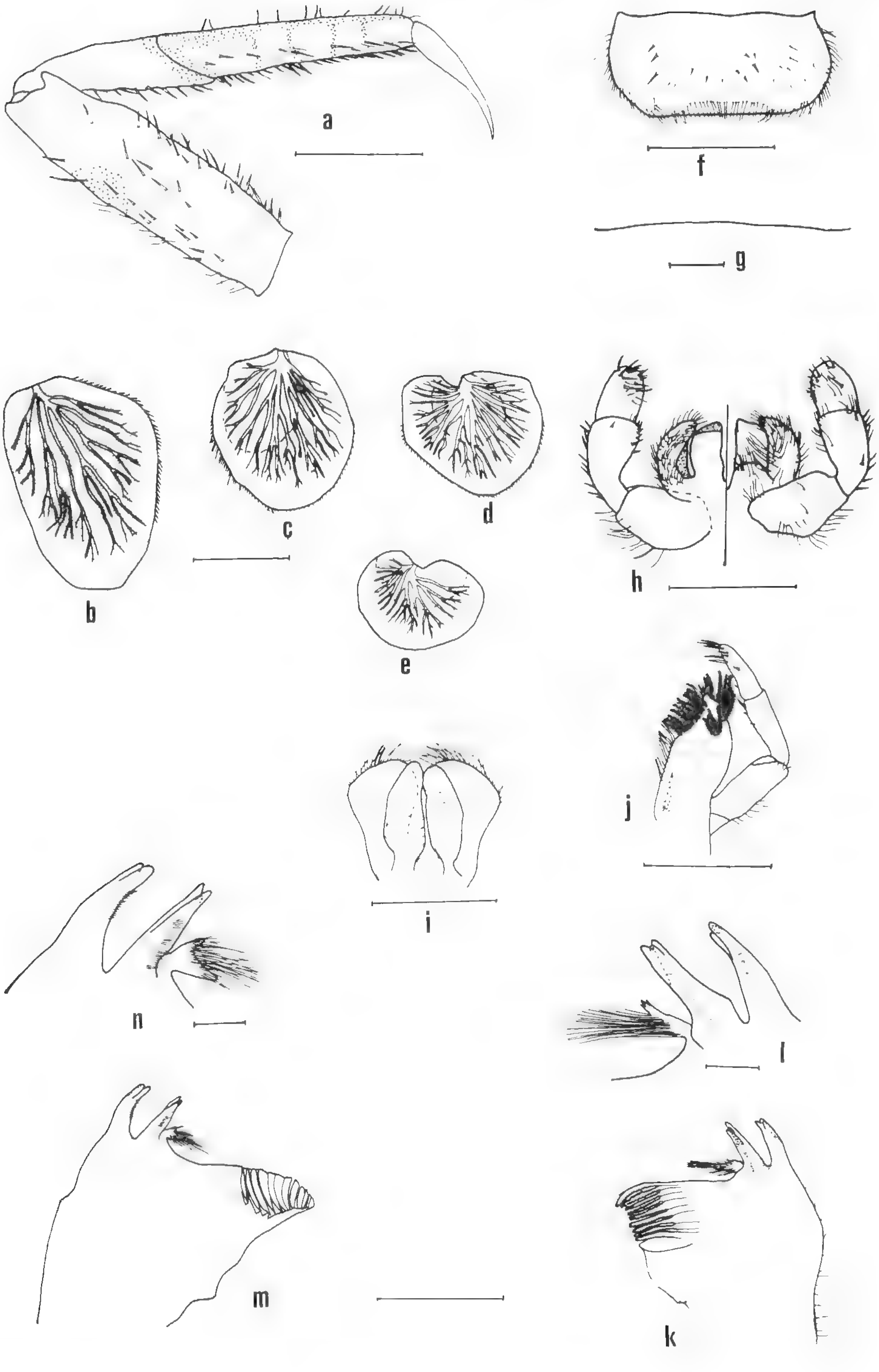

FIG. 29. *Tasmanophlebia* sp. mature nymph: a, fore leg; b, first abdominal gill; c, second abdominal gill; d, third abdominal gill; e, fourth abdominal gill; f, labrum, dorsal view; g, antero-median emargination, enlarged; h, labium, dorsal (left) and ventral views; i, hypopharynx; j, left maxilla, ventral view; k, left mandible, ventral view; l, left incisors and prostheca, enlarged; m, right mandible, ventral view; n, right incisors and prostheca, enlarged. Scale lines: b-e, 1 mm; a, f, h-k, m, 0.5 mm; g, l, n, 0.1 mm.

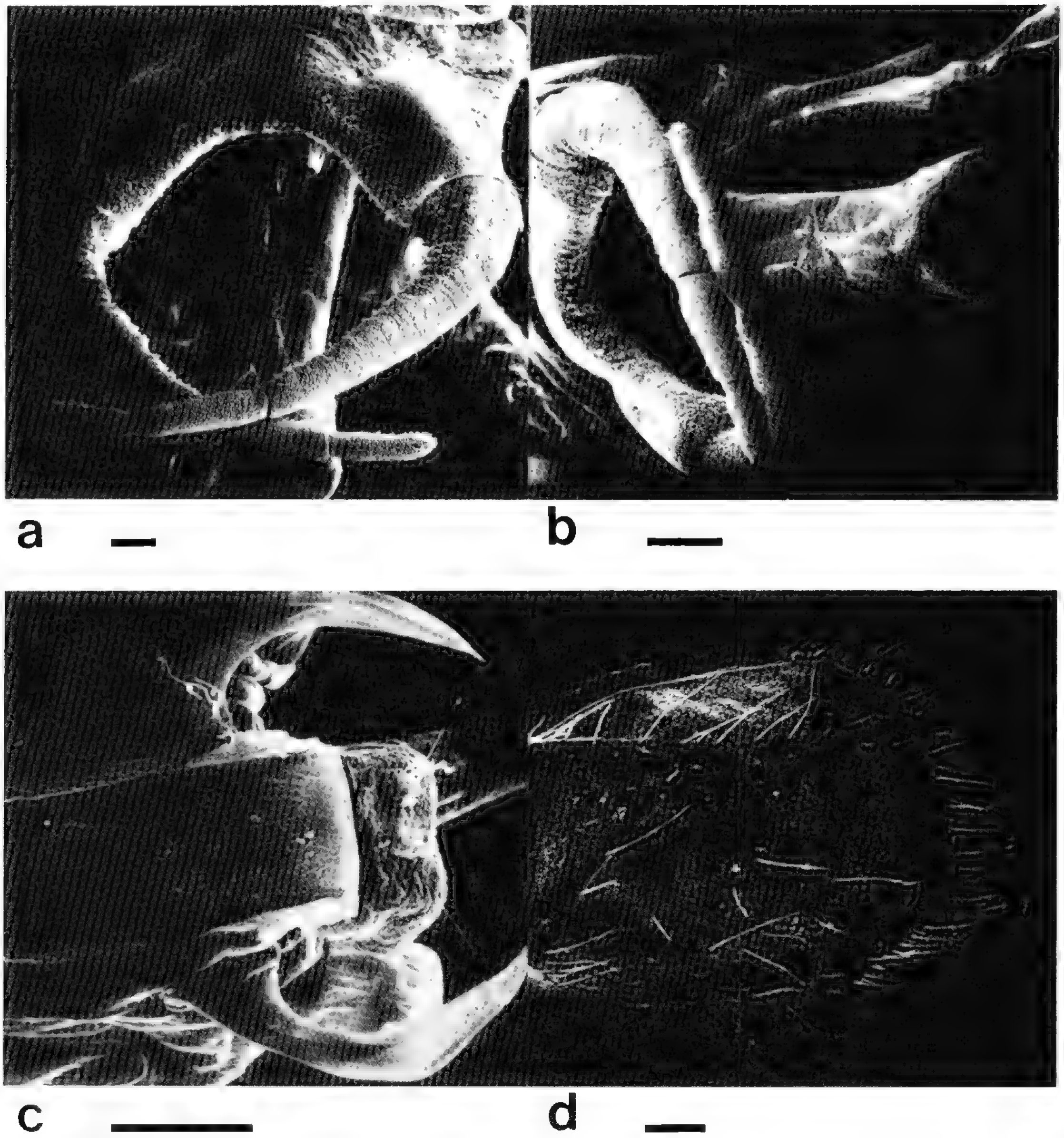

FIG. 30. SEM micrographs of *Tasmanophlebia* sp. and *Tasmanocoenis tillyardi*. *Tasmanophlebia* sp. a, b, genitalia of male imago, ventral views. *Tasmanocoenis tillyardi*. c, genitalia of male imago, ventral view; d, second gill of mature nymph. Scale lines: 100 μm.

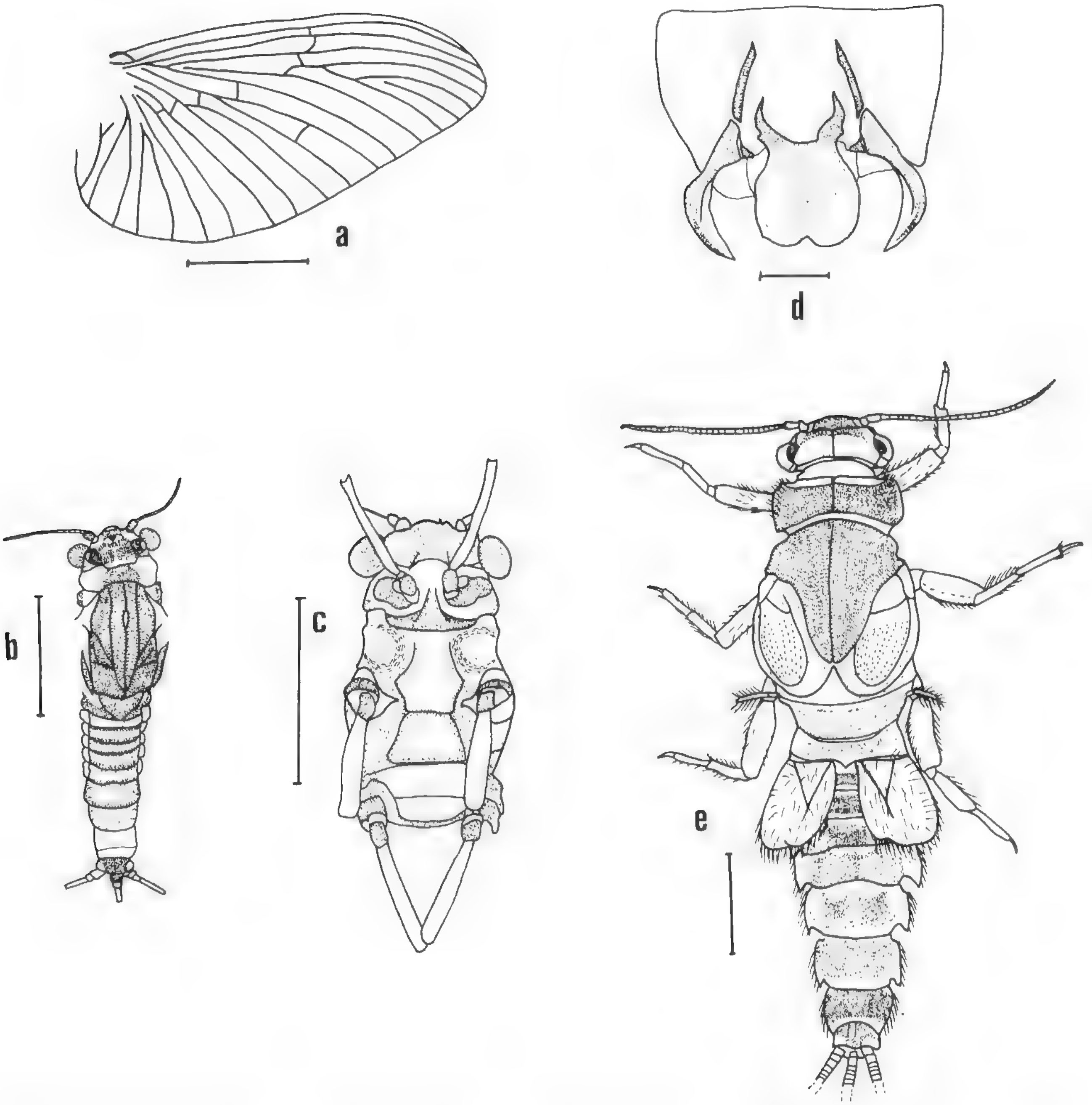

FIG. 31. *Tasmanocoenis tillyardi.* a-d, male imago: a, fore wing; b, dorsal colour pattern; c, thoracic sterna; d, genitalia, ventral view. e, mature nymph: dorsal colour pattern. Scale lines: a-c, e, 1 mm; d, 0.1 mm.

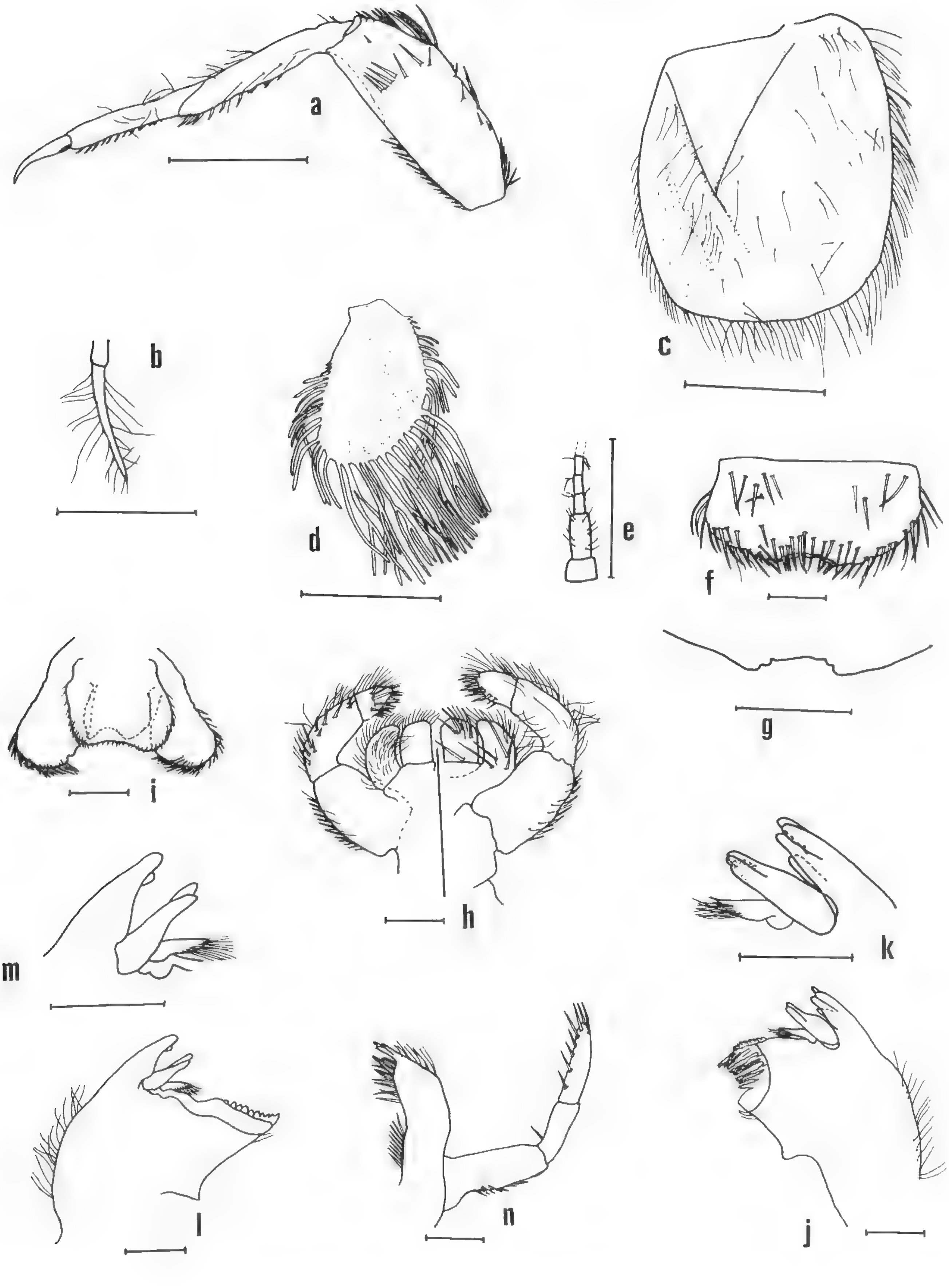

FIG. 32. *Tasmanocoenis tillyardi,* mature nymph: a, fore leg; b, first abdominal gill; c, second abdominal gill; d, third abdominal gill; e, basal antennal segments; f, labrum, dorsal view; g, antero-median emargination of labrum, enlarged; h, labium, dorsal (left) and ventral views; i, hypopharynx; j, left mandible, ventral view; k, left incisors and prostheca, enlarged; l, right mandible, ventral view; m, right incisors and prostheca, enlarged; n, left maxilla, ventral view. Scale lines: a-e, 0.5 mm; f-n, 0.1 mm.

FIRST REPRESENTATIVE OF THE ORDER MACROSTOMIDA IN AUSTRALIA (PLATYHELMINTHES, MACROSTOMIDAE)

BY RONALD SLUYS

Summary

A new species of macrostomid flatworm is described, Promacrostomum palum sp. nov., forming the third member of its genus and being the first representative of the order Macrostomida to be reported for Australia.

FIRST REPRESENTATIVE OF THE ORDER MACROSTOMIDA IN AUSTRALIA (PLATYHELMINTHES, MACROSTOMIDAE)

by

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(Manuscript accepted 6 January 1986)

ABSTRACT

SLUYS, R. 1986. First representative of the order Macrostomida in Australia (Platyhelminthes, Macrostomidae). *Rec. S. Aust. Mus.* 19(18): 399-404.

A new species of macrostomid flatworm is described, *Promacrostomum palum* sp. nov., forming the third member of its genus and being the first representative of the order Macrostomida to be reported for Australia.

INTRODUCTION

Macrostomid flatworms have been reported from all major parts of the world, except for Australia and New Zealand (cf. Ferguson 1939, Map 2; Ferguson 1954, Table 1; Williams 1980, p. 52). The majority of the species within the family Macrostomidae belong to the large genus *Macrostomum* O. Schmidt, 1848. The present paper describes a new macrostomid species, which was found in Australia. The species belongs to a genus which has a different and more complex female copulatory apparatus than is the case in *Macrostomum*.

Recent literature on the Macrostomidae is rather scattered but the papers of Ferguson (1939-40, 1954) still represent a useful introduction, whereas those of Papi (1953), Luther (1960) and Young (1976) are some of the larger papers among more recent publications.

SYSTEMATIC SECTION

Family **MACROSTOMIDAE** Van Beneden, 1870

Genus *Promacrostomum* An-der-Lan, 1939

Promacrostomum palum sp. nov.

Material Examined

Holotype: South Australian Museum, Adelaide, V3973, Elizabeth Springs, South Australia (29°21.36 S, 136°46.30'E), 27.11.1983, coll. W. Zeidler, W. Ponder, sagittal sections on two slides.

Paratypes: SAM, V3974, ibid., horizontal sections on one slide; SAM, V3975, ibid., transverse sections on one slide; Australian Museum, Sydney, W197775-1, Elizabeth Springs, South Australia, 5.09.1983, coll. W. Ponder, E. Hershler, D. Winn, sagittal sections on one slide; AM, W197775-2, ibid., horizontal sections on one slide.

The holotype was sectioned at intervals of 5 μm; the paratypes at 8 μm. All sections were stained in Mallory-Heidenhain.

Etymology

The specific epithet is from the Latin *pala* (= spade) and refers to the shape of the hind end of the body.

Description

External Features

The preserved specimens measured 2.38-3.5 mm in length and 0.75-1 mm in diameter. In some specimens of sample AM W197775 the front end of the body was pointed, but in others and in specimens from SAM V3973-75 it was broadly rounded (Figs 1, 2). The hind end of the body is of a peculiar shape. In preserved specimens the posterior lateral margins give rise to a dorsally directed ridge at either side of the body; the posterior margin of the body shows a convex middle section (Figs 1, 2, 3). The preserved animals are devoid of pigment. Eyes were not visible in preserved specimens but only in animals cleared in clove oil.

Epidermis and Subepidermal Musculature

The height of the epidermal cells is about 11.5 μm; the cells are provided with numerous cilia which have a length of about 9 μm. Numerous and well-developed packages of rhabdites pierce the body wall, whereas rhabdite-tracks ("Stäbchenstrassen") are present at the front end. "Haftpapillen" are absent. A cyanophilous, granular secretion is discharged through the ventral epidermis at the posterior tip of the body. The gland cells are situated in the parenchyma.

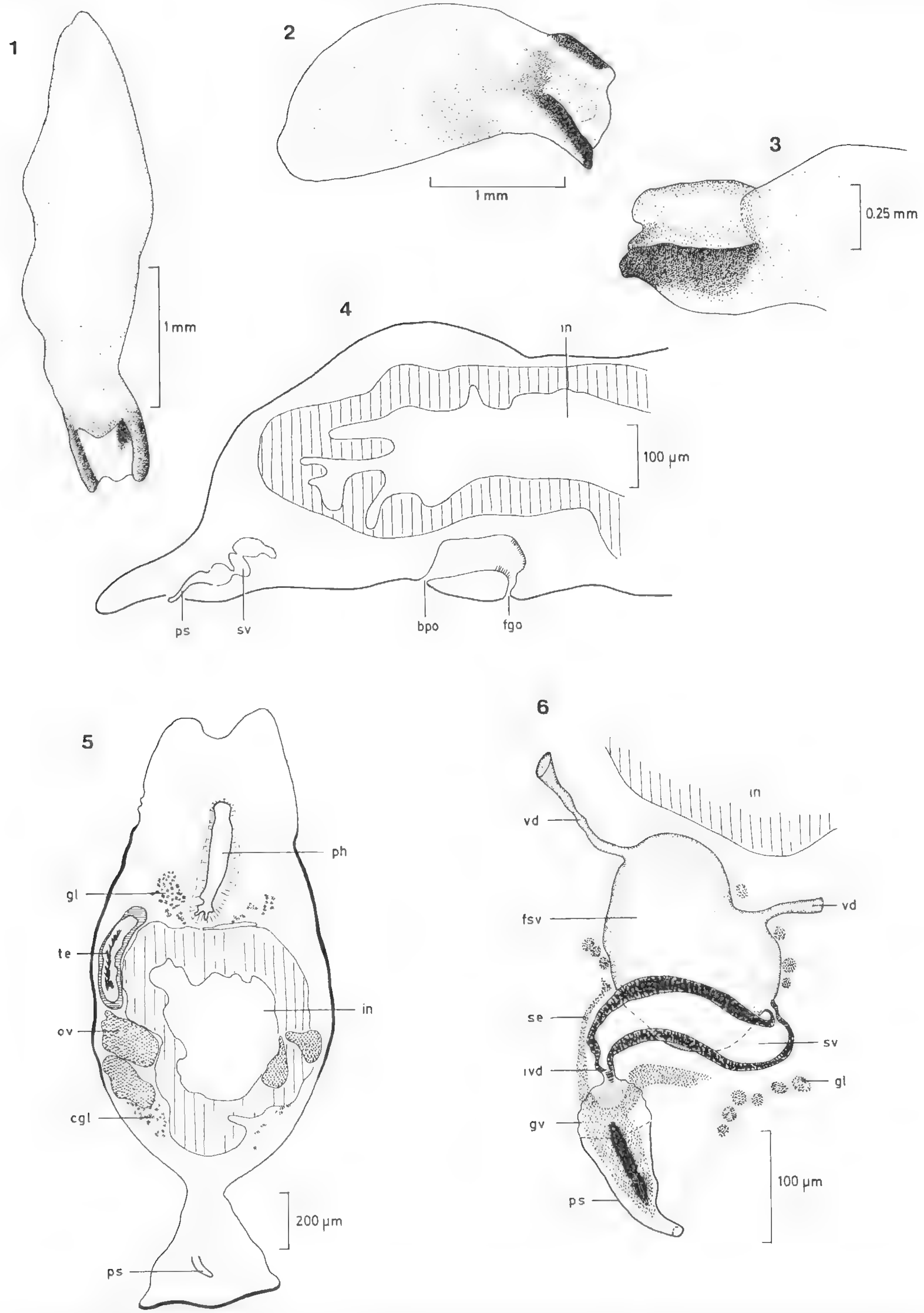
The subepithelial musculature consists of outer circular muscle fibres and inner longitudinal fibres.

Nervous System and Eyes

The brain lies just in front of the pharynx and is closer to the ventral than to the dorsal body surface. The two eyes are situated just on top of the brain.

Alimentary System

The thin epithelium lining the simple pharynx bears numerous well-developed cilia. Erythrophilous gland cells surround the pharynx where it communicates with the intestine. The intestinal cells are provided with long, but not very conspicuous, cilia. The intestine is underlain with a well-developed row of circular muscle



FIGS 1-6. *Promacrostomum palum* sp. nov. 1. Dorsal view of preserved specimen from sample W197775. 2. Dorsal-lateral view of preserved specimen from sample V3973-75. 3. Lateral view of the hind end of the body. 4. Sagittal reconstruction of holotype to show the position of the male and female copulatory organs and the intestine. 5. Horizontal section of V3974. 6. Horizontal reconstruction of the male copulatory organs of V3974.

fibres which is bounded by an outer row of longitudinal fibres. The sac-shaped intestine extends backwards to the male copulatory apparatus, and thus runs over the female copularory system (Fig. 4).

Male Reproductive System

The two elongated testes are situated ventrally and shortly behind the pharynx, one follicle at either side of the body (Fig. 5). The vasa deferentia open behind the posterior tip of the intestine, into a large false seminal vesicle (Fig. 6). The false seminal vesicle communicates with the true seminal vesicle by means of a considerable, muscularized constriction. This true seminal vesicle lies partly underneath the false seminal vesicle; the former is an elongated sac which is provided with a very thick muscular wall. A short and narrow intervesicular duct connects the true seminal vesicle with the rounded granular vesicle which receives the granular secretion of glands that lie distributed in the parenchyma. The wall of the granular vesicle is provided with a thin layer of muscles.

The proximal portion of the "chitinized" penis stylet is attached to the granular vesicle and consists of a broad cone that runs parallel to the body surface and which tapers into the much narrower distal section of the stylet. The distal section shows a pronounced bend towards the ventral body surface (Fig. 7). Sagittal sections already suggested the presence of a lateral flexure in the very distal portion of the stylet. This flexure did indeed show up in the transverse sections (Fig. 8). No unequivocal information could be obtained on the opening of the stylet. The sagittal sections suggested that the tip was closed such that there was a subterminal opening. On the other hand, the horizontal sections suggested the presence of a terminal opening, whereas in the transverse sections the tip of the stylet could not be discerned.

Female Reproductive System

The ovaries lie directly behind the testes and are situated ventrally; they are rather small (Fig. 5). The oviducts do not extend backwards but run directly towards the mid-line of the ventral body region, where they unite into a short common oviduct. The latter opens into the female antrum. There is a free connection between common oviduct and female antrum; a so-called "Verschlussapparat" is absent (Figs 9, 10).

The female antrum is lined with more or less cuboidal cells which bear long cilia. In specimen V3975 a large and thick mass of cells was attached to the dorsal surface of the antrum leaving at one place a small opening for the common oviduct. Sperm were attached to the clump of cells (Fig. 9). The antrum opens via a ciliated stalk into the ventral exterior. The lining epithelium of the stalk is penetrated by numerous openings of erythrophilous cement glands which are distributed in the parenchyma around the female antrum. The posterior wall of the female antrum meets a so-called seminal bursa. Communication between antrum and bursa may take place either via a considerable narrowing, as is the case, for example, in specimen W197775-1 (Fig. 11) and V3975, or via a much wider opening (Fig. 10). The seminal bursa is lined with tall, vacuolated, cells, whereas its lumen may contain sperm. The bursa communicates via a narrow ventral pore with the exterior. Female antrum and seminal bursa are surrounded by a well-developed layer of muscles.

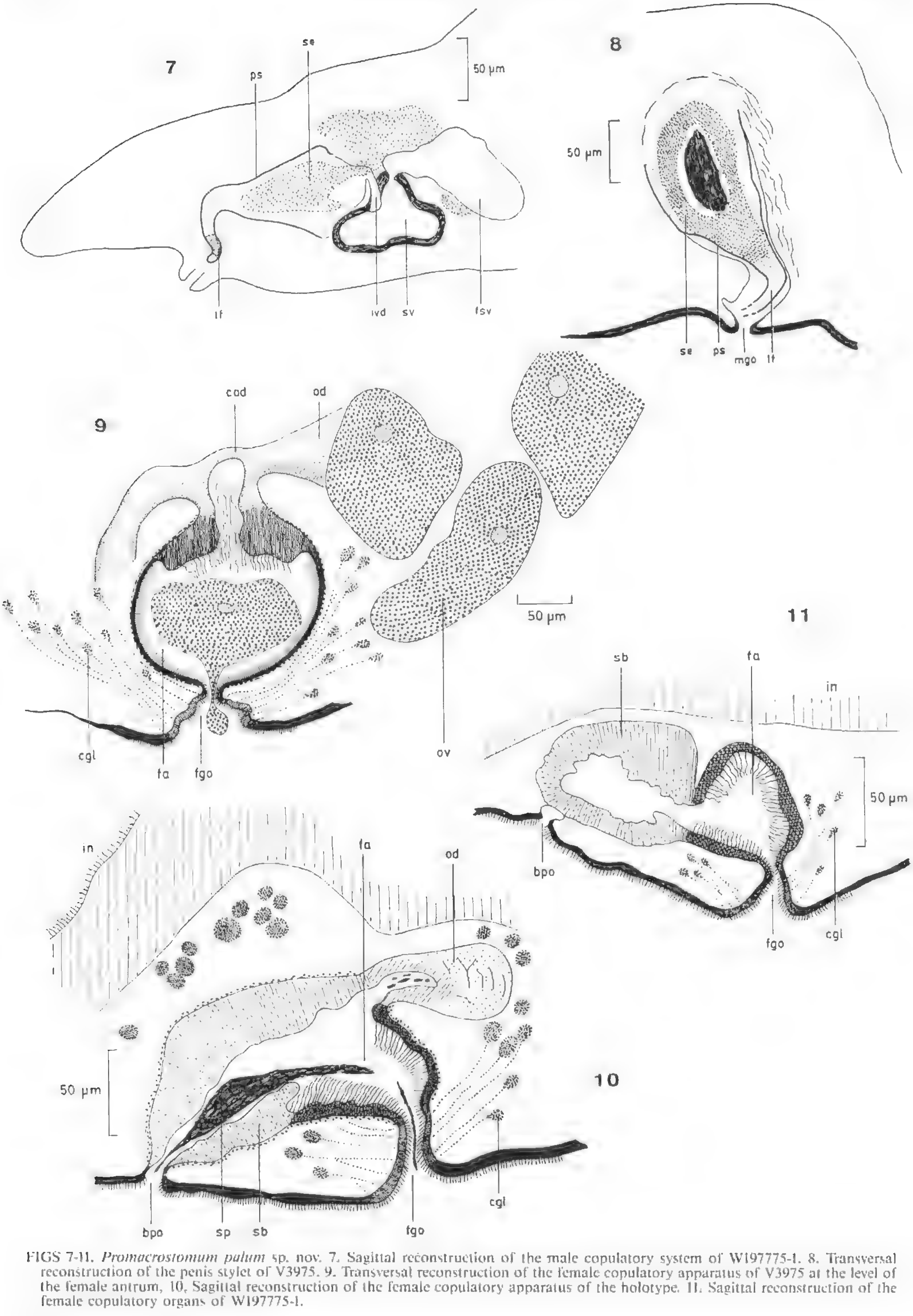
COMPARATIVE DISCUSSION

The genus *Promacrostomum* at present contains only three species, including the one described in this paper. The type species *P. paradoxum* was described from Lake Ohrid, Yugoslavia (An-der-Lan 1939).

On the basis of a description by Gieysztor (1931), Ferguson (1939-40) described the species *Macrostomum gieysztori* which he showed to be different from *M. gracile* (Pereyslawzewa, 1892; Graff, 1905) to which the first-mentioned author had assigned the specimens collected. Papi (1951a) transferred the species to the genus *Promacrostomum*, but Ferguson (1954) erected the genus *Axia* for the species *gieysztori*. The new generic name *Axia*, however, has not been accepted since it is not used in recent literature. *P. gieysztori* has been found in Spain and Italy; it is a thermophilic freshwater species (Ferguson 1939-40, 1954; Papi 1951b).

P. gieysztori has a distinct common oviduct which empties into a structure that possesses two openings to the exterior (cf. Papi 1951b, Fig. 54; Ferguson 1954, Fig. 23). The anterior portion of this body is rather spacious and secretion of cement glands is discharged into its ventral opening. The major part of this anterior structure is lined with cells bearing long cilia. Because of its shape, distinct ciliation, and the presence of cement glands around its pore, I consider this anterior section of the female copulatory apparatus of *P. gieysztori* to be homologous on the one hand with the female antrum of *Macrostomum* species, and on the other hand with the antrum of *P. palum*. As a consequence, the most anterior pore in *P. gieysztori* corresponds with the female gonopore.

The second opening of the female reproductive system in *P. gieysztori* lies posteriorly to the female gonopore and leads into the narrower posterior portion of the female apparatus, of which the ventral section is lined with cells having long cilia. The dorsal portion of this posterior part of the female apparatus is connected to the dorsal portion of the female antrum by means of a curved duct. The non-ciliated lining of this wide duct varies in height and consists of a syncytial cell mass; the duct is surrounded by a rather thick layer of circular muscles (cf. Papi 1951b, Fig. 54). It is because of structural and positional similarities that I consider this duct to be homologous with the seminal bursa of *P. palum*. For the same reasons I consider the posterior female pore of *P. gieysztori* to be homologous with the bursal pore of *P. palum*.



FIGS 7-11. *Promacrostomum palum* sp. nov. 7. Sagittal reconstruction of the male copulatory system of W197775-1. 8. Transversal reconstruction of the penis stylet of V3975. 9. Transversal reconstruction of the female copulatory apparatus of V3975 at the level of the female antrum, 10, Sagittal reconstruction of the female copulatory apparatus of the holotype. 11. Sagittal reconstruction of the female copulatory organs of W197775-1.

Unfortunately, less detailed histological information is available on the female copulatory apparatus of *P. paradoxum*. In this species too, the female apparatus has two ventral openings to the exterior. The posterior pore leads into a well-developed female antrum. The anterior pore leads into a section of the female copulatory apparatus that communicates anteriorly with the intestine and posteriorly with the female antrum. The connection with the female antrum goes via a rather spacious "middle section" of the female apparatus. This "middle section" is surrounded by well-developed circular muscles. The female antrum and "middle section" are lined with a relatively tall, almost syncytial, epithelium (An-der-Lan 1939; Ferguson 1954).

It is evident from An-der-Lan's account that he considered the female antrum of *P. paradoxum* to be homologous with the atrium of *Macrostomum* and considered the posteriorly located pore of the former to be homologous with the single female genital pore in *Macrostomum* species. I agree with An-der-Lan's conclusion, although no data are available on the presence or absence of cement glands around the posterior female genital pore of *P. paradoxum* or on the ciliation of the female antrum, and oviducts were absent in the specimens examined by An-der-Lan. My view on this subject is based only on the position and the overall shape of the female antrum (cf. An-der-Lan 1939, Fig. 3). Nevertheless, I postulate homologous relationships between the posteriorly located female gonopore in *P. paradoxum*, the anterior female genital pore in *P. gieysztori* and *P. palum*, and the single female gonopore in *Macrostomum*. Such relationships are, of course, also hypothesized for the female antra into which these pores lead.

It is even more difficult to evaluate the possible relationships of the anterior pore and the "middle section" of the female copulatory apparatus in *P. paradoxum* with structures in other macrostomids. Because of the poor state of that particular section of the preparations, An-der-Lan (1939) was unable to provide information on the histology of that portion of the female copulatory apparatus which communicates with the anterior pore. Therefore, it is only because of its position that I consider this anterior pore in *P. paradoxum* to be different from the posterior female pore in *P. gieysztori* on the one hand, and from the bursal pore in *P. palum* on the other hand.

If the above interpretation is correct, then both *P. palum* and *P. gieysztori* differ from *P. paradoxum* in that in both the first-mentioned species the "secondary" pore is situated behind the female gonopore, whereas in the latter it lies in front of the "primary" female pore ("primary" pore refers to that opening into which cement glands discharge — as in *Macrostomum* — no phylogenetic meaning is implied).

P. palum differs from the two other members of the genus *Promacrostomum* in the shape of its tail, stylet and that of the female copulatory apparatus (cf. Papi 1951b, Figs 52-54; Ferguson 1954, Figs 20-24).

Apart from similarities in the female copulatory apparatus, *P. palum* and *P. gieysztori* also agree in the absence of "Haftpapillen" and in the fact that the intestine runs over the female copulatory apparatus (cf. Ferguson 1939-40, 1954; Papi 1951b). In *P. paradoxum* the intestine terminates in front of the female copulatory apparatus and the species possesses well-developed "Haftpapillen" (An-der-Lan 1939).

From the account given above, one could conclude that *P. gieysztori* and *P. palum* have many more morphological similarities in common than either of them shares with *P. paradoxum*. In that respect the genus name *Axia*, as proposed by Ferguson (1954), may form indeed a plausible alternative for expressing the differences between *P. gieysztori* and *P. palum* on the one hand, and *P. paradoxum* on the other hand. However, absence of detailed histological information on the female system of *P. paradoxum* prevents a proper assessment of homologies. Pending such histological information it seems best, for the moment, to assign *P. gieysztori* and *P. palum* to the same genus as *P. paradoxum*.

The structure of the female copulatory apparatus in *Promacrostomum* invites a comparison with quite another member of the Macrostomida, viz. a representative of the family Microstomidae. In contrast to all other *Microstomum* species, the female apparatus of *M. spiriferum* Westblad, 1953 opens to the exterior by means of two ventral pores. These openings lead into two separate ducts, both connected with the single ovary. The most anterior duct is ciliated and opens into a small, ciliated chamber which is separated from the ovary by a sphincter. The posterior duct is non-ciliated and leads into a small seminal bursa which opens into the ovary (cf. Westblad 1953, Fig. 40). According to Westblad (*l.c.*) the anterior duct corresponds with the usual vagina but functions in *M. spiriferum* only as a discharging duct for the fertilized eggs. The posterior female duct would function as copulatory duct. It may be that the same functional distinction between both female pores holds true at least for *P. palum* and *P. gieysztori*. If such is the case, then it is clear that the same end result has been reached through parallel evolution.

It is evident from Papi's (1951b) account that he assumed such a functional distinction to be present in *P. gieysztori*. Papi described the female antrum of this species under the name of "antrum ovipositorum", whereas he designated the female gonopore as "porus ovipositorius". The posterior female pore in *P. gieysztori* leads, according to Papi, into the "vagina". Although I do not question the plausibility of such a functional distinction and even think it to be very likely, I have avoided terms such as vagina and antrum ovipositorum in the description of either *P. palum* or *P. paradoxum* and *P. gieysztori*. In the nomenclature of the various morphological features of the female apparatus I tried to use the same name for structures considered to be homologous in *Promacrostomum* and *Macrostomum.*

Ball (private communication) during his extensive collecting of freshwater planarians in Australia (1982-1984) has recorded specimens of macrostomids from caves in Yanchep National Park, Western Australia but not in surface water. Therefore, it is interesting that the first unequivocal record of a macrostomid turbellarian in Australia, *Promacrostomum palum* sp. nov., is also from a specialized habitat, viz. freshwater springs. Whether this situation represents an artifact or a real phenomenon remains an open question since in Australia scarcity of serious records for both freshwater and marine macrostomids also results from a lack of specialized interest in this group of animals.

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ABBREVIATIONS IN THE FIGURES

bpo	bursal pore
cgl	cement gland
cod	common oviduct
fa	female antrum
fgo	female genital pore
fsv	false seminal vesicle
gl	gland
gv	granular vesicle
in	intestine
ivd	intervesicular duct
lf	lateral flexure
mgo	male gonopore
od	oviduct
ov	ovary
ph	pharynx
ps	penis stylet
sb	seminal bursa
se	secretion
sp	sperm
sv	seminal vesicle
te	testes
vd	vas deferens

A REASSESSMENT OF THE PAPUAN SUBFAMILY ASTEROPHRYINAE (ANURA: MICROHYLIDAE)

BY THOMAS C. BURTON

Summary

Information obtained from examination of the osteology, myology and external morphology is used in a phylogenetic analysis to assess the relationships in the Asterophryinae, a subfamily of terrestrial and fossorial microhylid frogs restricted to the Papuan Subregion, and to assess the relationships between the Asterophryinae and the other Papuan subfamily, Genyophyrninae. While the Asterophyrinae is monophyletic, no evidence of monophyly of the Genyophryninnnae is found. Taxonomic changes are made and all genera redefined in light of the phylogenetic analysis: four new tribes are erected to accommodate monophyletic groups of asterophryine genera; the genus Mantophyne Boulenger is resurrected to accommodate three species currently included in Phrynomantis; and Xenorhina doriae is transferred to Phrynomantis.

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(Manuscript accepted 1 April 1986)

ABSTRACT

BURTON, T. C. A reassessment of the Papuan subfamily Asterophryinae (Anura: Microhylidae). *Rec. S. Aust. Mus.* 19(19): 405-450.

Information obtained from examination of the osteology, myology and external morphology is used in a phylogenetic analysis to assess the relationships in the Asterophryinae, a subfamily of terrestrial and fossorial microhylid frogs restricted to the Papuan Subregion, and to assess the relationships between the Asterophryinae and the other Papuan subfamily, Genyophryninae. While the Asterophryinae is monophyletic, no evidence of monophyly of the Genyophryninae is found. Taxonomic changes are made and all genera redefined in light of the phylogenetic analysis: four new tribes are erected to accommodate monophyletic groups of asterophryine genera; the genus *Mantophryne* Boulenger is resurrected to accommodate three species currently included in *Phrynomantis;* and *Xenorhina doriae* is transferred to *Phrynomantis.*

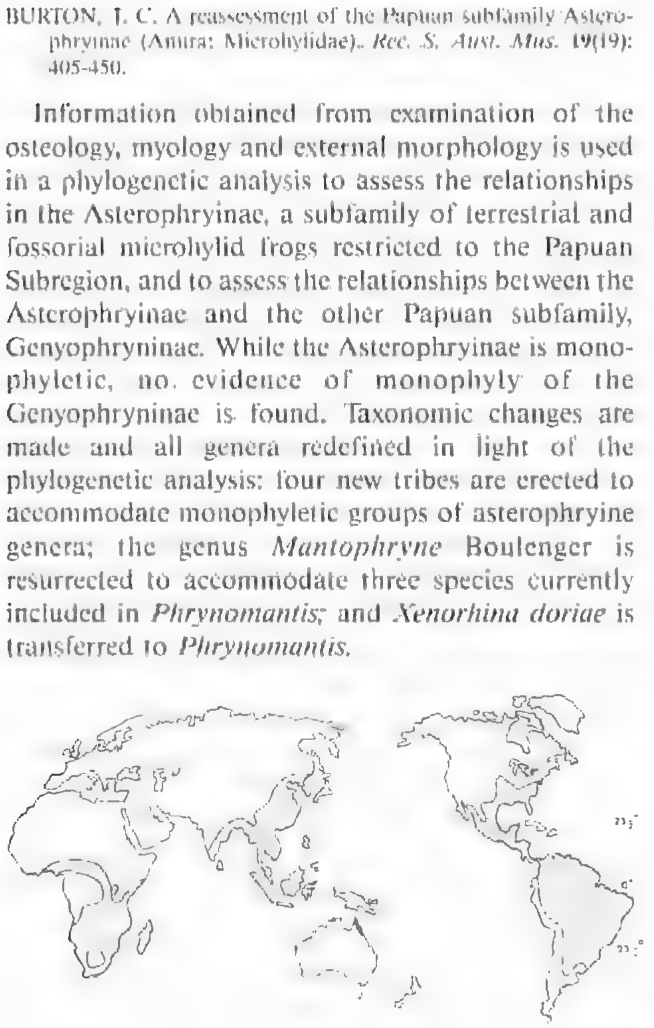

FIG. 1. Distribution of the Microhylidae (adapted from Savage, 1973).

INTRODUCTION

The Microhylids of the Papuan Zoogeographic Subregion

The frog family Microhylidae is distributed predominantly in the tropical areas of Asia, Africa, South America and the Australian Region, but with representatives also in the adjacent temperate areas of Asia, Africa and the Americas (Fig. 1). Frost (1985) lists 281 microhylid species, 61 genera and nine subfamilies, and the mean numbers of species per genus and of genera per subfamily are lower than in any other large family of frogs. The morphological diversity suggested by these figures reflects in part the ecological diversity found within the Microhylidae. There are fossorial, terrestrial, arboreal and aquatic species (Tyler 1976a), sharing the microhylid features of a firmisternal pectoral girdle, expanded sacral diapophyses, palatal folds, posteriorly directed process of the lower jaw (Roux 1944), *M. rectus abdominis pars anteroflecta* (Burton 1980) and a characteristic jawless tadpole (Parker 1934).

The subfamilial classification of the Papuan microhylids has long been contentious. In his monograph of the microhylids, in which he established the basis of the modern classification of the family, Parker (1934) recognized two Papuan subfamilies, Asterophryinae and Sphenophryninae. He recognized that these subfamilies were closely related and the only microhylids sharing the characteristic of direct development; as the distinctions between them were blurred by exceptions he expressed misgivings about separating them taxonomically: (a) while all sphenophrynines possessed a procoelous backbone, and nearly all of the asterophryines possessed a diplasiocoelous backbone, one asterophryine, *Genyophryne thomsoni* exhibited the sphenophrynine condition; (b) while the maxillae of all sphenophrynines were separated anteriorly by the premaxillae (the "eleutherognathine" condition), and nearly all of the asterophryines were symphygnathine, i.e., the two maxillae were fused on the midline anteriorly to the premaxillae, the three members of the genus *Metopostira, M. atra* (=*Barygenys atra*), *M. kopsteini* (=*Phrynomantis kopsteini*) and *M. ocellata* (=*Hylophorbus rufescens*)) and *G. thomsoni* exhibited the sphenophrynine condition. Parker considered, but rejected the advisability of classifying *G. thomsoni* as a sphenophrynine. *G. thomsoni* is a heavily built frog (as most asterophryines but few sphenophrynines are) and Parker considered the tongue of *G. thomsoni* to resemble the posteriorly adherent tongue of the asterophryines more than the sphenophrynine tongue, which is free posteriorly.

Zweifel (1971) and Savage (1973) independently tackled the problem of the unsatisfactory distinction between Asterophryinae and Sphenophryninae. Savage's solution was to declare the taxonomic distinction between these two subfamilies of direct-developing frogs "invalid". At the same time, echoing Noble (1931), he claimed that the Asian genus *Calluella* (which is not direct-developing) "appears to be a primitive genus from which the more highly evolved asterophryines [=Asterophryinae + Sphenophryninae] may have developed", and so he included the Sphenophryninae and *Cultuella* (*sensu* Inger, 1967) in an enlarged Asterophryinae.

Zweifel's solution was to examine the morphology of the animals, especially *G. thomsoni*, the species which had provided much of the heterogeneity in Parker's Asterophryinae. He found that in tongue morphology as in other features, *Genyophryne* resembled the sphenophrynines more than the asterophryines, and he transferred *G. thomsoni* into Sphenophryninae. Recognition that *G. thomsoni* was more closely related to the sphenophrynines allowed new diagnoses of two subfamilies which were consistently distinct for two characters: (1) Asterophryinae diplasiocoelous with adherent tongues, (2) Genyophryninae (Sphenophryninae plus *Genyophryne*) procoelous with tongues at least one-quarter free posteriorly; and mostly consistent for two others (almost all asterophryines with symphygnathine maxillae and dentaries; all genyophrynines with eleutherognathine maxillae and dentaries). (Zweifel 1981) and subsequent authors continued to refer to the augmented Sphenophryninae as Sphenophryninae, but Dubois (1985) indicates that Genophryninae Boulenger 1890 has priority over Sphenophryninae Noble 1931.) Zweifel (1972) considered Genyophryninae the parent group of the Asterophryinae. This implies that Genyophryninae is not a monophyletic sister-group but a paraphyletic parent-group. Subsequently, Tyler (1979) added to Zweifel's list of characters separating the subfamilies a character associated with the superficial submandibular musculature, viz., overlap of the *Mm. interhyoideus* and *intermandibularis* which he found present in all but one of the asterophryine genera and in no genyophrynines (*sensu* Zweifel, 1971) (Table 1). Tyler (1979) concurred with Zweifel's view that the Asterophryinae arose out of the Genyophryninae, and cited his study of the submandibular muscles (Tyler 1974) in support of this position.

TABLE 1. CHARACTERS TO DISTINGUISH THE ASTEROPHRYINAE FROM THE GENYOPHRYNINAE (AFTER TYLER 1979)

Character	Asterophryinae	Genyophryninae
Maxillae	Often overlapping premaxillae, maxillae, and usually in contact	Not overlapping premaxillae. Never in contact medially
Dentaries	In contact anteriorly (except in *Hylophorbus*)	Not in contact
Vertebral column	Diplasiocoelous	Procoelous
Tongue	Subcircular, entirely adherent, often with a median furrow and posterior pouch	Oval, half-free behind, lacking median furrow and posterior pouch
Interhyoideus muscle	Anteriorly underlies *intermandibularis* (except in *Hylophorbus*)	Does not underlie *intermandibularis*

In this study I follow Zweifel's classification and the terms "Asterophryinae" and "asterophryine" are used in Zweifel's restricted sense. The species and genera which constitute the Asterophryinae are listed in Table 2.

The Asterophryinae currently comprises 43 named taxa in seven genera. These species occur exclusively within the Papuan Subregion, mainly on the island of New Guinea, but some occur on islands from Seram, Amboina and Halmahera in the west to the Louisiade Archipelago in the east. The Genyophryninae is also centred upon the New Guinea mainland but ranges far more widely, from the Philippines in the north to tropical Australia in the south, and from Sulawesi and the Lesser Sunda Islands in the west to New Britain and the Louisiade Archipelago in the east. All of the six genyophrynine genera (Table 3) occur on the island of New Guinea, and only three of these (*Cophixalus*, *Oreophryne* and *Sphenophryne*) occur elsewhere. Of approximately 70 species, 50 have been recorded from New Guinea (Zweifel and Tyler 1982).

TABLE 2. THE ASTEROPHRYINAE

Asterophrys Gunther 1858
  turpicula (Schlegel) 1837

Barygenys Parker 1936
  atra (Gunther) 1896
  cheesmanae Parker 1936
  exsul Zweifel 1963
  flavigularis Zweifel 1972
  maculata Menzies and Tyler 1977
  nana Zweifel 1972
  parvula Zweifel 1980

Hylophorbus Macleay 1878
  rufescens rufescens Macleay 1878
  r. extimus Zweifel 1972
  r. myopicus Zweifel 1972

Pherohapsis Zweifel 1972
  menziesi Zweifel 1972

Phrynomantis Peters 1867
  boettgeri (Mehely) 1901
  dubia (Boettger) 1895
  eurydactyla Zweifel 1972
  fusca Peters 1867
  glandulosa Zweifel 1972
  humicola humicola Zweifel 1972
  h. compta Zweifel 1972
  infulata Zweifel 1972
  kopsteini (Mertens) 1930
  lateralis (Boulenger) 1897
  louisiadensis (Parker) 1934
  personata Zweifel 1972
  robusta (Boulenger) 1898
  slateri (Loveridge) 1955
  stictogaster Zweifel 1972
  wilhelmana (Loveridge) 1948

Xenobatrachus Peters and Doria 1878
  bidens (van Kampen) 1909
  giganteus (van Kampen) 1915
  macrops (van Kampen) 1909
  mehelyi (Boulenger) 1898
  obesus Zweifel 1972
  ocellatus (van Kampen) 1913
  ophiodon Peters and Doria 1878
  rostratus Mehely 1898
  subcroceus Menzies and Tyler 1977

Xenorhina Peters 1863
  bouwensi (de Witte) 1930
  doriae (Boulenger) 1888
  minima (Parker) 1934
  oxycephala (Schlegel) 1858
  parkerorum Zweifel 1972
  similis (Zweifel) 1956

TABLE 3. GENERA OF THE GENYOPHRYNINAE

Choerophryne	van Kampen 1915
Cophixalus	Boettger 1892
Copiula	Mehely 1901
Genyophryne	Boulenger 1890
Oreophryne	Boettger 1895
Sphenophryne	Peters and Doria 1878

Zweifel (1972) undertook a major revision of the asterophryines (*sensu* Zweifel, 1971). In that paper, Zweifel used characters of cranial osteology and external morphology, and erected two alternative phylogenetic trees to indicate intergeneric relationships (Fig. 2). These proposed phylogenies agree in

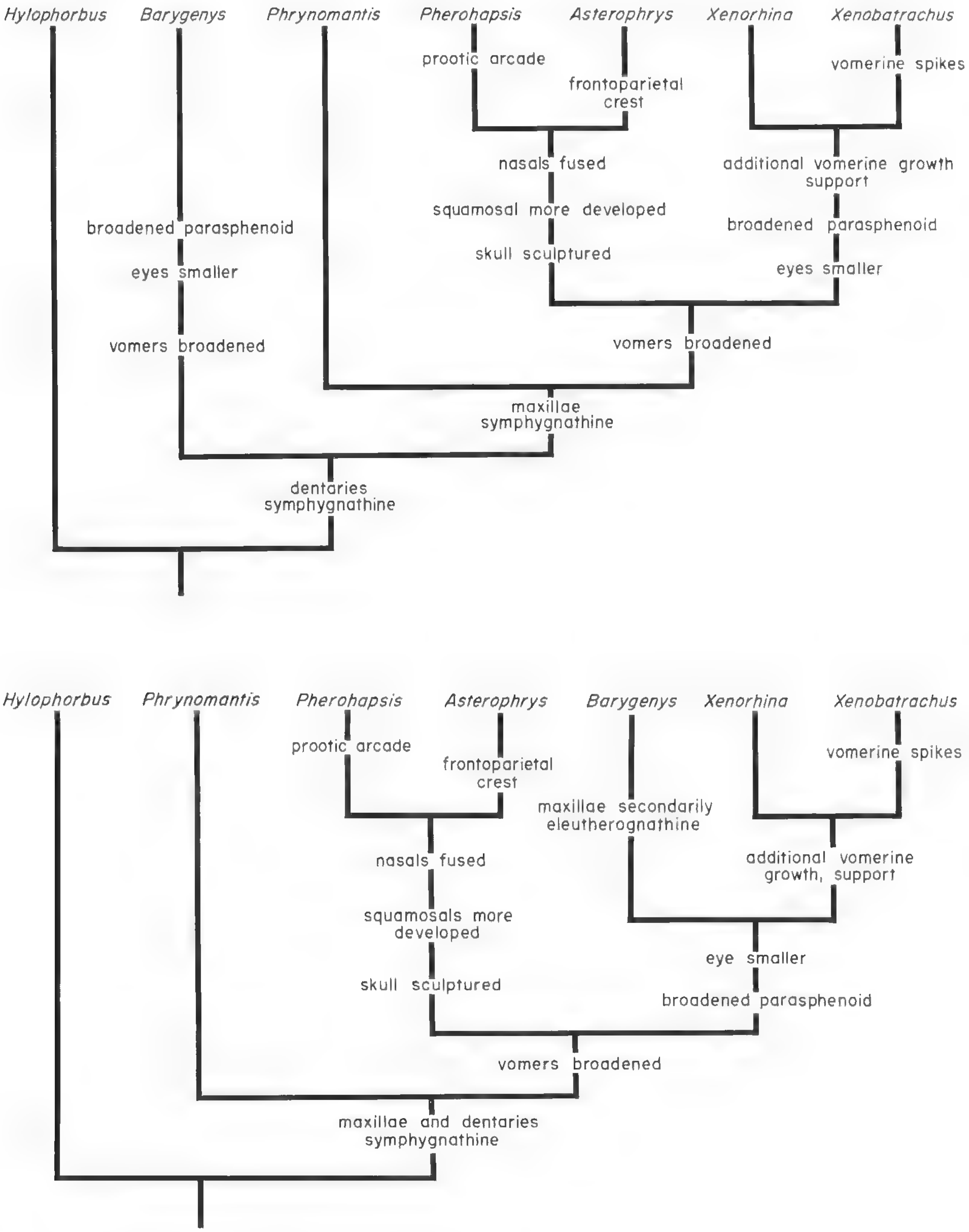

FIG. 2. Alternative proposed phylogenies of the Asterophryinae. Redrawn from Zweifel (1972, pp. 430, 431).

suggesting that *Hylophorbus* is the most primitive asterophryine genus, an hypothesis supported on the basis of features of the submandibular musculature by Tyler (1979). The proposed phylogenies differ in the placement of *Barygenys*, which is regarded as either a primitive genus which has undergone much parallel evolution with *Xenorhina* and *Xenobatrachus*, or a genus closely related phylogenetically to the other two, but which has undergone a reversal to partial eleutherognathy.

The Myology and Osteology of the Papuan Microhylids

The only published study of the entire musculature of any Papuan microhylid is that of Burton (1983a). Tyler (1974, 1979) and Emerson (1976a) examined the superficial throat musculature of some Papuan microhylids; Horton (1982) included in her review of tongue musculature one genyophrynine (*Sphenophryne robusta*); Trewavas (1933) examined the hyoid musculature of one genyophrynine (*Oreophryne celebensis*); Jones (1933) examined the pectoral musculature of four genyophrynines (*Cophixalus verrucosus, Genyophryne thomsoni, Oreophryne variabilis* and *Sphenophryne cornuta*); and Fry (1917) and Zweifel and Allison (1982) examined aspects of the musculature of *Cophixalus pansus*.

While osteological features were used by Boulenger (1882) and van Kampen (1923), the main osteological studies of Papuan microhylids are those of Mehely (1901), Wandollek (1910) and Zweifel (1971, 1972). Important contributions have also been made by Noble (1931), Parker (1934, 1936), Brongersma (1953) and Menzies and Tyler (1977).

Mehely (1901) described in detail the osteology and in particular cranial osteology of the following Papuan microhylids (Mehely's names in parentheses): *Phrynomantis (Mantophryne) lateralis, P. (Gnathophryne) boettgeri, P. (G.) dubia, P. (G.) robusta, Hylophorbus rufescens (Metopostira ocellata), Xenobatrachus rostratus (Xenorhina rostrata), Xenorhina oxycephala, Cophixalus (Phryxinalus) biroi, C. (P.) montanus, Copiula fistulans (C. oxyrhina), Oreophryne (Sphenophryne) biroi, O. celebensis, O. moluccensis (O. senckenbergiana), Sphenophryne mehelyi (Chaperina fusca)* and *S. (C.) polysticta*.

Wandollek (1910) described the osteology and illustrated the cranial bones and hyoids of *Choerophryne (Copiula) rostellifer, Oreophryne biroi (Mehelyia affinis* and *M. lineata), Sphenophryne cornuta, S. macrorhyncha (Chaperina quatuorlabata)* and *S. schlaginhaufeni)*.

Noble (1931) and Parker (1934, 1936) included a small number of skeletal characters in their generic and subfamilial diagnoses; Brongersma (1953) described the skeleton of *Asterophrys turpicula;* Zweifel (1971) used some skeletal characters in his analysis of the relationships of *Genyophryne;* and Menzies and Tyler (1977) described osteological features of a number of burrowing Papuan microhylids of the genera *Barygenys, Choerophryne, Copiula* and *Xenobatrachus*.

In his revision of the Asterophryinae, Zweifel (1972) relied to a large extent on cranial osteology. He described general features of the skeletons of asterophryines, the diagnostic features of each genus in generic accounts, and particular features of some species in species accounts. Zweifel's account of the cranial skeletons of asterophryines is comprehensive but scattered, and the contributions of the present study to the knowledge of the cranial skeleton are the addition of a few previously unrecorded features, and also information on a number of species not examined by Zweifel. This permits reinterpretation of some cranial characters.

There are problems in the interpretation of the cranial skeletons of asterophryines and in the selection of characters for phylogenetic analysis. The problems of interpretation arise from a number of factors: in all asterophryines there are some bones that are fused; in some asterophryines many bones are fused; and in some asterophyrines the task of discriminating bone margins is further complicated by exostosis.

The most problematic bone of the microhylid skull is the product of fusion of the vomer and the palatine. Mehely (1901) interpreted a narrow anterad projection of this bone skirting the medial margin of the choana as a vomer, and the remainder as a palatine. Noble (1931) and Parker (1934) referred to the entire bone as a prevomer and Zweifel (1972) as a vomer. The presence of odontoids on this bone convinced Noble and Parker (1926) that the bone was not a palatine, and they interpreted cases of separation of the anterad process from the rest of the bone as division of the prevomer, rather than separation of the prevomer from the palatine. I prefer to follow Trueb (1973) in regarding the identity of the bone as insoluble until ontogenetic data become available, and follow her in referring to this bone as a "vomero-palatine".

The most problematic species is *Pherohapsis menziesi*, the skull of which is heavily fused and exostosed, and particularly difficult to interpret in the absence of ontogenetic data. As myological and external similarities of *Pherohapsis* to *Hylophorbus*, three species of *Phrynomantis* and to a lesser extent *Asterophrys* indicate a close relationship with those taxa, I interpret the cranial structures of *Pherohapsis* as homologous with structures in those frogs. For example, I interpret the prootic arcade of *Pherohapsis*, a ribbon of dermal bone which forms an arch between the frontoparietal and the squamosal (Fig. 17), as a mediad extension of the posterad projection of the zygomatic ramus of the squamosal exhibited only by *Asterophrys, Hylophorbus* and the three *Phrynomantis* species. Similarly, although the dorsal surface of the otic capsule is so fused and featureless that it is impossible to identify individual bones, the conformation of that surface and the adjacent broad medial flange of the squamosal shaft is consistent with the interpretation that at least part of the bone covering the otic capsule is an otic ramus of the squamosal. The dorsal surface of this otic ramus is continuous with the anterior surface of the medial flange of the squamosal shaft. This interpretation is comparable to the condition in *Asterophrys, Hylophorbus* and the three *Phrynomantis* species.

The post-cranial skeleton of asterophryines has been considered too uniform to be informative of relationships within the subfamily (Zweifel 1972, p. 428). In contrast, the post-cranial skeleton provides characters fundamental to the separation of the Asterophyrinae and Genyophryninae (nature of the vertebral column), and to the diagnosis of genyophrynine genera (nature of the pectoral girdle).

Following Zweifel's revision of the Asterophryinae, a number of papers have appeared focussing on variation in the post-cranial skeleton of frogs. Trueb (1973) provided a useful survey of skeletal characters and subsequently demonstrated the use of measurements of skeletal features (Trueb 1977). Andersen (1978) surveyed variation of the manus and pes, and Tyler (1976b), Emerson (1979), Emerson and DeJongh (1980) and Emerson (1982) demonstrated and evaluated characters of the pelvic girdle. As a result of these studies more information and hypotheses relating to post-cranial skeletons are available to systematists.

Ecology of the Papuan Microhylids

The Papuan microhylids are diverse ecologically. Menzies (1975) uses four categories to accommodate the common species; to these Zweifel and Tyler (1982) add a fifth to accommodate some less common species. These categories are (a) fossorial, the frogs are normally found below ground from whence they call, rarely or never encountered on the surface: *Barygenys, Xenobatrachus* and probably *Xenorhina* (Menzies' placement of *Xenorhina* among the terrestrial genera is based on the only common *Xenorhina* species, *X. doriae*, which is shown in this study to be more appropriately assigned to *Phrynomantis*), *Choerophryne* and *Copiula* (Menzies and Tyler 1977), and probably *Genyophryne* (Zweifel 1971); (b) terrestrial, hiding under the ground by day, but moving about on the ground at night: *Asterophrys, Hylophorbus, Pherohapsis, Phrynomantis*, some species of *Cophixalus*, e.g., *C. pansus* (Zweifel and Allison 1982), some species of *Sphenophryne*; (c) scansorial, climbing low vegetation to two or three metres; some species of *Cophixalus* and *Sphenophryne*; (d) arboreal, climbing high into the trees: some species of *Cophixalus, Oreophryne*; (e) aquatic: *Sphenophryne palmipes* (Zweifel 1956).

Menzies stresses that there is overlap between these categories, and that it is arbitrary to a degree. Moreover, little is known of the ecology of the majority of species; but it is clear that the asterophryines are far less diverse ecologically than the genyophrynines.

The terrestrial and fossorial frogs of both subfamilies burrow head first (Menzies and Tyler 1977). The frogs I observed in captivity (*Barygenys flavigularis, Phrynomantis lateralis, P. wilhelmana, Copiula fistulans, Cophixalus kaindiensis, Sphenophryne fryi, S. schlaginhaufeni*) conform with this mode of burrowing, the driving power coming mainly from the hind legs, the arms being used mainly to part leaf litter and moss. This mode of burrowing contrasts with that of other frogs which are described as burrowing head first, *Hemisus marmoratus* (Emerson 1976b) and *Arenophryne rotunda* (Tyler *et al.* 1984), both of which propel themselves largely by arm movements (Emerson 1976b, pers. obs.).

Aims of this Study

This study arose out of the observation by Tyler (1974) of diversity in the superficial throat musculature of the asterophryines. It was believed that a detailed comparative myological study might not only aid in the evaluation of Zwiefel's (1972) phylogenetic hypotheses but also provide characters with which to evaluate the hypotheses of relationships between the two New Guinea subfamilies. Moreover, as differences were observed between Zweifel's (1972) drawing of the ilium of *Phrynomantis louisiadensis* and the ilia of several genyophrynines stored as alizarin preparations in the Department of Zoology, University of Adelaide, the potential usefulness of examination of the post-cranial skeleton was realized. Finally, unremarked heterogeneity in Zweifel's diagrams of skull morphology suggested that reassessment of skull characters might also yield useful characters.

The aims of this study have been to determine the relationships of the asterophryine genera, using characters of myology and osteology, and to contribute to the assessment of the merits of uniting the asterophryines and genyophrynines into a single subfamily.

MATERIALS AND METHODS

Material Available

The course of this study was dictated in part by the availability of material. Specimens of adult asterophryines available for dissection are often difficult or impossible to obtain. Of the 40 taxa examined by Zweifel (1972), 18 were represented in collections by fewer than 10 specimens each, and the three species named subsequently are known only by their type series. Although additional specimens of some of the very rare species have been collected since 1972, none has become commonly represented in collections. As a result there are a number of species unavailable for dissection and skeletal preparation.

As asterophryines undergo direct development and eggs of most species are hidden in leaf litter, under moss or under logs, the discovery of eggs or larvae is rare and accidental. As asterophryines are very difficult to rear from the eggs to adulthood, identification of eggs generally is impossible unless an attendant adult is found; even then the evidence of identity is circumstantial. There are no published accounts of complete life histories of asterophryine larvae (Tyler 1976a), and larval material is so limited that a comparative study is impossible.

Techniques such as gel electrophoresis, karyology and microcomplement fixation are possible only when freshly killed specimens are available. It was impossible to obtain adequate samples from New Guinea to use any of these techniques.

Material Examined

A total of 268 specimens of preserved adult microhylids were examined, including 196 specimens of 33 species or subspecies of asterophryines, representing all seven genera. Of the 268 specimens, 256 were examined externally, 159 specimens (114 asterophryines) were dissected, at least partially, for myological examination, 115 specimens (82 asterophryines) were cleared and stained for osteological examination, 16 dried skeletons (10 asterophryines) were prepared, and x-rays were obtained of 37 specimens (all asterophryines). Three specimens (AUZ A206, 207, 208) had previously been cleared and stained.

A total of 23 specimens of preserved adult ranoids were examined externally, and partially dissected for myological examination. These specimens represent two families, 10 genera and 14 species. All are uncatalogued specimens housed in the Department of Zoology, University of Adelaide: Ranidae — *Cacosternum* sp. (1 specimen), *Hemisus marmoratus* (1), *Natalobatrachus* sp. (1), *Platymantis papuensis* (1), *Pyxicephalus* sp. (2), *Rana fuscigula* (1), *R. grayi* (1), *R. grisea* (5), *R. papua* (1); Hyperoliidae — *Afrixalus* sp. (2), *Hyperolius marmoratus* (2), *H. tuberilinguis* (1), *Kassina* sp. (2) and *Leptopelis* sp. (2).

The specimens were preserved in 65% or 70% ethanol. Most were lent by the institutions listed. Others collected on a field trip are lodged in the collection of the Department of Zoology, University of Adelaide. These specimens were killed in a 3% chloral hydrate solution, fixed in 3% formalin, and preserved in 65% ethanol.

Specimens Examined

Abbreviations: AA: Collection of Dr A. Allison, Wau Ecology Institute, PNG; AM: Australian Museum, Sydney; AMNH: American Museum of Natural History, New York; AUZ: Department of Zoology, University of Adelaide (unregistered apart from skeletal preparations); BPBM: Bishop Museum, Honolulu; FMNH: Field Museum of Natural History, Chicago; MCZ: Museum Comparative Zoology, Harvard; RMNH: Rijksmuseum van Natuurlijke Historie, Leiden; SAMA: South Australian Museum, Adelaide; UPNG: Biology Museum, University of Papua New Guinea, Port Moresby.

ASTEROPHRYINAE

Asterophrys turpicula (9) Vogelkop: RMNH 16655; Olsobip: UPNG 1548; Megalsimbip, Ok Menga: UPNG 6739-45.

Barygenys atra (8) Lejo via Popondetta; UPNG 3831, 3832, 3836, 3837, 3957, 3958, 5475, 5476.

Barygenys exsul (1) Alotau: UPNG 5201.

Barygenys flavigularis (7) Mt Kaindi: AUZ A729; B726a, B726b, B728, D741, SAMA R23851, UPNG 5134.

Barygenys maculata (11) Agaun: UPNG 5091-99, 5101, 5102.

Barygenys nana (4) Fungoi, Kaironk Valley, Schrader Mts: AM 22802; Kaironk Valley, Schrader Mts: UPNG 3245, 3247; Elimbari: UPNG 3249.

Barygenys sp. nov. (6) Mt. Missim: AA 11171, 11172, BPBM 9366-69.

Hylophorbus r. rufescens (11) Baiyer River: AUZ A722, D738; SAMA R23844; Madang: UPNG 2285, 2286, 2288; Agaun: UPNG 5041, 5042, 5044; Manga, Huon Pen: UPNG 5714; Go River, Huon Pen: UPNG 5732.

Hylophorbus r. extimus (1) Mt Riu, Sudest I.: AMNH 60092.

Hylophorbus r. myopicus (1) Kulumadau, Woodlark I.: AMNH 59988.

Pherohapsis menziesi (6) Sogeri: UPNG 1865, 1970, 2093, 2578, 2579, 5196.

Phrynomantis eurydactyla (2) Kahilfon, Bultem: UPNG 5306-07.

Phrynomantis fusca (1) Rohua, S. Seram: UPNG 5257.

Phrynomantis h. humicola (18) Kotuni, Mt Otto: AMNH 66266-70 (2 specimens); Daulo Pass: MCZ 52970-81, 52983-86.

Phrynomantis h. compta (3) Kaironk Valley, Schrader Mts: SAMA R9387 (3 specimens).

Phrynomantis infulata (3) Arau, Kratke Mts: AMNH 66685, 66699, 66670.

Phrynomantis lateralis (13) Taraka via Lae: AUZ A730, B724a, B724b, D737, SAMA R23838; Lae: MCZ 59000; 16 km S of Popondetta; MCZ 87535; McDowell L., Purari R.: UPNG 2499, 2500; Alotau: UPNG 2619, 2621, 2622, 5202.

Phrynomantis louisiadensis (5) Mt Rossel, Rossel I.: AMNH 60135-43 (2 specimens); Rossel I.: AMNH 89117; Abaleti, Rossel I.: AMNH 69347, UPNG 5689.

Phrynomantis personata (2) Lumi: AMNH 78092; Rauit: UPNG 4087.

Phrynomantis robusta (4) Derongo: MCZ 81688; SAMA R10580; Siagara, Misima I.: UPNG 4295; Bwagaoia, Misima I.: UPNG 4303.

Phrynomantis stictogaster (17) Lufa Patrol Post: MCZ 59908-16; Okapa: SAMA R20886-93.

Phrynomantis wilhelmana (16) Wahgi-Sepik Divide:

AM R16825; Daulo Pass: AM R66747; Eastern slopes of Mt Wilhelm: AMNH 65868-86 (2 specimens); Tomba: AUZ A727, B721(a), B721(b), B723, B731; Mt Giluwe: SAMA R23849; Kogi, Suai Ra: MCZ 59891-96.

Xenobatrachus giganteus (4) Eipomek Valley: UPNG 5346, 5347, 5679, 5680.

Xenobatrachus mehelyi (6) Derongo: MCZ 81673, 81674; Imigabip: MCZ 81675, 81676; Tabubil: UPNG 4790; no data: AUZ.

Xenobatrachus obesus (3) 20 km NE of Lumi: AMNH 78187-207 (2 specimens); Amanab: UPNG 2822.

Xenobatrachus rostratus (1) Kaironk Valley, Schrader Mts: SAMA R9386 (4 specimens), UPNG 3240, 3244, 3342, 5014; Eipomek Valley: UPNG 5681, 5682.

Xenobatrachus subcroceus (5) Lae: UPNG 4390-93, 4143.

Xenorhina bouwensi (10) Kigonmendip, Ok Sibil Valley, Star Mts: RMNH 16657 (5 specimens), 16658 (5 specimens).

Xenorhina doriae (4) Mt Lamington: AM R9604; Camp III, Nimi R.: MCZ 64405; Bomai: SAMA R6284; Alotau: UPNG 2608.

Xenorhina minima (2) Eipomek Valley: UPNG 5677, 5737.

Xenorhina oxycephala (3) S. coast of Humboldt Bay: RMNH 5032; Fak-Fak: RMNH 17017; Eipomek Valley: UPNG 5678.

Xenorhina parkerorum (1) Halalinja, Nipa: UPNG 5827.

Xenorhina similis (1) Lake Habbema, Bele R., 18 km N: AMNH 43726.

GENYOPHRYNINAE

Choerophryne rostellifer (1): Moiyokabip Village, Bultem: UPNG 4410.

Cophixalus darlingtoni (2) Tomba, Mt Hagen: AUZ B735, SAMA R23844.

Cophixalus kaindiensis (1) Mt Kaindi: AUZ.

Cophixalus neglectus (3) Mt Bellenden Ker, Qld: AUZ A744, A747, B749.

Cophixalus ornatus (5) S. Bell Peak, Malbon Thompson Ra, Qld: AUZ A720, B725(a), B725(b), D740, SAMA R23845.

Cophixalus pansus (3) Bulldog Rd, Wau: AUZ (2 specimens), AUZ A209.

Cophixalus parkeri (2) Okapa: SAMA R5604 (2 specimens).

Cophixalus riparius (4) Okapa: SAMA R5216 (4 specimens).

Cophixalus shellyi (2) no data: AUZ (2 specimens).

Cophixalus variegatus (8) Mt Kaindi: AUZ B719, B743, D739, SAMA R23839-43.

Cophixalus verrucosus (3) Sogeri: AUZ (3 specimens).

Copiula fistulans (5) Lae: AUZ A723, D742, SAMA R23836, R23837; Agenchambo via Popondetta: SAMA R14241.

Genyophryne thomsoni (4) Agaun: AUZ (1 specimen), UPNG 5118, 5120, 5130.

Oreophryne biroi (1) Karimui: SAMA R10899.

Oreophryne insulana (2) Ma-u R., Camp I: AUZ B745, UPNG 3556.

Sphenophryne cornuta (1) Kigonmendip, Sibil Valley: SAMA R11599.

Sphenophryne fryi (5) S. Bell Peak, Malbon Thompson Ra, Qld: AUZ A746, B734, D736, SAMA R23854-55.

Sphenophryne robusta (4) Boonjie, 16 km SE of Malanda, Qld: AUZ (1 specimen), AUZ A208; Millaa Millaa, Qld: AUZ (1 specimen), AUZ A207.

Sphenophryne sp. (2) Wau: BPBM 9879, 9882.

Sphenophryne schlaginhauferi (2) Trauna Ridge, 13 km NE of Baiyer River, AUZ B733, SAMA R23852.

BREVICIPITINAE

Breviceps mossambicus (2) Bronkhorstbrust, S. Africa: AUZ.

Breviceps sp. (1) Durban N., S. Africa: AUZ.

DYSCOPHINAE

Calluella guttulata (1) Kuala Tahan, Pahang, Malaya: FMNH 143960.

MICROHYLINAE

Chaperina fusca (1) Deramakot, Kinabatangan Dist, N. Borneo: FMNH 77253.

Elachistocleis sp. (4) Tunapuna, Trinidad: AUZ (3 specimens), AUZ B748.

Glyphoglossus molossus (1) Sakaerat, Ampho Pak Thong Chai, Nakhon Ratchasima Prov., Thailand: FMNH 182650.

Kalophrynus pleurostigma (1) Nanga Tekalit Camp, Mengiong R., Kapit Dist, Sarawak: FMNH 138052.

Kaloula pulchra (1) Siracha, Chalemlarb, Chon Buri, Thailand: FMNH 175952.

Microhyla heymonsi (1) Bukit Lanjan, Selangor, Malaya: FMNH 186029.

Microhyla pulchra (1) Sakaerat, Amphoe Pak Thong Chai, Nakhon Ratchasima Prov., Thailand: FMNH 183064.

Methods: Morphology

External examination included the taking of standard measurements of snout-vent length (S-V), head width (HW), eye diameter (E), eye to naris distance (E-N), internarial span (IN), tympanum diameter (T), and tibiofibula length (TL). The measurements were taken with Mitutoyo dial calipers according to the methods described by Zweifel (1972). In 188 specimens the following additional measurements were taken: (a) head length (HL), the distance from the tip of the snout to the angle of the jaw (Fig. 3A); (b) mouth width (MW), the distance between the corners of the mouth (Fig. 3B); (c) mouth length (ML), the distance between the most anterior point of the mouth and the posterior corner (Fig. 3C).

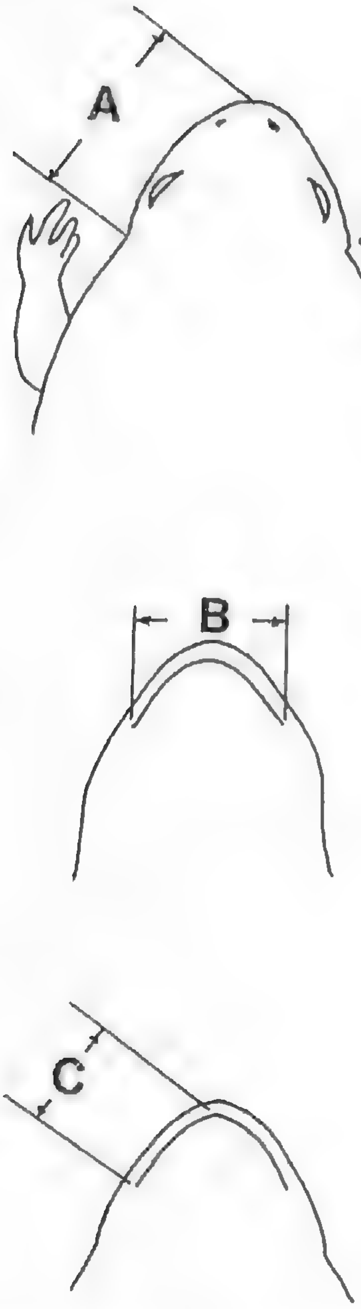

FIG. 3. Methods of measurement: A, head length; B, mouth width; C, mouth length

Myological dissections were carried out with the assistance of topical applications of the iodine-potassium iodide solution of Bock and Shear (1972). In cases where muscles were obscured by connective tissue, the tissue was bathed in 30% nitric acid until the connective tissue was removed, and the nitric acid was then aspirated. In 134 specimens all of the skeletal musculature was examined. In 32 specimens of rare species, dissection was prohibited, but partial examination of the muscles was carried out through pre-existing incisions made by previous workers. One rare specimen, *Phrynomantis fusca* UPNG 5257, was partly dissected through straight incisions in the skin, which was then folded back, and muscle groups previously known to be taxonomically significant were examined.

The tongues and associated musculature of six specimens were examined histologically. Transverse sections were stained with Mayer's haematoxylon and eosin.

Muscle descriptions follow the terminology of Ecker (1889) as modified for the throat by Tyler (1971), the jaw by Starrett (1968), the hyolaryngeal apparatus by Trewavas (1933), the pectoral girdle by Jones (1933), the forearm and manus by Gaupp (1896), the pelvic girdle by Dunlap (1960) and cutaneous muscles by Burton (1980).

One hundred and one specimens were cleared and double-stained for skeletal examination by the Alcian blue-Alizarin red technique of Dingerkus and Uhler (1977). Seventeen specimens were cleared and stained with Alizarin red by the technique of Davis and Gore (1947) to reveal bones. Sixteen specimens were flensed, cleared of adherent soft tissue by application of sodium hypochlorite solution, and allowed to dry slowly. Thirty-seven specimens, most of them too rare to dissect, were radiographed from several aspects and prints obtained on a Rank Xerograph in positive mode.

As the drying process led to some collapse of skulls and caused some bones which are not articulated in cleared and stained specimens to come into contact, the osteological descriptions are based primarily on cleared and stained specimens. Osteological descriptions follow the nomenclature of Trueb (1973).

The skeletal preparations were surveyed in order to evaluate the potential for taking measurements in the manner of Trueb (1977). This survey indicated that the features with the best potential for yielding information regarding relationships were the angle between the vertebral column and the leading edge of the sacral diapophysis, the sacral expansion and the angle between the ilial shafts. These were measured using a goniometer attachment on a Wild M5 stereomicroscope, care having been taken that the features being measured were lying in a horizontal plane.

All myological and osteological drawings were prepared with the use of a Wild M5 stereomicroscope with an attached camera lucida.

Methods: Phylogeny

The approach adopted in this study is that of Hennig (1966) as defined by Wiley (1976). This involves the attempt to falsify competing hypotheses of recency of common ancestry of groups of taxa, using as evidence the distribution among the taxa of synapomorphies, that is, shared uniquely derived character states. The myology, osteology and external morphology of the asterophryines, genyophrynines and the other microhylids examined provided the characters that were the basis of the phylogenetic analysis.

There are a number of problems associated with the recognition of synapomorphy: first, the determination of primitive and derived character states, second, distinction of cases where a shared derived character state has arisen once in a common ancestor (i.e., are "homologous" *sensu* Bock, 1963) from cases where similar character states have arisen independently in different lineages (i.e., are "homoplasious" *sensu* Bock, 1963), and third, how to handle cases of conflicting evidence of synapomorphy.

The problem of character state polarity has been addressed frequently in recent papers, e.g., Crisci and Stuessy (1980), De Jongh (1980), Stevens (1980, 1981), Arnold (1981), Bock (1981), Watrous and Wheeler (1981) and Wheeler (1981). In these papers many criteria have been assessed and, while a consensus has not emerged, the case favouring the use of outgroup analysis alone is compelling. That is, useful information regarding the direction of change can only be derived from analysis of the distribution of those states between the group under study and an outgroup. A character state shared by members of the group under study and the outgroup is considered primitive relative to a character state found only in some members of the group under study. The character state shared by members of the study group and the outgroup is assumed to have arisen in a common ancestor of the two groups, while the restricted character state is assumed to have arisen more recently in an ancestor common only to those species which share the state.

The outgroup method is by far the most widely used method of assessing character state polarities. Studies, including those of Marx and Rabb (1970), Lundberg (1972), Lynch (1973, 1975a, b, 1978), Moffat (1973), Heyer (1975), Heyer and Liem (1976), Wiley (1976), Hecht and Edwards (1976), Michener (1977), and Enghoff (1981) have relied primarily on outgroup analysis.

In consideration of the asterophryine genera, the most appropriate outgroup is the Genyophryninae, whose status as a group closely related to the Asterophryinae has been established by a synapomorphy, direct development of larvae (Parker 1934).

It is not necessary for the Genyophryninae to be recognized as a distinct taxon in order for it to be an outgroup. Watrous and Wheeler (1981) defined the concept of a functional outgroup and demonstrated that an out-group need not be taxonomically distinct. This concept is similar in application to, though presented more rigorously than, Kluge's (1976) use of the ingroup, *viz.*, that a character state widespread among taxa related at the next higher taxonomic level "that otherwise have little in common" is primitive, a position supported also by Arnold (1981). This is not the same as the "commonality principle" based ingroup analysis, where the more common character state within the group is coded as primitive, a position criticized by a number of workers, including Moffat (1974), Stevens (1980), and Watrous and Wheeler (1981), who demonstrated the logical shortcomings of the commonality principle. All cladograms based on the commonality principle must root near the middle, and no three-taxon hypothesis can be solved by the commonality principle, since any shared character state must be the more common, hence primitive, and so there can be no shared, derived character states. While it is necessary to demonstrate that the Asterophryinae is a natural group whose monophyly (*sensu* Hennig, 1966) is attested by autapomorphy and that it is therefore possible to postulate its evolution, it is not necessary to the study of the asterophryine genera to establish the naturalness and taxonomic viability of the Genyophryninae.

In the search for evidence of synapomorphy to support the hypotheses of the monophyly of the Asterophryinae and of the Genyophryninae, the outgroup consists of ranoid frogs and microhylids of other subfamilies, listed previously. Myological, skeletal and external morphological data obtained from specimens representing 10 species in the subfamilies Brevicipitinae, Dyscophinae and Microhylinae (Oriental and Neotropical) and 14 ranoid species are used to assess whether either subfamily possesses autapomorphies.

It is considered impossible by many authors to make *a priori* the judgement that the sharing of a given derived character state results from homoplasy; such a judgement can only be made when evidence from different characters is shown to conflict (le Quesne 1969; Cracraft 1981; Wheeler 1981; but Bock, 1981, presents a contrary view). When two characters support incompatible hypotheses of common ancestry, one of them is homoplasious, i.e., the character has been subject to convergence (*sensu lato*) or reversal. Which of the two characters is the homoplasious one remains to be determined.

The approach almost universally advocated, e.g., by Camin and Sokal (1965), Kluge and Farris (1969), Lundberg (1972), Eldredge and Cracraft (1980), Nelson and Platnick (1981), for resolving such conflicts is to favour the cladogram supported by the greatest number of characters, or "the hypothesis that has been rejected the least number of times" (Wiley 1976), and then to reject those characters which do not contribute to the cladogram, on the grounds that they are homoplasies. That is, some form of numerical analysis is suggested in order that the hypothesis of relationships depicted in a cladogram be the most parsimonious, on the grounds that while evolution may not be parsimonious, scientific hypotheses of evolution, as of anything else, must be (Kluge and Farris 1969; Wiley 1975; Cracraft 1979; *contra* Inger, 1967).

However, numerical approaches must be applied to cladistic analyses with caution, as they are based on a number of questionable assumptions (Panchen 1982). First, when one hypothesis of relationships is preferred to another because it is rejected by fewer characters, the notion of what constitutes a character is crucial. A character appears in practice to be any feature of a group of taxa which is perceived to be relatively constant within taxa but variable between them. It is assumed in using most numerical techniques that all characters used in a cladistic analysis are of equal value to the assessment of relationships. But this need not be the case. For example, characters obtained from different parts of the phenotype may be correlated. Such correlation may be obvious: characters relating to the length of a bone and the site of origin of a muscle on that bone may well be correlated and be treated better as a single character. But correlation may be less obvious. For example, leg length and tongue morphology may well be correlated in a particular case because both may be adaptations to capture of the same kind of food. Hecht and Edwards (1976) showed that radically different interpretations of frog phylogeny resulted from different perceptions of the associations of characters of tadpole morphology. An assessment of character correlation appears to be one of the legitimate roles of functional analysis, which could not be carried out for this study, beyond observations of living specimens during the field trip.

Whether a suite of correlated characters be weighted highly, as suggested by Hecht and Edwards (1976), Hecht (1977), or be given equal weight with other characters is problematical. While the Hecht and Edwards (1976) weighing scheme seems arbitrary, and Hecht's numerical value scheme more so, the principle that some form of assessment of characters to determine their relative "credibility" in the case of conflict (Schlee 1975) seems valid, Moller-Anderson's (1978) caveat regarding the difficulty of applying Schlee's scheme notwithstanding.

A second problem with the use of numerical analyses is the likelihood of high levels of homoplasy in morphologically uniform animals like birds or frogs (Bock 1963; Hecht and Edwards 1976). Such animals are constrained in their evolution by similar developmental possibilities, for example, the physical requirements for flight severely limit the possibilities of evolution of the avian body form. This is particularly so at low taxonomic levels when the animals are genetically similar, and might therefore be expected to evolve independently similar character states under similar environmental constraints. But the history of frog taxonomy gives testimony to a high rate of homoplasy even at family level. Classifications based on features of, for example, the teeth (Günther 1858; Boulenger 1882) and nature of the pectoral girdle (Noble 1931), both characters now believed to have evolved convergently, and incompatible phylogenies of frog families erected by, for example, Hecht (1963) and Inger (1967) on one side and Kluge and Farris (1969) and Lynch (1973) on the other, indicate the high frequency of homoplasy and the difficulty of discerning it even at the family level.

The use of numerical techniques to resolve conflicts between characters presupposes that homologies outnumber homoplasies, or that "evolution is normally divergent" (Panchen 1982; Friday 1982). This proposition is dubious, for the reasons indicated in the previous paragraph.

One means of resolving these conflicts is to relate observed structures to their functions. Gans (1966) points out that it is not possible to deduce function simply from morphology, and few direct studies of the relation of form and function in living frogs have been carried out, mainly studies of the muscles involved in tongue action, e.g., Gans (1962), Gans and Gorniak (1982) and of the muscles involved in locomotion (Emerson and De Jongh 1980). However, a second approach based on the correlation of morphologies with particular modes of burrowing (Emerson 1976b, Sanders and Davies 1984) has provided dramatic examples of convergence in muscle complexes, as groups of muscles of identical form adapted for similar burrowing techniques are found in frogs from different families.

Other morphological patterns related with particular functions have been identified but not treated. Liem (1970) and Anderson (1978) identify as an adaptation to climbing the division of the *M. palmaris longus* into several slips with separate tendons of insertion, which their comparative studies have shown to be characteristic of treefrogs of several families. Liem based his division of the firmisternal treefrogs (the Rhacophoridae and the Hyperoliidae) into separate families partly on the grounds that the different patterns of division of this muscle indicated that the division had been acquired by different evolutionary steps. That is, it is likely that tree climbing had evolved independently in the two groups. This in turn implies that other derived characters shared by these groups that are recognisable adaptations to tree climbing, e.g., the possession of finger discs and of intercalary cartilages, must be seen as likely convergences.

This is relevant to the asterophryine frogs, all of which spend part of each day underground, and some of which seldom or never emerge above ground, the genera listed in the Introduction as fossorial. Evidence in this group of the adoption of different evolutionary strategies in the adaptation to the fossorial mode may be indirect evidence of convergence in other shared adaptations to the same mode.

Convergence may also be suspected as the source of conflict between apparent synapomorphies in cases where a particular apparently derived morphology is observed to recur in distantly related groups, even if the function is unknown. For example, the reduction of the pectoral girdle in some genera of microhylids and ranids is certainly due to convergence. Possession of a reduced pectoral girdle by different microhylid genera does not seem to be a reliable character in phylogenetic analysis as it has been shown to be liable to convergence, and in cases where this character conflicted with other apparent synapomorphies it would be considered of low value. Panchen (1979, 1982) indicated a third problem: that the number of synapomorphies detected in a systematic analysis is unlikely to be the complete set of synapomorphies. The assumption must therefore be made in numerical analyses that the ratio of "true" to "false" synapomorphies revealed in the study of a limited number of characters equals the ratio of "true" to "false" synapomorphies in the whole set.

In this study, characters are deemed to be of equal weight unless there is reason to believe that characters are correlated, and then the suite of correlated characters is regarded as equal to one character, on the grounds that such a suite may be deemed to have resulted from but one evolutionary event. In the case of conflicts between characters, judgements as to the relative likelihoods of the relevant character state transformations are made whenever possible. The use of numerical procedures is restricted in this study to the illustration rather than the evaluation of the conflicting hypotheses of relationships in a case where the data conflict intractably.

RESULTS

Taxonomic Recommendations and Nomenclature

In order to avoid confusion and tedious repetition in the following character state analysis, I foreshadow taxonomic recommendations which derive from the analysis, and which I make formally in the systematics section of this paper. Two of the asterophryine genera, *Phrynomantis* and *Xenorhina* (Table 2) are heterogeneous assemblages, and the following changes are necessary. (a) Removal of *Phrynomantis lateralis, P. infulata* and *P. louisiadensis* from *Phrynomantis*. These species share a number of character states with *Asterophrys, Hylophorbus* and *Pherohapsis* which indicate that it is with those genera that their affinities lie. Their removal from *Phrynomantis* makes this genus a much more natural assemblage supported by autapomorphies. The three species removed from *Phrynomantis* do not fit neatly into any of the other existing genera. I recommend resurrection of *Mantophryne* Boulenger 1897 (type species, *M. lateralis*) to accommodate them, and subsequently refer to these species as *Mantophryne lateralis, M. infulata* and *M. louisiadensis*. (b) *Xenorhina doriae* does not conform morphologically with other members of its genus, showing affinities rather to *Phrynomantis (sensu stricto)*, and sharing apomorphies with the other members of that genus. *Xenorhina* becomes a much more uniform group without *X. doriae*, and the remaining members of the reduced genus share many derived characters not shared by *X. doriae*. I recommend that *X. doriae* be transferred to *Phrynomantis* and subsequently refer to it as *Phrynomantis doriae*.

As well as these asterophryine genera, the genyophrynine genus *Cophixalus* is heterogeneous to the extent that it is impossible to make general statements about it in the following discussions. *Cophixalus darlingtoni* and *C. variegatus* are considered as an entity distinct from *Cophixalus*. As the term "*variegatus*-group" was used by Menzies (1975) to denote a group of four or more small (S-V length approximately 12 mm) cryptic species, I employ the term "*darlingtoni*-group" to refer to the group of species comprising *C. darlingtoni* and the *C. variegatus*-group. Myologically and osteologically, the *darlingtoni*-group is uniform and is clearly more closely related to *Choerophryne* than to other *Cophixalus*, as it shares many unusual characters with *Choerophryne* alone. Whether the *darlingtoni*-group should form a new genus as a sister-group to *Choerophryne* as suggested by Zweifel (*in litt.*, 19 May, 1982) or the definition of *Choerophryne* be broadened slightly to accommodate the *darlingtoni*-group (which may be paraphyletic) is beyond the scope of this study. The removal of the *darlingtoni*-group reduces the heterogeneity of *Cophixalus*. In this study, the term "*Cophixalus*" refers to the genus *Cophixalus*, but excluding the *darlingtoni*-group. As no *Choerophryne* specimens were available for complete dissection, only the superficial musculature of the venter, pectoral girdle and throat and the jaw musculature were examined in this genus and details of the osteology were derived from Menzies and Tyler (1977).

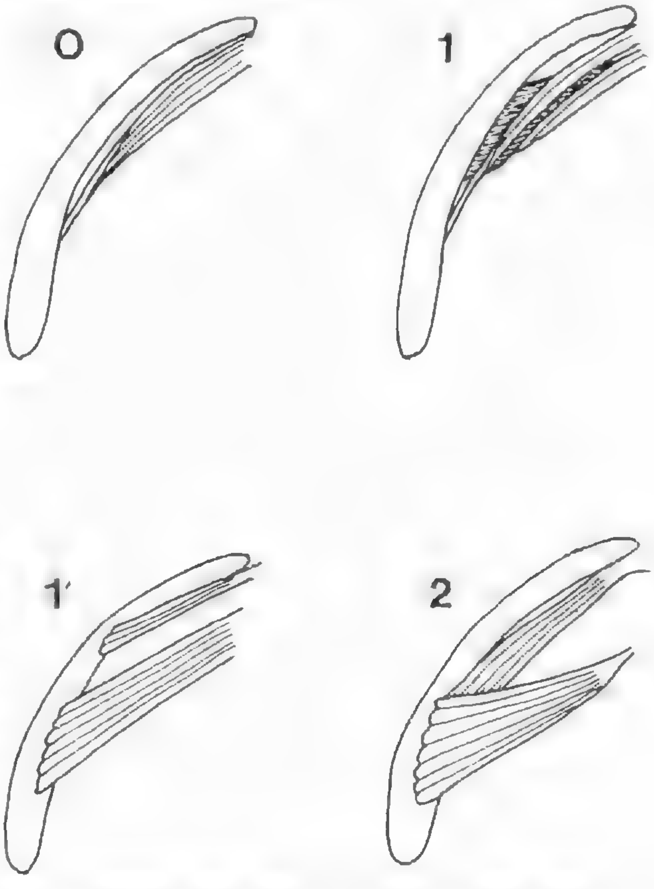

FIG. 4. Supplementary slips to the *M. intermandibularis* in asterophryines. *Abbreviations:* 0, State (0) single origin via a tendon; 1, State (1) origins via a tendon and direct from the dentary; 1′, State (1′) origins from the ventral surface of the angulosplenial; 2, State (2) origins from adjacent parts of the ventral surface of the angulosplenial.

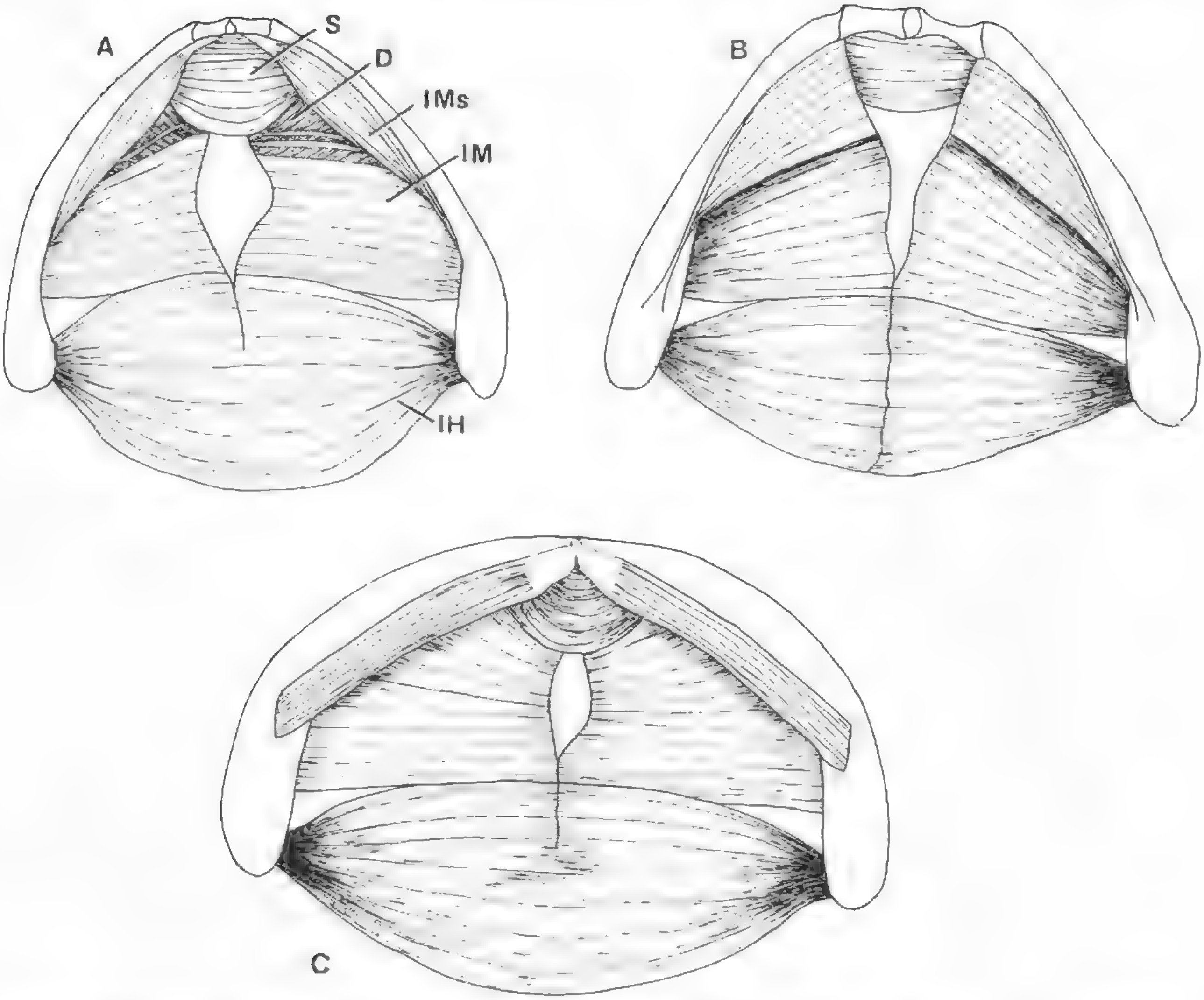

FIG. 5 Superficial mandibular musculature of (A) *Cophixalus kaindiensis* AUZ; (B) *Copiula fistulans* AUZ D742; (C) *Genyophryne thomsoni* UPNG 5130. Abbreviations: D, dorsal slip of the *M. interhyoideus*; IH, *M. interhyoideus*; IM, *M. intermandibularis*; IMs, supplementary slip of *M. intermandibularis*; S, *M. submentalis*.

Character State Analysis

The characters discussed are ones which vary in such a way as to be of potential use in a phylogenetic study of the asterophryines or to shed light on relationships between the Asterophyrinae and Genyophryninae. Characters which are numbered are those whose states are distributed in such a way as to warrant subsequent discussion. The distribution of the states of these characters are listed in Table 4. States designated 0 are primitive states. States designated 1, 1′, 1″ etc. are derived, but the relationship between these derived states is unknown. States designated 1, 2, 3, etc. are derived with the polarity 1 → 2 → 3 etc. States designated by letters are states of unknown polarity, i.e., the primitive state cannot be identified.

The *M. submentalis*: Variation in the attachments of this muscle is in part related to the shape of the mentomeckelians. In the Asterophryinae alone the mentomeckelians are posterior to the dentaries and deflected posteroventrally. Consequently, the mentomeckelians are more prominent sites of attachment of the *M. submentalis* in asterophryines than in other microhylids, and in at least some species of *Xenorhina* the mentomeckelians are the only site of attachment. I treat this involvement of the mentomeckelians in asterophryines as a character of the mentomeckelians, below.

Among the asterophryines there is wide variation in the posterior extent of the *M. submentalis* reaching an extreme expansion in *Barygenys utra* (Fig. 6), but this variation is partly independent of generic classifications and so cannot be employed in a phylogenetic analysis at the generic level.

Character 1. Nature of the supplementary slips of the *M. intermandibularis*. Four states occur among the asterophyrines (Fig. 4): (0) a single supplementary slip arising via a tendon (*Hylophorbus*, *Pherohapsis* and *Mantophryne*); (1) two supplementary slips, the anterior arising via a tendon, the posterior direct from the dentary (*Phrynomantis*) (Burton, 1983); (1′) two supplementary strap-like slips from the ventral surface of the angulosplenial, the posterior slip inserting on the median aponeurosis of the *M. intermandibularis* (*Asterophrys*, *Xenobatrachus* and *Xenorhina*) (Fig. 6);

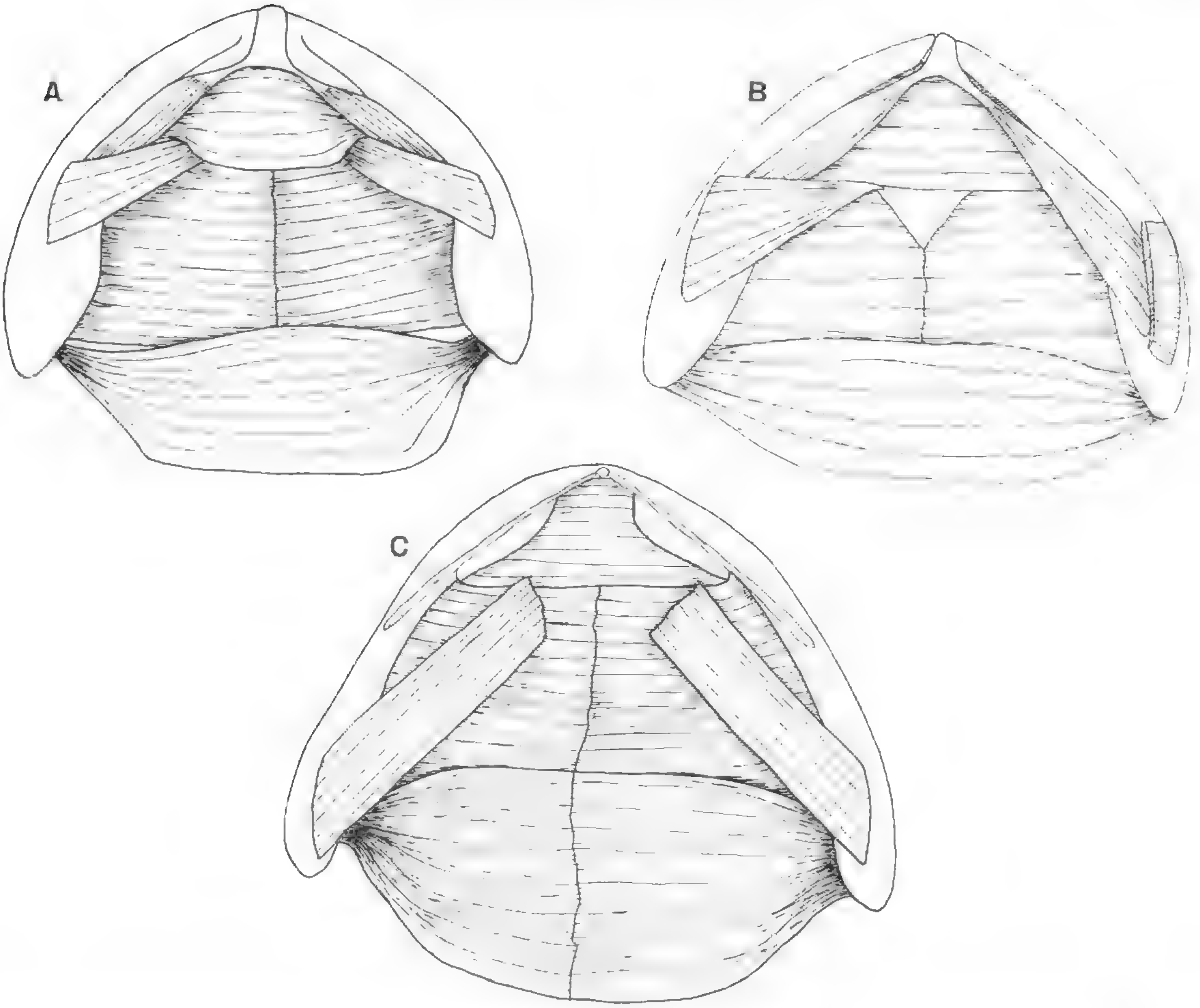

FIG. 6. Superficial mandibular musculature of (A) *Barygenys flavigularis* AUZ D741; (B) *Barygenys atra* UPNG 3836, left posterior supplementary slip removed; (C) *Xenobatrachus rostratus* SAMA R9386a.

and (2') two supplementary slips from the angulosplenial, the posterior slip inserting via a narrow tendon on the *M. genioglossus basalis* (*Barygenys*) (Fig. 6).

State (0) occurs also in the Genyophryninae (Burton, 1984), and is primitive among the Asterophryinae. State (1) is likely to have evolved directly from State (0), and State (2') may have evolved from State (1'), but it is not clear whether State (1') evolved from State (1) or directly from State (0). The polarities are either 0 → 1 → 1' → 2' or 2' ← 1' ← 0 → 1.

Character 2. Occurrence of a dorsal sheet of posteromedially directed fibres on the *M. intermandibularis*. Two states occur among the Papuan microhylids: (0) dorsal fibres present (Genyophryninae) (Burton 1984, Fig. 5A). These fibres are not always visible from the ventral surface (Figs 5B, 5C); and (1) dorsal fibres absent (Asterophryinae).

State (0) is shared by the other microhylids examined, and is primitive among the Papuan microhylids.

Character 3. Overlap of the *Mm. intermandibularis* and *interhyoideus*. Two states occur among the Papuan microhylids: (0) no overlap (Genyophryninae (Burton 1984, Fig. 5), except *Cophixalus pansus* and *C. riparius; Xenorhina bouwensi)*; and (1) overlap of the muscles, the anterior fibre of the *M. interhyoideus* lying on the ventral surface of the posterior fibres of the *M. intermandibularis* (Asterophryinae (Burton 1983, Fig. 6) except *Xenorhina bouwensi;* also *Cophixalus pansus* and *C. riparius*).

State (0) is shared by most of the other microhylids examined, and is primitive. Overlap occurs also in *Calluella* and *Kaloula*, but it is different in form from State (1) as it is the *M. intermandibularis* which overlaps on the ventral surface of the *M. interhyoideus* in these two genera. The possession of State (0) by Papuan microhylids appears to be related to small size. *Xenorhina bouwensi* (17.9, 21.3, 20.7 mm S-V) is the smallest asterophryine examined, while *Cophixalus riparius* is the largest genyophrynine examined, and *C. pansus* among the most densely muscled. Similarly,

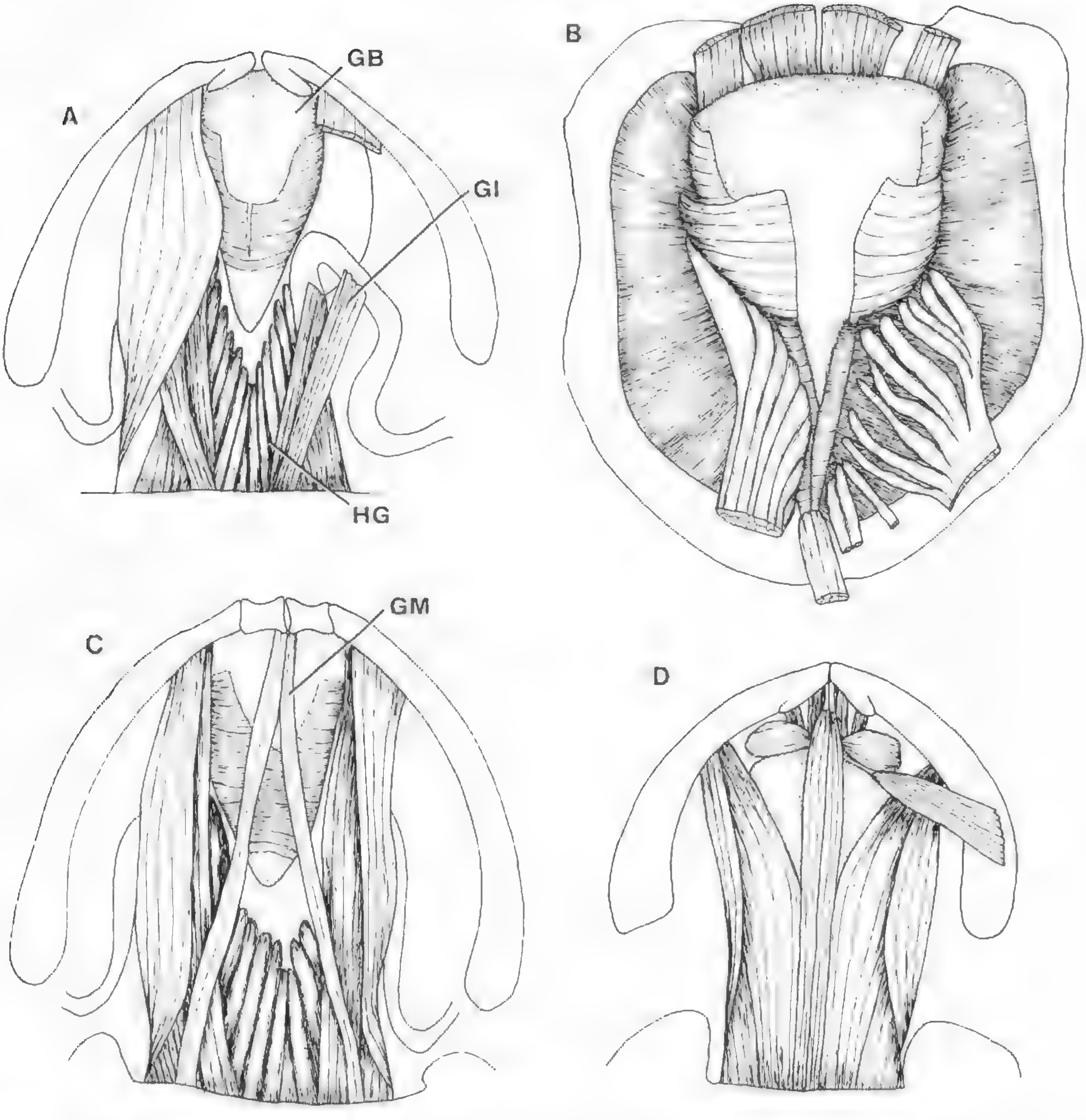

FIG. 7. (A) Deeper musculature of the throat of *Hylophorbus r. rufescens* AUZ D738, left *M. geniohyoideus lateralis externus* severed to reveal the *M.g.l. internus* origin from the hyale; (B) Tongue musculature of *Xenobatrachus giganteus* UPNG 5680; (C) Deeper throat musculature of *Sphenophryne schlaginhaufeni* AUZ B733; (D) *Barygenys flavigularis* AUZ D741, the left posterior supplementary slip to the *M. intermandibularis* not removed. Abbreviations: GB, *M. genioglossus basalis*; GI, *M. geniohyoideus lateralis internus*; GM, *M. genyohyoideus medialis*; HG, *M. hyoglossus*.

Calluella and *Kaloula* are the largest of the other microhylids examined.

Character 4. Occurrence of the *M. geniohyoideus medialis.* Two states occur in the asterophryines: (0) *M.g. medialis* present (*Barygenys*) (Fig. 7C). (1) *M.g. medialis* absent (other asterophryines (Fig. 7A, B)).

State (0) is shared by all genyophrynines, and is the primitive state for the asterophryines.

Character 5. Origin of the *M. geniohyoideus lateralis internus.* Three states occur in the asterophryines: (A) origins from the dentary and the hyale (*Phrynomantis*) (Burton 1983); (B) origin from the dentary only (*Barygenys* (Fig. 7C), *Xenobatrachus* and *Xenorhina*); and (C) origin from the hyale only (*Asterophrys, Hylophorbus* (Fig. 7A), *Mantophryne* and *Pherohapsis*).

All of these states occur among the genyophrynines and so polarities cannot be assigned by out-group analysis.

Character 6. The *M. genioglossus.* Three states occur among the Asterophryinae: (0) the *M.g. basalis* labiform, and the *M.g. dorsalis* comprising two strap-like muscles (*Asterophrys, Hylophorbus, Mantophryne, Pherohapsis* and *Phrynomantis*) (Fig.

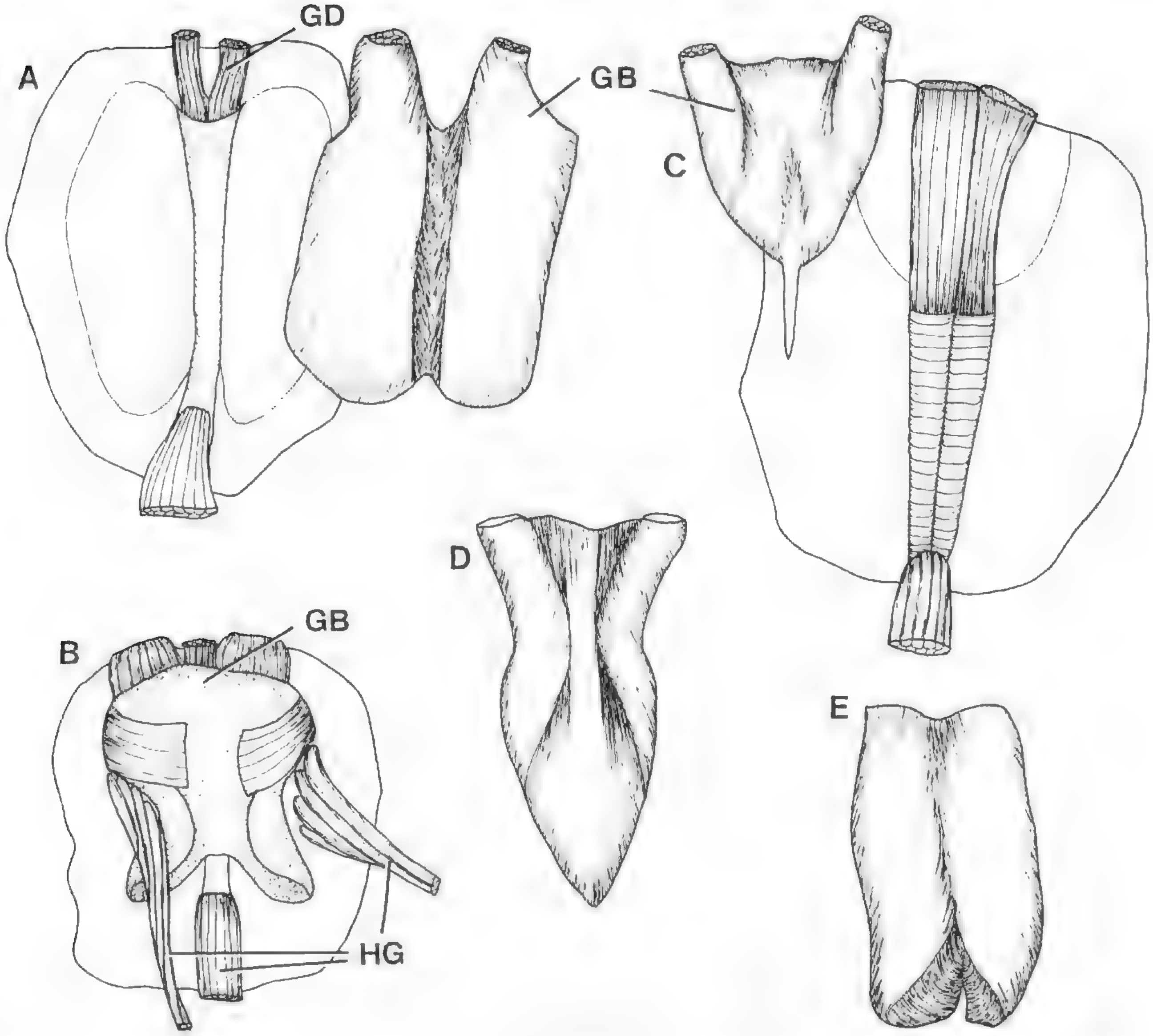

FIG. 8. (A) Ventral view of the *M. genioglossus* of *Barygenys atra* UPNG 3836, *M.g. basalis* reflected to the left to reveal *M.g. dorsalis*; (B) Ventral view of the deepest muscles of the tongue of *Barygenys flavigularis* AUZ D741; (C) Ventral view of the *M. genioglossus* of *Xenobatrachus giganteus* UPNG 5680, *M.g. basalis* reflected to the right to reveal *M.g. dorsalis*; (D) Dorsal view of the *M.g. basalis* of *Phrynomantis stictogaster* SAMA R20886; (E) Dorsal view of the *M.g. basalis* of *Genyophryne thomsoni* UPNG 5130. Abbreviations: GB, *M. genioglossus basalis*; GD, *M.g. dorsalis*; HG, *M. hyoglossus*.

7A); (1) the *M.g. basalis* bearing a posterad cultriform process, and the *M.g. dorsalis* comprising two strap-like muscles (*Xenobatrachus* and *Xenorhina*) (Figs 7B, 8C); and (1') the *M.g. basalis* lamellate and folded, and the *M.g. dorsalis* fused and ensheathed in connective tissue (*Barygenys*) (Figs 8A, 8B).

State (0) is the usual state among microhylids including all genyophrynines except the unique *Genyophryne*, and is the primitive state. In *Genyophryne* (Fig. 8D) the *M. genioglossus* is short and bilobular and unlike that of any other microhylid examined. There is no evidence to indicate the relationship between states 1 and 1'.

Character 7. Occurrence of a deep slip of the *M. hyoglossus*. Two states occur in the Papuan microhylids: (0) slip present (Genyophryninae, except *Genyophryne*); and (1) slip absent (Asterophryinae and *Genyophryne*).

State (0) appears to be the usual microhylid condition (Trewavas 1933), and is probably the primitive state of the Papuan microhylids. Its absence in *Kaloula* is interpreted as a case of parallel evolution.

Barygenys possesses a unique state of the *M. hyoglossus* (Fig. 8A), but the reduction and division of this muscle into three narrow, discrete sections appears to have evolved in association with the lamellate *M. genioglossus basalis*, which excludes the *M. hyoglossus* from access to the tongue except at three sites: the two lateral folds of the *M.g. basalis* and the posterior notch in the *M.g. basalis*. As the forms of these two muscles are so intimately related, they cannot be considered separately.

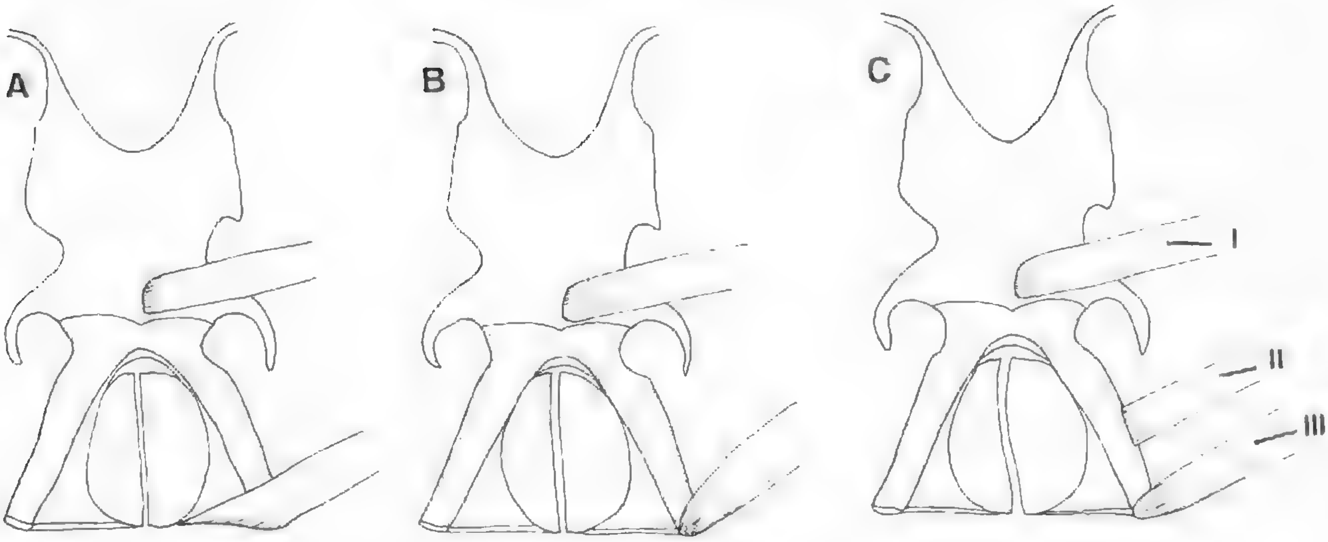

FIG. 9. Insertions of the *Mm. petrohyoidei posteriores* in Papuan microhylids. (A) State (0) two *Mm. p. posteriores*, the posterior of which inserts on the tip of the postero-medial process of the hyoid and the hyocricoid ligament; (B) State (1) two *Mm. p. posteriores*, the posterior of which inserts only on the tip of the posteromedial process of the hyoid; (C) State (1') three *Mm. p. posteriores*. Abbreviations: I, *M. petrohyoideus posterior* I; II, *M.p. posterior* II; III, *M.p. posterior* III.

Character 8. Number and insertions of the *Mm. petrohyoidei posteriores*. Three states occur among the Papuan microhylids (Fig. 9): (0) two *Mm. p. posteriores*, the posterior of which inserts on the epicondyle of the posteromedial process of the hyoid and the adjacent hyocricoid ligament (Genyophryninae, except *Genyophryne*) (Fig. 10A); (1) two *Mm. p. posteriores*, the posterior of which inserts on the epicondyle alone (*Barygenys*) (Fig. 10B); and (1') three *Mm. p. posteriores*, of which the *M.p. posterior* II inserts on the hyocricoid ligament, and the *M.p. posterior* III on the epicondyle (Asterophryinae except *Barygenys; Genyophryne*) (Burton 1983).

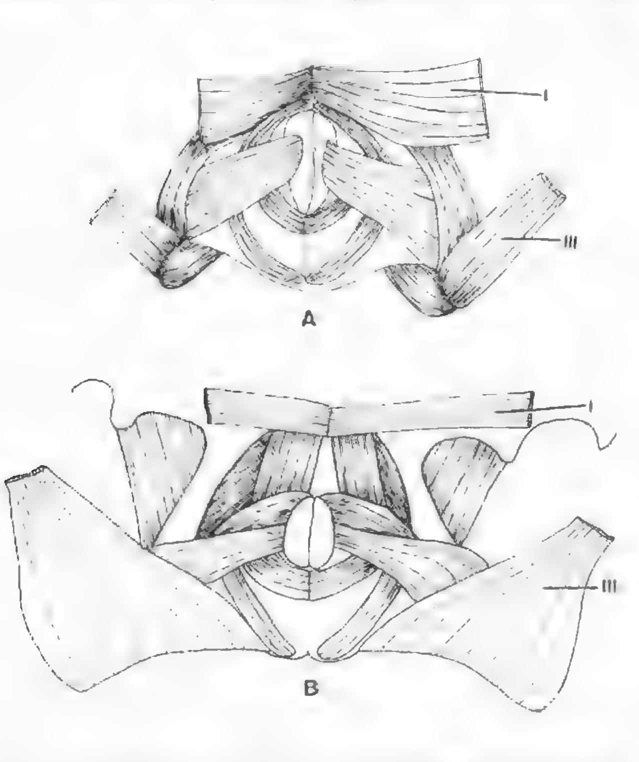

FIG. 10. Dorsal view of the larynx of (A) *Cophixalus riparius* SAMA R5216a; (B) *Barygenys atra* UPNG 3836. Abbreviations: I, *M. petrohyoideus posterior* I; III, *M.p. posterior* III.

State (0) is shared by *Calluella*, the Oriental microhylines and *Gastrophryne* (Trewavas 1933) and is primitive among the Papuan microhylids. The occurrence of State (1') in *Elachistocleis* is interpreted as a case of convergence. While State (1') appears to have derived directly from State (0) by division of the muscle, it is unclear whether State (1) derives from State (0) or from State (1').

Character 9. Two states of the origin of the *M.p. posterior* III occur in the Asterophryinae: (0) origin from the otic ramus of the squamosal and the adjacent exoccipital (*Barygenys, Xenobatrachus* and *Xenorhina*) (Fig. 11C), and (1) origin from the zygomatic ramus of the squamosal (*Hylophorbus, Phrynomantis, Mantophryne infulata* and *M. louisiadensis*) or its posterad projection (*Asterophrys, Pherohapsis* and *Mantophryne lateralis*) (Figs 11A, B).

State (0) is shared by the genyophrynines (Fig. 11D) and is primitive among the asterophryines.

Character 10. Extent of the anterior origin of the *M. depressor mandibulae*. Two states occur among the asterophryines: (0) origin from the entire ventral margin of the tympanic ring, and in some small specimens also from the adjacent epimysium of the *M. adductor mandibulae externus superficialis* (*Phrynomantis*, except *P. doriae*) (Fig. 11A); and (1) from the posterior 1/2 only of the ventral margin (*Asterophrys, Barygenys, Hylophorbus, Pherohapsis, Xenobatrachus, Xenorhina, Phrynomantis doriae* and *Mantophryne*) (Fig. 11C).

State (0) is shared by the genyophrynines (Fig. 11D), and is primitive.

Character 11. Extent of the slip of the *M. depressor mandibulae* from the otic ramus. Two states occur

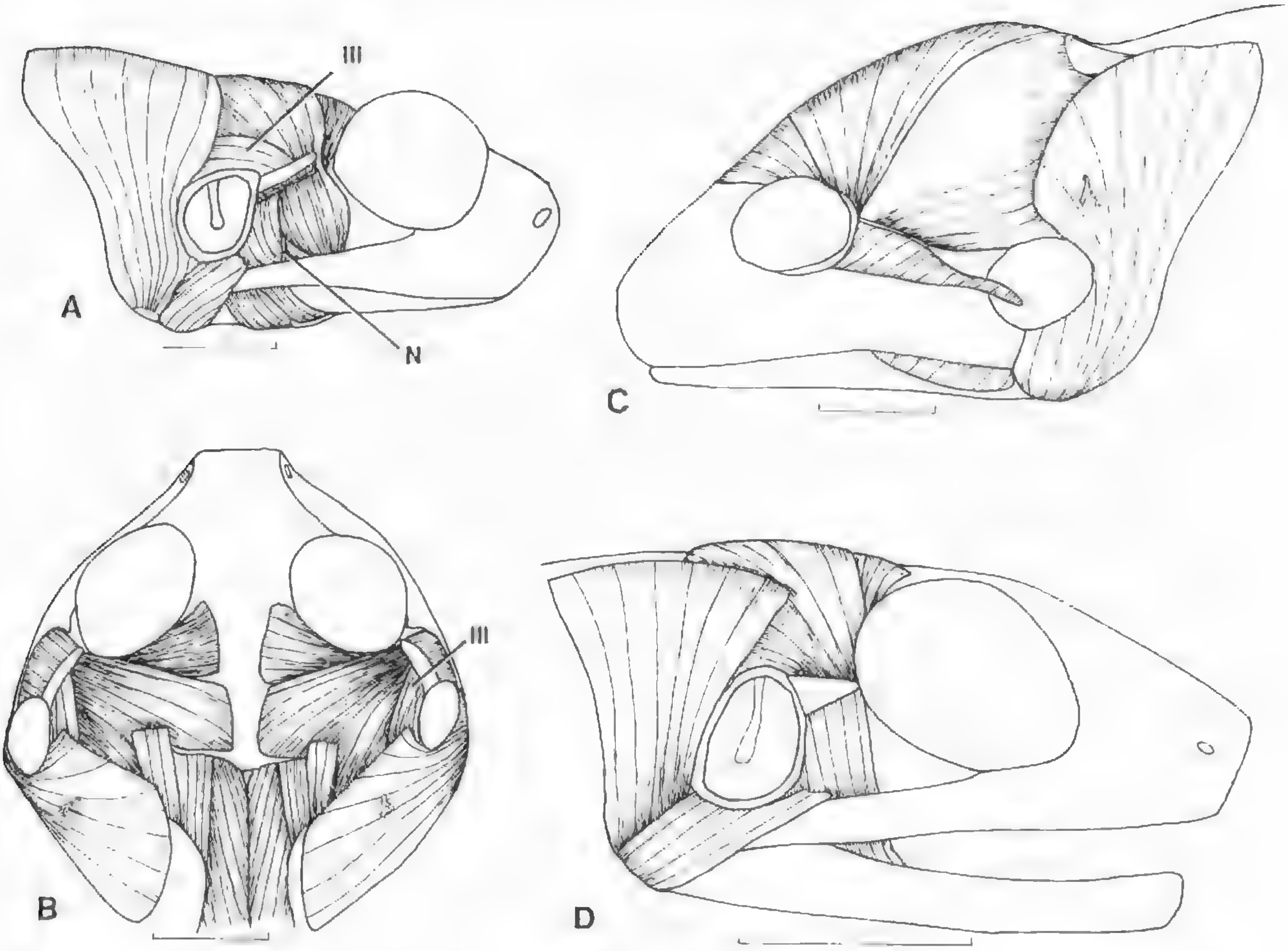

FIG. 11. A. Right lateral view of the jaw musculature of *Phrynomantis h. humicola* MCZ 52970, *M. adductor mandibulae externus superficialis* removed to reveal the position of the mandibular branch of the trigeminal nerve; B. Dorsal view of the jaw musculature of *Phrynomantis wilhelmana* AM R66747; C. Left lateral view of the jaw musculature of *Xenobatrachus giganteus* UPNG 5680; D. Right lateral view of jaw muscles of *Sphenophryne schlaginhaufeni* AUZ B733. Scale bar = 5 mm. Abbreviations: N, trigeminal nerve; III, origin of *M. petrohyoideus posterior*.

among the asterophryines: (0) origin relatively small, significantly less bulky than the slip from the dorsal fascia, or absent (*Asterophrys, Barygenys, Hylophorbus, Mantophryne, Pherohapsis* and *Phrynomantis*); and (1) origin relatively extensive, approximately equal in bulk to the slip from the dorsal fascia (*Xenobatrachus, Xenorhina*).

State (0) is shared by all genyophrynines, except *Choerophryne* and the *darlingtoni*-group, which share an unusual conformation of the depressor musculature, which does not occur in asterophryines. State (0) is considered primitive among the asterophryines.

Character 12. Development of the *M. adductor mandibulae posterior longus.* Three states occur among the asterophryines: (0) the fibres passing directly from their origins on the surfaces of the frontoparietal, prootic and exoccipital to a tendon placed anterolaterally in the orbit, the fibres not organized into discrete segments (*Hylophorbus, Mantophryne, Pherohapsis* and *Phrynomantis*) (Figs 11B, 12A); (1) the fibres from the frontoparietal passing laterally and the fibres from the prootic and exoccipital passing anteriorly, so that the two sets of fibres form segments (*Asterophrys*); and (2) the fibres organized into segments as in State (1), some fibres from the more posterior origin inserting on a superficial tendon which unites distally with the usual deep tendon of insertion (*Barygenys, Xenobatrachus* and *Xenorhina*) (Fig. 11C).

State (0) is shared by the genyophrynines (Fig. 11D) and is primitive. States (1) and (2) appear to be by-products of the massiveness of the adductor muscles of *Asterophrys, Barygenys, Xenobatrachus* and *Xenorhina.* The direction of evolution 1 → 2 is associated in part with a diminution of the relative size of the skull, and a consequent tendency of the jaw muscles to bulge in *Barygenys, Xenobatrachus* and *Xenorhina.*

The exclusion of the *M.a.m. posterior longus* from an exostosed or otherwise adorned skull in *Asterophrys, Hylophorbus, Mantophryne* and *Pherohapsis* is considered below as a character state of the skull.

Character 13. Origin of the *M. adductor mandibulae externus superficialis.* Two states occur among the asterophryines: (0) origin from the zygomatic ramus of the squamosal, with little or no origin from the fascia between the anterior tip of the zygomatic ramus

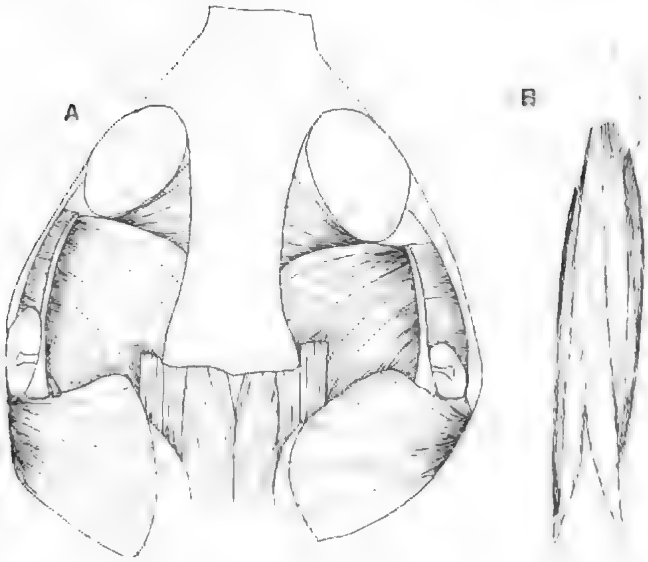

FIG. 12. A. Dorsal view of the jaw musculature of *Mantophryne lateralis* AUZ D737; B. Anterior muscles of the shank of *Mantophryne lateralis* AUZ D737. Scale bar = 5 mm.

and the eye (*Asterophrys*, *Hylophorbus*, *Pherohapsis*, *Mantophryne* and *Phrynomantis*) (Figs 11A, B, 12A); and (1) an extensive origin from the fascia anterior to the anterior tip of the zygomatic ramus (*Barygenys*, *Xenobatrachus* and *Xenorhina*) (Fig. 11C).

State (0) is shared by the genyophrynines (Fig. 11D) and is primitive. State (1) is related to the long expanse between the tip of the zygomatic ramus and the eye in *Barygenys*, *Xenobatrachus* and *Xenorhina*, which in turn is related to the smallness of the eye in these two genera, and consequently this character cannot be considered independently of Character 47: eye-size.

The origin of this muscle in *Pherohapsis* is modified as a result of the connexion between the zygomatic ramus and the maxilla, but although the *M.a.m. externus superficialis* is entirely deep to this sheet of bone, its origin is from the zygomatic ramus as in other asterophryines.

The Trigeminal nerve: The position of the mandibular branch of the trigeminal nerve is too inconsistent to be useful as a character in phylogenetic analysis.

Character 14. Insertion of the *M. longissimus dorsi*. Two states occur among the asterophryines: (0) insertion on the exoccipital (Asterophryinae except *Barygenys*) (Figs 11B, 12A); and (1) insertion partly on the dorsal fascia (*Barygenys*).

State (0) is shared by genyophrynines, and is primitive among the asterophryines.

The *M. ileolumbaris*: Two states of the *M. ileolumbaris* occur among the asterophryines: origin from the tip of the ilial shaft (*Asterophrys*, *Barygenys*, *Phrynomantis*, *Xenobatrachus*, *Xenorhina* and *Mantophryne louisiadensis*); and origin from a site well posterior to the tip (*Hylophorbus*, *Pherohapsis*, *Mantophryne infulata* and *M. lateralis*). Both states occur in the genyophrynines. The former state occurs in species with the ilio-sacral articulation type IIA of Emerson (1979), and the latter in species with a type I articulation. This character cannot be considered independently of Character 46: "ilio-sacral articulation type".

Character 15. Tendinous inscriptions in the *M. rectus abdominis*. Two states occur among the microhylids: (A) one abdominal tendinous inscription (Asterophryinae, Genyophryninae and *Breviceps*); and (B) three abdominal tendinous inscriptions (*Microhylinae* and *Calluella*).

Neither state occurs among the ranoids in which two states occur: four abdominal tendinous inscriptions (most genera); and two abdominal tendinous inscriptions (*Hemisus*). It is impossible from such data to determine the primitive state in the microhylids.

Character 16. Extent of fibres of the *Mm. obliqui abdominis externus* and *transversus abdominis*. Two states occur among the asterophryines: (0) ventral insertions on a broad tendon which covers the ventral abdomen (*Asterophryinae*, except *Barygenys*; and (1) fibres from the two sides meeting on the mid-ventral surface of the abdomen, at least in part (*Barygenys*)).

State (0) is shared by the genyophrynines and is primitive among the asterophryines.

The origin of the *M. rhomboideus anterior*. Two states occur among the asterophryines: origin entirely from the exoccipital (*Asterophrys*, *Pherohapsis*); and origin partly from the dorsal fascia (*Barygenys*, *Hylophorbus*, *Mantophryne*, *Phrynomantis*, *Xenobatrachus* and *Xenorhina*) (Figs 11B, C, 12A).

Both states occur among the genyophrynines. The condition of this muscle in *Asterophrys* and *Pherohapsis* could be related to modifications of the skulls of these genera. The genyophrynines which possess a partial orgin from the dorsal fascia are the more heavily muscled terrestrial or fossorial species (*Cophixalus neglectus*, *C. pansus*, *Copiula*, *Genyophryne* and *Sphenophryne*), and this condition may be related to the utilization of an additional site of origin in the face of crowding by muscles of the limited skull surface. This character will not be considered further.

Character 17. Insertion of the *M. serratus medius*. Two states occur among the asterophryines: (0) two insertions on the suprascapula: one dorsal and one ventral to the site of insertion of the *M. levator scapulae superior* (*Asterophryinae*, except *Barygenys*); and (2) one insertion posterior to the insertions of the *Mm. levatores* (*Barygenys*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 18. Origins of the *M. levator scapulae inferior*. Two states occur among the asterophryines: (0) origin partly from the ventral surfaces of the two anterior vertebrae (*Asterophrys*, *Hylophorbus*, *Mantophryne*, *Pherohapsis* and *Phrynomantis*) (Burton 1983); and (1) origin partly from the ventral

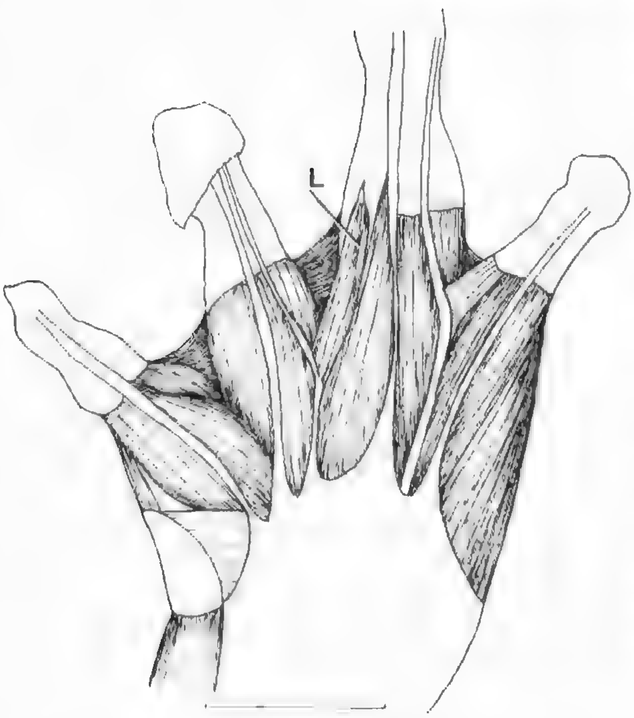

FIG. 13. Ventral superficial muscles of right manus of *Barygenys atra* UPNG 3836. Abbreviation: L, *M. lumbricalis brevis digiti* IV. Scale bar = 1 mm.

surfaces of the three anterior vertebrae (*Barygenys*, *Xenobatrachus* and *Xenorhina*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 19. Development of a deep slip of the *M. pectoralis sternalis.* Two states occur among the asterophryines: (0) deep slip poorly developed and uniting distally with the superficial muscle (*Asterophrys*, *Hylophorbus*, *Mantophryne*, *Pherohapsis* and *Phrynomantis*); and (1) deep slip well developed, oblique to the superficial muscle and inserting separately (*Barygenys*, *Xenobatrachus* and *Xenorhina*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 20. Origin of the *M. lumbricalis brevis digiti* IV of the manus. Two states of the origin of the medial slip occur among the asterophryines: (0) origin from a superficial tendon, muscle slender (*Barygenys*) (Fig. 13); and (1) origin via a short, stout tendon from the centrale postaxiale; muscle large and fusiform (*Asterophryinae*, except *Barygenys*) (Burton 1983).

State (0) occurs in *Cophixalus riparius* and *Genyophryne thomsoni* among the genyophrynines. In all genyophrynines this is a slender muscle arising from a long narrow tendon, usually from the palmar aponeurosis. State (1) does not occur among the genyophrynines. State (0) is considered primitive among the asterophryines.

Character 21. Position of division of the *M. tibialis anticus longus* into bellies. Two states occur among the asterophryines: (A) within the proximal 2/3 of the muscle (*Barygenys*, *Pherohapsis*, *Phrynomantis*, *Xenobatrachus* and *Xenorhina*) (Burton 1983); and (B) division within the distal 1/4 of the muscle (*Asterophrys*, *Hylophorbus* and *Mantophryne*) (Fig. 12B).

As both states occur among the genyophrynines, no polarities can be ascribed to the states of this character, which may well be correlated with Character 22.

Character 22. Origin of the *M. tibialis anticus brevis.* Two states occur among the asterophryines: (0) origin entirely or partly within the proximal 2/3 of the tibiofibula (*Barygenys*, *Phrynomantis*, *Xenobatrachus* and *Xenorhina*); and (1) origin entirely within the distal 1/4 of the tibiofibula (*Asterophrys*, *Hylophorbus*, *Mantophryne* and *Pherohapsis*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 23. Origin of the *M. opponens hallucis.* Two states occur among the asterophryines: (0) origin from the tarsalia (*Asterophryinae*, except *Barygenys*) (Burton 1983); and (1) origin from the dorsal surface of the plantar aponeurosis (*Barygenys*).

State (0) is shared by the genyophrynines, and is primitive.

Character 24. Union of the *Mm. lumbricales breves digitorum* IV and V. Two states relating to the degree of fusion of the lateral slip of the *M.l.b. digiti* IV and the medial slip of the *M.l.b. digiti* V occur in the asterophryines: (0) separation proximal, much less than 1/2 the medial slip of the *M.l.b. digiti* V involved in fusion (*Barygenys*); and (1) separation distal, the *M.l.b. digiti* V almost entirely fused to the *M.l.b. digiti* IV (*Asterophryinae*, except *Barygenys*).

State (0) is shared by the Genyophryninae, and is primitive among the asterophryines.

Character 25. Relative breadth of the frontoparietals. Two states occur among the asterophryines: (0) frontoparietals broad, length approximately 2× breadth of the combined frontoparietals (*Barygenys*) (Fig. 14A); and (1) frontoparietals relatively narrow, length approximately 3× the breadth (*Asterophryinae*, except *Barygenys*) (Figs 14C, 15A, C, E, 16A, C).

State (0) is shared by the genyophrynines (Figs 17A, 18A) and is primitive among the asterophryines.

Character 26. Occurrence of parasagittal ridges on the frontoparietals. Two states occur among the Papuan microhylids: (0) parasagittal ridges lacking (Barygenys, Phrynomantis, Xenobatrachus, Xenorhina and Genyophryninae except Genyophryne) (Figs 14A, C, 15A, 18A); and (1) parasagittal ridges present (*Hylophorbus*, *Mantophryne*, *Pherohapsis* and *Genyophryne) (Fig. 16C).*

State (0) occurs in the other microhylids and is primitive in the Papuan microhylids. The frontoparietals differ in form among those microhylids exhibiting State (1). In Hylophorbus and *Mantophryne infulata* the ridges are small, and the area between the ridges is unadorned. In the other taxa the area between the ridges is rugose, and the effect is that the mid-dorsal

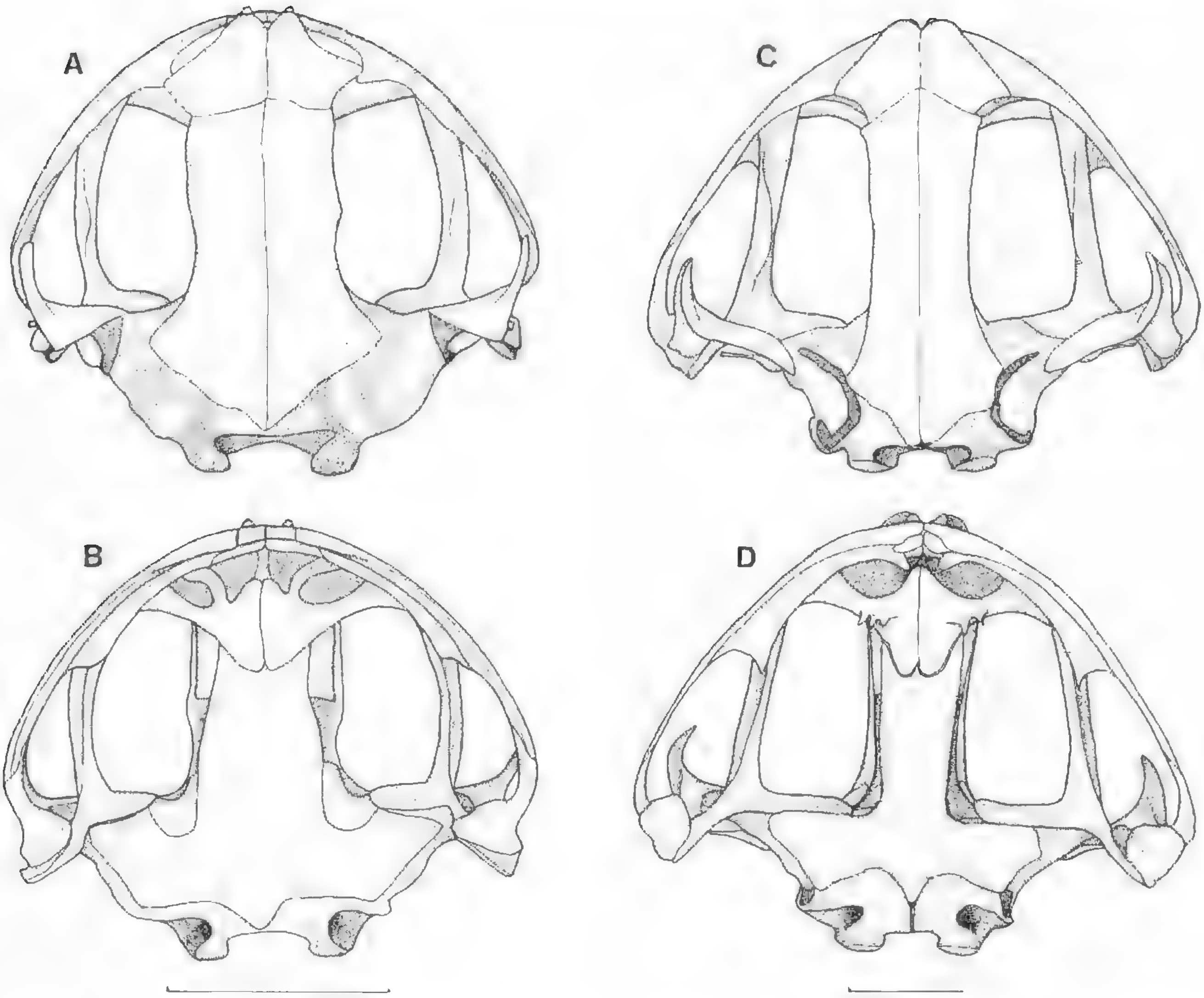

FIG. 14. A. Dorsal and B. ventral view of the skull of *Barygenys atra* UPNG 3836; C. Dorsal and D. ventral views of the skull of *Xenobatrachus giganteus* UPNG 5680. Scale bar = 5 mm.

surface of the cranium appears as a rugose plateau. It is assumed that the two conditions described are alternative forms of the one state. The state of *Asterophrys* (Fig. 16A) is not clear (see discussion of Character 27, following).

Character 27. Occurrence of a sagittal crest on the cranium. Two states occur among the asterophryines: (0) sagittal crest lacking (Asterophryinae except *Asterophrys* and some specimens of *Xenobatrachus obesus* and *Phrynomantis doriae*); and (1) sagittal crest present (*Asterophrys* and some specimens of *Xenobatrachus obesus* and *Phrynomantis doriae*) (Figs 15C, 16A).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines. The development of a strong sagittal crest in large specimens of *Phrynomantis doriae* and *Xenobatrachus obesus* clearly results from an ontogenetic effect — progressive lateral compression of the frontoparietals and raising of a sagittal crest as the frontoparietals are forced against each other. This may result from the disproportionate development of adductor muscles during ontogeny. The crest of the small specimen of *Asterophrys* that I examined was very similar to that of the largest specimen of *P. doriae*, but the specimen figured by Zweifel (1972) possesses an exostosed plateau on the mid-dorsal cranium similar to that of *Pherohapsis, Mantophryne lateralis, M. louisiadensis* and *Genyophryne*, but narrower. Whether the evolution of the sagittal crest of *Asterophrys* followed a pattern similar to the ontogeny of the crest in *P. doriae*, or occurred by lateral compression of an exostosed plateau is unknown.

Character 28. Fusion and expansion of the vomero-palatine. Though many states occur in the Microhylidae (Parker 1934; Carvalho 1954) (Fig. 19), two appear relevant to this study: (0) vomero-palatine not forming a large plate extending from a median suture to the maxillae (Microhylidae, except Asterophryinae and Genyophryninae); and (1) vomero-palatine a large plate extending from a median suture to the maxillae (Asterophryinae and Genyophryninae) (Figs 14B, D, 15B, D, F, 16B, D, 17B, D, 18B).

Though the primitive state of the microhylids is

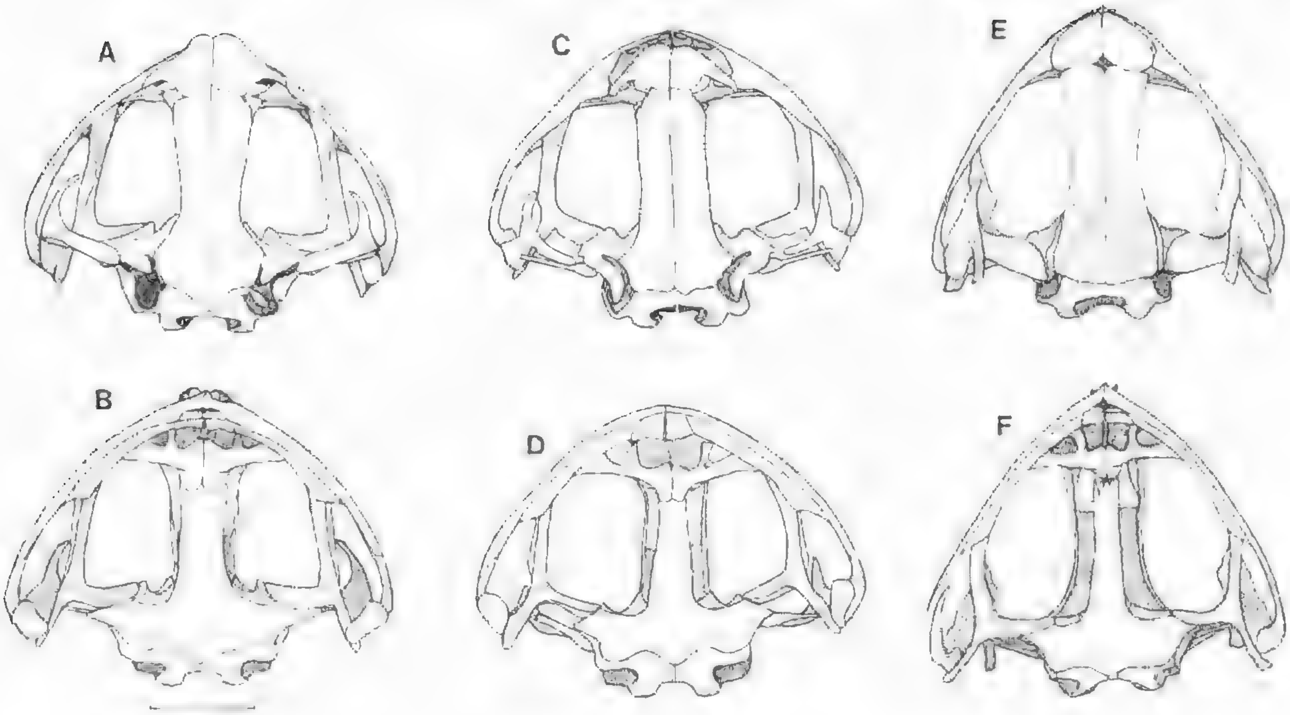

FIG. 15. A. Dorsal and B. ventral views of the skull of *Phrynomantis stictogaster* SAMA R 20886; C. Dorsal and D. ventral views of the skull of *Phrynomantis doriae* SAMA R6284; E. Dorsal and F. ventral views of the skull of *Mantophryne lateralis* AUZ D737. Scale bar = 5 mm.

unclear, it is unlikely that it is the unique state exhibited by the New Guinea subfamilies, and State (1) is considered derived.

Character 29. Lateral expansion of the vomero-palatine. Two states occur in the Papuan microhylids: (0) vomero-palatine not expanded close to its lateral articulations (Genyophryninae, except *Cophixalus pansus* and *Genyophryne*) (Fig. 18B); and (1) vomero-palatine expanded laterally (*Asterophryinae, C. pansus* and *Genyophryne*) (Figs 14B, D, 15B, D, F, 16B, D, 17B, D).

As the vomero-palatine of other microhylids are reduced relative to the Papuan microhylids, the unexpanded condition, State (0) is likely to be primitive.

Character 30. Extent of median expansion of the vomero-palatine. Two states occur among the asterophryines: (0) expansion moderate (*Asterophrys, Hylophorbus, Mantophryne, Pherohapsis* and *Phrynomantis*) (Figs 15B, D, F, 16B, D, 17D); and (1) expansion large (*Barygenys, Xenobatrachus* and *Xenorhina*) (Figs 14B, D).

State (0) is shared by the genyophrynines (Figs 17B, 18B), and is primitive among the asterophryines.

Character 31. Occurrence of spike-like odontoids on the vomero-palatine. Two states occur among the asterophryines: (0) spikes absent (*Asterophryinae,* except *Xenobatrachus*); and (1) spikes present (*Xenobatrachus*) (Fig. 14D).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 32. Width of the cultriform process of the parasphenoid. Two states occur among the Papuan microhylids: (A) cultriform process relatively narrow, less than 1/2 of the width of the frontoparietals (Asterophryinae, except *Barygenys, Xenobatrachus* and *Xenorhina*; Genyophryninae, except *Genyophryne*) (Figs 15B, D, F, 16B, D, 17D, 18B); and (B) cultriform process broad, more than 2/3 of the width of the frontoparietals (*Barygenys, Xenobatrachus, Xenorhina* and *Genyophryne*) (Figs 14B, D, 17B).

Both states are shared by the other microhylids examined, and it is not possible to assign polarities to this character.

Character 33. Extent of the articulation of the pterygoid with the prootic. Two states occur in the Papuan microhylids: (0) articulation short (Genyophryninae, except *Genyophryne*) (Fig. 18B); and (1) articulation long (*Asterophryinae* and *Genyophryne*) (Figs 14B, D, 15B, D, F, 16B, D, 17B, D).

State (0) is shared by the other microhylids examined, and is primitive among the Papuan microhylids.

Character 34. Development of the quadratojugal. Two states occur in the Papuan microhylids: (0) quadratojugal poorly developed, articulation with the maxilla brief or lacking (Genyophryninae, except *Genyophryne*) (Fig. 18B); and (1) quadratojugal well developed, articulation with the maxilla long (Asterophryinae and *Genyophryne*) (Figs 14B, D, 15B, D, F, 16B, D, 17B, D).

State (0) is shared by the other microhylids examined, and is primitive among the Papuan microhylids.

Character 35. Relationship between the squamosal and the maxilla. Two states occur among the Papuan microhylids: (0) no contact between the zygomatic

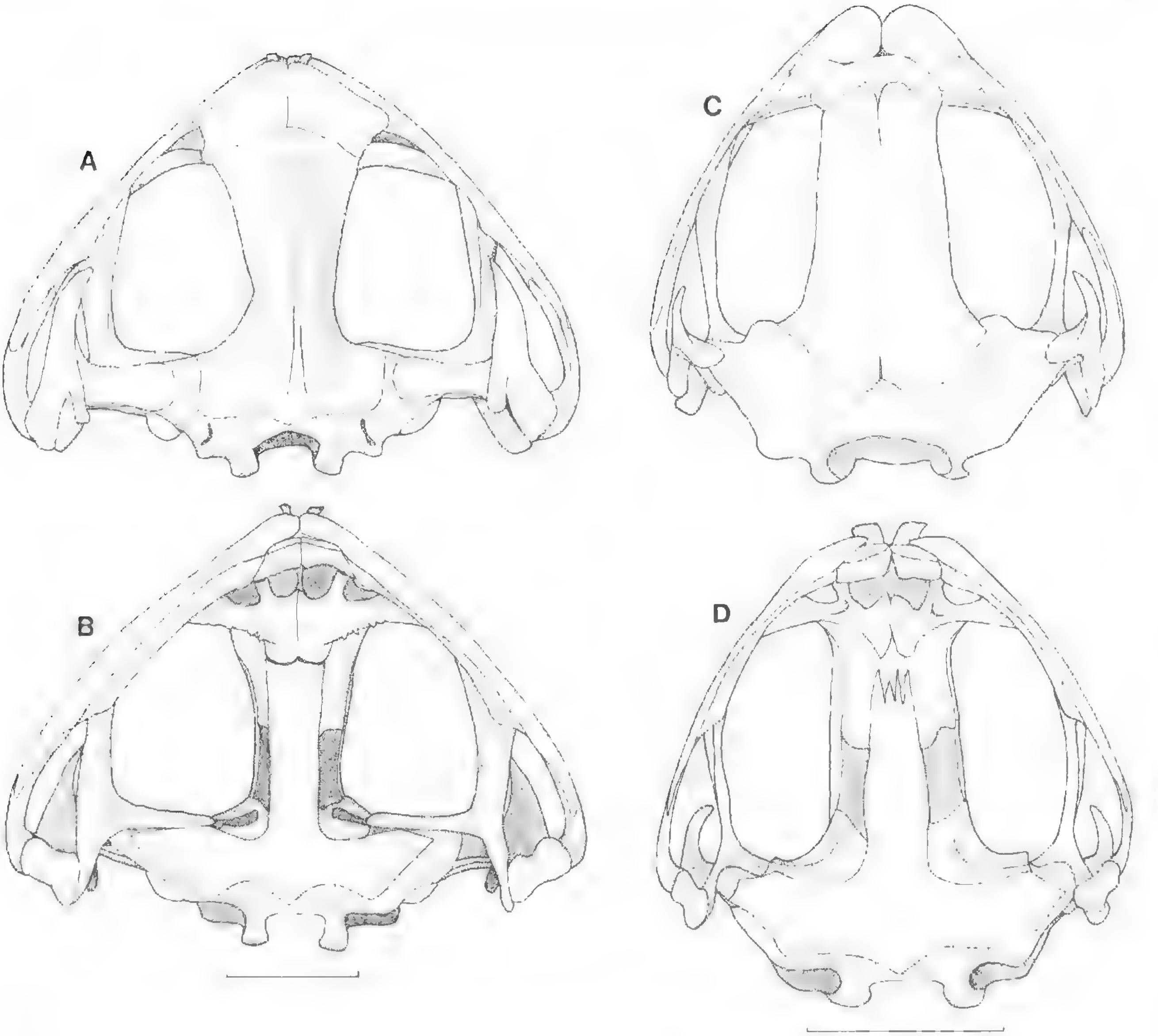

FIG. 16. A. Dorsal and B. ventral views of the skull of *Asterophrys turpicula* RMNH 16655; C. Dorsal and D. ventral views of the skull of *Hylophorbus r. rufescens* AUZ D738. Scale bar = 5 mm.

ramus and the maxilla (Genyophryninae, except *Genyophryne*; Asterophryinae, except *Asterophrys* and *Pherohapsis*); and (1) ventral margins of the zygomatic ramus and the squamosal shaft in contact with the dorsal margins of the quadratojugal and the maxilla, and the lateral surface of the resultant sheet of bone exostosed (*Asterophrys, Pherohapsis* and *Genyophryne*) (Figs 15A, 17A).

State (0) is shared by the other microhylids examined, and is primitive among the Papuan microhylids. The small specimen of *Asterophrys* that I examined lacks this connexion (Figs 16A, B) but Zweifel (1972) reports and figures it in other specimens.

Character 36. Occurrence of a posterad extension of the zygomatic ramus of the squamosal. Two states occur among the asterophryines: (0) no posterad extension, or else a slight flange on the posterior surface of the base of the otic ramus (*Barygenys, Hylophorbus, Phrynomantis, Xenobatrachus, Xenorhina, Mantophryne infulata, M. louisiadensis*); and (1) posterad expansion of the zygomatic ramus (*Asterophrys, Pherohapsis* and *Mantophryne lateralis*) (Figs 15E, 16A, 17C).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 37. Nature of the otic ramus of the squamosal. Four states occur among the Papuan microhylids: (0) dorsal surface of the otic ramus a flat plate continuous with the anterior surface of the medial flange of the squamosal shaft; ramus short, not extending to articulate with the crista parotica (Genyophryninae, except *Choerophryne*, the *darlingtoni*-group and *Genyophryne*) (Fig. 18A); (1) as in State (0), but ramus longer, overlying the crista parotica (*Asterophrys, Hylophorbus, Mantophryne, Pherohapsis, Xenobatrachus, Xenorhina, Choerophryne*, the *darlingtoni*-group and *Genyophryne*) (Figs 14C, 15E, 16A, C, 17C); (1′) dorsal surface of the otic ramus continuous with the lateral shaft; ramus extending medially; medial flange of shaft reduced

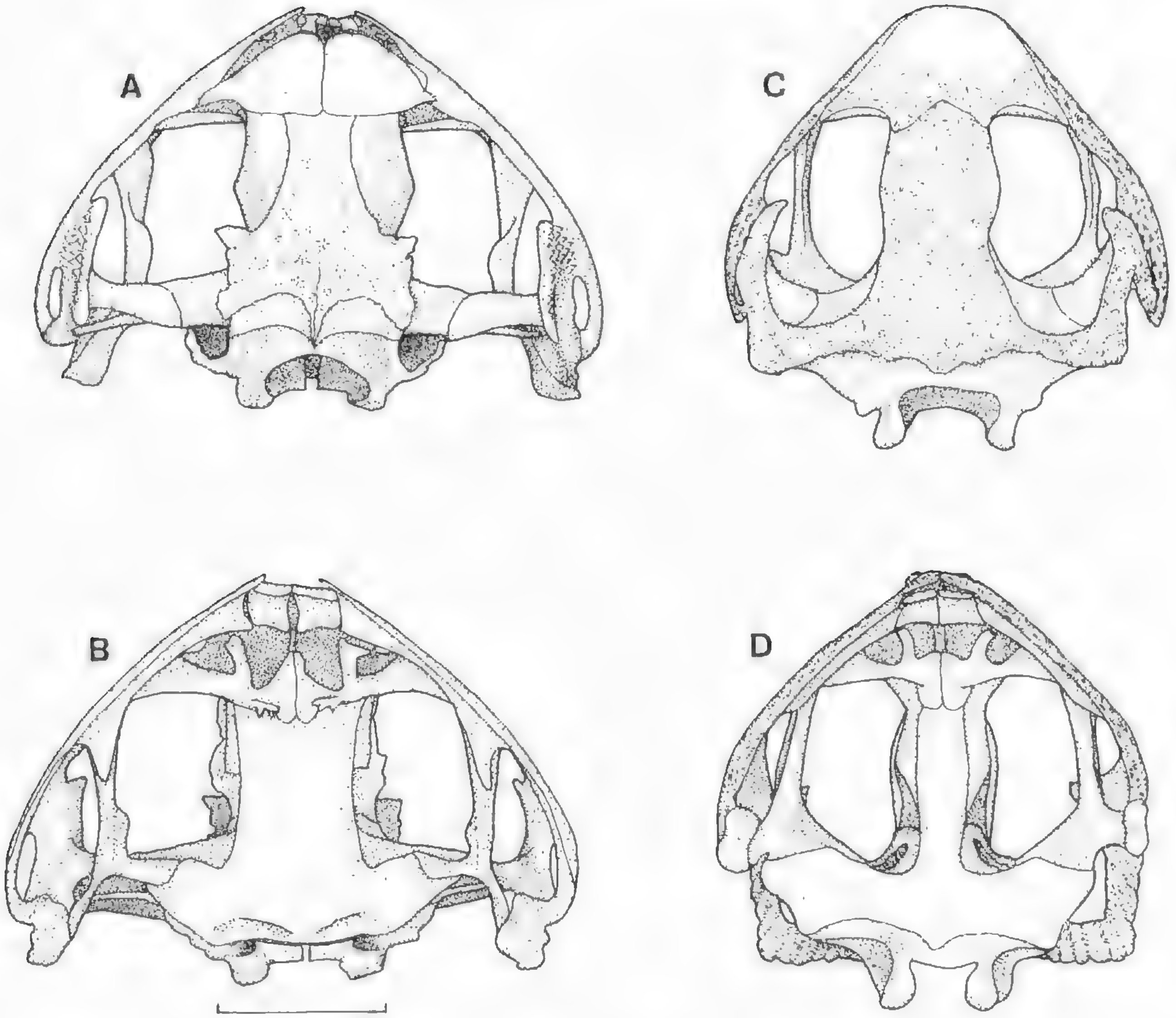

FIG. 17. A. Dorsal and B. ventral views of the skull of *Genyophryne thomsoni* UPNG 5130; C. Dorsal and D. ventral views of the skull of *Pherohapsis menziesi* UPNG 2579. Scale bar = 5 mm.

(*Phrynomantis*) (Figs 15A, C); and (1'') dorsal surface of the otic ramus continuous with the anterior surface of the medial flange; ramus not a flat plate, but folded so that it forms a sheet covering the anterior surfaces of the otic capsule; just extending to articulate on the anterodorsal margin of the crista parotica (*Barygenys*) (Fig. 14A).

State (0) occurs in the other microhylids and appears to be primitive among the Papuan microhylids. State (1) is likely to have been derived directly from State (0), but is unlikely to have formed an intermediate stage in the evolution of State (1') as State (1) involves an even greater expansion of the medial flange of the squamosal shaft than does State (0), and State (1') involves a reduction of the medial flange to a ridge on the shaft. In State (1'') the medial flange is expanded and this state may have been derived from either State (0) or State (1). The polarity of this character is either $1 \leftarrow 0 \vert$ or $1' \leftarrow 0 \rightarrow 1 \rightarrow 1''$.

Character 38. Occurrence of an anterior connexion between the partes faciales of the maxillae. Four states occur among the Papuan microhylids (Fig. 20): (0) partes faciales produced antero-medially to overlap the premaxillae slightly; direct ligamentous connexion between the tips of the partes faciales lacking (Genyophryninae, except *Genyophryne*); (1) partes faciales produced anteromedially to overlap the premaxillae slightly, but more than in State (0); dense ligamentous connexion between the tips of the partes faciales (*Genyophryne* and *Hylophorbus*; (2) partes faciales broadly overlapping the premaxillae; connexion by dense ligaments or by a median suture (Asterophryinae, except *Barygenys* and *Hylophorbus*; and (1') no anteromediad projection of the partes faciales, no overlap of the premaxillae, no ligamentous connexion (*pace* Zweifel, 1971); premaxillae narrow, compressed between the maxillae (*Barygenys*).

State (0) occurs in other microhylids, and is primitive among the Papuan microhylids. State (1') is more likely to have been derived from State (0) than from State (1) or (2), as State (1'), which is associated with three thickened ridges of skin on the snout corresponding

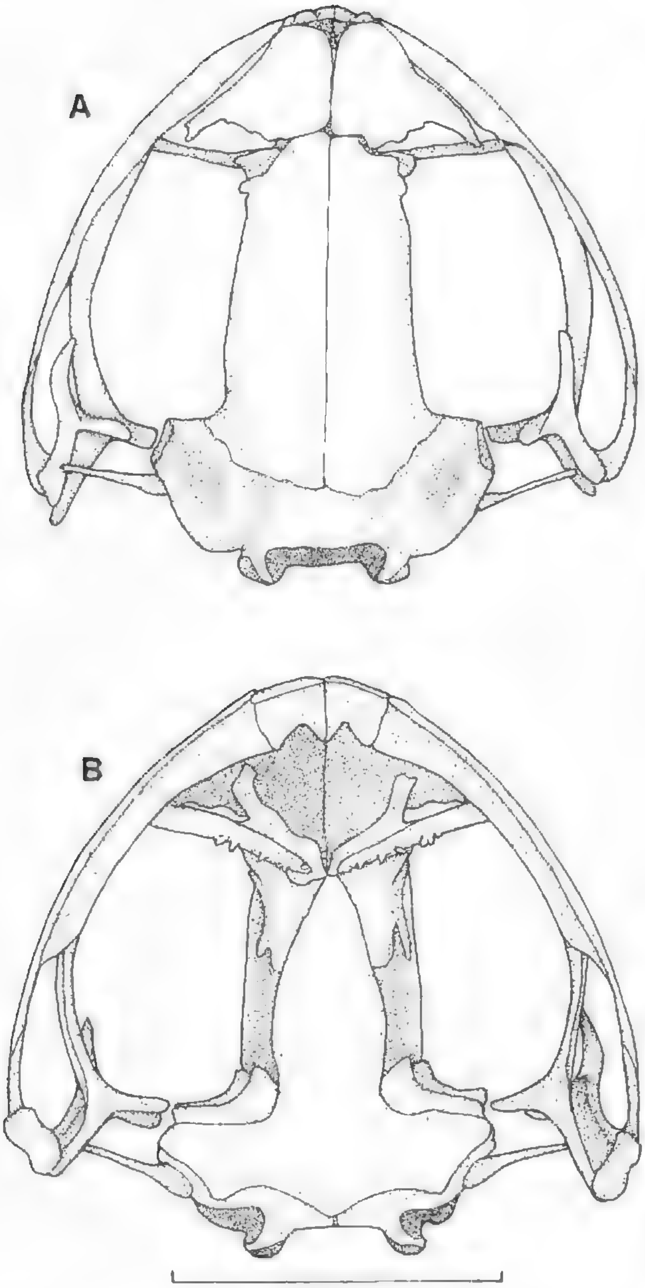

FIG. 18. A. Dorsal and B. ventral views of the skull of *Cophixalus riparius* SAMA R5216a. Scale bar = 5 mm.

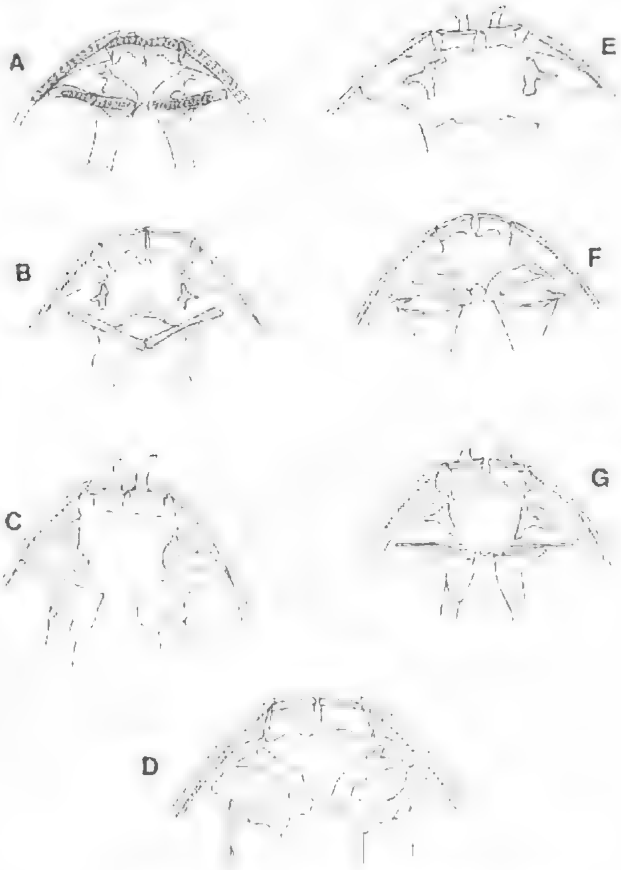

FIG. 19. Ventral views of anterior bones of the skull of various microhylids, with the vomero-palatine and palatine shelf of the maxillary shaded. (A) *Calluella guttalata*; (B) *Chaperina fusca*; (C) *Elachistocleis* sp.; (D) *Glyphoglossus molossus*; (E) *Kalophrynus pleurostigma*; (F) *Kaloula pulchra*; (G) *Microhyla pulchra* (partly after Parker, 1934).

with sites of articulation of the maxillae and premaxillae, represents a radically different mode of snout reinforcement from that represented by States (1) and (2). State (1) is likely to have been derived from State (0) by extension of the anteromediad processes of the partes faciales and the establishment of a ligamentous connexion between them. The polarity of this character is thus 1' ← 0 → 1 → 2.

I regard States (1) (possessed by *Genyophryne* and *Hylophorbus*) and (2) (*symphygnathy*) as differing only in degree, and consider the distinction between them somewhat arbitrary. Mehely (1901), Parker (1934) and Zweifel (1971, 1972), on the other hand, regarded the distinction as, to varying degrees, crucial. The difference between my appraisal and that of Mehely and Parker may arise in part from my having access to a large number of cleared and double-stained specimens, in which the presence or absence of ligamentous connexions is more obvious than in dried skeletons. Zweifel (1971) noted ligamentous connexions in *Genyophryne* (and implied their presence in *Barygenys* and *Hylophorbus*), but decided that the degree of closeness of contact of the maxillae is a more important indicator of relationships. I contend that closeness of contact has been overemphasised, as in some "symphygnathine" species, e.g., *Mantophryne infulata*, the distance between the partes faciales (up to 0.3 mm) approaches that of *Genyophryne* and *Hylophorbus*, and in *Genyophryne* and *Hylophorbus* the partes faciales are closer than in those genyophrynines exhibiting the State (0) condition. Whether or not my contention that the condition of *Genyophryne* and *Hylophorbus* is close to that exhibited by those asterophryines of State (2) condition is accepted, the possession by *Genyophryne* and *Hylophorbus* of a state different from State (0) and intermediate between States (0) and (2) is indisputable.

Character 39. Occurrence of a posteromediad process of the anterior margin of the palatal shelf of the maxilla. Two states occur among the asterophryines: (0) process lacking (*Asterophrys, Barygenys,*

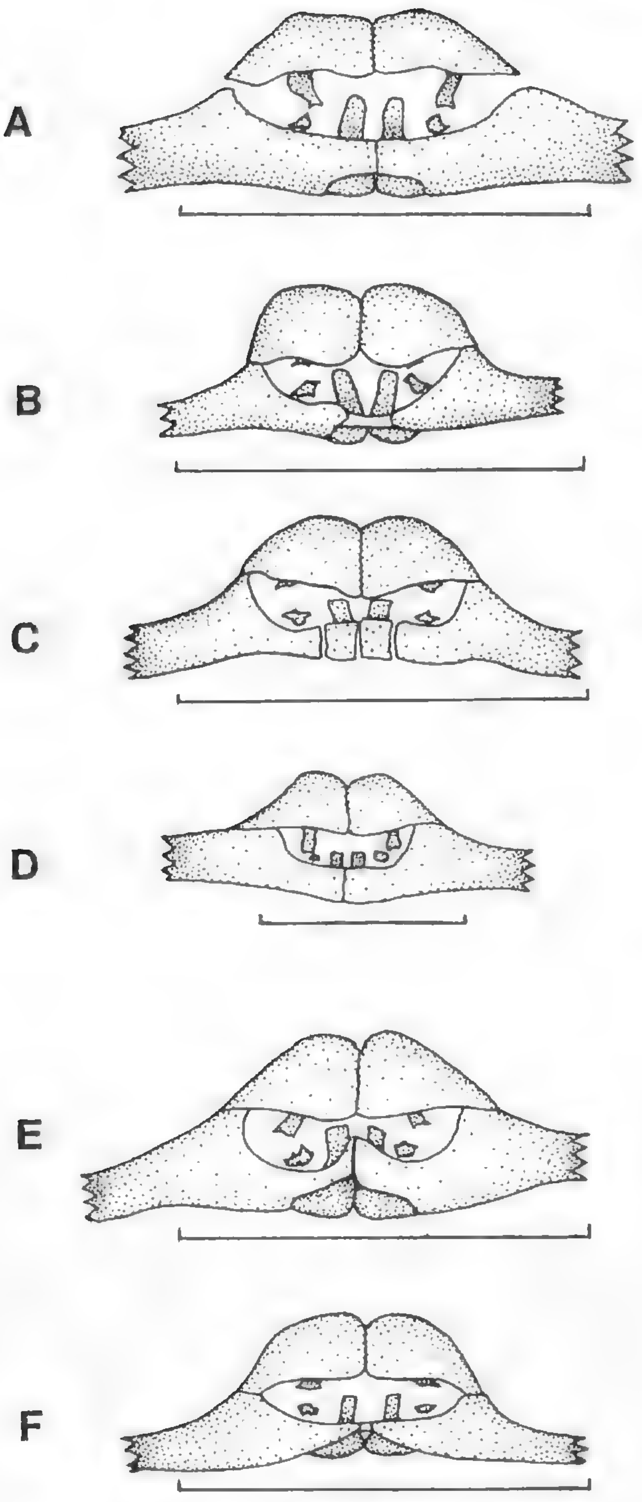

FIG. 20. Anterior view of the bones of the snouts of (A) *Phrynomantis humicola compta* SAMA R9387a; (B) *Hylophorbus r. rufescens* AUZ D738; (C) *Barygenys atra* UPNG 3836; (D) *Xenobatrachus giganteus* UPNG 5680; (E) *Mantophryne lateralis* AUZ D737; (F) *P. infulata* AMNH 66685. Scale bar = 5 mm.

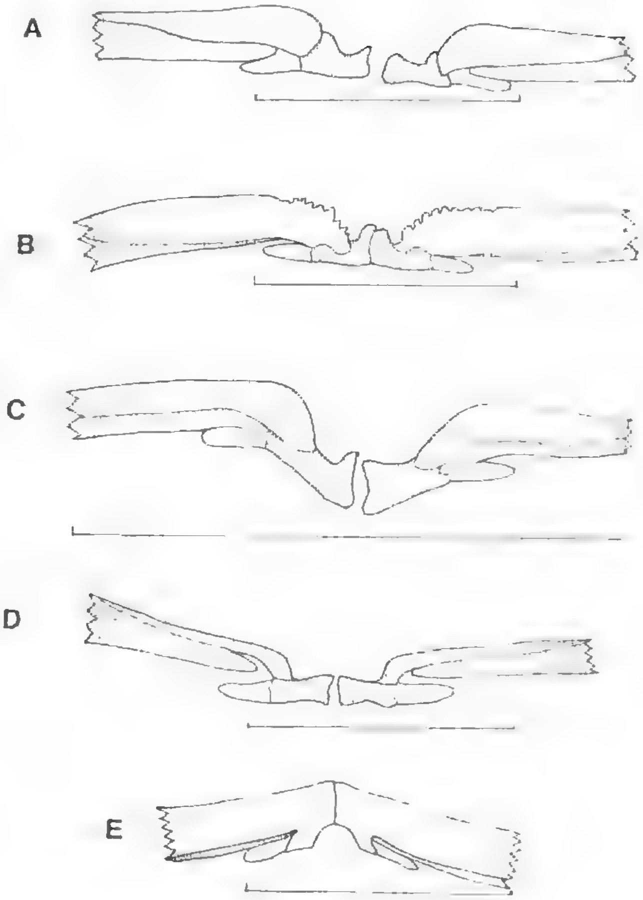

FIG. 21. Anterior views of the mandibles of (A) *Rana grisea* AUZ; (B) *Genyophryne thomsoni* UPNG 5130; (C) *Sphenophryne schlaginhaufeni* AUZ B733; (D) *Kaloula pulchra* FMNH 175952; (E) *Barygenys* sp. nov. AA 11171. Scale bar = 5 mm

Hylophorbus, Pherohapsis, Mantophryne and *Phrynomantis*); and (1) process present (*Xenobatrachus* and *Xenorhina*) (Fig. 14D).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 40. Calcification of the nasal capsule. Two states which occur among the asterophryines are considered: (0) anterior portion of the nasal capsule cartilaginous (*Asterophryinae*, except *Barygenys*); and (1) anterior portion of the nasal capsule calcified to form a calcified arc between the septomaxillaries (*Barygenys*) (Fig. 20C). State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 41. Relations of the dentaries and mentomeckelians. Two states occur in the Papuan microhylids: (0) dentary and mentomeckelian not fused; mentomeckelians lying on the rim of the mandible between the dentaries; angle between the long axes of the mentomeckelians obtuse (Genyophryninae) (Fig. 21B, C); and (1) dentary and mentomeckelian fused; mentomeckelians largely or entirely excluded from the rim of the mandible by the dentaries; angles between the long axes of the mentomeckelians acute (Asterophryinae) (Fig. 21E).

State (0) is shared by ranoids and other microhylids (Figs 21A, D), and is primitive among the Papuan microhylids. State (1) embraces the condition in *Hylophorbus* and *Mantophryne infulata*, in which the dentaries do not meet, and that of other asterophryines in which they do (the symphygnathine condition), as I consider this difference a matter of degree only, and not as indicative of relationships as the similarities of

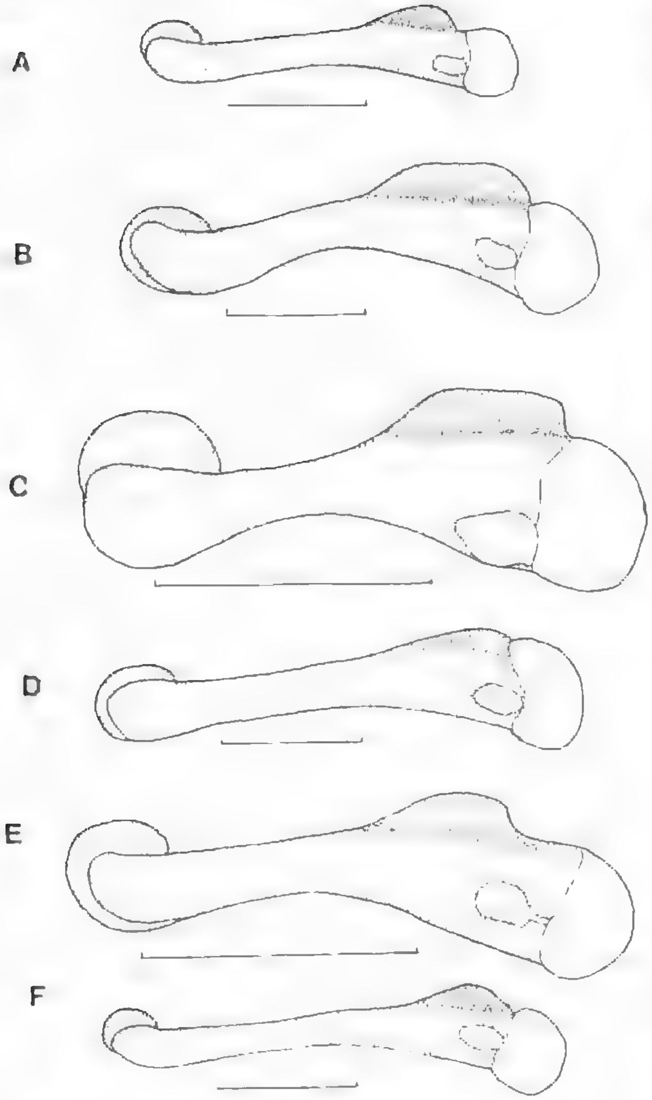

FIG. 22. Right humerus of (A) *Phrynomantis humicola compta* SAMA R9387a; (B) *Xenobatrachus giganteus* UPNG 5680; (C) *Barygenys atra* UPNG 3836; (D) *Asterophrys turpicula* RMNH 16655; (E) *Genyophryne thomsoni* UPNG 5130; (F) *Cophixalus riparius* SAMA R5216a. Scale bar = 5 mm.

the conformation of the mentomeckelians and the relationship between the dentary and the mentomeckelian, which are unique to the Asterophryinae.

Character 42. Degree of development of the humerus. Two states occur among the Papuan microhylids: (A) humerus relatively straight; crista ventralis moderately developed (Asterophryinae, except *Barygenys, Xenobatrachus* and *Xenorhina*; Genyophryninae, except *Genyophryne*) (Figs 22A, D, F) (B) humerus curved; crista ventralis well developed (*Barygenys, Xenobatrachus, Xenorhina* and *Genyophryne*) (Figs 22B, C, E).

Both states occur among the other microhylids, and so polarities cannot be assigned. No noticeable sexual difference occurs in this character.

Character 43. Reduction of the pectoral girdle. Four states occur among the Papuan microhylids (Fig. 23): (0) procoracoids present; clavicle extending laterally to articulate with scapula (*Sphenophryne*); (1) procoracoids present; clavicles not extending as far laterally as the scapula (*Oreophryne*); (2) procoracoids present; clavicles absent (*Genyophryne*); and (3) procoracoids absent; clavicles absent (Asterophryinae, *Choerophryne, Cophixalus, Copiula* and the *darlingtoni*-group).

Reduction of the pectoral girdle occurs in other microhylid subfamilies (Fig. 23) and in the Ranidae, and is believed to have occurred independently several times. A complete pectoral girdle is generally regarded as primitive, e.g., Trueb (1973), Laurent (1979). Certainly the reacquisition of elements of the pectoral girdle lost in the evolutionary history of the genyophrynines is less likely than the alternative, a progressive loss of elements of the pectoral girdle.

Character 44. Nature of the vertebral column. Two states occur among the Papuan microhylids: (A) all presacral vertebrae procoelous (vertebral column procoelous) (Genyophryninae); and (B) all presacral vertebrae procoelous except the eighth, which is opisthocoelous (vertebral column diplasiocoelous) (Asterophryinae). Both states occur in ranoids (Duellman 1975) and other microhylids, and although State (B) is the more common (Parker 1934) it is not possible to ascribe polarities to this character on the basis of outgroup analysis. Parker (1934) and Carvalho (1954) demonstrated variation in this character within the Microhylinae. Whether this indicates that this character is of little significance in the Microhylidae as a whole (Savage 1973) is unclear.

Character 45. Occurrence of a dorsal crest on the ilium. Two states occur among the asterophryines (Fig. 24): (0) ilial shaft lacking a dorsal crest (*Barygenys* and *Phrynomantis*); and (1) ilial shaft bearing a dorsal crest (*Asterophrys, Hylophorbus, Mantophryne, Pherohapsis, Xenobatrachus* and *Xenorhina*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryinae.

Character 46. Nature of the ilio-sacral articulation. Two states occur in Papuan microhylids: (A) articulation indirect, a dorsal ligament connecting the ilial shafts; this is the type I articulation of Emerson (1979) (*Hylophorbus, Pherohapsis, Mantophryne infulata, M. lateralis, Choerophryne, Cophixalus, Copiula, Oreophryne* and the *darlingtoni*-group); and (B) articulation by a ligament attaching to the dorsal surface of the sacral diapophysis close to its base; this is the type IIA articulation of Emerson (1979) (*Asterophrys, Barygenys, Phrynomantis, Mantophryne louisiadensis, Xenobatrachus, Xenorhina, Genyophryne* and *Sphenophryne*).

Both states occur among the other microhylids, and it is not possible to ascribe polarities to this character.

Character 47. Eye-size. Two states occur among the Papuan microhylids: (0) eye relatively large; $E : S\text{-}V > 0.090$ (Asterophryinae, except *Barygenys, Xenobatrachus, Xenorhina* and *Phrynomantis doriae* — see below; Genyophryninae, except *Copiula* and *Genyophryne*); and (1) eye relatively small; $E: S\text{-}V <$

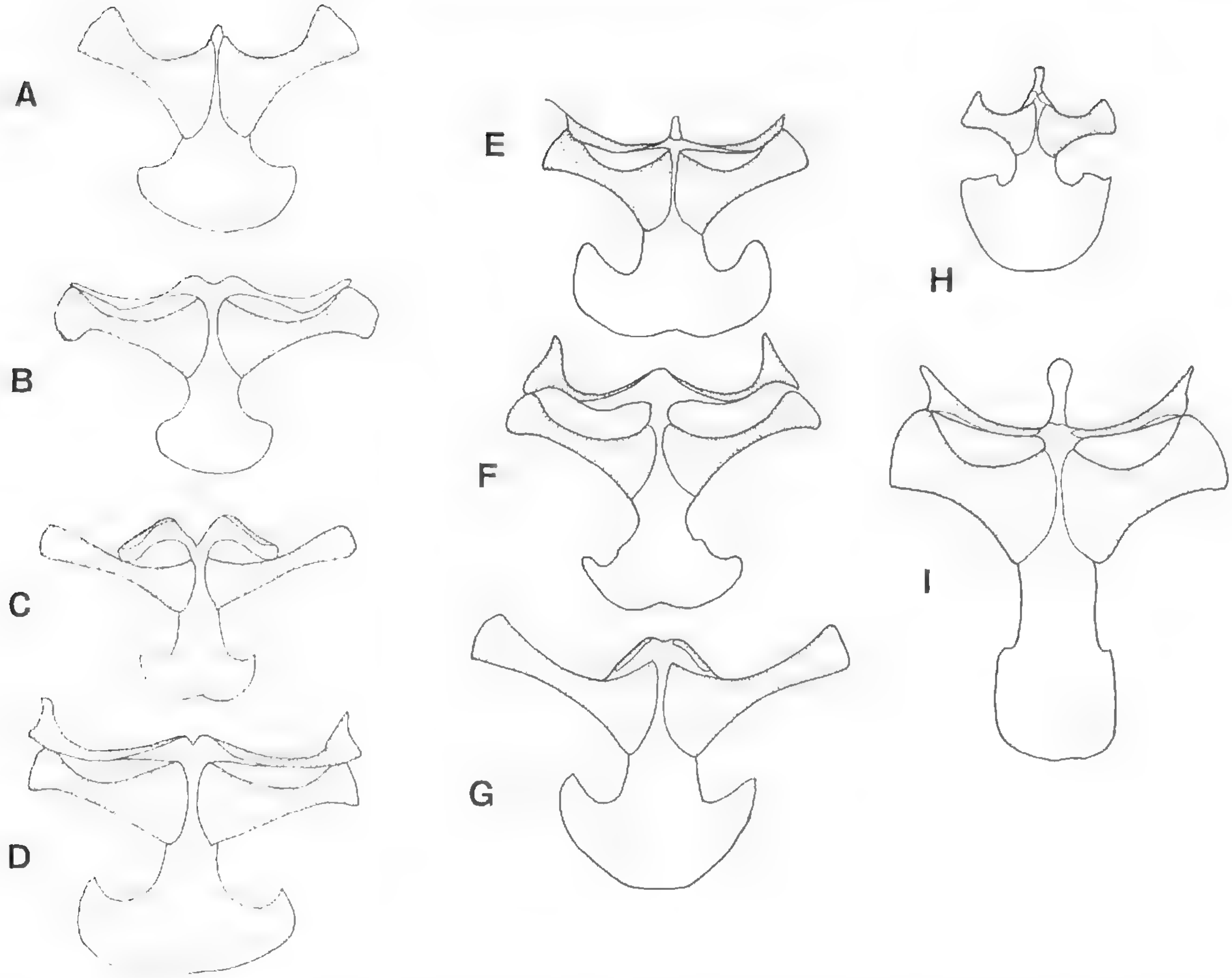

FIG. 23. Ventral views of the pectoral girdles of (A) *Cophixalus ornatus* AUZ D740; (B) *Genyophryne thomsoni* UPNG 5130; (C) *Oreophryne biroi* SAMA R10899; (D) *Sphenophryne cornuta*; (E) *Calluella guttulata*; (F) *Chaperina fusca*; (G) *Elachistocleis* sp.; (H) *Kaloula pulchra*; (I) *Kalophrynus pleurostigma* (D-I modified after Parker, 1934).

0.090 (*Barygenys, Xenobatrachus* except *X. ocellatus, Xenorhina, Copiula* and *Genyophryne*).

The eyes of the genera exhibiting State (1) are generally smaller than those of the other microhylids examined and State (0) is regarded as primitive among the Papuan microhylids.

Zweifel (1972) characterizes *Phrynomantis doriae* as a small-eyed frog, with a relative eye size conforming to the ratios seen in *Xenorhina*. The sample sizes for populations I examined are too small to document conclusively an ontogenetic trend to smaller relative eye sizes within asterophryine species, but a trend to smaller relative eye size in larger species within genera is apparent. Figures 25 and 26 show the logs of eye diameter to snout-vent length plotted against snout-vent length in *Phrynomantis* and *Xenorhina* and *Xenobatrachus* combined, with the ratios of specimens of *P. doriae* plotted on both graphs. Clearly, although the eye of *P. doriae* is smaller that that of other *Phrynomantis*, it conforms better to the trend to smaller relative eye size in larger *Phrynomantis* better than to the similar trend in *Xenorhina* and *Xenobatrachus*.

Character 48. Development of subarticular tubercles. Two states occur among the asterophryines: (0) subarticular tubercles poorly developed or absent (*Barygenys, Phrynomantis, Xenobatrachus* and *Xenorhina*); and (1) subarticular tubercles well developed (*Asterophrys, Hylophorbus, Mantophryne* and *Pherohapsis*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 49. Adherence of the tongue. Two states occur among the Papuan microhylids: (0) tongue free posteriorly, for at least 1/4 of its length (Genyophryninae); and (1) tongue adherent posteriorly (Asterophryinae).

Although both states occur among the other microhylids, only State (0) appears to be found among the ranoids. For this reason I regard State (0) as primitive among the Papuan microhylids.

Character 50. Uniformity of the tongue surface. Two

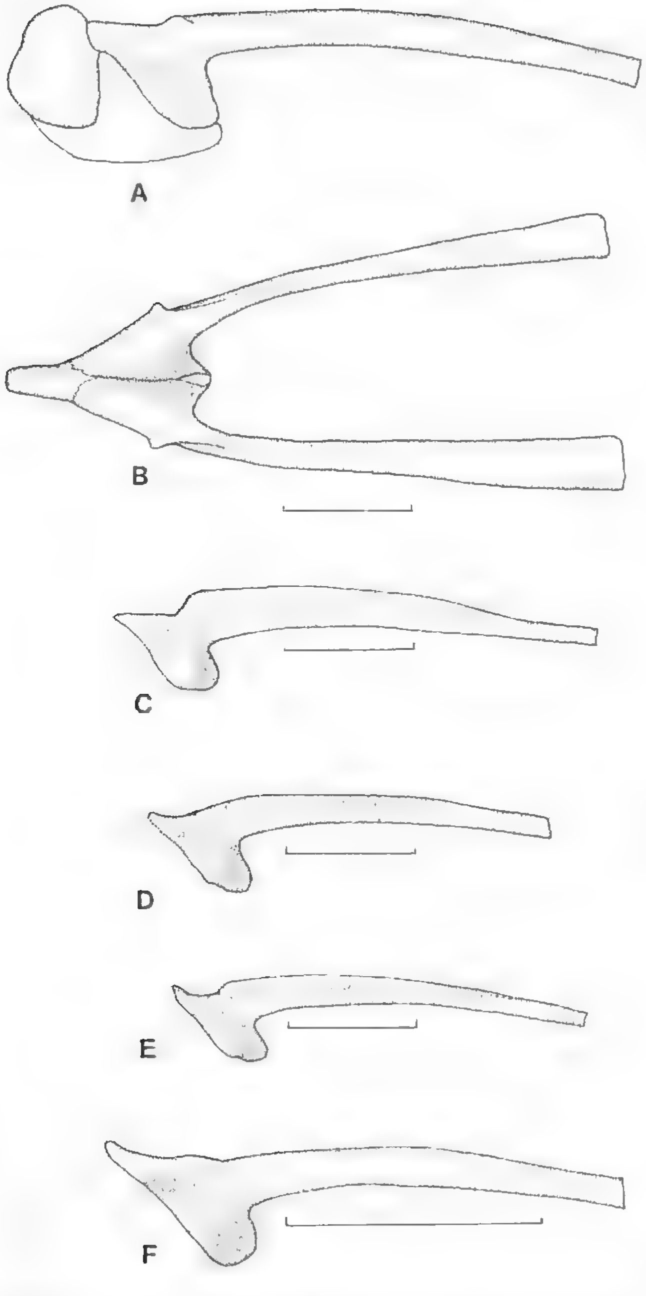

FIG. 24. A. Right lateral and B. dorsal views of the pelvic girdle of *Phrynomantis stictogaster* SAMA R20886; lateral view of right ilium of (C) *Mantophryne lateralis* AUZ D737; (D) *Xenobatrachus giganteus* UPNG 5680; (E) *Hylophorbus r. rufescens* AUZ D738; (F) *Barygenys atra* UPNG 3836. Scale bar = 5 mm.

states occur among the Papuan microhylids (Fig. 27): (0) tongue uniformly pitted and glandular (Genyophryninae, except *Cophixalus riparius*); and (1) tongue divided into an anterior smooth, non glandular section and a posterior glandular section (Asterophryinae and *Cophixalus riparius*).

State (0) occurs in other microhylids, and is primitive among the Papuan microhylids. *C. riparius* is the largest of the genyophrynines examined, and the occurrence of this character may be related to ontogeny, as it is lacking in juvenile specimens of *Phrynomantis h. humicola*.

Character 51. Nature of the glandular surface of the tongue. Two states occur among the asterophryines: (0)

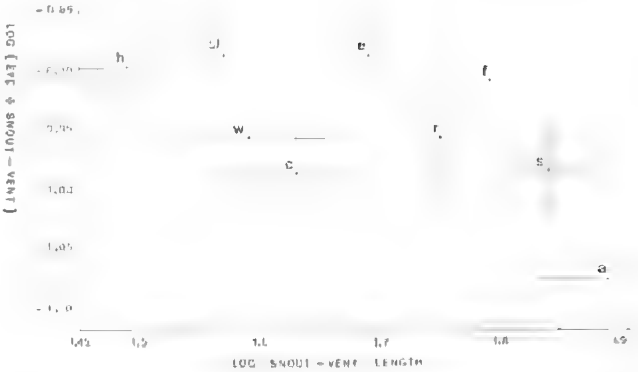

FIG. 25. Graph of log of eye to snout-vent length ratio against log of snout-vent length of *Phrynomantis* species. Means and standard deviations are shown for each species. Legend: a, *Phrynomantis doriae*; c, *P. humicola compta*; e, *P. eurydactyla*; f, *P. fusca*; h, *P.h. humicola*; r, *P. robusta*; s, *P. stictogaster* sl, *P. slateri*; w, *P. wilhelmana*.

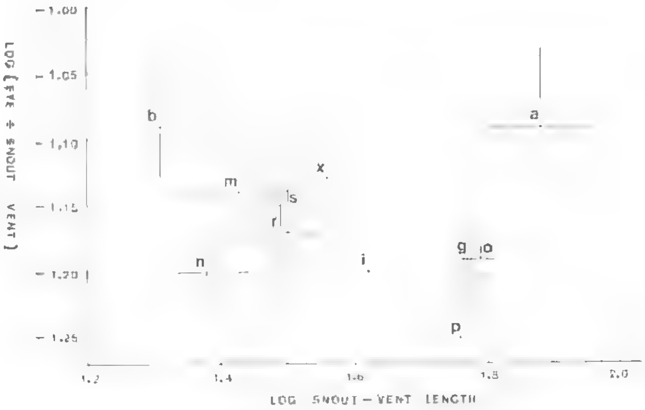

FIG. 26. Graph of the log of eye to snout-vent ratio against the log of snout-vent length in species of *Xenobatrachus* and *Xenorhina*, including *Phrynomantis doriae* for comparison. Means and standard deviations are shown for each species. Legend: g, *Xenobatrachus giganteus*; m, *X. mehelyi*; o, *X. obesus*; r, *X. rostratus*; s, *X. subcroceus*; b, *X. bouwensi*; i, *X. similis*; n, *X. minima*; p, *X. parkerorum*; x, *X. oxycephala*; a, *Phrynomantis doriae*.

glandular surface more or less uniformly pitted (*Asterophrys, Barygenys, Hylophorbus, Mantophryne, Pherohapsis* and *Phrynomantis*) and (1) glandular surface bearing deep longitudinal striae (*Xenobatrachus* and *Xenorhina*) (Fig. 27).

State (0) is shared by the genyophrynines, and is primitive.

Character 52. Possession of a pair of warts on the chin. Two states occur among the asterophryines: (0) warts absent (*Barygenys, Hylophorbus, Phrynomantis, Xenobatrachus* and *Mantophryne infulata*); and (1) two warts or wart-like protrusions on the chin (*Asterophrys, Pherohapsis, Mantophryne lateralis, M. louisiadensis*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 53. Number of denticles on the posterior prepharyngeal fold. Two states occur among the asterophryines: (0) large number of denticles, usually far more than 10 except in a few specimens (*Asterophrys, Hylophorbus, Mantophryne,*

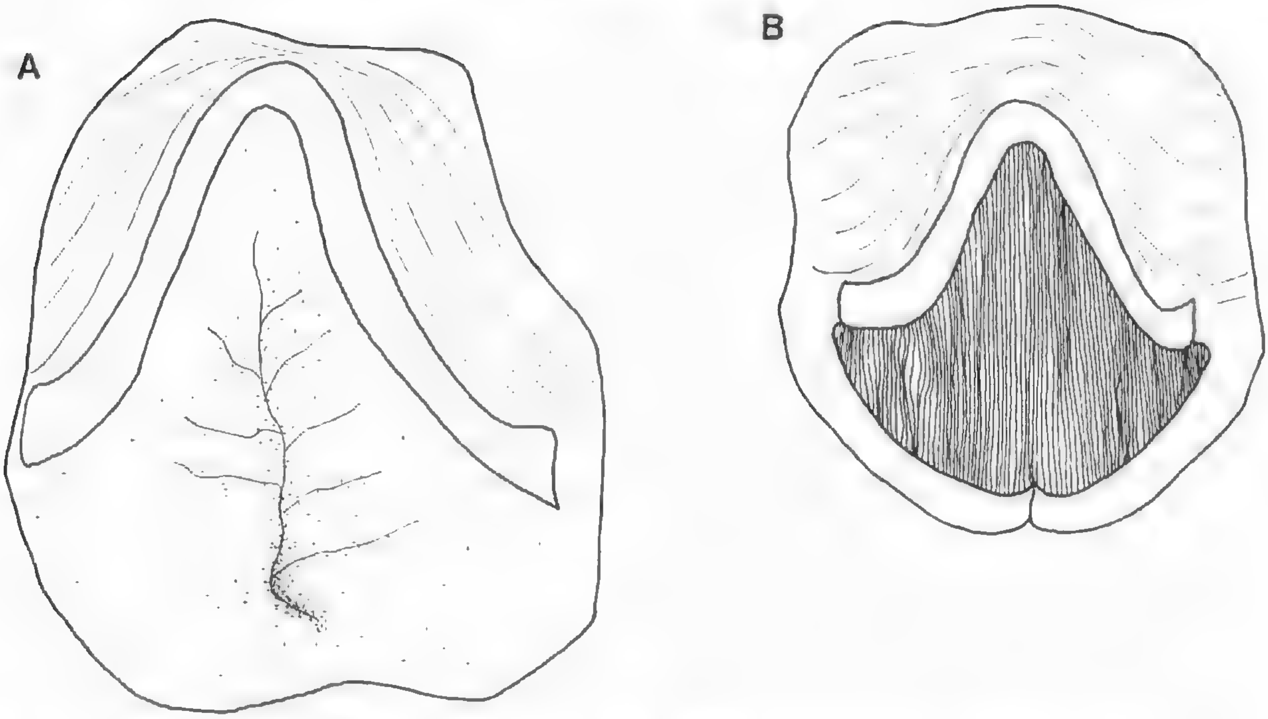

FIG. 27. Dorsal surfaces of the tongues of (A) *Barygenys atra* UPNG 3836; (B) *Xenobatrachus giganteus* UPNG 5680.

Pherohapsis and *Phrynomantis*); and (1) small number of denticles, less than 10 (*Barygenys*, *Xenobatrachus* and *Xenorhina*).

State (0) is shared by the genyophrynines, and is primitive among the asterophryines.

Character 54. Life history. There are many states of life history among the Microhylidae (Parker 1934), but two are considered here: (0) larva possessing an operculum; metamorphosis usually completed outside the egg capsule (Microhylidae, except Asterophryinae and Genyophryninae); and (1) larva lacking an operculum; metamorphosis completed within the egg capsule (Asterophryinae and Genyophryninae).

State (0) is the usual condition of frogs, and is primitive.

Occurrence of digital grooves and discs: Zweifel (1972) noted that the occurrence of grooves and discs varies within genera, particularly *Phrynomantis*, *Xenobatrachus* and *Xenorhina*. The changes I propose in the composition of the genera do not affect this variability. Zweifel (P. 429) chose to use the development of discs as a phylogenetic character despite identifying "separate parallel trends towards reduction of digital discs" within these genera. He coded *Phrynomantis* and *Xenobatrachus* and *Xenorhina* differently on the grounds that some *Phrynomantis* species which possess discs possess broader discs than *Xenobatrachus* and *Xenorhina* species. I regard this character as too variable for use in a phylogenetic analysis and will not consider it further.

Cladistic Analysis

Here hypotheses are presented relating to the monophyly of groups of microhylids, and the evidence for and against these hypotheses, leading to the establishment of a cladogram. Throughout this section reference is made to the polarities of characters discussed in the previous section summarised in Table 4, and numbers in parentheses are references to the number ascribed to a particular character in the previous section.

Hypothesis 1. Monophyly of the Papuan microhylids

The monophyly of the Papuan microhylids has not been questioned since Parker's (1934) synthesis. Though I attempted to identify autapomorphies of the Papuan microhylids, I was able to add only one character of dubious polarity (15, number of tendinous inscriptions of the *M. rectus abdominis*) to the two characters (28, development of the vomero-palatine; and 54, life history and larval form) presented by Parker (1934).

On the other hand there is no evidence of conflicting synapomorphies suggesting that either Papuan subfamily forms a natural group with any other subfamily examined.

Hypothesis 2(a). Monophyly of the Asterophryinae and of the Genyophryninae

Zweifel (1972) and Tyler (1979) present the opinion that the Asterophryinae descended from a genyophrynine ancestor. Implicit in this belief is the conclusion that the Genyophryninae form a paraphyletic group, and that the Asterophryinae are monophyletic.

This study yielded no unequivocal evidence of the monophyly of the Genyophryninae. Of the four characters in which the two subfamilies differ consistently, three present evidence for the monophyly of the Asterophryinae, and one is of doubtful polarity.

The hypothesis of asterophryine monophyly is supported by: (a) lack of a set of posteromedially

TABLE 4. SUMMARY OF CHARACTER STATES

Character number	*Asterophrys*	*Barygenys*	*Hylophorbus*	*Pherohapsis*	*Phrynomantis*	*Xenobatrachus*	*Xenorhina*	*Mantophryne*	*Choerophryne*	*darlingtoni*-group	*Cophixalus*	*Copiula*	*Genyophryne*	*Oreophryne*	*Sphenophryne*	Other Microhylidae
1	1'	2'	0	0	1	1'	1'	0	0	0	0	0	+	0	+	0
2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
3	1	1	1	1	1	1	0/1	1	0	0	0/1	0	0	0	0	0, +
4	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
5	C	B	C	C	A	B	B	C	C	C	A	B	B	A	B	A,B
6	0	1'	0	0	0	1	1	0	—	0	0	0	0	0	0	0
7	1	1	1	1	1	1	1	1	—	0	0	0	1	0	0	0,1
8	1'	1	1'	1'	1'	1'	1'	1'	—	0	0	0	1'	0	0	0,1'
9	1	0	1	1	1	0	0	1	—	0	0	0	0	0	0	0,1
10	1	1	1	1	0/1	1	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	1	0	+	+	0	0	0	0	0	0
12	1	2	0	0	0	2	2	0	0	0	0	0	0	0	0	0
13	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
14	0	1	0	0	0	0	0	0	—	0	0	0	0	0	0	0
15	A	A	A	A	A	A	A	A	—	A	A	A	A	A	A	A,B
16	0	1	0	0	0	0	0	0	—	0	0	0	0	0	0	0
17	0	1	0	0	0	0	0	0	—	0	0	0	0	0	0	0
18	0	1	0	0	0	1	1	0	—	0	0	0	0	0	0	0,1, +
19	0	1	0	0	0	1	1	0	—	0	0	0	0	0	0	0
20	1	0	1	1	1	1	1	1	—	0	0	0	0	0	0	0
21	B	A	B	A	A	A	A	B	—	A	A	B	A	A	B	A,B
22	1	0	1	1	0	0	0	1	—	0	0	0	0	0	0	0
23	0	1	0	0	0	0	0	0	—	0	0	0	0	0	0	0
24	1	0	1	1	1	1	1	1	—	0	0	0	0	0	0	0
25	1	0	1	1	1	1	1	1	—	0	0	0	0	0	0	0
26	0	0	1	1	0	0	0	1	—	0	0	0	1	0	0	0
27	1	0	0	0	0/1	0/1	0	0	—	0	0	0	0	0	0	0
28	1	1	1	1	1	1	1	1	—	1	1	1	1	1	1	0
29	1	1	1	1	1	1	1	1	—	0	0/1	0	1	0	0	0
30	0	1	0	0	0	1	1	0	+	+	0	0	0	0	0	0
31	0	0	0	0	0	1	0	0	—	0	0	0	0	0	0	0
32	A	B	A	A	A	B	B	A	—	A	A	A	B	A	A	A,B
33	1	1	1	1	1	1	1	1	—	0	0	0	1	0	0	0
34	1	1	1	1	1	1	1	1	—	0	0	0	1	0	0	0
35	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
36	1	0	0	1	0	0	0	0/1	—	0	0	0	0	0	0	0
37	1	1''	1	1	1'	1	1	1	1	1	0	0	1	0	0	0
38	2	1'	1	2	2	2	2	2	—	0	0	0	1	0	0	0
39	0	0	0	0	0	1	1	0	—	0	0	0	0	0	0	0
40	0	1	0	0	0	0	0	0	—	0	0	0	0	0	0	0
41	1	1	1	1	1	1	1	1	—	0	0	0	0	0	0	0
42	A	B	A	A	A	B	B	A	—	A	A	A	B	A	A	A,B
43	3	3	3	3	3	3	3	3	3	3	3	3	2	1	0	0-3
44	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A,B
45	1	0	1	1	0	1	1	1	—	0	0	0	0	0	0	0
46	B	B	A	A	B	B	B	A/B	—	A	A	A	B	A	B	A,B
47	0	1	0	0	0	1	1	0	0	0	0	1	1	0	0	0
48	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
49	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0,1
50	1	1	1	1	1	1	1	1	0	0	0/1	0	0	0	0	0
51	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
52	1	0	0	1	0	0	0	0/1	0	0	0	0	0	0	0	0
53	0	1	0	0	0	1	1	0	—	0	0	0	0	0	0	0
54	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

See text for discussion of State numbers. (—) indicates information is not available; (+) indicates a derived state not discussed in the foregoing character analysis; only states shared with the Asterophryinae and the Sphenophryninae recorded in the "Other Microhylidae" column.

oriented fibres on the dorsal surface of the *M. intermandibularis* (2); (b) a unique structure of the mandible (41); and (c) a tongue that is adherent and superficially complex (49 and 50).

The procoelous vertebral column (44) of genyophrynines may or may not represent an autapomorphy. However, while the hypothesis of paraphyly of a group may be rejected on the evidence of a single autapomorphy, the absence of an autapomorphy does not disprove monophyly: it may reflected the inability of the worker or of the techniques employed to detect autapomorphy. The monophyly of the Genyophryninae can only be disproven by autapomorphies which conflict with the hypothesis of monophyly. Such would be an autapomorphy supporting the monophyly of one or more of the genyophrynine genera with the Asterophryinae.

If, in Figure 28, a genyophrynine genus (G) and the Asterophryinae form a monophyletic group, then the Genyophryninae (S + G) would consist of descendants of a common ancestor (C), but excluding one descendant of (C), the Asterophryinae. That is, the

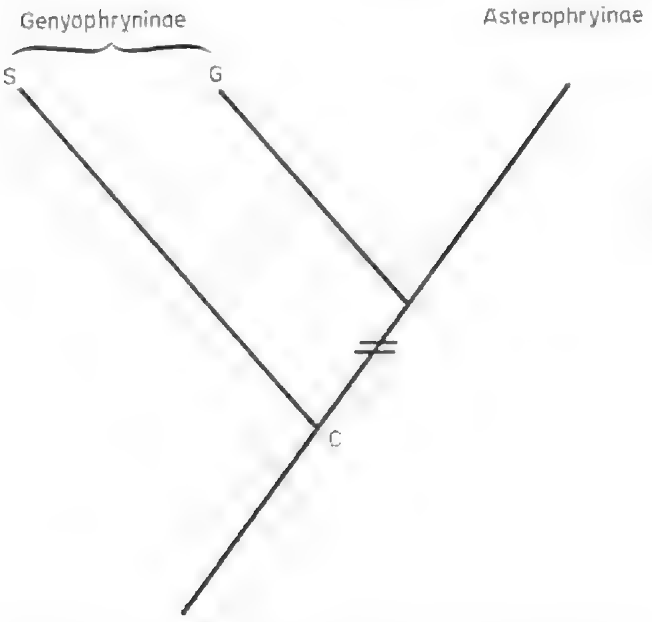

FIG. 28. Phylogeny of the New Guinea microhylids postulated in hypothesis of monophyly 2(b). Abbreviations: C, common ancestor of the Asterophryinae and Genyophryninae; G, Genyophrynine genus sharing synapomorphies with the Asterophryinae; S, other genyophrynine genera. Horizontal strokes through lines indicate acquisition of derived character states.

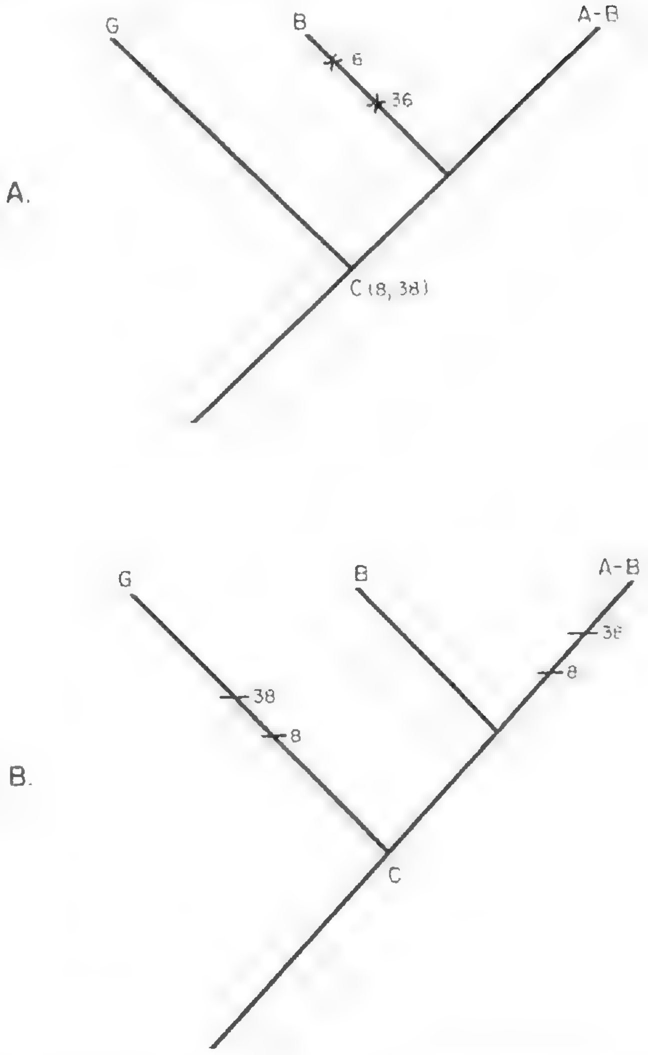

FIG. 29. Postulated relationships of *Genyophryne*, *Barygenys* and the other Asterophryinae. A. Common ancestor (C) of *Genyophryne* (G), *Barygenys* (B) and the other Asterophryinae (A-B) possesses the derived states of characters 8 and 38, and *Barygenys* undergoes reversals, indicated by crosses, in these characters; B. Common ancestor possesses the primitive states of characters 8 and 38, and the derived states are acquired independently in *Genyophryne* and the Asterophryinae except *Barygenys*, which possesses the primitive states.

Genyophryninae would be united only by plesiomorphies and be, by Hennig's (1966) definition, paraphyletic.

Hypothesis 2(b). Monophyly of the group formed by *Genyophryne* and the Asterophryinae

The monotypic genus *Genyophryne* has had a complex history (Introduction), as *Genyophryne thomsoni* possesses a mixture of genyophrynine and asterophryine character states, plus a number of states which do not occur elsewhere in the Microhylidae (e.g. odontoids on the dentary). Consequently, since Parker's (1934) monograph it has been allied with the asterophryines (Parker 1934), the genyophrynines (Zweifel 1971), and has been the cause of amalgamation of the subfamilies (Savage 1973).

There are three characters of which *Genyophryne* shares with the whole of the Asterophryinae the derived state: lack of a deep slip to the *M. hyoglossus* (7); an extensive articulation of the pterygoid with the prootic (33); and a well developed quadratojugal with a long articulation with the maxilla (34).

Though these characters appear to provide strong evidence of the monophyly of *Genyophryne* plus the Asterophryinae, there are three lines of argument that may be marshalled against this hypothesis.

(i) Conflict with relationships within the Asterophryinae.

There are two characters of which *Genyophryne* shares the derived condition with all of the asterophryines except *Barygenys*: possession of three *Mm. petrohyoidei posteriores* (8); and extension and ligamentous connexion of the maxillae (38). If *Genyophryne* and the Asterophryinae form a monophyletic group, either their common ancestor had evolved three *Mm. petrohyoidei posteriores*, and extension of and connexion of the partes faciales which subsequently underwent reversal in *Barygenys* (Fig. 29A), or else the common ancestor maintained the genyophrynine condition, and parallel evolution occurred, *Genyophryne* and Asterophryinae except *Barygenys* acquiring the apomorphous states independently (Fig. 29B).

It is necessary to assess the relative likelihood of these two models. The *Mm. petrohyoidei posteriores* of *Barygenys* differ from both the asterophryine and genyophrynine conditions, and have evolved either by loss of the entire *M.p. posterior* II of an asterophryine-like ancestor, or by reduction of the posterior slip of a genyophrynine-like ancestor. As indicated earlier in the discussion of this character, I can see no reason to favour either hypothesis.

On the other hand, the conformation of the snout of *Barygenys* seems unlikely to have evolved from the condition shared by the asterophryines and *Genyophryne*, as such as evolutionary step would involve the loss by a burrowing animal of one mode of reinforcement of the snout (by extension of the maxillae and their connexion anteriorly to the premaxillae) and acquisition of a radically different mode of reinforcement, involving reduction of the premaxillae, and the buffering of the points of weakness in the snout (the gaps between the bones) by ridges of thickened skin (Fig. 20). Such a course of evolution, from one specialised burrowing conformation to another radically different, seems far less likely than the *de novo* acquisition of the different burrowing adaptations in the different lineages from a generalised genyophrynine- or microhyline-like ancestor.

Thus, while a common ancestor of *Genyophryne*, *Barygenys* and the other asterophyrines possessing the asterophryine condition of three *Mm. petrohyoidei posteriores* may be envisaged, I cannot envisage an ancestor of *Barygenys* possessing the snout conformation shared by *Genyophryne* and the asterophryines, and I favour the hypothesis that this state evolved convergently (*sensu lato*) in *Genyophryne* and the Asterophryinae, which raises the possibility that the other similarities of *Genyophryne* and the Asterophryinae are likewise convergences.

(ii) Conflict with apparent synapomorphies between other genyophrynines and the asterophryines.

Some characters indicate that if the Asterophryinae indeed evolved from a genyophrynine ancestor, *Cophixalus* rather than *Genophryne* forms the sister group to the Asterophryinae, the position implied by Zweifel (1972) and Tyler (1979), presumably on the grounds that *Cophixalus* and the Asterophryinae share the derived state of a reduced pectoral girdle (43). If a case can be made to establish *Cophixalus* as a possible sister-group of the Asterophryinae, it would decrease the plausibility of the apparent autapomorphies of the group *Genyophryne*-Asterophryinae, and, provided the case for a natural group *Cophixalus*-Asterophryinae were not too compelling, weaken the credibility of the hypothesis that the Asterophryinae evolved from any genyophrynine ancestor.

Two additional characters support the monophyly of *Cophixalus* and the Asterophryinae: overlap of the *Mm. interhyoideus* and *intermandibularis* (2); and complex tongue-surface (50).

The characters supporting *Cophixalus*-Asterophryinae monophyly are not compelling. The pectoral girdle has undergone reduction many times in the Microhylidae and Ranidae, and there is a reasonable likelihood that reduction took place independently in *Cophixalus* and the Asterophryinae from an ancestor with the condition exhibited by *Genyophryne*. Moreover, I suggest that as small and juvenile specimens of asterophryines exhibit the genyophrynine states of characters (2) and (50), and only large specimens of *Cophixalus* exhibit the asterophryine states of these characters, these may be states related to degrees of development, rather than states which evolved in a common ancestor shared only by *Cophixalus* and the Asterophryinae.

TABLE 5. GROUP SHARING DERIVED CHARACTERS WITH *GENYOPHRYNE*

Group	Character
Barygenys, Xenorhina	32 Broad cultriform process of the parasphenoid (probably derived).
	42 Well-developed crista ventralis of the humerus (probably derived).
Barygenys, Xenorhina, Copiula	47 Small eye.
Asterophrys, Hylophorbus, Pherohapsis, Xenorhina, Mantophryne	37 Otic ramus of the squamosal overlying the crista parotica.
Asterophryinae, Cophixalus pansus	29 Laterally broadened palatine-prevomer.
Asterophrys; Pherohapsis	35 Connection of the zygomatic ramus of the squamosal and the maxillary.
Hylophorbus, Pherohapsis, Mantophryne	26 Parasagittal ridge delimiting the extent of adductor muscles on the frontoparietals.

I conclude that the evidence for *Cophixalus*-Asterophryinae monophyly is too weak to threaten the case for *Genyophryne*-Asterophryinae monophyly.

(iii) Cases of convergence involving *Genyophryne* and members of the Asterophryinae.

There are seven derived states shared by *Genyophryne* and a small number of asterophryines, and sometimes some genyophrynines (Table 5). In many cases the distributions of these states support incompatible natural groups, and the derived states of characters 29 and 47, which would support very odd natural groups, are highly unlikely to have evolved only once.

Importantly, of the 12 characters shared by *Genyophryne* and some or all of the Asterophryinae, eight (characters 26, 29, 32, 33, 34, 35, 37 and 38) relate to the enlarging and reinforcement of bones of the skull, and with two others (42, development of the humerus; and 47, reduced eye size) are likely burrowing adaptations. If these ten characters were reduced to one: "adaptation to a head-first burrowing mode of life", this may better express the relationship between *Genyophryne* and the asterophryines. The two shared derived states (7, loss of a deep slip to the *M. hyoglossus*; and 8, possession of three *Mm. petrohyoidei posteriores*) which are not at least notionally related to the burrowing way of life are states which have evolved independently in the Microhylinae (in *Kaloula* (7) and *Elachistocleis* (8)).

I therefore regard the hypothesis of monophyly of *Genyophryne* and the Asterophryinae, although apparently supported by many characters, only weakly supported when the characters are examined. If the monophyly of this group is only weakly supported, then the hypothesis of the monophyly of the Genyophryninae is not falsified but still an open question.

Hypothesis 3. Monophyly of the genera and suprageneric groups within the Asterophryinae

Having established the monophyly of the Asterophryinae and having discussed its relationship with the Genyophryninae, I now establish the monophyly of groups within the Asterophryinae.

(a) Monophyly of *Barygenys*.

The monophyly of *Barygenys* is supported by the following autapomorphies: posterior supplementary slip of the *M. intermandibularis* from the ventral surface of the angulosplenial to the ventral surface of the *M. genioglossus basalis* (1); lamellate *M. genioglossus basalis* (6); two *Mm. petrohyoidei posteriores*, the posterior of which inserts on the epicondyle of the posteromedial process of the hyoid only (8); insertion of the *M. longissimus dorsi* on the dorsal fascia (14); the *Mm obliqui* and *transversi* of each side meeting on the ventral surface of the abdomen (16); the *M. serratus medius* with only one insertion (17); the *M. opponens hallucis* from the dorsal surface of the plantar aponeurosis (23); the otic ramus of the squamosal overlying the anterior and dorsal surfaces of the otic capsule (37); no overlap of the maxillae anterior to the premaxillae; compression of the premaxillae between the maxillae; possession of three cutaneous ridges of the snout (38).

Barygenys is a very uniform genus and of the above nine character states, none is shared by any other microhylid examined.

(b) Monophyly of *Phrynomantis*.

The monophyly of *Phrynomantis* (including *Phrynomantis doriae*) is supported by two autapomorphies: two supplementary slips to the *M. intermandibularis*, the anterior from a deep tendon, the posterior direct from the dentary (1); and the dorsal surface of the otic ramus of the squamosal continuous with the lateral surface of the squamosal shaft; the medial flange of the shaft reduced (37).

Of these states the first (1) is unique, and the latter is shared only by microhylines with very small otic rami (e.g. *Microhyla*), far smaller than those of *Phrynomantis*.

(c) Monophyly of *Xenobatrachus* and *Xenorhina*.

The monophyly of the group comprising *Xenobatrachus* and *Xenorhina* is supported by the following autapomorphies: the *M. genioglossus basalis* possessing a posterad cultriform projection (6); a major component of the *M. depressor mandibulae* arising on the otic ramus of the squamosal (11); posteromedial projection of the anterior margin of the palatine process of the maxillary (39); posterior section of the tongue bearing deep longitudinal striae (51).

Of these four autapomorphies, three (6, 39, 51) are states which occur only in these two genera, and though the *M. depressor mandibulae* arises mostly from the otic ramus in *Choerophryne* and the *darlingtoni*-group, the form of the *M. depressor mandibulae* in those taxa is very different, as there is no slip from the dorsal fascia overlying the otic ramus. In subsequent discussion I refer to this pair of genera collectively as the *Xenorhina*-group.

(d) Monophyly of *Asterophrys*, *Hylophorbus*, *Mantophryne* and *Pherohapsis*.

The monophyly of this group is supported by two autapomorphies: distal organ of the *M. tibialis anticus brevis* (22); and large subarticular tubercles (48). A third shared state which is unique among the Asterophryinae and is probably derived is the origin of the *M. geniohyoideus lateralis internus* entirely from the hyale (5).

Several other characters which are derived or probably derived are shared by members of this group: distal separation of the *M. tibialis anticus longus* into bellies (*Asterophrys*, *Hylophorbus* and *Mantophryne*) (21); parasagittal ridges on the frontoparietals (*Hylophorbus*, *Mantophryne* and *Pherohapsis*) (27); exostosed sheet of bone between the squamosal and the maxillary (*Asterophrys*, *Pherohapsis*) (35); posterad projection of the zygomatic ramus of the squamosal (*Asterophrys*, *Pherohapsis*, *Mantophryne lateralis*) (36); type I ilio-sacral articulation (*Hylophorbus*, *Pherohapsis*, *Mantophryne infulata* and *M. lateralis*) (46); and wart-like protrusions of the skin of the chin (*Asterophrys*, *Pherohapsis*, *Mantophryne lateralis* and *M. louisiadensis*) (52).

Neither of the autapomorphies of this group (22, 48) occurs in the other microhylids examined. This group's state of the *M. geniohyoideus lateralis internus* is shared by the aberrant *darlingtoni*-group and *Elachistocleis*.

The hypothesis of monophyly of this group is in conflict with the hypothesis of monophyly of *Asterophrys*, *Xenobatrachus* and *Xenorhina*. The latter hypothesis is supported by two apparent autapomorphies: (1) supplementary slips of the *M. intermandibularis* arising from posteriorly on the ventral surface of the angulosplenial; and (12) segmentation of the *M. adductor mandibulae posterior longus*. The ventral origin of the supplementary slips has occurred probably independently in three other Papuan microhylid genera: *Barygenys*, *Genyophryne* and *Sphenophryne*. Segmentation of the *M. adductor mandibulae posterior longus* has probably arisen independently in *Barygenys*. I regard neither of these characters as reliable an indicator of relationships as characters (5), (22) and (48).

I regard *Asterophrys*, *Hylophorbus*, *Mantophryne* and *Pherohapsis* as forming a monophyletic group which has undergone extensive radiation, reflected in its disposition by Zweifel (1972) into four genera, three of them monotypic. In subsequent discussion in this section this group is referred to as the *Asterophrys*-group, and the taxonomic implications of its monophyly are deferred.

Hypothesis 4. Monophyly of *Phrynomantis*, the *Xenorhina*-group and the *Asterophrys*-group.

In four characters, *Barygenys* alone of the asterophryines exhibits the plesiomorphic condition, and *Phrynomantis*, the *Xenorhina*-group and the *Asterophrys*-group share the apomorphic condition: lack of the *M. geniohyoideus medialis* (4); the *M. lubricalis brevis digiti* IV medial slip (of the manus) a stout muscle arising via a short tendon from the centrale postaxiale (20); distal separation of the *Mm. lumbricales breves digitorum* IV and V of the pes (24); and the lateral margins of the frontoparietals strongly down curved, so that the braincase is relatively narrow (25).

This apparently well-supported hypothesis conflicts with another apparently well-supported hypothesis: the monophyly of a group formed by *Barygenys* and the *Xenorhina*-group. The derived character states shared by these genera are: the *M. adductor mandibulae posterior longus* segmented with a superficial tendon of insertion (12); the *M.a.m. externus superficialis* arising partly from the fascia (13); origin of the *M. levator scapulae inferior* in part from the ventral surfaces of the first three vertebrae (18); a large deep slip of the *M. pectoralis sternalis* (19); mesial expansion of the vomero-palatine well developed (30); and reduction in the number of denticles on the posterior palatal fold (53).

In addition to the shared and derived states exclusive to this group, a number of other states which are probably derived are shared also by other non-asterophryine taxa: cultriform process of the parasphenoid broad (*Genyophryne*) (32); crista ventralis of the humerus well developed (*Genyophryne, Elachistocleis, Glyphoglossus* and *Kaloula*) (42); and eyes small (*Copiula* and *Genyophryne*) (47).

Despite the preponderance of apparent autapomorphies supporting the concept of *Barygenys-Xenorhina*-group monophyly, and falsifying the hypothesis of *Phrynomantis- Xenorhina*-group *Asterophrys*-group monophyly, the latter hypothesis is preferable for the following reasons.

(a) The monophyly of *Barygenys* and the *Xenorhina*-group implies that the sister-group of *Barygenys* and the *Xenorhina*-group is either *Phrynomantis*, the *Asterophrys*-group, or a hypothetical common ancestor of those two groups (Fig. 30). Therefore the hypothetical ancestor of *Barygenys* and the *Xenorhina*-group would be postulated to possess the states of characters 4, 20, 24 and 25 possessed by the *Xenorhina*-group and the other asterophryines, and the states possessed by *Barygenys* (*M. geniohyoideus medialis* present; genyophrynine-like conditions of the *M. lumbricalis brevis* IV of the manus and *Mm. lubricales breves* IV and V of the pes; broad, relatively flat frontoparietals) to be reversals to the genyophrynine condition. The implications of this are:

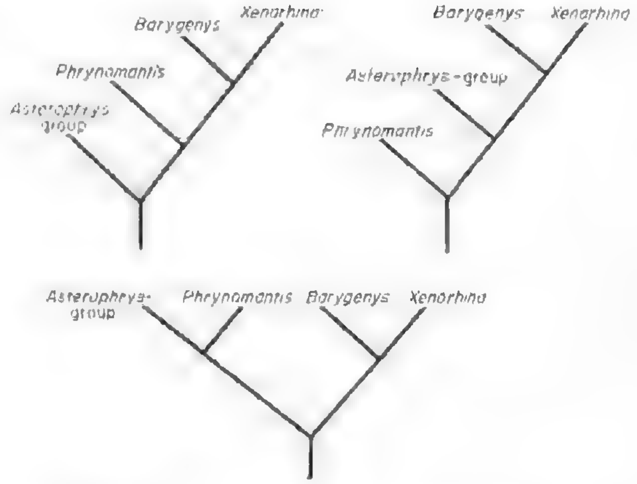

FIG. 30. Possible cladograms of the Asterophryinae, assuming *Barygenys-Xenorhina* group monophyly.

(i) *Barygenys* must have reacquired a muscle, the *M. geniohyoideus medialis* (4) not present in its ancestral species. While this is possible, it is less likely than the situation in which a common ancestor of *Barygenys* and the other asterophryines possessed the muscle, and that it subsequently was lost in the ancestor of the other asterophryines but retained in *Barygenys*.

(ii) The Asterophryines are all either terrestrial or fossorial, whereas the genyophryines occupy a variety of niches: scansorial, terrestrial, fossorial and aquatic. The reversion of the specialised fossorial *Barygenys* to the generalised condition of hand and foot musculature of the diverse genyophrynines (20, 24) appears unlikely.

(iii) As has been discussed above, the loss of maxillary extension and connexion and acquisition of a radically different mode of adaptation of the snout to burrowing, as are implied by the postulated common ancestry of *Barygenys* and the *Xenorhina*-group, appear unlikely evolutionary events.

(b) Of the nine shared and derived characters supporting the hypothesis of monophyly of *Barygenys* and the *Xenorhina*-group, three relate to the strengthening of the arm action (18, 19, 42), two to the reinforcement of the skull (30, 32), and two to the reduction of size of the eye (13, 47). These all relate, at least notionally, to the burrowing habit. The arm action of *Barygenys* when walking is extreme (as the forearm is pulled through about 180°, from the vicinity of the eye to the flank — personal observation). The arms are involved in pulling *Barygenys* through the moss and leaf litter, and Characters 18, 19 and 42 appear to relate to this action. Acquisition of a similar mode of burrowing in the *Xenorhina*-group, of which I did not observe living specimens, would be expected to lead to similar adaptations. That three of these shared character states (32, 42, 47) occur in unrelated fossorial species indicates the possibility of convergent acquisition of these states in the two fossorial genera of asterophryines also.

(c) While differences in characters do not indicate distance of relationship, I accept Arnold's (1981) argument that evolution in two taxa of different solutions to common problems is indirect evidence that the taxa may be distant. As well as differences in the mode of reinforcement of the premaxillary region, *Barygenys* and the *Xenorhina*-group differ in some other forms of skull reinforcement: in *Barygenys* alone, there is a calcified arc between the septomaxillaries (4), in the *Xenorhina*-group alone the anterior margins of the palatine shelves of the maxillae project posteromesially towards the anterad process of the vomerpalatine (39).

(d) The *Asterophrys*-group and the *Xenorhina*-group share a derived state, possession of a dorsal crest of the ilium (45). This state, which does not occur in other microhylids is an apparent autapomorphy supporting the hypothesis of monophyly of the *Asterophrys*-group and the *Xenorhina*-group, which is incompatible with *Barygenys-Xenorhina*-group monophyly.

The evidence, therefore, favours the hypothesis that *Phrynomantis*, the *Xenorhina*-group and the *Asterophrys*-group form a natural group, and that *Barygenys* and the *Xenorhina*-group do not.

Hypothesis 5. Monophyly of the *Xenorhina*-group and the *Asterophrys*-group.

The solution of the three-taxon problem of relationships between *Asterophrys*-group, *Phrynomantis* and the *Xenorhina*-group is modified by the establishment of *Barygenys* as the sister-group of the three taxa. However, the estimation of polarities of character states is not made easier. As the states of character (10), (12), (13), (18), (19), (30), (32), (42), (47) and (53) exhibited by *Barygenys* conflict with those exhibited by the genyophrynines, the fact that *Barygenys* joins the Genyophryninae in the role of out-group to the three taxa simply obscures the polarities of these characters.

The only unequivocal autapomorphy supporting the monophyly of the *Xenorhina*-group and the *Asterophrys*-group is the possession of the ilial crest (45). Another shared and probably derived character is the extension of the otic ramus medially to overlie the crista parotica (37). This state is shared by *Genyophryne*, and a similar but not identical extension is seen also in *Choerophryne* and the *darlingtoni*-group. This state has been subject to convergence and is not a reliable indicator of relationships.

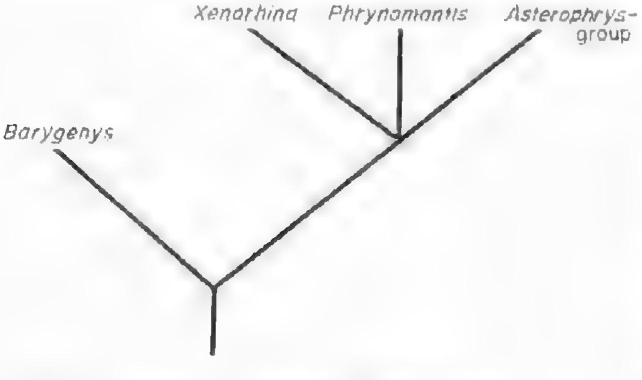

FIG. 31. Cladogram of the groups of asterophryines.

This hypothesis of monophyly is in conflict with the hypotheses that *Phrynomantis* and the *Xenorhina*-group form a natural group, for which there is no evidence, and that the *Asterophrys*-group and *Phrynomantis* form a natural group, which I now consider.

Hypothesis 6. Monophyly of *Phrynomantis* and the *Asterophrys*-group.

This hypothesis is supported by one apparent autapomorphy: origin of the *M. petrohyoideus posterior* III from the zygomatic ramus or its posterad projection (9). This state occurs also in *Elachistocleis*.

There appears to be no way of deciding between the hypotheses 5 and 6 of monophyly presented here. Both characters (45) supporting monophyly of the *Xenorhina*-group and the *Asterophrys*-group and (9) supporting monophyly of the *Xenorhina*-group and *Phrynomantis* appear equally valid. Given the present state of knowledge, the best course appears to be to admit that the relationship between the three groups is unresolved, and best expressed on a cladogram as a trichotomy (Fig. 31).

Phylogeny of the *Asterophrys*-group: Here I attempt to establish a phylogeny of the *Asterophrys*-group. This exercise is undertaken on the assumption that the *Asterophrys*-group is monophyletic (*sensu* Hennig, 1966), i.e., that this group comprises all of the descendants of a common ancestor. *Phrynomantis kopsteini* was unavailable for dissection (only three specimens are known), and as this may well be a member of the *Asterophrys*-group, conclusions concerning the phylogeny of this group can only be conditional. Evidence that *P. kopsteini* is a member of the *Asterophrys*-group is that (1) the "subarticular tubercles are strong" (Zweifel 1972, p. 479: *contra* Mertens, 1930), and (b) "the anterior process of the maxillae are only narrowly separated at the midline, so the condition is virtually symphygnathine" (Zweifel 1972, p. 479). This condition of the maxillae appears similar to that of *Mantophryne infulata*, in which the maxillae are separated by between 0.2 and 0.3 mm in the three specimens available.

As has been pointed out above, the *Asterophrys*-group is very diverse, and within this group relationships are obscure. Conflicting trends occur, e.g., towards exostosis of the skull — none in *Hylophorbus* and *Mantophryne infulata*, slight in *M. louisiadensis*, moderate in *M. lateralis*, heavy in *Asterophrys* and *Pherohapsis* — and towards lightening of the skull, expressed in the lack of symphygnathy in *Hylophorbus* and the marginal symphygnathy of *M. infulata*. Moreover, in a phylogenetic analysis, "trends" are

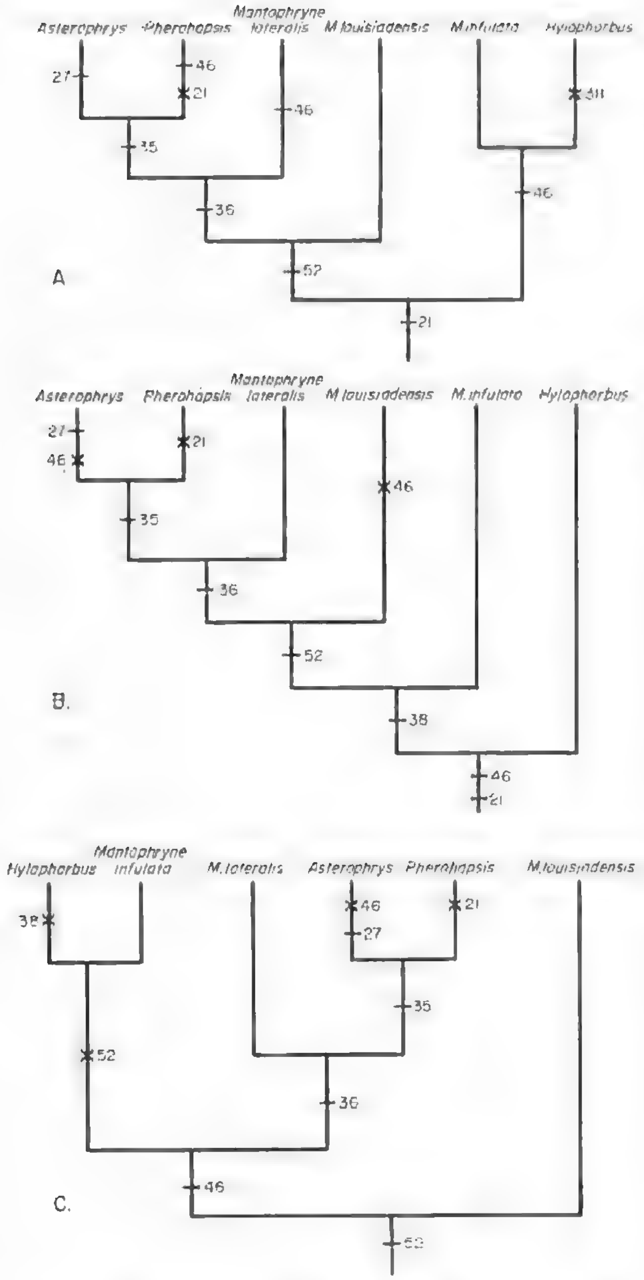

FIG. 32. Three of the most parsimonious cladograms of the *Asterophrys*-group produced by the WISS method. Horizontal strokes through lines indicate acquisition of a derived character state; crosses indicate reversals. Several cladograms as parsimonious as (B) can be produced with different treatments of character 46.

uninformative unless shared, derived character states can be identified.

The establishment of character state polarities is also complicated by uncertainty as to the appropriate sister-group of the *Asterophrys*-group (Fig. 30), resulting from any inability to resolve the *Phrynomantis-Xenorhina*-group-*Asterophrys*-group trichotomy. The sister-group, the most appropriate functional outgroup for this group of species, could be *Barygenys* or the *Xenorhina*-group or *Phrynomantis*, depending on how the trichotomy were resolved. Consequently, only six characters potentially informative of relationships in this group can be assigned polarities, and the polarity of Character 38, symphygnathy of the upper jaw, is unknown. On the other hand, the polarity of Character 46 is resolved, type I ilio-sacral articulation being the derived state. The polarities are listed in Table 6.

TABLE 6. CHARACTER STATES OF THE *ASTEROPHRYS*-GROUP

	Character						
Species	21	27	35	36	38	46	52
Asterophrys turpicula	1	A[1]	1	1	A[2]	0	1
Hylophorbus rufescens	1	B	0	0	B	1	0
Pherohapsis menziesi	0	B	1	1	A	1	1
Mantophryne infulata	1	B	0	0	A	1	0
M. lateralis	1	B	0	1	A	1	1
M. louisiadensis	1	B	0	0	A	0	1

[1] The relationship between the sagittal crest of *Asterophrys* and the parasagittal ridges of other species is unknown.

[2] As there is conflict in the information from the outgroup, polarities cannot be assigned.

The other characters given conflicting evidence of relationship: Character 21 (division of the *M. tibialis anticus longus*) supports the monophyly of *Asterophrys, Hylophorbus* and *Mantophryne;* Character 35 (connexion between the squamosal and maxilla) supports the monophyly of *Asterophrys* and *Pherohapsis*, Character 36 (posterad projection of the zygomatic ramus) supports the monophyly of *Asterophrys, Pherohapsis* and *Mantophryne lateralis*; Character 46 (nature of the iliosacral articulation) supports the monophyly of *Hylophorbus, Pherohapsis, Mantophryne infulata* and *M. lateralis*; and Character 52 (chin warts) supports the monophyly of *Asterophrys, Pherohapsis, Mantophryne lateralis* and *M. louisiadensis.* There is no reason to believe that any of these characters is more reliable than the others: the derived states of Characters 35 and 46 have evolved convergently within the Genyophryninae; the homology of the prootic arcade of *Pherohapsis* with the posterad process of *Asterophrys* and *Mantophryne lateralis* (36) is unproven (Introduction); and Character 21 may well be related in this group to the relative length of the tibiofibula, which is relatively less in *Pherohapsis* than in other members of the *Asterophrys*-group, and is variable within genera (Zweifel 1972). In order to illustrate graphically the possible relationships Figs 32-34 show the most parsimonious cladograms constructed by the Weighted Invariant Step Strategy of Farris, Kluge and Eckhardt (1970) (Fig. 32), the Wagner Tree method of Lundberg (1972) (Fig. 33) and a phylogenetic tree constructed by the Character Compatibility Analysis method of Meacham (1981) (Fig. 34). These demonstrate the ambiguities arising from the uncertain polarity of Character 38 (cf. Figs A and B of each Figure) and from the paucity of characters. However, I conclude from these figures the following:

(i) Monophyly of the groups *Asterophrys-Pherohapsis* and *Asterophrys-Pherohapsis-Mantophryne lateralis* appear to be best supported by the data.

(ii) No support is given to the hypothesis of the monophyly of *Mantophryne. M. lateralis* appears to be related to *Pherohapsis* and *Asterophrys*, the

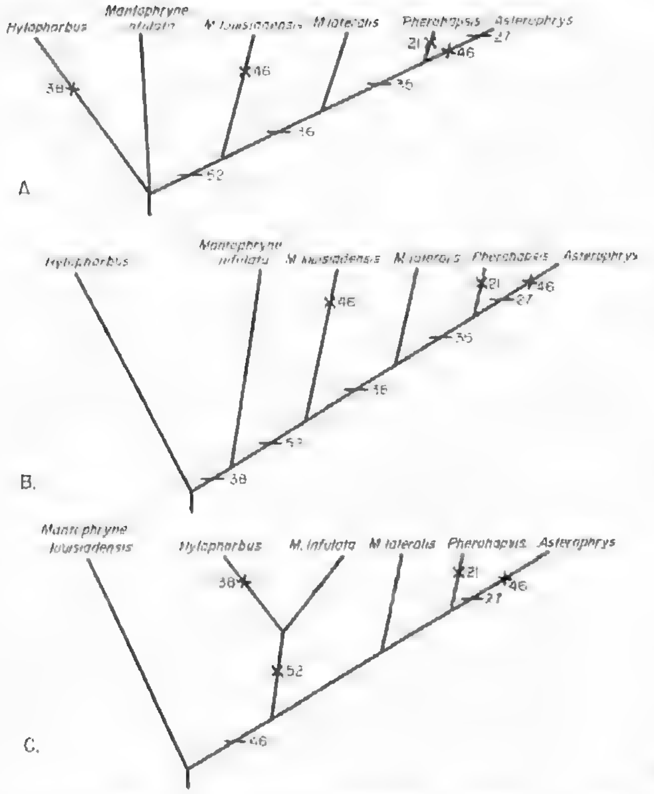

FIG. 33. Three of the most parsimonious cladograms of the *Asterophrys*-group produced by Lundberg's (1972) method.

relationships of *M. louisiadensis* are obscure, and the close phenetic relationship *M. infulata* bears to *Hylophorbus* may or may not be the result of symplesiomorphy.

(iii) Parallel acquisition of the type I ilio-sacral articulation by *Hylophorbus, Pherohapsis, M. infulata* and *M. lateralis* and parallel reversal to the type IIA articulation by *Asterophrys* and *M. louisiadensis* are equally parsimonious hypotheses.

It is clear that the data are insufficient for many confident statements to be made about relationships within this group.

Hypothesis 7. Monophyly of *Xenorhina* and *Xenobatrachus*

The one feature distinguishing these genera is the occurrence in *Xenobatrachus* of the derived state of Character (31), presence of one or more spike-like odontoids on the vomero-palatine. I conclude that *Xenorhina* is paraphyletic and *Xenobatrachus* arose from a Xenorhina-like ancestor.

DISCUSSION

Taxonomic Implications of the Phylogenetic Analysis

Some of the data presented in this study point inescapably to the necessity for taxonomic changes which involve redefinition of the asterophryine genera. The changes to be made will involve decisions related to the philosophy of classification.

Few would disagree that a classification should be useful. Yapp (1981, p. 245) encapsulated the functions and properties of a useful classification: "The fundamental object of classification is to facilitate economical statements. If we can agree that bats, cats and rats are mammals, we say, 'Mammals have hair,' instead of 'Bats . . . cats . . . rats have hair,' and if a newly discovered kangaroo is a mammal, it too has hair. A secondary value is to enable a museum curator to put his specimens in appropriate cupboards." Yapp implies that whatever its basis, a classification must establish "groupings about which generalizations can be made" (Mayr 1981, p. 511), and so have maximal predictive value, and, because its information content is high, be stable in the face of new information.

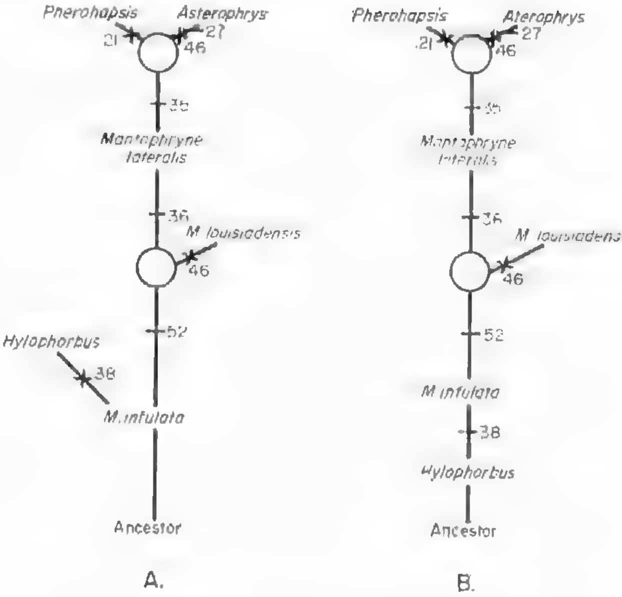

FIG. 34. Two of the most parsimonious cladograms of the *Asterophrys*-group produced by the Character Compatibility Analysis method.

Each of three schools of classification, the phenetic (e.g., Sneath and Sokal 1973) the evolutionary (e.g., Mayr 1969; Michener 1978; Mayr 1981) and the cladistic (e.g., Farris 1977; Eldredge and Cracraft 1980) claims to incorporate maximum information content and predictive value into its classifications. Each claims to seek out "natural groups". However, the meaning of "natural group" differs between the schools. Pheneticists define natural groups as groups based on overall similarity (Sneath and Sokal 1973, p. 24); evolutionists define natural groups as groups sharing greatest genetic similarity (Mayr 1969); and cladists define natural groups as monophyletic (*sensu* Hennig 1966) or as groups sharing particular defining characters (Nelson and Platnick 1981, p. 328). In the recognition of natural groups, cladistic relationship is either irrelevant,

> ". . . this measure of similarity does not carry with it any necessary implication as to the relationship by ancestry, but does imply exhaustive estimates of similarity of the phenotypes." (Sneath and Sokal 1973, p. 28)

relevant, but not the whole story,

> ". . . a relationship, in the evolutionary sense is determined by

> both processes of phylogeny, namely, branching and subsequent divergence." (Mayr 1969, p. 70)

or all,

> "The prime goal of systematics, according to cladists, is the definition and recognition of monophyletic groups." (Eldredge and Cracraft 1980, p. 10)

The schools are not monolithic. For example, Holmes (1980) reviewed the diversity of the evolutionary school, and well publicised differences of opinion occur between practitioners of transformed cladistics (i.e., cladistics divorced from evolutionary theory, e.g., Platnick 1980; Patterson 1980; Nelson and Platnick 1981) and Hennigian phylogeneticists, who relate phylogenetic patterns to evolution (e.g., Eldredge and Cracraft 1980; Ball 1981; Wiley 1981; Beatty 1982). However, though not monolithic, the schools are well delineated, and a systematist revising and redefining taxonomic groups must either knowingly or unknowingly follow the tenets of one of the schools.

The phenetic school claims that the most useful, objective and stable classification arises out of an analysis of as large a selection of characters as possible, in order to gain a measure of overall similarity, without reference to the evolution of the taxa. The stability of phenetic classifications has been thrown into doubt by the studies of Mickevich and Johnson (1976) Mickevich (1978) and Schuh and Polhemus (1980).

It has long been known that different clustering methods to discover groups of most similar taxa produce different results, and this has been demonstrated conclusively by Presch (1979). Though Sneath and Sokal (1973, p. 31) saw a virtue in this divergence:

> ". . . some types of differences in results may themselves be of great interest leading to new insights into the nature of the organisms or of the taxa being studied",

in practice different results from different cluster techniques appear rather to cause confusion. For example, Blake (1973, p. 123) in his revision of the myobatrachine frogs simply rejected the results of one of his two clustering methods on the grounds that it yielded results "inconsistent with other [unspecified] indicators of relationship"; Key (1976, p. 28), lacking "any convincing ground of principle" for choosing between eight different classifications derived from the same data by eight clustering techniques, adopted the previously recognised species-groups as the basis for his classification of the morabine grasshoppers. When such actions are taken it is difficult to accept the efficacy of phenetic classifications.

Some studies, notably that of Blackith and Blackith (1967) on orthopteroids, demonstrated concordance in classifications based on phylogenetic and phenetic methods. However, though they attribute this concordance to their use of a large number of characters, it appears more likely to be the result of the high taxonomic level at which this study was carried out. The study of Schuh and Polhemus (1980) on the Leptopodomorpha indicate that at lower taxonomic levels agreement between the results of phylogenetic and phenetic methods is low.

Pheneticists sacrifice the information content of phylogeny for objectivity and stability. On both counts phenetic techniques appear to fail, as groups claimed to be natural because they are based on overall similarity must be chosen by a subjectively chosen technique, and appear to be susceptible to change if new information is added. The sense in which such a group can be said to be natural is obscure.

The other two schools utilize phylogenetic data, but differ in that the classifications of evolutionists incorporate anagenetic information, as they claim that this action increases the information content and predictivity of their classifications, a claim disputed by Farris (1977). At the heart of the dispute between these schools is the treatment of paraphyletic groups. Evolutionists, e.g., Ashlock (1971, 1974), Mayr (1974), Brothers (1975), Bock (1977) and Michener (1977, 1978), consider paraphyletic groups natural and worthy of recognition; phylogeneticists and "transformed" cladists, e.g., Hennig (1975), Nelson (1978), Eldredge and Cracraft (1980), Nelson and Platnick (1981) and Wiley (1979, 1981) consider only monophyletic (*sensu* Hennig) groups natural.

The arguments of both sides to this question appear to have merit. It is argued by evolutionists that if it is assumed that, for example, fleas evolved from a fly species and therefore, flies are paraphyletic (Michener 1978), a name is needed for fleas and flies to distinguish them, as useful generalizations can be made about each group. Mayr (1974) argues also that paraphyletic groups may be considered natural if they have retained morphological similarities owing to their fidelity to an adaptive zone (e.g. the reptiles), because this morphological similarity may be assumed to be the result of genetic similarity, and it is the relative genetic uniformity of a group that makes it natural.

Against this view it is argued that paraphyletic groups such as the flies do not necessarily represent a group of most closely related species: among the flies there is a sister-group to the fleas. That group of flies is more closely related to the fleas than to the other flies, and therefore paraphyletic groups should not be considered natural: they are defined simply by lack of the autapomorphies of the fleas. Indeed the assumption that retained morphological similarity is necessarily related to a retained genetic similarity is questionable. Patterson (1981a) cites the study of Bruce and Ayala (1979) to show that, despite their morphological similarity to *Pongo*, the African apes, a paraphyletic group with the taxonomic removal of man, are genetically far closer to man than to *Pongo*; and Patterson shows that carp, a member of the paraphyletic Osteichthyes, are much closer genetically to man and to chickens, to which they are phylogenetically closer, than to sharks which they resemble morphologically. As assumed genetic affinity is the basis for belief in the naturalness of paraphyletic groups, evolutionary classifications are of dubious value.

The demonstrated stability of cladistic classifications (Mickevich 1978; Schuh and Polhemus 1980), the necessity of cladistic classifications in some methods of historical biogeography (Brundin 1966, 1968; Rosen 1978; Patterson 1981b), their high information content (Farris 1977), and the unanimous belief of evolutionists and phylogeneticists that monophyletic groups are natural, suggest the desirability of adopting a phylogenetic classification. However, as I pointed out above, paraphyletic groups, to the extent that they are useful, i.e., to the extent that useful generalizations can be made about them, need to be recognized.

The Annotated Linnean Hierarchy of Wiley (1979, 1981) is based on only monophyletic groups, but can accommodate paraphyletic and polyphletic groups, and also groups of unknown affinities. It appears to offer the kind of compromise that is needed. In Wiley's scheme, taxa forming an asymmetrical part of a phylogenetic tree may be placed at the same categorical rank and sequenced in their phylogenetic order of origin, thereby relaxing the Hennigian requirement of a separate taxonomic rank for every fork of such a tree. Trichotomies are recognized by the term "*sedis mutabilis*" to indicate the sequence of the three taxa in the hierarchy is interchangeable. Groups that are paraphyletic, polyphyletic or of unknown status are denied formal rank, and are labelled by inverted commas and the term "*incertae sedis*". As the Annotated Linnean Hierarchy appears to offer a phylogenetic classification that has the capacity to incorporate additional useful anagenetic information without loss of rigour, I use it in this revision of asterophryine taxonomy, with the modification that as the genus is a mandatory category, the paraphyletic genera, though labelled as such in the hierarchy, have formal rank.

Taxonomic Recommendations

A. Genyophryninae

The monophyly of the Genyophryninae has not been demonstrated. Nor has its paraphyly. The status of this subfamily must await a phylogenetic analysis of the subfamilies of the Microhylidae, and the action of amalgamating the Genyophryninae and the Asterophryinae would be premature.

B. *Phrynomantis doriae*

Phrynomantis doriae lacks the autapomorphies of the *Xenorhina*-group: the supplementary slips of the *M. intermandibularis* arising from the angulosplenial; the cultriform process of the *M. genioglossus basalis*; the striated tongue; and the posteromedial expansion of the anterior corner of the palatine process of the maxillary. It also lacks many other derived states shared by *Xenorhina* and other genera (Characters 1, 13, 18, 19, 30, 47, 53).

P. doriae possesses the autapomorphies of *Phrynomantis*: the two supplementary slips to the *M. intermandibularis*, the anterior from a deep tendon, the posterior direct from the dentary; and the medial flange of the squamosal shaft reduced, the dorsal surface of the otic ramus instead continuous with the lateral surface of the shaft.

Therefore, I recommend that *Xenorhina doriae* be transferred to the genus *Phrynomantis*, as *P. doriae* (Boulenger).

C. *Xenorhina* and *Xenobatrachus*

Xenorhina is paraphyletic, differing from *Xenobatrachus* only in lacking one or more large odontoids on the vomero-palatine. There appear to be two taxonomic options: *Xenobatrachus* could be referred to the synonomy of *Xenorhina* Peters (which has priority); or the genera retain their identities with *Xenorhina* annotated to indicate its paraphyly.

The advantage of the first course is the elimination of the *Xenorhina-Xenobatrachus* dichotomy with its unfortunate concomitant, the obliteration of the relationships of the throat muscles when the diagnostic odontoids are sought. The advantages of the second course are that current nomenclature is conserved; and the identities of two monophyletic groups, *Xenobatrachus* and the *Xenorhina*-group are expressed. As the second course appears to produce a more informative classification, I adopt it.

D. *Mantophryne*

The three species *Mantophryne infulata*, *M. lateralis* and *M. louisiadensis* show affinities to the *Asterophrys*-group rather than to *Phrynomantis*. When these species are removed, *Phrynomantis* becomes a much more homogeneous genus supported by the autopomorphies listed in the preceding discussion of *P. doriae*. The derived characters shared by these three species with other members of the *Asterophrys*-group are: distal origin of the *M. tibialis anticus brevis* (22); crested ilium (45); large subarticular tubercles (48); and the possible apomorphy: origin of the *M. geniohyoideus lateralis internus* entirely from the hyale (5). It is therefore appropriate to remove these species from *Phrynomantis*. I recommend resurrection of *Mantophryne* Boulenger 1897, type species *M. lateralis*, to accommodate the three species, as there are no compelling data to associate any of the species with any of the existing *Asterophryne*-group genera. No autopomorphy of *Mantophryne* was found, so its monophyly is uncertain. The status of this genus is discussed further in the next section.

E. The *Asterophrys*-group

The *Asterophrys*-group comprises three divergent monotypic genera (*Asterophrys*, *Hylophorbus* and *Pherohapsis*) and *Mantophryne*, which is a group of uncertain affinities and uncertain monophyly.

Although *Hylophorbus* is phenotypically distinctive, the polarity of its one defining generic character (38: separated maxillae) is dubious, and thus its status as a genus is dubious. The taxonomic choice lies between (a) inclusion of the six species into a single genus (*Asterophrys*) and (b) retention of *Asterophrys* and *Pherohapsis*, resurrecting *Mantophryne* Boulenger 1897 to accommodate three of the species, and regarding *Hylophorbus* and *Mantophryne* as "*incertae sedis*", i.e., paraphyletic or of uncertain monophyly, and "*sedis mutabilis*", i.e., of doubtful order of arising.

I adopt the latter course of action because (a) it conserves much of the current classification; (b) as the species of this group are very divergent, a single generic name would be of little heuristic value; and (c) the monophyly of the entire group and the uncertainty of the status of *Hylophorbus* and *Mantophryne* are expressed.

The convention of placing sister-groups on the same rank necessitates the insertion of a rank intermediate between the subfamily and the genus, which have traditionally been the only ranks between the family and the species in the Microhylidae. I follow Parker (1940) and Lynch (1971) who use the tribe as an intermediate rank in the Leptodactylidae.

The classification I favour is:

FAMILY: MICROHYLIDAE
SUBFAMILY: Asterophryinae
TRIBE: Barygenyini
GENUS: *Barygenys*
TRIBE: Asterophryini *sedis mutabilis*
Asterophryini *incertae sedis "Hylophorbus" sedis mutabilis*
Asterophryini *incertae sedis "Mantophryne" sedis mutabilis*
GENUS: *Asterophrys*
GENUS: *Pherohapsis*
TRIBE: Phrynomantini *sedi mutabilis*
GENUS: *Phrynomantis*
TRIBE: Xenorhinini *sedis mutabilis*
Xenorhinini *incertae sedis "Xenorhina"*
GENUS: *Xenobatrachus*

F. *Phrynomantis h. humicola* and *Ph. compta*

In distinguishing these subspecies, Zweifel (1972) stressed two features: occurrence of a pale orange postocular stripe in *Ph. compta* (lacking in *Ph. humicola*); and possession by *Ph. humicola* of relatively longer legs than those of *Ph. compta*. According to Zweifel's data the ranges of these taxa are essentially allopatric: *Ph. compta* is a western form with its range centring on the Madang and Western Highlands Province, and extending eastwards into Chimbu Province; *Ph. humicola* is an eastern form with its range centring on the Eastern Highlands Province and extending westwards into Chimbu Province. Zweifel (1972) reported one case of sympatry at Igindi, Chimbu Province, but was unwilling to name *Ph. humicola* and *Ph. compta* as separate species until evidence of reproductive isolation was available, as the two taxa are very similar morphologically.

These two taxa differ anatomically in two respects: (a) *Ph. compta* possesses a slip of the *M. depressor mandibulae* arising from the posterior margin of the tympanic ring. *Ph. humicola* and some *Barygenys* species are the only asterophryines to lack this slip. (b) In *Ph. compta* the mandibular branch of the trigeminal nerve passes anterolaterally between the *Mm. adductores mandibulae posterior longus* and *anterior longus*. It passes laterally around the anterior margin of the *M.a.m. posterior longus* and posteroventrally across the lateral surface of that muscle until the nerve reaches the mandible. *Ph. humicola* is the only asterophryine which does not conform to this pattern. Instead the nerve passes directly lateroventrally from the braincase, penetrating the *M.a.m. posterior longus*. It emerges on the lateral surface of the *M.a.m. posterior longus* close to that muscle's insertion on the mandible, and passes ventrally on the lateral surface of the muscle until it reaches the mandible.

The specimens examined are from allopatric sites. Examination of sympatric specimens could provide evidence of introgression or genetic isolation.

Systematic Accounts

ASTEROPHRYINAE (part.) Parker, 1934

Asterophryinae Zweifel, 1971
Asterophryidae Günther (1858) p. 51
Xenorhinidae Mivart (1869) p. 289
Symphygnathinae and Eleutherognathinae (part.) Mehely (1901) pp. 172-189
Cacopinae (part.) Noble (1931) p. 531

Diagnostic definition: (2) posteromedially directed dorsal sheet of fibres on *M. intermandibularis* lacking; (3) overlap of *Mm. interhyoideus* and *intermandibularis* (except *Xenorhina bouwensi*); (7) deep slip of *M. hyoglossus* to hyoid lacking; (15) three tendinous inscriptions of *M. rectus abdominis*; (28), (29) palatine and vomer fused and expanded both laterally and mesially where each combined bone meets its fellow; (33) broad contact of medial ramus of pterygoid with prootic; (34) broad contact of quadratojugal with maxilla; (41) dentary fused to anterior surface of mentomeckelian and usually in contact anteriorly with its fellow (except *Hylophorbus*), mentomeckelians in contact at an acute angle; (43) pectoral girdle lacking clavicles, procoracoids and omosternum; (44) vertebral column diplasiocoelous; (49), (50) tongue adherent and divided superficially into anterior and posterior sections; (54) larva undergoing metamorphosis in egg capsule, and lacking open gill clefts, operculum and spiracle, respiration performed through non-muscular, vascular tail in known species. Additional states not referred to in previous sections also occur: maxillary and vomerine teeth absent; ear fully developed.

The states of characters (2), (41) and the combination of the states of (49) and (50) are diagnostic of the Asterophryinae. The Asterophryinae comprises four tribes.

ASTEROPHRYINI New Tribe

This tribe accommodates the genera *Asterophrys, Hylophorbus, Mantophryne* and *Pherohapsis.*

Diagnostic definition: (4) *M. geniohyoideus medialis* absent; (5) *M. geniohyoideus lateralis internus* arising from hyale only; (6) *M. genioglossus basalis* labiform; (8) three *Mm. petrohyoidei posteriores;* (9) *M. petrohyoideus posterior* III arising from zygomatic ramus of squamosal; (10) *M. depressor mandibulae* not arising from anterior 1/2 of ventral margin of tympanic ring; (11) origin of *M. depressor mandibulae* from otic ramus slender; (12) superficial tendon of *M. adductor mandibulae posterior longus* lacking; (13) *M. adductor mandibulae externus superficialis* arising entirely from zygomatic ramus; (14) *M. longissimus dorsi* not inserting on dorsal fascia; (16) *Mm. transversi abdominis* and *Mm. obliqui abdominis externi* terminating on broad ventral aponeuroses; (17) two sites of insertion of *M. serratus medius;* (18) origin of *M. levator scapulae inferior* partly from first two vertebrae; (19) deep slip to *M. pectoralis sternalis* slender; (20) medial slip of *M. lumbricalis brevis digiti* IV of manus cylindrical, arising from centrale postaxiale; (22) *M. tibialis anticus brevis* arising from distally on tibiofibula; (23) *M. opponens hallucis* arising from a distal tarsale; (24) *Mm. lumbricales breves digitorum* IV and V of pes fused along most of their length; (25) frontoparietals 3× as long as broad; (30) median expansion of vomero-palatine moderate; (32) cultriform process of parasphenoid narrow; (37) dorsal surface of otic ramus of squamosal continuous with anterior surface of medial flange of squamosal shaft; (38) maxillae overlapping premaxillae and connected by ligament or suture, no ridges on snout; (39) mesial expansion of anterior margin of palatine shelf of maxilla lacking; (40) anterior margin of nasal capsule not calcified; (42) humerus relatively straight, crest moderately developed; (45) ilium bearing a moderate dorsal crest; (47) eye large (E: S-V > 0.090); (48) subarticular tubercles large and prominent; (51) surface of posterior section of tongue pitted uniformly; (53) posterior pre-pharangeal fold bearing large number of denticles (rarely fewer than ten).

Of these states, (5), (22) and (48) are diagnostic of the Asterophryini.

GENUS ***Asterophrys*** TSCHUDI, 1838

Asterophrys Tschudi (1838) p. 82
(type species *Ceratophrys turpicola* Schlegel [1837 (1838-1844)]
Asterophrys (part.), Parker (1934) p. 66
Asterophrys Zweifel (1972) p. 432

Diagnostic definition: (1) two supplementary slips to *M. intermandibularis,* each arising from ventral margin of angulosplenial; (12) *M. adductor mandibulae posterior longus* divided into segments; (21) *M. tibialis anticus longus* divided distally; (26) parasagittal ridges on frontoparietals lacking; (27) sagittal crest on cranium well developed; (35) squamosal and maxilla meeting in large specimens; (36) posterad extension of zygomatic ramus well developed; (38) maxillae meeting anteriorly; (46) direct ligamentous connection between ilium and sacrum; (52) warts on chin well developed.

The states of (1), (12), (27) and (52) are peculiar to *Asterophrys* among the Asterophryini.

Content: A. turpicula (Schlegel).

GENUS ***Hylophorbus*** MACLEAY 1878

Hylophorbus Macleay (1878) p. 136
(type species *H. rufescens* Macleay)
Mantophryne (part.) Boulenger (1897) p. 12
Metopostira Mehely (1901) p. 239
Hylophorbus Zweifel, 1972

Diagnostic definition: (1) one supplementary slip to *M. intermandibularis* via tendon from deep on angulosplenial; (12) *M. adductor mandibulae posterior longus* unsegmented; (21) *M. tibialis anticus longus* divided distally; (26) parasagittal ridges present; (27) sagittal crest lacking; (35) squamosal and maxilla not meeting; (36) posterad extension of zygomatic ramus a slight flange only; (38) maxillae well separated (about 1 mm) anteriorly; (46) ligamentous connexion between ilium and sacrum lacking; (52) chin warts lacking.

The state of character (38) is peculiar to *Hylophorbus* among the Asterophryini.

Content: There are three subspecies of *Hylophorbus rufescens* Macleay: *H.r. rufescens; H.r. extimus* Zweifel 1972; *H.r. myopicus* Zweifel 1972.

Remarks: This genus may be paraphyletic as the polarity of character (38) is dubious.

GENUS ***Mantophryne*** BOULENGER 1897

Mantophryne Boulenger (1897) p. 12
(type species *M. lateralis* Boulenger)
Mantophryne Vogt (1911) p. 427
Hylophorbus Fry (1913) p. 48
Asterophrys (part.) Parker (1934) pp. 62, 63
Phrynomantis (part.) Zweifel (1972) pp. 476-479, 480-489

Diagnostic definition: (1) one slip to *M. intermandibularis* via a tendon from deep on angulosplenial; (12) *M. adductor mandibulae posterior longus* unsegmented; (21) *M. tibialis anticus longus* divided distally; (26) parasagittal ridges present or absent; (27) sagittal crest absent; (35) squamosal and maxilla not meeting; (36) posterad projection of zygomatic ramus well or poorly developed; (38) maxillae meeting or only narrowly separated (maximum 0.3 mm) anteriorly; (46) ligamentous connexion between ilium and sacrum present or absent; (52) chin warts present or absent.

Content: M. infulata (Zweifel) 1972; *M. lateralis* Boulenger; *M. louisiadensis* (Parker) 1934.

Remarks: This is probably a paraphyletic genus, and its relationships with the other genera of the

Asterophryini are uncertain. It differs from *Hylophorbus* in Character 38, from *Asterophrys* in Characters 1, 12, 27 and 52, and from *Pherohapsis* in Characters 21 and 36. I was not able to examine *Phrynomantis kopsteini* Mertens, which may be closely related to the species which comprise *Mantophryne*.

GENUS **Pherohapsis** ZWEIFEL 1972

Pherohapsis Zweifel (1972) p. 456
(type species *P. menziesi* Zweifel)

Diagnostic definition: (1) one slip to *M. intermandibularis* via tendon from deep on angulosplenial; (21) *M. tibialis anticus longus* divided relatively proximally; (26) parasagittal ridges present; (27) sagittal crest lacking; (35) squamosal and maxilla meeting; (36) posterad extension of zygomatic ramus extended medially to meet frontoparietal to which fused to form prootic arch; (38) maxillae meeting anteriorly; (46) ligamentous connexion between ilium and sacrum lacking; (52) chin warts poorly developed.

The states of characters (21) and (36) are peculiar to *Pherohapsis* among the Asterophryini.

Content: P. menziesi Zweifel.

BARYGENYINI New Tribe

This tribe accommodates the genus *Barygenys*.

Diagnostic definition: (1) two supplementary slips to *M. intermandibularis* from the ventral surface of angulosplenial, posterior inserting on *M. genioglossus basalis* by narrow tendon; (4) *M. geniohyoideus medialis* present or absent; (5) *M. geniohyoideus lateralis internus* arising from mandible only; (6) *M. genioglossus basalis* lamellate; (8) two *Mm. petrohyoidei posteriores;* (9) *M. petrohyoideus posterior* III arising from exoccipital and otic ramus; (10) *M. depressor mandibulae* not arising from anterior 1/2 of ventral margin of tympanic ring; (11) origin of *M. depressor mandibulae* from the otic ramus absent or slender; (12) *M. adductor mandibulae posterior longus:* superficial tendon present; segmented in larger species; (13) anterior origin of *M. adductor mandibulae externus superficialis* from fascia; (14) *M. longissimus dorsi* inserting in part on dorsal fascia; (16) *Mm. transversi abdominis* meeting on ventral abdomen, *Mm. obliqui abdominis externi* meeting on ventral abdomen; (17) only one site of insertion of *M. serratus medius;* (18) origin of *M. levator scapulae inferior* partly from first three vertebrae; (19) deep slip of *M. pectoralis sternalis* well developed; (20) medial slip of *M. lumbricalis brevis digiti* IV of manus a narrow sheet from superficial tendon; (22) *M. tibialis anticus brevis* arising relatively proximally; (23) *M. opponens hallucis* arising from palmar aponeurosis; (24) *Mm. lumbricales breves digitorum* IV and V separated proximally; (25) frontoparietals twice as long as broad; (30) median expansion of vomero-palatine well developed; (32) cultriform process of parasphenoid broad; (37) dorsal surface of otic ramus of squamosal continuous with anterior surface of medial flange of squamosal shaft, and overlying anterior surface of prootic as well as dorsal surface; (38) premaxillae compressed between maxillae; maxillae not meeting; three vertical, dermal ridges on snout; (39) mesial expansion of anterior margin of palatine shelf of maxilla lacking; (40) anterior margin of nasal capsule calcified; (42) humerus curved, crest well developed; (45) ilial crest lacking; (46) direct ligamentous attachment between ilium and sacrum; (47) eye small (E: S-V < 0.090); (48) subarticular tubercles absent or poorly developed; (51) surface of posterior part of tongue pitted uniformly; (53) posterior pre-pharyngeal fold with < 10 denticles.

Of these states, (1), (4), (6), (8), (14), (16), (17), (20), (23), (24), (25), (37), (38) and (40) are peculiar to *Barygenyini* among the Asterophryinae.

GENUS **Barygenys** PARKER 1936

Barygenys Parker (1936) p. 73
(type species *B. cheesmanae* Parker)
Baragenys [sic] Zweifel (1956) p. 9

Diagnostic definition: As above for the tribe Barygenyini.

Content: B. atra (Gunther), 1896; *B. cheesmanae* Parker, 1936; *B. exsul* Zweifel, 1963; *B. flavigularis* Zweifel, 1972; *B. maculata* Menzies and Tyler, 1977; *B. nana* Zweifel, 1972.

Remarks: A new species from Mt Missim is being described (Allison and Burton, *in prep.*).

PHRYNOMANTINI New Tribe

This tribe accommodates the genus *Phrynomantis*.

Diagnostic definition: (1) two slips to *M. intermandibularis*, anterior via narrow tendon, posterior direct from dentary; (4) *M. geniohyoideus medialis* absent; (5) *M. geniohyoideus lateralis internus* arising from both mandible and hyale; (6) *M. genioglossus basalis labiform;* (8) three *Mm. petrohyoidei posteriores;* (9) *M. petrohyoideus posterior* III from zygomatic ramus; (10) *M. depressor mandibulae* with origin usually from entire ventral margin of tympanic ring, rarely posterior 1/2; (11) origin of *M. depressor mandibulae* from otic ramus slender or moderate; (12) *M. adductor mandibulae posterior longus* unsegmented; (13) anterior origin of *M adductor mandibulae externus superficialis* entirely from zygomatic ramus; (14) *M. longissimus dorsi* not inserting on dorsal fascia; (16) *Mm. transversi abdominis* and *obliqui abdominis externi* terminating on ventral abdominal aponeuroses; (17) two sites of insertion of *M. serratus medius;* (18) origin of *M. levator scapulae inferior* partly from first two vertebrae; (19) deep slip of *M. pectoralis sternalis* poorly developed; (20) medial slip of *M. lumbricalis brevis digiti* IV of manus cylindrical, arising from centrale postaxiale; (22) *M. tibialis anticus brevis* arising relatively proximally; (23) *M. opponens hallucis* arising from a distal tarsale; (24) *Mm. lumbricales breves digitorum* IV and V fused along much of length; (25) frontoparietals 3× as long as broad; (30) median expansion of vomero-palatine moderately developed;

(32) cultriform process of parasphenoid narrow; (37) dorsal surface of otic ramus continuous with lateral surface of squamosal shaft, medial flange poorly developed; (38) maxillae meeting anteriorly, no ridges on snout; (39) mesial expansion of anterior margin of palatine shelf of maxilla lacking; (40) anterior margin of nasal capsule not calcified; (42) humerus relatively straight, crest moderately developed; (45) ilial crest lacking; (46) direct ligamentous attachment between ilium and sacrum; (47) eye large (E: S-V > 0.090 usually); (48) subarticular tubercles poorly developed; (51) surface of posterior part of tongue pitted uniformly; (53) posterior pre-pharyngeal fold bearing rarely fewer than ten denticles.

Of these states, (1), (10) and (37) are peculiar to the Phrynomantini among the Asterophryinae.

GENUS *Phrynomantis* PETERS 1867

Phrynomantis Peters (1867) p. 35
(type species by subsequent designation [Noble (1926) p. 20] *P. fusca* Peters)
Callulops Boulenger (1898) p. 345
Gnathophryne Mehely (1901) p. 177
Pomatops Barbour (1910) p. 89
Phrynomantis Zweifel (1972) p. 460

Diagnostic definition: As above for the tribe Phrynomantini.

Content: P. boettgeri (Mehely) 1901; *P. doriae* (Boulenger) 1888; *P. dubia* (Boettger) 1895; *P. eurydactyla* Zweifel, 1972; *P. fusca* Peters, 1867; *P. glandulosa* Zweifel, 1972; *P. humicola* Zweifel, 1972; *P. kopsteini* (Mertens) 1989; *P. slateri* (Loveridge) 1955; *P. stictogaster* Zweifel, 1972; *P. wilhelmana* (Loveridge) 1948.

Remarks: I have not seen *P. boettgeri, P. dubia, P. glandulosa* or *P. kopsteini*. While it is likely that the first three species are correctly assigned to *Phrynomantis*, the large subarticular tubercles and narrowly separated maxillae of *P. kopsteini* (Zweifel, 1972) indicate that it may be more appropriately assigned to *Mantophryne*. Two subspecies of *P. humicola* (*P.h. humicola* and *P.h. compta*) have been described (Zweifel, 1972). I have added (above) characters emphasizing their phenotypic distinctness.

XENORHININI New Tribe

This tribe accommodates the genera *Xenobatrachus* and *Xenorhina*.

Diagnostic definition: (1) two supplementary slips to *M. intermandibularis* from the ventral margin of angulosplenial, posterior inserting on median aponeurosis; (4) *M. geniohyoideus medialis* absent; (5) *M. geniohyoideus lateralis* arising from mandible only; (6) *M. genioglossus basalis* with cultriform posterior projection; (8) three *Mm. petrohyoidei posteriores;* (9) *M. petrohyoideus posterior* III arising from exoccipital and otic ramus; (10) *M. depressor mandibulae* lacking origin from anterior 1/2 of ventral margin of typanic ring; (11) origin of *M. depressor mandibulae* from otic ramus broad, well developed; (12) *M. adductor mandibulae posterior longus* segmented, bearing superficial tendon of insertion; (13) anterior origin of *M. adductor mandibulae externus superficialis* from fascia; (14) *M. longissimus dorsi* not inserting on dorsal fascia; (16) *Mm. transversi abdominis* and *obliqui abdominis externi* terminating on ventral abdominal aponeuroses; (17) two sites of insertion of *M. serratus medius;* (18) origin of *M. levator scapulae inferior* partly from first three vertebrae; (19) deep slip of *M. pectoralis sternalis* well developed; (20 medial slip of *M. lumbricalis brevis digiti* IV of manus cylindrical, arising from centrale postaxiale; (22) *M. tibialis anticus brevis* arising relatively proximally; (23) *M. opponens hallucis* arising from a distal tarsale; (24) *Mm. lumbricales breves digitorum* IV and V of pes fused along much of length; (25) frontoparietals 3× as long as broad; (30) median expansion of vomero-palatine well developed; (32) cultriform process of parasphenoid broad; (37) dorsal surface of otic ramus continuous with anterior surface of medial flange of squamosal shaft; (38) maxillae meeting anteriorly, no ridge on snout; (39) mesial expansion of anterior margin of palatine shelf of maxilla well developed; (4) anterior margin of nasal capsule not calcified; (42) humerus curved, crest well developed; (45) ilium bearing moderately developed dorsal crest; (46) direct ligamentous attachment between ilium and sacrum; (47) eye small (E: S-V < 0.090 usually); (48) subarticular tubercles absent or poorly developed; (51) surface of posterior part of tongue bearing deep longitudinal striae; (53) posterior pre-pharyngeal fold bearing few denticles (usually < 10).

Of these states, (6), (11), (39) and (51) are peculiar to the Xenorhinini among the Asterophryinae.

GENUS *Xenobatrachus* PETERS and DORIA 1878

Xenobatrachus Peters and Doria (1878) p. 432
(type species *X. ophiodon* Peters and Doria)
Choanacantha Mehely (1898) p. 175

Diagnostic definition: (31) one or more spike-like odontoids on the vomero-palatine.

Content: X. bidens (van Kampen) 1909; *X. giganteus* (van Kampen) 1915; *X. macrops* (van Kampen) 1909; *X. mehelyi* (Boulenger) 1898; *X. obesus* Zweifel 1960; *X. ocellatus* (van Kampen) 1913; *X. ophiodon* Peters and Doria, 1878; *X. rostratus* (Mehely) 1898; *X. subcroceus* Menzies and Tyler, 1977.

GENUS *Xenorhina* PETERS 1863

Xenorhina Peters (1863) p. 82
(type species, *Bombinator oxycephalus* Schlegel)
Pseudengystoma de Witte (1930) p. 132
Asterophrys (part.) Parker (1934) p. 58
Xenorhina Zweifel (1972) p. 529

Diagnostic definition: As above for the tribe Xenorhinini.

Content: X. bouwensi (de Witte) 1930; *X. minima* (Parker) 1934; *X. oxycephala* (Schlegel) 1858; *X.*

parkerorum Zweifel, 1972; *X. similis* Zweifel, 1956.

Remarks: This is a paraphyletic genus closely related to *Xenobatrachus.*

ACKNOWLEDGMENTS

This project was supported in part by grants from the Australian Museum and the University of Adelaide. The Department of Science and Industry supported field work in Papua New Guinea and the Department of Biology, UPNG, supported my visa application. In PNG I was assisted in many ways by Dennis and Krista Black, Roy and Margaret Mackay, Rupert Stocks and Allen Allison.

Specimens were provided by the following institutions: American Museum of Natural History (R. G. Zweifel); Australian Museum (H. G. Cogger); Museum of Comparative Zoology (J. Rosado); Rijksmuseum van Natuurlijke Historie, Leiden (M. Hoogmoed); South Australian Museum (M. J. Tyler); University of Papua New Guinea (L. Hill, D. Black). Keith McDonald provided live specimens from Queensland. Ross McDonald took radiographs of specimens deemed too precious to dissect. Mike Tyler suggested and supervised this project and provided access to specimens so that I could get it under way. Mike was an unfailing source of support and encouragement throughout the project. He read and criticised drafts of the manuscript. Margaret Davies aided me by instruction and encouragement with artwork and in the divers arts of osteology, and critically read drafts of the manuscript. Philippa Horton led me back to the long-forgotten realms of histology, and helped me with proof-reading. I owe much to the generosity and forbearance of these three. Terry Schwaner, Jenny Gardner, Graeme Browning, Alice Wells, Cherie Burton and Mary Meredith lent their ears and gave useful advice and ideas when I needed them. Linda Trueb gave me invaluable advice on anatomical drawings, and made useful suggestions for this paper.

Rev. Br. John Marks, my former employer, gave me time off to complete this project with generous conditions, and some of my colleagues, particularly Mary Meredith and Peter Taylor, bore added burdens as a result of my absence.

This project could not have begun without the pioneering work of Dr R. G. Zweifel, who placed the taxonomy of the Asterophryinae on a firm basis. He was prompt and generous in the provision of specimens, transparencies, advice and encouragement.

It was my wife, Cherie, who suggested that I take time off work to finish this project. I owe much to her tolerance, constant support and encouragement.

Heather Kimber and Sandra Lawson typed the manuscript and Ruth Evans drew Figs 28, 32-34.

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Printed by Graphic Services, South Australia.