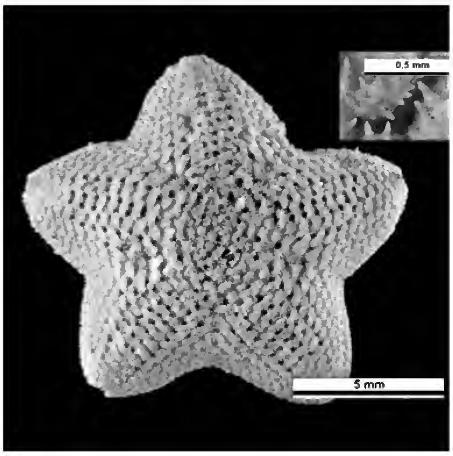
Memoirs of Museum Victoria

Volume 66 Issue Number 2 31 December 2009



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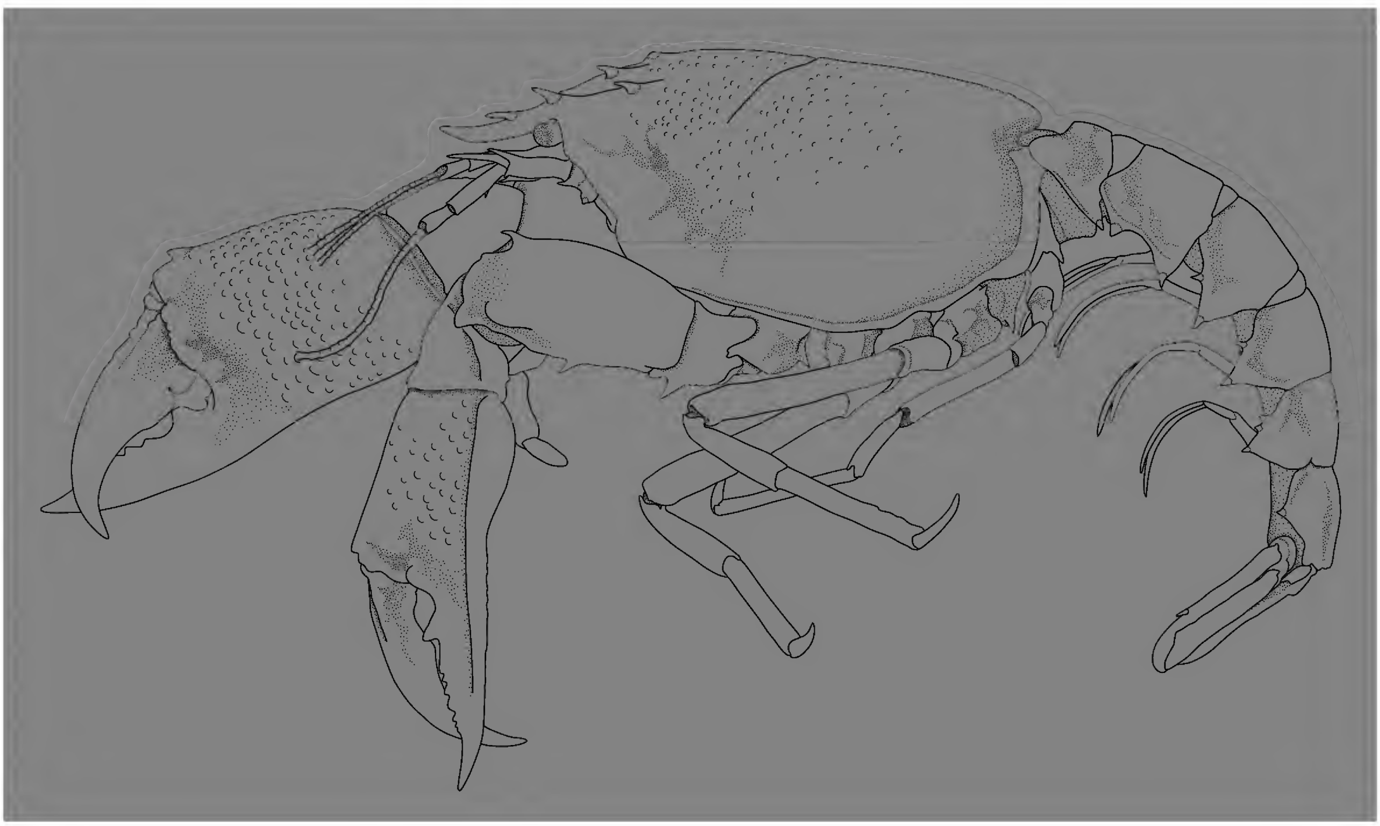

Memoirs of Museum Victoria

ISSN 1447-2546 (Print) 1447-2554 (On-line)
http://museum.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria

MELBOURNE AUSTRALIA

Volume 66
Issue Number 2
31 December, 2009

MUSEUMVICTORIA

Published by Order of the Museums Board Of Victoria

Typeset by the printer's drawers
Printed by BPA Print Group

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Memoirs of Museum Victoria (formerly known as *Memoirs of the National Museum of Victoria* until 1983) is the museum's scientific journal and advances the museum's objectives by publishing papers on original research in the natural sciences pertinent to Victoria and/or the museum's collection. It is published annually, on 31 December.

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Deadline for submission of papers

Final manuscripts (prior to papers being refereed) and accompanying illustrations must be submitted to the editor **no later than 1 August**. Earlier submission is encouraged.

Submission of papers and illustrations

Papers must be submitted to the editor in final manuscript form as a **word document file only** and double line spaced. Any accompanying images or drawings must be submitted separately and NOT embedded within the text.

All **illustrations** (photographs, line drawings) must be submitted as **600dpi scans at A4 size and as print ready files**. In the case of numerous and large files, illustrations should be **supplied on a cd and not electronically**. Although not preferable, original artwork (photographs, line drawings) can be accepted for scanning by the museum. In the latter, whilst the museum takes no responsibility for any damage to original artwork, the utmost care will be taken whilst it is in their possession.

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Instructions for authors

An outline of the required **format and style guide** is supplied here, however, authors should also refer to the previous edition of *Memoirs of Museum Victoria* for a more in depth guide.

Papers should be arranged as follows:

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introduction
main text
acknowledgements
references
index (only if extensive)
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- Author's **email addresses** in contact details should be in brackets.
- Primary **headings** are in bold and left justified; secondary headings in italics and left justified. *Italics* in the text should otherwise be restricted to generic and specific names. **Paragraphs** are indented. **Measurements** must be in the metric system (SI units).
- **Abbreviation** of River and Island/s: Use R for River. Use I for Island and Is. for Islands.
- For **numbers, use numerals except** when used in text narrative when they should be spelt out, but only up to and including the number ten. Numerals should also be spelt out when used as follows: first, second, third, fourth, tenth, twentieth etc.
- The word **Figure** should be spelt out when used below a genus name in the body of the text and in the Figure caption. However, when figures are referred to within the text do not spell out and instead use lowercase fig. or figs.
- **Captions** to illustrations must be submitted separately at the end of the manuscript and should follow this example:

  Figure 1. *Storthyngurella hirsuta* sp. nov., male, holotype: a, b, dorsal and lateral views of body; c, d, frontal and lateral views of cephalon.
- **References** should be listed alphabetically at the end of the manuscript. Journal and book titles must be in full and italicised, with the year of publication, edition, page number, publisher and city of publication in roman. Authors should follow this example:

  Paulin, C.D. 1986. A new genus and species of morid fish from shallow coastal waters of southern Australia. *Memoirs of Museum Victoria* 47: 201–206.

  Last, P.R., and Stevens, J.D. 1994. *Sharks and rays of Australia.* CSIRO Publishing: Melbourne. 513 pp.

  Wilson, B.R., and Allen, G.R. 1987. Major components and distribution of marine fauna. Pp. 43–68 in: Dyne, G.R. and Watson, D.W. (eds), *Fauna of Australia Volume 1A General articles*. Australian Government Publishing Service: Canberra.
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- **Supplementary information** (extended lists of material examined, databases etc) should be submitted separately and with the final manuscript to be forwarded to referees. The Editorial Board encourages use of supplementary information to minimise the cost of printing as long as the requirements of the International Code of Zoological Nomenclature are met in the printed paper.

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ISSN 1447-2546 (Print) 1447-2554 (On-line)
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The postcranial anatomy of two Middle Devonian lungfishes (Osteichthyes, Dipnoi) from Mt. Howitt, Victoria, Australia

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Abstract

Long, J.A. and Clement, A.M. 2009. The postcranial anatomy of two Middle Devonian lungfishes (Osteichthyes, Dipnoi) from Mt. Howitt, Victoria, Australia. *Memoirs of Museum Victoria* 66: 189–202.
The postcranial skeletons of two upper Givetian lungfishes from Mt. Howitt, Victoria, Australia, show remarkable similarities, despite the fact that one is a tooth-plated form (*Howidipterus* Long 1992) whilst the other has a denticulate dentition (*Barwickia* Long 1992). Both genera show identical body shape with a short first dorsal fin and greatly elongated second dorsal fin, and small anal fin. The cleithra and clavicles are remarkably similar except for *Barwickia* lacking external ornament on the lateral lamina of the cleithrum and having a smaller branchial lamina on the clavicle. Both have paddle-shaped subdermal anocleithra that meet the posterior process of the I bone, approximately the same numbers of cranial ribs, pleural ribs, supraneural and subhaemal spines, the same expanded dorsal and anal fin basals with similar number of proximal and middle radials supporting the fins, and approximately the same number of radials supporting the hypochordal lobe of the caudal fin. These numerous similarities in the postcranial skeletons of the two genera strongly suggest that their differing feeding mechanisms probably evolved from a shared ancestral form having a similar postcranial skeleton. Implications for hypotheses of dipnoan phylogeny are discussed.

Keywords Pisces, osteichthyes, Dipnomorpha, Devonian, postcranial skeleton, anatomy, evolution, Australia

Introduction

Since the time of Dollo (1895) the significance of postcranial features in the large scale evolutionary trends of the Dipnoi has been repeatedly noted (Graham-Smith and Westoll, 1937; Westoll, 1949; Lehman, 1966; Bemis, 1984; Long, 1990; Pridmore and Barwick, 1993). However, despite the recent wealth of new information on the cranial anatomy of early lungfishes, there is a lack of information on their postcranial skeletons. Over seventy Devonian genera of lungfish are now known (Marshall, 1987; Jarvik, 1980; Janvier 1996) yet only four of these, *Fleurantia denticulata* (Graham-Smith and Westoll, 1937), *Dipterus valencienessi* (Ahlberg and Trewin, 1994) and two genera from the Late Devonian Gogo Formation of Western Australia, *Chirodipterus australis* and *Griphognathus whitei* (Pridmore and Barwick, 1993; Campbell and Barwick, 2002), have had the postcranial skeleton described in detail. Other Devonian dipnoans which have had aspects of the postcranial skeleton described include *Uranolophus* (Denison, 1968; Campbell and Barwick, 1988a), *Dipterus* (e.g. Schultze 1970, 1975; Campbell and Barwick, 1988a, Campbell et al. 2006), *Rhinodipterus* (Schultze, 1975), *Pillararhynchus* (Barwick and Campbell 1996), *Adololopas* (Campbell and Barwick 1998), *Griphognathus* (Schultze, 1969; Campbell and Barwick, 1988a; Pridmore and Barwick, 1993). Isolated vertebral centra of dipnoans from indeterminate taxa have been figured and described also by several workers (e.g. Jarvik, 1952). Therefore the complete description of the postcranial skeleton in two more Devonian genera, presented in this paper, contributes significant new information to the subject, and allows discussion of phylogenetic problems concerning the monophyly of tooth plated versus denticulated dipnoan lineages.

The Mt. Howitt fauna, of uppermost Givetian age (Young, 1993, 1999), represents one of the best preserved and most diverse late Middle Devonian freshwater fish assemblages from any single site in the Southern Hemisphere, and is also significant in being the keystone for biostratigraphic correlations throughout eastern Victoria (Long, 1983, 2004; Long and Werdelin, 1986; Cas et al 2003). There are two genera of lungfish at Mt. Howitt, regarded by Long (1993) as members of the Family Fleurantiidae (*contra* Long, 1992, in which *Howidipterus* was placed provisionally in the Dipteridae). One has tooth-plates with occasional denticles between the tooth-ridges *(Howidipterus)*; the other has a denticle-covered dentition, although rows of teeth may be clearly distinguished on the pterygoids *(Barwickia)*. Although Long (1993) suggested that the fleurantiid dentitions probably evolved by heterochronic processes (McKinney and McNamara, 1991), namely paedomorphic retention of tooth-row development in conjuction with peramorphic development of denticle fields ("dissociated heterochony"), it is the nature of the postcranial skeletons in these forms that gives further information on their possible phylogenetic affinities. The phylogenetic analysis of Devonian lungfishes by Ahlberg et al. (2006) supported a close relationship between *Howidipterus* and *Barwickia*.

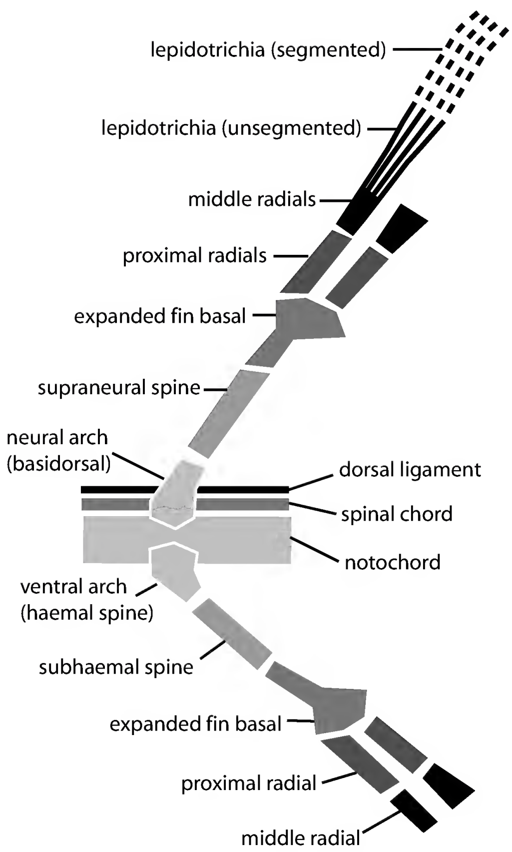

Figure 1. Terminology used for axial skeleton components.

Materials and methods

The Mt. Howitt lungfishes were studied from latex casts of the natural moulds preserved in black shale. The specimens are generally preserved as flattened, slightly disrupted carcasses, but often fine preservation of cartilage bones, such as elements of the visceral skeleton, are clearly seen from the latex peels. Photographs are of latex casts dusted with ammonium chloride. The description of the postcranial skeleton follows terminology used by Goodrich (1958), Graham-Smith and Westoll (1937), Long (1987, for the cleithrum) and Cloutier (1996). Figure 1 outlines the terminology used for axial skeleton components used in this work.

Outline drawings and descriptions of postcranial features have been made using a camera lucida. Comparative material examined includes three-dimensional lungfish bodies from the Gogo Formation of Western Australia held in the W.A. Museum and in the Geology Department, The Australian National University, Canberra, and collections of North American and European Devonian lungfishes held in the British Museum of Natural History, London, The National Museum of Scotland, Edinburgh and the Australian Museum, Sydney. Specimens referred to in this work are housed in the palaeontological collections of the Museum of Victoria, Melbourne (MV), The Australian Museum, Sydney (AM), and the Western Australian Museum (WAM), Perth.

Descriptions of the postcranial skeletons

The two genera show remarkably similar body form and postcranial skeletal morphology. Both genera are commonly preserved in size ranges of 10–20 cm, the largest individual indicating a maximum length estimated at close to 40 cm *(Howidipterus)*. Although there are many specimens representing both forms which show the overall shape and proportions of the body and fins (e.g. figs. 4, 6), very few specimens show good preservation of the axial skeletal elements, and in most specimens the counts of these elements are based on impressions of ribs and supraneurals that have been overprinted by the squamation.

Pectoral girdle

The exoskeletal pectoral girdle in both genera consists of a large cleithrum and clavicle, and a smaller paddle-shaped subdermal anocleithrum which articulates anterodorsally with the posterior subdermal process of the I bone. The scapulocoracoid is not commonly preserved, and was probably largely cartilaginous, as were the axial mesomeres that presumably formed the pectoral and pelvic fin skeletons. In one specimen *(Barwickia*, MV P198046) there is an impression of part of the scapulocoracoid showing the exposed portion to have a similar form as that figured for *Chirodipterus* (Campbell and Barwick, 1987). Neither the shape of the glenoid fossa nor the support buttresses for the scapulocoracoid can be determined from the latex peel.

Cleithrum. The cleithra in *Howidipterus* (fig. 3) and *Barwickia* (figs. 3, 5) are very similar in overall form and shape. Both are generally similar to the cleithra of other Late Devonian dipnoans, especially *Eoctenodus microsoma* (Long, 1987) and *Scaumenacia* (Jarvik, 1980). The cleithrum has an expanded dorsal end, strong dorsoventral lateral thickening and extensive, inwardly directed branchial lamina that meets the branchial lamina of the clavicle along a prominent thickened ridge. They differ from each other in that the externally exposed region of

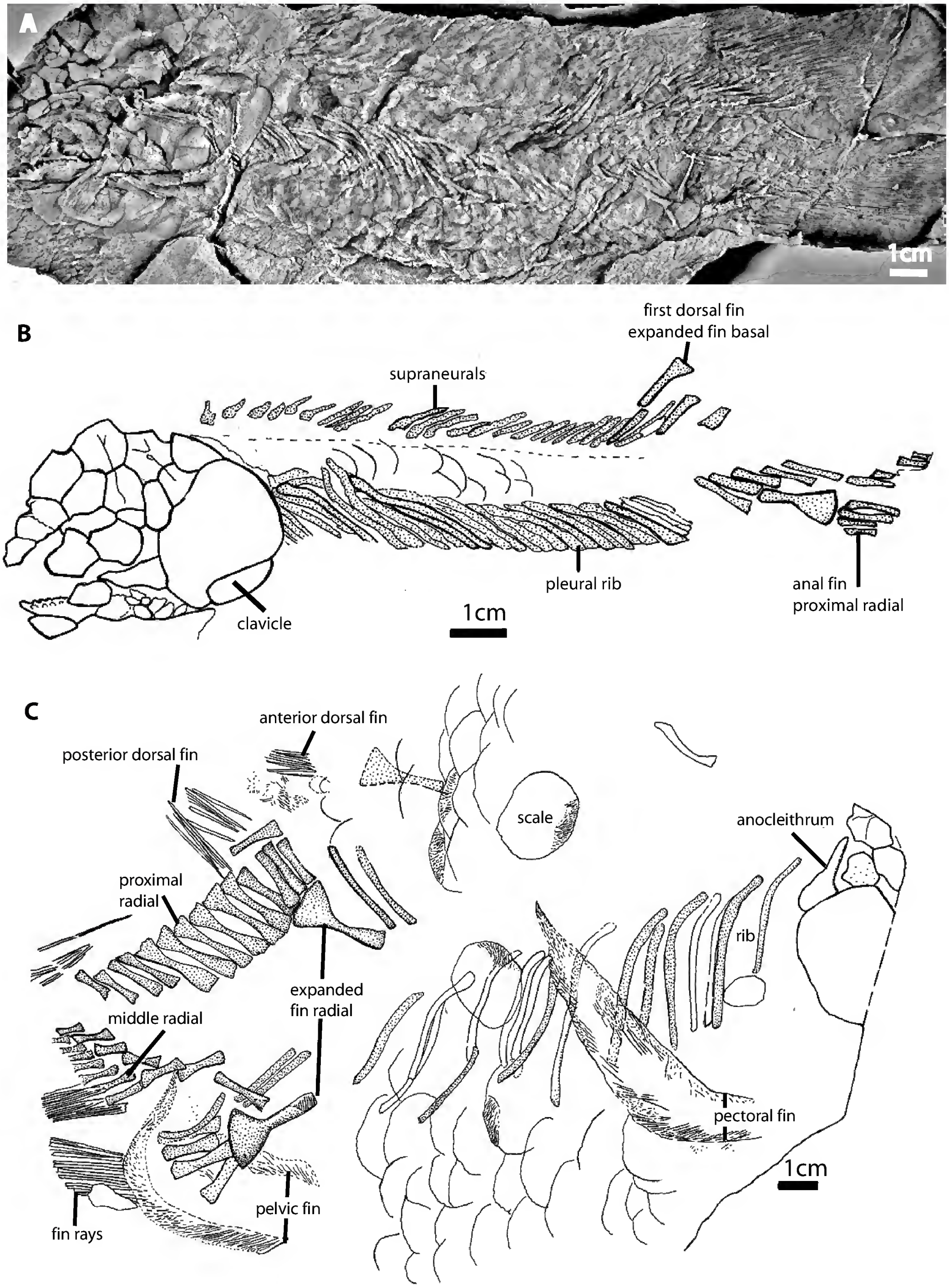

Figure 2. *Howidipterus donnae*: a, photograph of MV P181792; b, interpretive drawing of MV P198045; c, MV P198042, sketch interpretation of large specimen, slightly disarticulated.

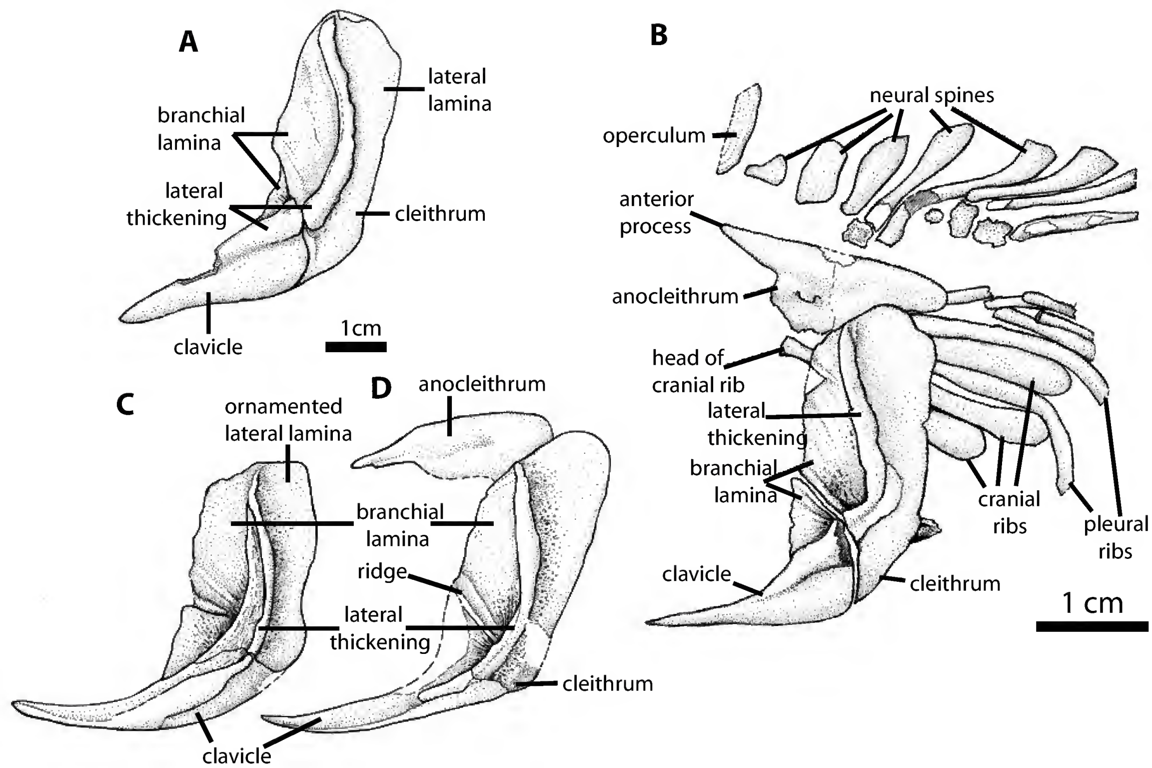

Figure 3. Shoulder girdle: a, *Barwickia downunda* cleithrum and clavicle, MV P181890; b, *Barwickia downunda* with anterior ribs and neural spines, MV P198046; c, *Howidipterus donnae* exoskeletal shoulder girdle, MV P 181883; and d, also showing anocleithrum, MV P181792.

the cleithrum (lateral lamina) in *Howidipterus* has weakly developed surface pitting, indicating it was situated just below the dermis in life. The cleithrum of *Barwickia* shows no external ornament or marking on its lateral lamina, and appears to have a more strongly developed lateral thickening. As in *Eoctenodus* there is a marked anterior angle on the branchial lamina in both forms, and a roughened mesial pit is formed where the branchial lamina meets the lateral lamina. *Eoctenodus* differs in having a notch present at the ventromesial corner of the branchial lamina (Long 1987, Fig. 6) which is not seen in either of the Mt. Howitt forms.

There are some variations seen within the cleithra of *Howidipterus*. P181883 (Fig. 3; figured only in part by Long, 1992, Fig. 3G) shows the presence of a distinct mesial lamina in addition to a branchial lamina. This outer, mesial lamina is part of the lateral thickening of the cleithrum, and may have served to separate the overlap area of the operculum from the gill chamber.

In visceral view there is no indication of the shape or size of the scapulocoracoid attachment area in either form, as seen in some other early lungfishes (e.g. *Uranolophus,* Campbell and Barwick, 1988b; *Chirodipterus,* Campbell and Barwick, 1999).

Clavicle. The clavicles are well-preserved in several specimens from both genera (figs. 2, 3, 5). They are large bones, almost as long as the cleithrum and smoothly curved throughout their extent. Overlap between the cleithrum and clavicle in the Mt. Howitt genera was relatively short and narrow, unlike the primitive form *Uranolophus* in which the clavicle had an elongate, extensive dorsal overlap surface (Campbell Barwick, 1988b). The ventral laminae in both Mt. Howitt forms are of simple triangular shape, lacking a notch for overlap of the principal gular plate as seen in some other Devonian lungfish such as *Chirodipterus* (e.g. WAM 90.10.8) and *Uranolophus* (Campbell and Barwick, 1988b, Figs. 23–25). The clavicles of both *Howidipterus* and *Barwickia* possess a strong lateral thickening along the outermost edge, which increases in thickness towards the junction with the cleithrum. The branchial lamina of the clavicle of *Howidipterus* is notably more extensive than that in *Barwickia* (fig. 3).

Anocleithrum. The anocleithrum is well-preserved and of similar paddle-shape in several specimens of both forms *(Barwickia, figs. 3, 5; Howidipterus, Long, 1993: Fig. 5).* In *Barwickia* the anocleithrum is 80% as long as the cleithrum.

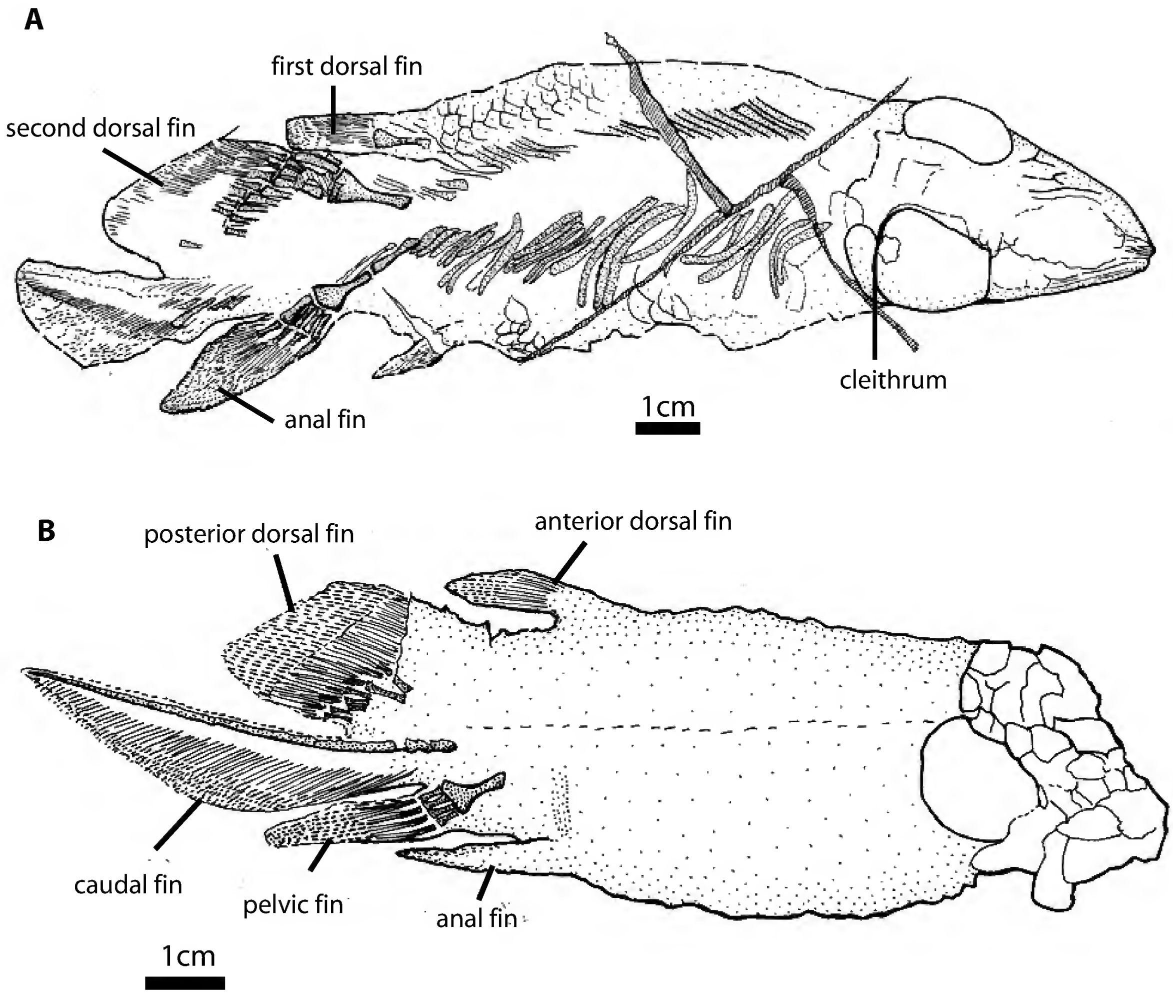

Figure 4. Outline of postcranial body and fins: a, *Barwickia downunda*; b, *Howidipterus donnae*.

In *Howidipterus* the anocleithrum appears to be slightly smaller compared with the cleithrum. The anterior end of the anocleithrum is slender and produced into a strong anterior spine that remains in contact with the posterior process of the I bone of the skull in many specimens, suggesting a strong ligamentous connection in life.

Pectoral and pelvic fins

Pectoral fin. The pectoral fin is well-preserved in many specimens, although it shows only the outline of the fringing fin rays and some small scales covering the fin. There is no preservation of endoskeletal fin bones in either genus. In both genera the pectoral fin approximates to the same length as the skull roof, and is approximately four times as long as its broadest part. The fin rays emerge from the edges of the fin as long, curved, unbroken elements which then subdivide into smaller elements close to the margins of the fin. The fin rays emerge a short distance from the beginning of the fins, and there are approximately 45–50 rows of lepidotrichia present.

Pelvic fin and girdle. Part of the endoskeletal pelvic girdle is seen preserved only in one specimen of *Barwickia* (AM F98074 part and counterpart, fig. 6 A, B). It shows a large articulatory facet for the axial mesomeres of the pelvic fin, and a short process near this facet which might be the homologue of the dorsomesial process described on the pelvic girdle of *Chirodipterus* (Young et al., 1990, Fig. 4). The overall shape and size of the girdle in *Barwickia* closely matches the girdle of *Chirodipterus* being almost a parallelogram in shape, not elongated with a long anterior process as in *Griphognathus*.

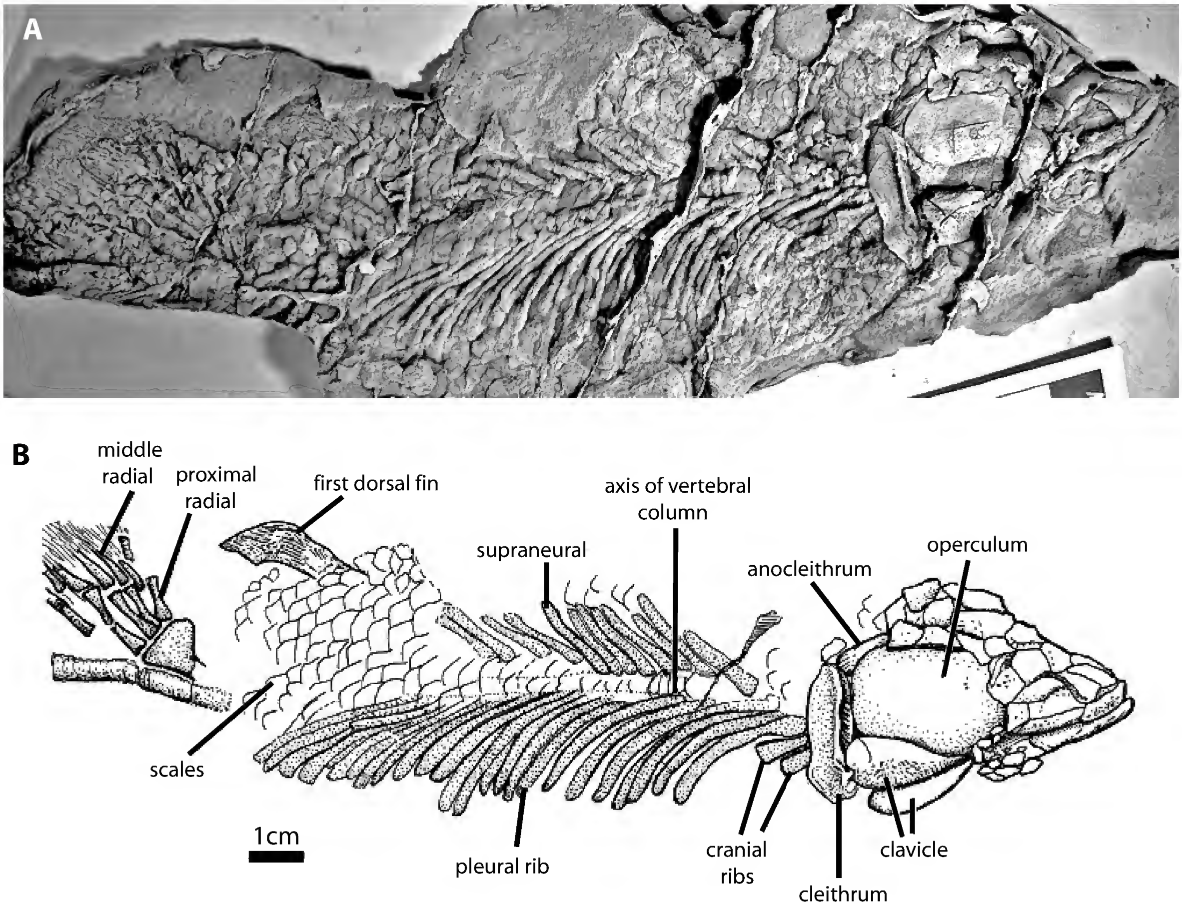

Figure 5. *Barwickia downunda*, features of postcranial skeleton: a, MV P181784; b, interpretive drawing of same.

The pelvic fin is well-preserved in many specimens (e.g. figs. 4, 6) and is of identical shape and proportions to that of the pectoral fin in both genera, exhibiting exactly the same style of fin-ray bifurcation and proportions. The pelvic fin emerges opposite the first dorsal fin, at the point where the paired pleural ribs end. Approximately 40–50 rows of lepidotrichia fringe the dorsal and ventral margins of the fin.

Median fins

Anterior dorsal fin. The anterior, or first dorsal fin, is the smallest of the median fins, being about one fifth the length of the second dorsal fin at its base, and slightly smaller than the anal fin, being approximately 3% of the total length of the fish in both forms. It originates from approximately the 20th to 22nd myotomal segment, and is supported by a dorsally expanded racquet-shaped fin basal (radial), which itself is supported by a shortened supraneural relative to the lengths of the supraneurals anterior and posterior to it. In some specimens of *Barwickia* there is a short median anteriorly directed process developed on the expanded fin support (fig. 6E), a feature not seen in any specimen of *Howidipterus*. The expanded fin basal is approximately half as broad as the expanded anterior support bone for the second dorsal fin.

Groups of three or four stiff lepidotrichia attach to approximately three proximal radials that articulate ventrally with the anterior dorsal fin support bone. These bunches of four or more unsegmented lepidotrichia continue for about half the extent of the fin before giving way to smaller segmented and bifurcating fin rays for the distal extent of the fin. About 16–18 lepidotrichial rows are present at the insertion of the anterior dorsal fin of both genera. The area of the fin supported by unsegmented lepidotrichia was covered by small scales.

Posterior dorsal fin. The posterior, or second dorsal fin, is the largest median fin and extends for approximately 15% the total

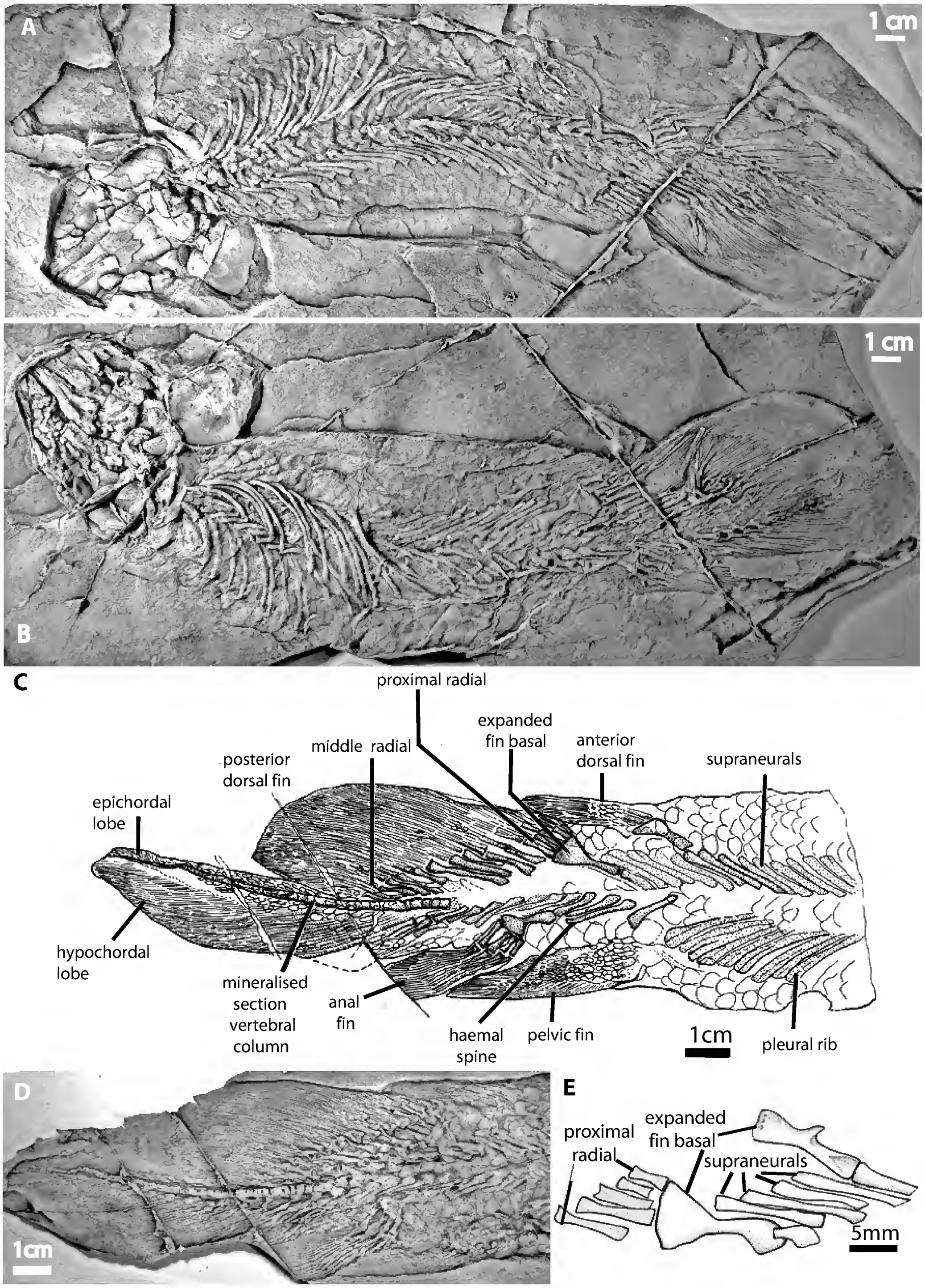

Figure 6. *Barwickia downunda* a and b, AM F98074 body flattened showing postcranial skeleton and head: a, dorsal view; b, ventral view; c, MV P181784, showing details of tail and fins; d, MV P181784, photograph of tail and fins; e, MV P198044, internal support bones for first and second dorsal fins.

length of the fish in both genera (figs. 4, 6). It begins at a point slightly anterior to the anterior margin of the anal fin, although the supraneural leading to the fin-support bones of this fin meets the notochordal axis at the same myotomal segment as the infrahaemal supporting the expanded anal fin bone. In both genera the posterior dorsal fin has a gently lobate shape, and is supported anteriorly by a large expanded radial that articulates distally with five proximal radials that support four middle radials (fig. 6 C, D) that each carry the bunches of 3–4 unsegmented lepidotrichia. This expanded radial has a waisted, stout shaft that expands ventrally to articulate with a thick supraneural. The five proximal radials that support the anterior end of the fin increase evenly in size posteriorly. There are 10–11 other proximal radials that follow posteriorly from the five, articulating with the anterior expanded bone thus totalling 15 or 16 elements. Each of the anterior proximal radials and the anterior expanded bone are supported by supraneurals articulating to the vertebral column, although the posteriormost three or four may articulate directly to the mineralised section of the vertebral column. Their exact position is not clear from the preservation of the material. About 60 rows of unsegmented lepidotrichia support the ventral half of the fin. The expanded anterior fin basal is approximately as large and of identical shape to that of the anal fin support bone.

Anal fin. The anal fin in both genera is only slightly broader in shape than the first dorsal fin and inserts into the same myotomal segment (c. 24th) as the anterior margin of the second dorsal fin. It is supported by a stout racquet-shaped fin basal bone (*Howidipterus*, fig. 2; *Barwickia*, fig. 6C) which articulates dorsally with a short but thick infrahaemal spine. Four proximal radials articulate posteroventrally with the expanded fin basal and these each articulate with a middle radial that supports bunches of 3–5 stiff lepidotrichia. Approximately 15–20 lepidotrichial rows support the dorsal half of the fin.

Caudal fin. The caudal fin is well-preserved in several specimens of both genera and appears to have exactly the same outline and development of fin-ray support bones. The tail is heterocercal with a triangular shape, the axis of the vertebral column being deflected about 20° from the main axis of the body (figs. 4, 6, 8). The ventral edge of the hypochordal lobe begins almost immediately posterior to the anal fin, and equivalent in position to half-way along the posterior dorsal fin. The anterior edge of the hypochordal lobe is supported by three rows of fin support bones: the dorsal series (subhaemals) articulate with the vertebral axis, and distally these articulate with a row of proximal radials which articulate with a 1:1 ratio with middle radials. The middle radials have bunches of unsegmented lepidotrichia attached to them. There appears to be only 8–9 rows of middle radials before the tail narrows, and the proximal radials or subhaemals support the fin directly on the vertebral axis. At this point the rest of the fin structure is unclear, and appears to consist largely of bunches of lepidotrichia inserting directly into the axis of the vertebral column. A small epichordal lobe of segmented lepidotrichia is present in both genera (e.g. *Barwickia*, fig. 6C).

Axial skeleton

The axial skeleton consists of the vertebral column and its articulating spines and ribs. Paired pleural ribs are present throughout the anterior half of the fish, articulating with the first 19–21 vertebral elements within each myoseptum in *Howidipterus*, and between the 20–22 myosepta in *Barwickia*, thereby being almost identical (exact counts are difficult to make due to the overprinting of paired ribs in the crushed state of preservation).

The vertebral column is well-ossified in the tail region of both species, although individual centra are not clearly differentiated, instead there is a continuous ossified or mineralised column. This may represent mineralisation of the notochord in this region as suggested by Schultze (1970) and Arratia *et al*. (2001), or they could be individual ring centra that are only well-ossified in the caudal part of the vertebral column. Anteriorly there are poorly preserved remains of vertebral arches in some specimens (fig. 7). These closely resemble the dorsal arch elements (basidorsals) described in *Griphognathus* by Campbell and Barwick (1988a, Figs. 34, 35). Ventral elements, possibly representing ossified basiventrals are sometimes seen, and impressions of whole body specimens suggest that they were present throughout the vertebral column in younger individuals. The largest specimens

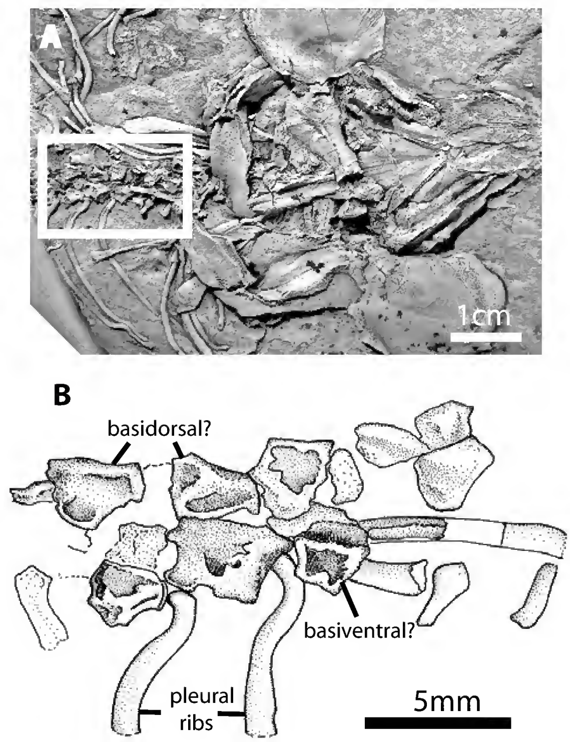

Figure 7. *Barwickia downunda*: a, photograph and b, interpretive drawing of MV P181868, details of anterior vertebral elements.

show no vertebral ossification at all (e.g. large *Howidipterus*, fig. 2). Supraneurals articulate to the vertebral column throughout its length, but no secondary supraneurals are present as exists near the first dorsal fin as in *Fleurantia* (Graham-Smith and Westoll, 1937).

Howidipterus and *Barwickia* have approximately 20–22 vertebrae and supraneurals anterior to the first dorsal fin, then 4–5 or so supraneurals before the second dorsal fin support in *Barwickia*, and 5–7 supraneurals before the second dorsal fin support in *Howidipterus* (these are accurate counts and reflect individual variations). Both forms then show identical development of the second dorsal fin shape and the numbers of supraneurals supporting this fin and subhaemal spines, as described above.

Cranial ribs. Cranial ribs are present in both forms, and appear identical in shape (figs. 3, 5). Long (1993) gave a preliminary description of the cranial ribs in both the Mt. Howitt lungfishes. The expanded rectangular distal ends of the cranial ribs can be often recognised in specimens where the squamation has overprinted the axial skeleton. Each cranial rib has a slightly expanded flat head, narrow neck, and a flat shaft that broadens gradually throughout its distal length. Two pairs of cranial ribs are present in each genus. They are easily identified as being present in the head region of weakly disarticulated specimens of *Barwickia*, being followed by the first pair of pleural ribs. In no specimens can we see the neurocranium preserved, so we can only deduce from the anterior extent of the cranial ribs, moreso than for the pleural ribs (e.g. Long 1993, Fig. 3) that they did articulate to the ventral suture of the brainacase and posterior stalk of the parsphenoidid as in other lungfishes. In AM F89074 (fig. 6) the flat articulatory heads of the cranial ribs are seen lying adjacent to the posterior end of the ossified neurocranium. In *Neoceratodus forsteri* the cranial ribs are oriented almost horizontally (Goodrich, 1958), and it appears that in the fossilised forms from Mt. Howitt the orientation of the cranial ribs was similar as they are commonly observed lying in a different orientation to the paired pleural ribs.

Pleural ribs. Paired pleural ribs (figs. 2, 3, 5–8) are gently curved, almost sigmoid shaped elongate rounded elements which run for most of the length of the trunk, terminating at the level of origin of the pelvic fin. Anterior pleural ribs are longer than the posterior elements, and have a more distinct curvature.

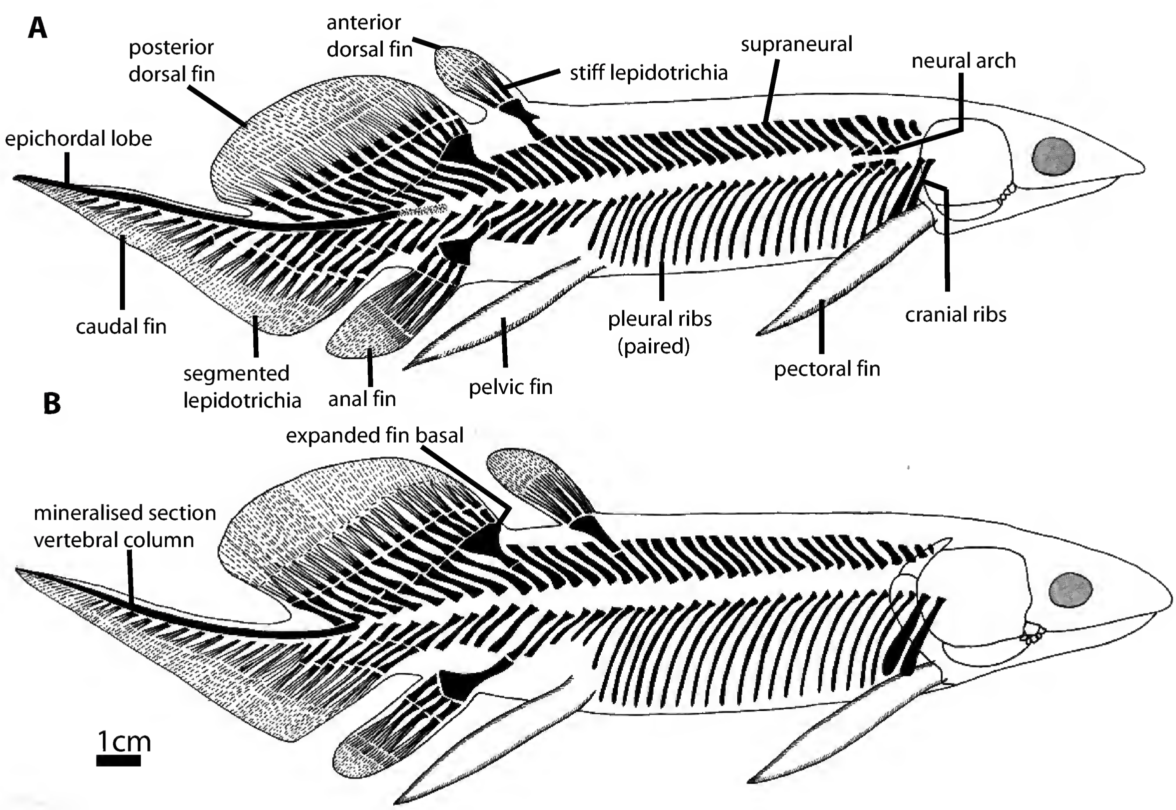

Figure 8. Reconstructions of postcranial skeletons: a, *Barwickia* and b, *Howidipterus*. Paired elements such as pleural and cranial ribs are drawn in full.

Approximately 18–20 pairs of these ribs are present in both forms. They articulate dorsally with the basiventral element of the vertebral column at a slightly expanded head having a flat articulatory surface meeting the basiventral (fig. 7).

Phylogenetic significance of dipnoan postcranial features

During the Devonian Period lungfishes underwent major changes in both their cranial and postcranial skeletons, leading directly to the lineage of tooth-plated forms including the modern genera. By the Early Carboniferous, forms like *Uronemus (Ganopristodus)* had acquired essentially the same body and fin shape seen in all subsequent lungfishes, including extant forms: a single continuous dorsal fin that is merged with the caudal and anal fins to give a diphycercal fin shape. A transformation series of intermediate morphological stages in acquiring this pattern can be seen in various Devonian dipnoans, represented by the few known from complete or near complete body fossils (e.g. Long 1993, Fig 7).

The series begins with the only Early Devonian genus in which the approximate form of the body and fins is known, *Uranolophus*. It shows the presence of two dorsal fins and a large, separate anal fin, and a heterocercal caudal fin with high angle axis of tail to body (although it is incompletely preserved, Denison, 1968; Campbell and Barwick, 1988b). Even in the earliest known dipnoan the anterior dorsal fin is slightly smaller than the posterior fin. Some Late Devonian forms, like *Rhynchodipterus* retain this primitive pattern in having two almost equidimensional dorsal fins, a similarly sized anal fin and large upturned heterocercal tail (Save-Soderbergh, 1937). In *Griphognathus* there are also two widely separated dorsal fins, with the anterior fin is seen to be slightly smaller than the posterior dorsal fin (Schultze 1969; Campbell and Barwick 2002).

Dipterus shows a slightly more derived condition than these forms in that the second dorsal fin is enlarged much more than the first dorsal fin (Forster-Cooper, 1937 plate 3; Ahlberg and Trewin, 1994). In *Dipterus* the first dorsal fin has about 18 unsegmented lepidotrichia as in *Howidipterus* and *Barwickia*, while the second dorsal fin has about 40 or so unsegmented lepidotrichia, as compared with approximately 60 or so in the Mt. Howitt forms. Whilst these Australian genera closely resemble *Pentlandia* in this respect, the latter, from the Middle Devonian of Scotland, has several distinguishing differences in the skull morphology. However *Pentlandia* requires a detailed study to determine its exact affinities and is here regarded as having similar level of organisation in its postcranial skeleton as the two Mt. Howitt genera. *Pinnalongus* from the Eifelian of Scotland shows a similar condition to the Mt Howitt forms in having a very small anterior dorsal fin and extensive posterior dorsal fin (Newman and Den Blaawen 2007).

Fleurantia represents the next stage in the transformation series from the Mt. Howitt forms (and possibly *Pentlandia*). *Fleurantia* has a much larger second dorsal fin, with many more proximal radials (16–21 elements, approximately 100 rows of unsegmented lepidotrichia; Cloutier, 1996). The first dorsal fin is approximately the same size and has a similar number of unsegmented lepidotrichia as in the Mt. Howitt forms, but the anal fin in *Fleurantia* is further reduced in only having 3 proximal radials articulating with the expanded fin basal. Unlike the Mt. Howitt forms, *Fleurantia* lacks an expanded fin basal supporting the anterior region of the second dorsal fin and has a few secondary supraneurals present near the first dorsal fin.

Scaumenacia represents the next stage in the series in having a greatly expanded, but low first dorsal fin, and a larger second dorsal fin (supporting approximately 180 long lepidotrichia; Cloutier, 1996). It is also more derived than *Fleurantia* and the Mt. Howitt forms in having lost the ossified radials supporting the first dorsal fin, and in having the tail terminate in a long, thin caudal filament.

Phaneropleuron, from the Famennian Rosebrae Beds of Scotland, shows similar level of organisation to *Scaumenacia* but incorporates both dorsal fins with the enlarged epichordal lobe of the tail, which has now achieved a diphycercal shape, although the anal fin is still separate. This genus also requires further study of its postcranial skeleton before it can be compared in detail with the previous forms.

Finally, merging the anal fin with the diphycercal tail arrives at the condition seen in all later lungfishes, as typified in the Lower Carboniferous genus *Uronemus* (=*Ganopristodus*, Schultze, 1992).

From the above descriptions and discussion the following observations and hypotheses can be suggested regarding the phylogenetic significance of each character.

Cleithrum. In primitive dipnoans the cleithrum has a weakly developed branchial lamina (*Uranolophus*, Campbell and Barwick, 1988b), although the feature is subsequently well-developed in many Devonian forms (e.g. *Scaumenacia, Chirodipterus, Eoctenodus, Barwickia, Howidipterus).* Campbell and Barwick (1988a) pointed out several differences between the cleithrum of denticulate lungfishes and that of the presumed monophyletic 'tooth-plated forms'. Their comparisons used *Griphognathus* and *Uranolophus* as denticulated forms, and *Chirodipterus, Scaumenacia* and *Eoctenodus* as tooth-plated forms. The new material from Mt. Howitt shows that unlike the condition described for *Griphognathus* and *Uranolophus, Barwickia* possessed a cleithrum (and clavicle) that was essentially the same as in *Howidipterus* in possessing a large, medially extensive branchial lamina. The same type of extensive branchial lamina is also present in *Holodipterus*, regarded as one of the members of the denticle-shedding lineage by Campbell and Barwick (1991) but by Smith (in Campbell and Smith 1987, p.165) as a form that could have been derived from earlier tooth-plated forms such as *Dipterus* or *Speonesydrion*.

Fin support bones. The development of expanded racquet-shaped median fin support bones is seen only in the Mt. Howitt forms and in the anal fin of *Fleurantia*. In *Griphognathus whitei* there are large expanded basal bones, but these do not taper into thin rods as occurs in *Fleurantia, Barwickia* and *Howidipterus*. Furthermore, *Griphognathus whitei* has a unique type of dorsal and anal fin-support bone with enlarged secondary fin basals supporting several proximal radials, and can be regarded as specialised in this respect (e.g. WAM 86.9.

645, Pridmore and Barwick, 1993, Fig. 8 shows the fin basal for the posterior dorsal fin). Thus the expanded racquet-shaped fin basals could either represent a synapomorphy of *Fleurantia* and the Mt. Howitt lungfishes or a homoplasy. As *Fleurantia* and the Mt. Howitt forms otherwise show very similar levels of development and dentition (Long, 1993), and the similar shaped second dorsal fin of *Scaumenacia* does not have a similar enlarged basal, we here consider it to be a derived feature of the Family Fleurantiidae (defined nodally as the clade *Fleurantia, Howidipterus* and *Barwickia* in Ahlberg et al. 2006), and possibly also including *Jarvikia*, based only on cranial features shared with *Fleurantia* (Campbell and Barwick, 1990, Cloutier, 1996); and *Andreyevichthys*, based on similar dentition (Smith et al., 1993). The presence of a few secondary supraneurals near the first dorsal fin of *Fleurantia* is here considered an autapomorphy of that genus as such bones have not been recorded in any other fossil lungfish.

Fin shapes. The stages leading to the acquisition of the modern dipnoan body and fin shape have been summarised in the discussion above. The primitive condition is having two equidimensional or nearly equally sized dorsal fins, separate anal and heterocercal caudal fins without epichordal lobes as seen in other sarcopterygians (e.g. *Osteolepis, Glyptolepis).* The following characters are therefore seen as derived with respect to this condition, as outlined in Ahlberg and Trewin (1994): (a) reduction of first dorsal fin, slight enlargement of second dorsal fin (e.g. *Dipterus);* (b) enlargement of second dorsal fin *(Howidipterus, Barwickia, Pentlandia*); (c) greater enlargement of second dorsal fin *(Fleurantia)*; (d) first dorsal fin elongated but low, greater expansion of second dorsal fin, long caudal filament developed on main axis of caudal fin *(Scaumenacia); (e),* continuous long dorsal fin axis of tail horizontal, not inclined *(Phaneropleuron); (f)* anal fin merged with continuous dorsal fin *(Conchopoma, Uronemus,* all Late Palaeozoic to Recent lungfishes).

Vertebrae. The vertebrae are weakly ossified in primitive forms, consisting of ossified neural arches that straddle an unconstricted notochord *(Uranolophus,* Campbell and Barwick, 1988b; *Dipterus*, Ahlberg and Trewin, 1994; Schultze, 1975). Through the arches passes the spinal chord and dorsal ligament.

Ossified spool-shaped centra are found only in a few forms (e.g. *Griphognathus)*, and are considered to be a derived condition by outgroup comparison with other primitive sarcopterygians (e.g. separate intercentra and pleurocentra are primitive for other sarcopterygians; Andrews and Westoll, 1970; Ahlberg, 1989). The presence of vertebrae, as separate basidorsal and/or basiventral ossifications is observed in *Scaumenacia* (Cloutier, 1996) and at various growth stages in the Mt. Howitt forms. Modern lungfishes have basidorsals and basiventrals present as cartilaginous units (Goodrich, 1958; Shute, 1972), possibly a derived condition due to loss of bone from primitive forms.

Ribs. These have been found in all dipnoans where whole body features are preserved, and are often referred to as 'pleural ribs' in the thoracic region of the body. It is unknown whether paired pleural ribs were extensively present in *Uranolophus* or other primitive marine dipnoans like *Dipnorhynchus, Speonesydrion, Ichnomylax* or *Melanognathus*. If so, then this feature would have no special significance for evolution within the Dipnoi, but otherwise could be a derived condition within later dipnoans that co-evolved with the development of larger lungs. The well-developed ribs present in all the marine dipnoans from the Middle-Late Devonian Gogo (Campbell and Barwick 2002) and Bergisch-Gladbach faunas (Schultze 1975) do not appear to be strongly curved as in the Mt Howitt forms, so we assume this kind of 'pleural' rib found in the Mt Howitt species evolved for accommodation of a larger lung for air-breathing. The pleural ribs in *Dipterus* appear to be primitively short compared with the longer elements seen in *Barwickia* and *Howidipterus*.

Cranial ribs. Early reports of cranial ribs in one specimen of *Fleurantia* (Graham-Smith and Westoll: 255) and in *Scaumenacia* (Goodrich, 1909) have been confirmed by observation of casts of these species held in the collections of the Geology Department at the Australian National University, and of original specimens of *Scaumenacia* held in the Museum of Victoria. Aside from *Barwickia* and *Howidipterus*, the only other Devonian dipnoans to have cranial ribs are *Rhinodipterus ulrichi* (Schultze, 1975), a marine form, and possibly incipient cranial ribs in *Dipterus* (Ahlberg and Trewin, 1994), known from both freshwater and marine environments. Observation of the marine Gogo specimens of *Chirodipterus, Gogodipterus* and *Griphognathus* also show that cranial ribs were absent in these forms (Campbell and Barwick 2002). The presence of cranial ribs in lungfishes, being absent in plesiomorphic fully marine forms), would appear to be a good synapomorphy uniting air-gulping forms (Long, 1993). The actual morphology of the cranial ribs has not been previously considered, although some new information is now at hand. In *Dipterus* (Ahlberg and Trewin, 1994, Fig. 6) the enlarged ribs identified as possible cranial ribs are not ventrally expanded, showing the condition of being enlarged pleural ribs that probably articulated with the posterior end of the braincase. The cranial ribs in *Barwickia* and *Howidipterus* are here considered to be more specialised than those of *Dipterus* in having distally expanded, flat shapes, allowing for more surface area on the lateral and mesial surfaces of the ribs for attachment of ligaments to anchor the pectoral girdle.We note the occipital ribs, that articulate to the posterodorsal surface of the neurocranium, have not been observed in the Mt.Howitt forms.

Dipnoan evolution: evidence from the Mt. Howitt dipnoans

The two genera of lungfishes from the Mt. Howitt deposit exhibit identical postcranial skeletons, and cranial morphologies that differ slightly but are still at a similar grade of evolution with respect to approximate numbers of skull roof bones and cheek bone patterns (Long, 1992). *Barwickia* shows a dentition that was at first thought to be typical of the denticulate feeding mechanism (Long, 1992) but later shown to be a form of tooth plate with large denticle fields present (Long, 1993). It should be pointed out though that the histology of these tooth plates is not known as the material can only be studied from latex peels.

Howidipterus shows more typical dipnoan tooth plates that closely resemble those of *Scaumenacia* in overall morphology but can also be demonstrated to be closely related to those of *Barwickia*. Dissociated heterochrony was invoked as a possible mechanism for the development of the *Barwickia* type tooth plate based on the known growth changes that occur during the ontogeny of *Andreyevichthys* toothplates (Long, 1993). This means that different rates of growth apply to the developmental stages, such as peramorphic development of the denticle field whilst there is restrained growth of the tooth rows (paedomorphosis). From these observations, and the overall nature of the Mt. Howitt fauna, with a high proportion of endemic fauna, and palaeogeographically representing a highland intermontane sedimentary basin deposit (Cas et al. 2004), and the recent phylogenetic analysis supporting the two lungfishes *Barwickia* and *Howidipterus* as very closely related (Ahlberg et al. 2006), we suggest that they may have had a comparatively recent divergence from a common ancestor. In overall body form they are identical, so must have had identical functional morphologies with respect to their mode and speed of swimming. As they inhabited the same lake system, each must have occupied a different niche primarily based on differing food preference in the lacustrine food chain. To date there are no invertebrate fossils known from the Mt. Howitt deposit, despite delicate, articulated preservation of both the fish (in all stages of growth) and plants, thus sources of food for the lungfish are possibly to be found in the known fossil record of the site, or alternatively as soft-bodied invertebrates not preserved in the fossil deposit. The teeth of *Barwickia* suggest it fed by a mechanism similar to those of denticulate forms, like *Fleurantia* or holodipterids that have predominantly denticle-covered plates with a few larger cusps set in rows (Pridmore et al., 1994), possibly being a predator on either smaller fishes or soft bodied invertebrates. *Howidipterus*, on the other hand, had more typical dipnoan crushing tooth plates suited to triturating food, potentially lycophytous and psilophytous plant material that grew or fell into in the lake.

Lakes are often highly endemic, closed systems (Day et al., 2009) and are analogous to islands in their isolated nature (Danley and Kocher, 2001). Local speciations and adaptive radiations are often influenced by past environmental factors such as climate change (Day et al., 2009) and sea level changes (Beheregaray et al., 2002, Bohlen et al., 2006). Another driving factor is that of resource availability (Liem, 1974), the evolution of variation has been demonstrated particularly for fish in low-resource environments (Schluter, 1995; Roy et al., 2004). There are many examples of sympatric lacustrine speciations of fish (Humphries and Miller, 1981; Day et al., 2009) and invertebrates such as gastropods (Glaubrecht and Kohler, 2004) and shrimp (von Rintelen et al., 2007). The best-known example is that of the cichlids in the great lakes of East Africa (Liem, 1974; Schliewen et al., 1994; Danley and Kocher, 2001; Streelman et al., 2007). These cichlids underwent three major bursts of cladogenesis; driven by habitat choice, competition for food resources, and the third burst has been attributed to sexual selection for male colouration. The secondary radiation (trophic morphology) was most pronounced in the rock-dwelling genera (Danley and Kocher, 2001).

This pattern of diversification of body form and trophic structure is also seen in many other freshwater fishes including the threespine stickleback *Gasterosteus aculeatus* (Cresko and Baker, 1996), the Arctic charr *Salvelinus alpinus* (Snorrason et al., 1989) and the Brook charr *Salvelinus fontinalis* (Dynes et al., 1999). However the condition exhibited by the Mt. Howitt fauna of divergent trophic morphologies with limited postcranial differentiation is much less common. Fish with similar postcranial morphologies are likely to have comparable locomotive ability and occupy a common habitat. Trophic specializations can diverge extremely rapidly (in "contemporary time") in response to different resource availability as seen in the Arctic charr (Adams et al., 2003; Knudsen et al., 2007; Michaud et al., 2008) and some cichlids (Liem, 1974; Streelman et al., 2007). This indicates that the two Mt. Howitt species may have only relatively recently diverged from a common ancestor into two morphs with radically differing dentition, most likely as a result of competition in a low-resource environment.

Acknowledgements

Thanks to Professor Jim Warren (Zoology Department, Monash University) for allowing JL to initially work on the Mt. Howitt material, and Mr. Ian Stewart for his assistance during the preparation and casting of the specimens.The following people are thanked for helpful discussion on the material: Professor Ken Campbell, Dr. Dick Barwick and Dr. Peter Pridmore (A.N.U. Geology Dept.), Dr. Gavin Young, (AGSO, Canberra), Dr. Richard Cloutier (Universite de Sciences et Techniques, Lille, France), Dr Ken McNamara (Cambridge University) and Dr. Hans-Peter Schultze (University of Kansas, U.S.A.). Tim Holland assisted in making latex peels of the Mt Howitt fishes. This work was supported under ARC Grant DP 0772138.

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Memoirs of Museum Victoria 66: 203–213 (2009)

ISSN 1447-2546 (Print) 1447-2554 (On-line)
http://museumvictoria.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria

New asterinid species from Africa and Australia (Echinodermata: Asteroidea: Asterinidae)

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Abstract

O'Loughlin, P.M. 2009. New asterinid species from Africa and Australia (Echinodermata: Asteroidea: Asterinidae). *Memoirs of Museum Victoria* 66: 203–213.

Three new species are described: *Aquilonastra shirleyae* sp. nov. from central Western Australia; *Asterina hoensonae* sp. nov. from southern Africa; *Callopatiria cabrinovici* sp. nov. from central east Africa. The variety *Disasterina leptalacantha* var *africana* Mortensen is *Tegulaster leptalacantha* (H.L. Clark). *Asterina gracilispina* H.L. Clark is reviewed systematically.

Keywords

Australia, Africa, Echinodermata, Asteroidea, Asterinidae, *Aquilonastra*, *Asterina*, *Callopatiria*, *Parvulastra*, *Tegulaster*, new species, generic reassignment

Introduction

This paper continues a series on family Asterinidae. Genus *Meridiastra* O'Loughlin, 2002 was erected to accommodate some southern Australian and Pacific species that had been assigned to *Asterina* Nardo, 1834. O'Loughlin et al. (2002) reviewed species *Patiriella regularis* (Verrill, 1867) using morphological and molecular data, and a new species of *Patiriella* Verrill, 1913 was described for New Zealand. O'Loughlin et al. (2003) reviewed genus *Patiriella* Verrill, 1913 using morphological and molecular data, and three new species were described for southern Australia. O'Loughlin and Waters (2004) revised genera of Asterinidae based on morphological systematics and a molecular phylogeny, and four new genera were erected with O'Loughlin as author. O'Loughlin and Rowe (2005) erected a new genus for the Indo-West Pacific region, and described five new species. Most recently O'Loughlin and Rowe (2006) undertook a morphological systematic revision of genus *Aquilonastra* O'Loughlin, 2004, and described 13 new species. In O'Loughlin and Waters (2004) and O'Loughlin and Rowe (2006) genera *Aquilonastra* O'Loughlin, *Asterina* Nardo, *Callopatiria* Verrill, 1913, *Parvulastra* O'Loughlin, 2004 and *Tegulaster* Livingston, 1933 were discussed in detail, and are the subjects of systematic work here.

This work is based on a continuing study of loan material from the Australian Museum (Sydney; AM with registration prefix J), Muséum National d'Historie Naturelle (Paris; MNHN with registration prefix EcAs), Museum of the Republic of Central Africa (Brussels; MRAC), Museum Victoria (Melbourne; NMV with registration prefix F), Natural History Museum (London; NHM), South Africa Museum (Cape Town; S.A.M. with registration prefix A for asteroids) and University of Florida (UF). Recently included in this study is a Western Australian Museum (Perth; WAM with registration prefix Z) loan of specimens from voyage SS10/05 by the RV *Southern Surveyor* for Australia's national science agency, the Commonwealth Scientific and Industrial Research Organization (CSIRO) through the Marine National Facility. New species of *Aquilonastra* O'Loughlin from Western Australia, *Asterina* Nardo from South Africa, and *Callopatiria* Verrill from east Africa are described. Type specimens of species of *Asterina* and *Disasterina* Perrier, 1875 that are held in the South Africa Museum are reviewed.

Methods

Skeletal plates were cleared for observation using commercial bleach. Terminology follows O'Loughlin and Waters (2004). Photographs for figures 1, 3a, 3c, and 4 were taken by Leon Altoff and Audrey Falconer using a Pentax K10D camera, with an Olympus 80 mm f4 macro lens with bellows for large specimens and Olympus 38 mm f2.8 macro lens with bellows for small specimens. Photographs for figures 2, 3b, 3d, and 5 were taken by Chris Rowley using a Leica MZ16 stereomicroscope, DC300 Leica digital camera, and "Auto-Montage" software. Figures were prepared by Caroline Harding.

Asterinidae Gray, 1840

Remarks. See O'Loughlin and Waters (2004).

Aquilonastra O'Loughlin, 2004

Remarks. See O'Loughlin and Waters (2004), O'Loughlin and Rowe (2006).

Aquilonastra shirleyae sp. nov.

Figure 1a–f

Material examined. Holotype: Western Australia, Point Cloates, 22°50'55" S, 113°30'39" E to 22°51'29" S, 113°30'50" E, 100 m, *Southern Surveyor*, SS10/2005 stn 135, M.P. Salotti and S. Slack-Smith, 9 Dec 2005, WAM Z37278.

Paratype: Red Bluff, 24°02'37" S, 113°01'37" E to 24°02'50" S, 113°01'44" E, 100 m, *Southern Surveyor*, SS10/2005 stn 126, M.P. Salotti and S. Slack-Smith, 8 Dec 2005, WAM Z37279 (1, denuded).

Description. Small, stellate, R = 13 mm, r = 5 mm (holotype; abnormal abactinal digitiform growth near disc), R = 8 mm, r = 4 mm (paratype; 2 rays regenerating); 5 sub-equal discrete rays, subdigitiform, interradial margin deeply incurved; rays tapering to narrow rounded distal end; rays flat actinally, high domed elevation abactinally; body integument not evident; single madreporite; not fissiparous; gonopores abactinal; glassy convexities on plates; superambulacral and superactinal plates present internally.

Abactinal: disc not discretely defined; rare proximal doubly or singly papulate carinal plates on holotype, weakly developed singly papulate carinal series on paratype, remaining upper ray plates irregular in arrangement; non-carinal plates crescentiform with single notch for papula; papular spaces small, single papula per space; 3 longitudinal series of singly papulate plates along each side of rays; rare secondary plates except in disc area; large white opaque bi-valved pedicellariae over papulae on upper sides of rays of holotype, less developed on small paratype; spinelets glassy, conical or columnar, up to about 0.15 mm long, tapered or splay-pointed distally, rugose, in splayed clusters on plates, in 3 small clusters across rare doubly papulate carinal plates, up to about 25 spinelets per plate; ends of distal abactinal interradial splayed spinelets rarely overlap ends of adjacent plate spinelets.

Margin: superomarginal plates about half size of inferomarginal plates, both in regular series; up to about 16 spinelets on both superomarginal and inferomarginal plates, thicker on inferomarginals.

Actinal: plates in longitudinal series, parallel to furrow; complete series of adradial actinal plates and spines. Actinal spines per plate: oral 8–10, suboral 7–9, ambulacral / furrow 7–8, subambulacral 7–8, proximal actinal 7–10, distal actinal, 7–10; oral spines digitiform, rugose; other actinal spines thin, glassy, rugose, pointed distally.

Colour. Live (photo of paratype): abactinal pale mottled with white, pale brown, pale orange; actinal white.

Preserved: white.

Distribution. Western Australia, Point Cloates, Red Bluff, continental shelf, 22–24° S, 113° E, 100 m.

Etymology. Named for Shirley Slack-Smith of the Western Australian Museum, with appreciation of her role in collecting these specimens, and in recognition of four decades of dedicated contribution to Australian marine mollusc research.

Remarks. The new species has the diagnostic characters of genus *Aquilonastra* O'Loughlin as detailed in the emended diagnosis by O'Loughlin and Rowe (2006): discrete rays, interradial margin deeply incurved, stellate; high domed abactinally, flat actinally; abactinal plates predominantly irregular in arrangement on upper rays; longitudinal series along sides of rays, not perpendicular to margin; predominantly single papular notch per plate; predominantly single papula per papular space; numerous elongate glassy spinelets on each abactinal plate; superomarginal and inferomarginal plates in regular series; suboral spines present; adradial actinal spines in complete series; superambulacral and superactinal plates present internally.

A key to the 24 species of *Aquilonatra* is provided by O'Loughlin and Rowe (2006). *Aquilonastra shirleyae* sp. nov. is close diagnostically to *Aquilonastra rowleyi* O'Loughlin and Rowe, 2006 (Sodwana Bay, SE Africa) and *Aquilonastra watersi* O'Loughlin and Rowe, 2006 (Arabian and Red Seas, and western Indian Ocean). *Aquilonastra shirleyae* is distinguished from *Aquilonastra rowleyi* (details in brackets) by: size (up to R = 23 mm); subdigitiform rays (rays short, wide at base; fig. 6i in O'Loughlin and Rowe, 2006); pedicellariae squat (elongate; fig. 10c in O'Loughlin and Rowe, 2006); disc not discretely defined (disc clearly bordered; fig. 10b in O'Loughlin and Rowe, 2006); superomarginal plates half size of inferomarginals (subequal); actinal interradial spines 7–10 (3–4).

Aquilonastra shirleyae is distinguished from *Aquilonastra watersi* (details in bracket) by: size (up to R = 19 mm); rays that are thinner, with narrower base (rays short with wide base; figs. 3j, 10e in O'Loughlin and Rowe, 2006); few singly and doubly papulate carinal plates (up to 10 doubly papulate); up to about 25 abactinal spinelets per plate (up to about 20); pedicellariae conspicuous (inconspicuous; fig. 6l in O'Loughlin and Rowe, 2006); up to about 16 superomarginal spinelets per plate (up to about 7); up to 10 actinal spines per plate (up to 8); mottled very pale white, pale brown, pale orange (mottled pale brown, red-brown, grey-brown, blue-grey; off-white; fig. 3j in O'Loughlin and Rowe, 2006).

O'Loughlin and Rowe (2006) reported most *Aquilonastra* species from the shallow sub-littoral to about 50 m. *A. batheri* (from Japan) was reported to 92 m, and *A. cepheus* (from southern China to northern Australia) to 70 m. *A. rosea* (SW Australia) was reported to 110 m, the only occurrence deeper than *A. shirleyae*.

Asterina gracilispina H.L. Clark, 1923

Figure 2a–d

Asterina gracilispina H.L. Clark, 1923: 286–287, pl. 16 figs. 3–4.—A.M. Clark, 1974: 437 (part).—A.M. Clark and Courtman-Stock, 1976: 77 (part).

Material examined. Holotype (dry): South Africa, East London, SW of Cove Rock, 40 m, S.A.M. A6421.

Description. Small, subpentagonal, R = 6 mm, r = 4 mm; rays 5, discrete, wide at base, short, rounded distally; low convex abactinally, flat actinally, sides not steep, margin acute; body integument not evident; single inconspicuous madreporite; not fissiparous; gonopores not seen; glassy convexities on plates; presence or absence of superambulacral and superactinal plates

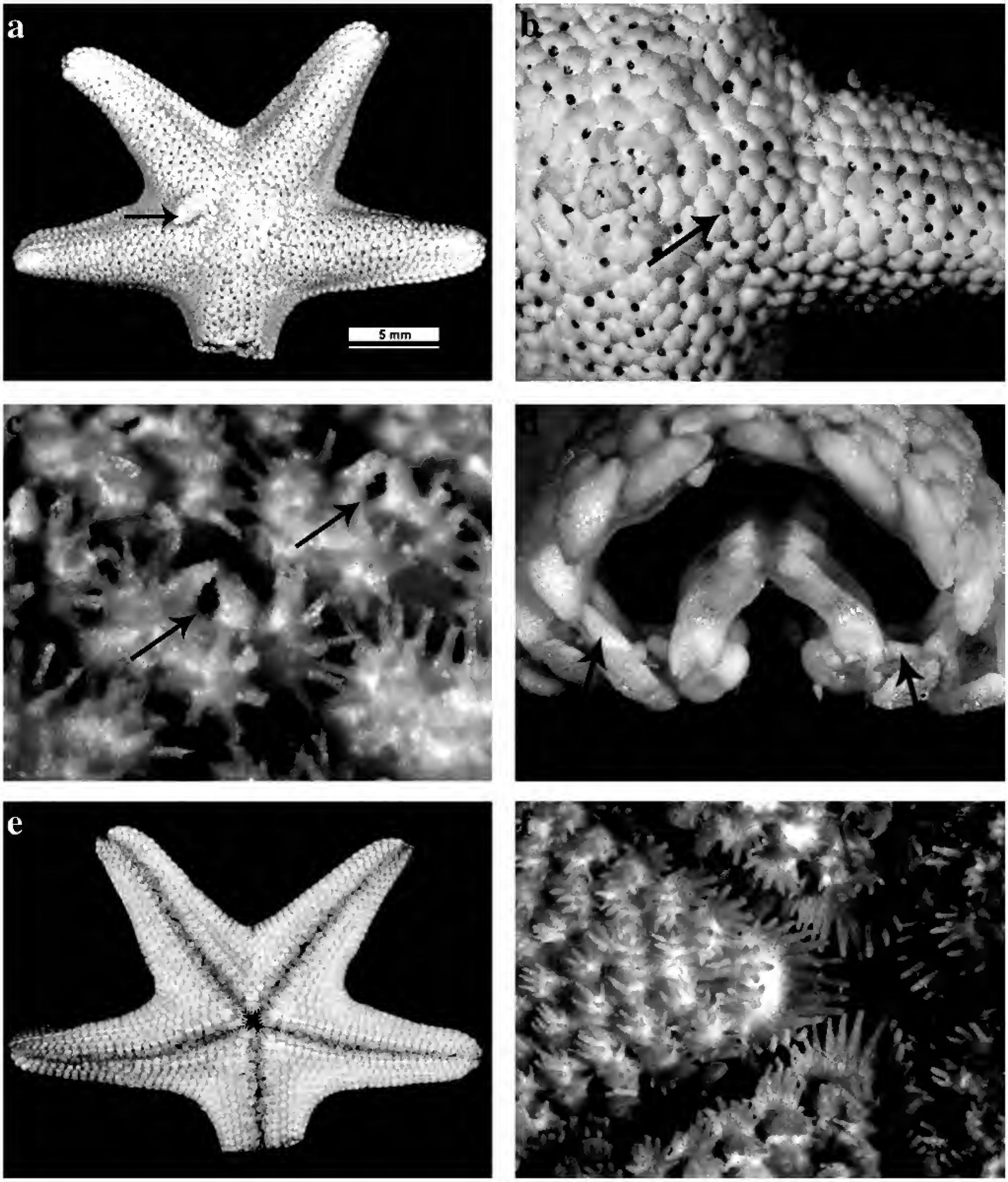

Figure 1. *Aquilonastra shirleyae* sp. nov. (photos by L. Altoff and A. Falconer). Holotype, WAM Z37278 (R = 13 mm; all except b); paratype WAM Z37279 (R = 8 mm; cleared; b only). a, abactinal surface (one ray dissected off; abnormal digitiform growth arrowed). b, disc not discretely defined; few proximal carinal plates with single papula arrowed. c, abactinal pedicellariae (arrowed) and spinelets on upper side of ray. d, section through cleared ray showing superambulacral plates (right arrow) and superactinal plates (left arrow). e, actinal surface with actinal plates in longitudinal series. f, oral, suboral, furrow, subambulacral and proximal actinal spines.

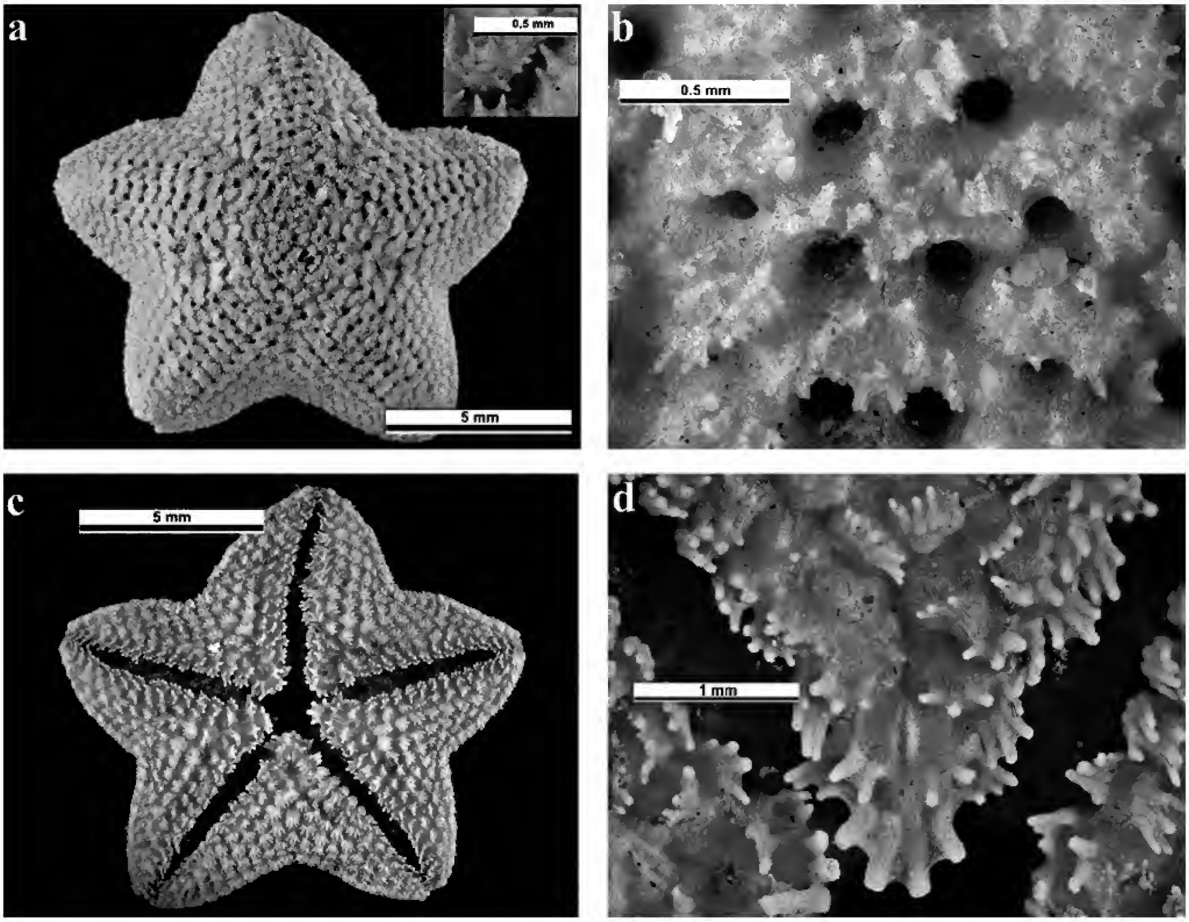

Figure 2. *Asterina gracilispina* H.L. Clark, 1923 (photos by C. Rowley). Holotype, S.A.M. A22559 (R = 6 mm). a, abactinal surface, insert showing spinelets. b, carinal series of doubly papulate plates and spinelets. c, actinal surface with actinal plates in longitudinal series. d, oral, suboral, furrow, subambualcral and proximal actinal spines.

unknown (small type specimen not dissected); glassy convexities on plates.

Abactinal: disc not distinctly bordered; plates imbricate, projecting proximal edge frequently tabular, plates not notched, slight proximal indentation for papula sometimes present, papulae emerge from under projecting proximal raised edge of plates; doubly papulate carinal series of plates along most of upper ray, rare secondary plates; papulae large, single per papular space, rarely 2; 8 longitudinal series of papulae across mid ray; small subsacciform to conical, pointed glassy spinelets, up to about 0.15 mm long, spread over plates, up to 20 per plate.

Margin: superomarginal plates longitudinally elongate, in regular series, up to about 14 spinelets spread over each plate, subequal with abactinal and inferomarginal spinelets, projecting inferomarginal plates with up to about 20 spinelets.

Actinal: interradial plates in longitudinal series, not predominantly oblique; complete series of adradial actinal plates and spines. Actinal spines per plate: oral 5 (2 long proximal; gap to 3 short distally, increasing in length to distalmost longest of 3); suboral 2 (webbed, long); furrow 4–3; subambulacral 4–3; adradial actinal 3–5; actinal interradial up to 7 mid ray, webbed transverse series, frequently 5–6; spines subsacciform to conical.

Distribution. South Africa, East London, 40 m.

Remarks. For O'Loughlin and Waters (2004) I used a specimen from Cape Agulhas, registered to the Natural History Museum in London as *Asterina gracilispina* (NHM 1975.10.29.47), as evidence for remarks on *A. gracilispina*. The subsequent availability of the holotype of *A. gracilispina* for examination in this work has made it possible for me to recognize that the

Cape Agulhas specimen is not conspecific. The Cape Agulhas specimen is similar in form, but is distinguished (R = 12 mm) by: disc distinctly bordered; conspicuous madreporite; short, blunt, digitiform to subgranular abactinal spinelets; 9 oral spines in series tapering evenly from long to very short, spines slightly swollen distally; up to 3 actinal spines mid ray. This specimen is described below as a new species.

Mortensen (1933) referred "with considerable doubt" a specimen (R = 10 mm) in the South Africa Museum from False Bay (26 m) to *A. gracilispina*. His grounds for doubt were: dorsal spinelets blunt; distinct madreporite; 2–3 stout actinal interradial spines. These characters are consistent with those of the Cape Agulhas specimen, described below as a new species of *Asterina*.

A.M. Clark (1974) reported on six specimens from South Africa determined as *A. gracilispina*, but her notes indicate to me that there were two species. Most of the specimens were in poor condition, but details of spine number for the Mossel Bay specimen (R = 6 mm) are compatible with the holotype of *A. gracilispina*. Notes that the Algoa Bay specimen (R = 10 mm) had 3–5 actinal spines per plate and an inconspicuous madreporite indicate that it is also probably *A. gracilispina*. But notes of 9 oral spines and only 2–3 actinal spines for the Cape Agulhas specimen (R = 12 mm; registered to the NHM) confirm the observations discussed above that it is not conspecific with *A. gracilispina* and it is the type for the new species referred to above and described below.

H.L. Clark (1923) was uncertain about generic assignment for this species, and chose *Asterina*. Currently there is inadequate data to confirm or reassign. However, the atypical arrangement and form of the oral spines is similar to that in *Parvulastra* O'Loughlin, 2004. If superambulacral and superactinal plates are present, then the species would be more appropriately assigned to *Parvulastra*.

Asterina hoensonae sp. nov.

Figure 3a–d

Asterina gracilispina.—Mortensen, 1933: 255–256 (non *A. gracilispina*).—O'Loughlin and Waters, 2004: 11, 15–16 (non *A. gracilispina*).—A.M. Clark, 1974: 437 (part non *A. gracilispina*).—A.M. Clark and Courtman-Stock, 1976: 77 (part non *A. gracilispina*).

Material examined. Holotype (in alcohol; part dissected): South Africa, Cape Agulhas, 34°S, 20°E, C. Griffiths (University of Cape Town), NHM 1975.10.29.47.

Description. Small, subpentagonal, R = 12 mm, r = 9 mm; rays 5, discrete, wide at base, short, rounded distally; body integument not evident; low convex abactinally, sides not steep, margin acute, single conspicuous madreporite; gonopores not detected; absence of pedicellariae; absence of superambulacral and superactinal plates; margin supported by internal contiguous projections of abactinal and actinal plates; glassy convexities on plates.

Abactinal: plates imbricate, surface flat, not broken by raised edges of plates, plates not notched, shallow concave proximal indentations for papulae; doubly papulate carinal series of plates along upper ray; papular spaces large, 0–2 secondary plates per space, 0–3 large papulae per space, 10 longitudinal series of papulae across mid ray; disc distinctly bordered; spinelets digitiform to subgranuliform, short, blunt, up to about 0.15 mm long, cover projecting abactinal plates, up to 16 spinelets per plate.

Margin: superomarginal and inferomarginal plates longitudinally elongate, in regular series, up to about 11 slightly conical subgranuliform spinelets spread over each superomarginal plate, subequal with inferomarginal spinelets, projecting inferomarginal plates with up to about 16 spinelets.

Actinal: interradial plates in variably longitudinal and oblique series; complete series of adradial actinal plates and spines. Actinal spines per plate: oral 9 (series tapering uniformly from tall proximally to short distally, tallest spines slightly swollen distally, smallest pointed distally); suboral 3; furrow 6; subambulacral 4; adradial actinal 2–3; actinal interradial 2–3 mid ray, 3–5 distally; spines digitiform, webbed.

Distribution. South Africa, Cape Agulhas (E of Cape Town).

Etymology. Named in appreciation of the contribution to this work by Elizabeth Hoenson of the South Africa Museum, who went to considerable lengths to make available essential loans for this work.

Remarks. The new species has the diagnostic characters of genus *Asterina* Nardo as detailed in the emended diagnosis by O'Loughlin and Rowe (2006): 5 discrete rays; not fissiparous; disc distinctly bordered; carinal series of doubly papulate plates; extensive papulate areas, numerous papulae and secondary plates; abactinal spinelets digitiform to subgranuliform; predominantly 2–3 digitiform actinal spines per plate; lacking superambulacral and superactinal plates; margin supported internally by contiguous projections of abactinal and actinal plates.

Some characters distinguishing *Asterina hoensonae* sp. nov. from *Asterina gracilispina* are listed under *A. gracilispina* above. *Asterina hoensonae* is distinguished from most of the remaining species of *Asterina* (*A. gibbosa, A. ocellifera, A. pancerii*, *A. phylactica* and *A. stellifera*) by lacking pedicellariae; and from *A. fimbriata* by having a distinctly bordered disc.

I discuss this specimen under *Asterina gracilispina* above. It is the specimen I wrongly accepted as being *Asterina gracilispina* in O'Loughlin and Waters (2004). Another specimen (False Bay, 26 m; R = 10 mm) in the South Africa Museum, referred "with considerable doubt" to *A. gracilispina* by Mortensen (1933), is probably *A. hoensonae* (see above). Specimens from Algoa Bay and Mossel Bay referred to *A. gracilispina* by A.M. Clark (1974) and A.M. Clark and Courtman-Stock (1976) are probably *A. hoensonae* (see above).

Callopatiria cabrinovici sp. nov.

Figure 4a–f

Material examined. Holotype: East Africa, Zanzibar, M. Angel, NHM 1965.6.1.743 (dry).

Paratypes: type series, NHM 1965.6.1.744 (1); East Africa, Zanzibar, Mazizini, rocky outcrop, M.D. Richmond, 1993, NHM 2004.2833 (1, dry); Zanzibar, C. Crossland, NHM 1903.4.2.61–62 (2);

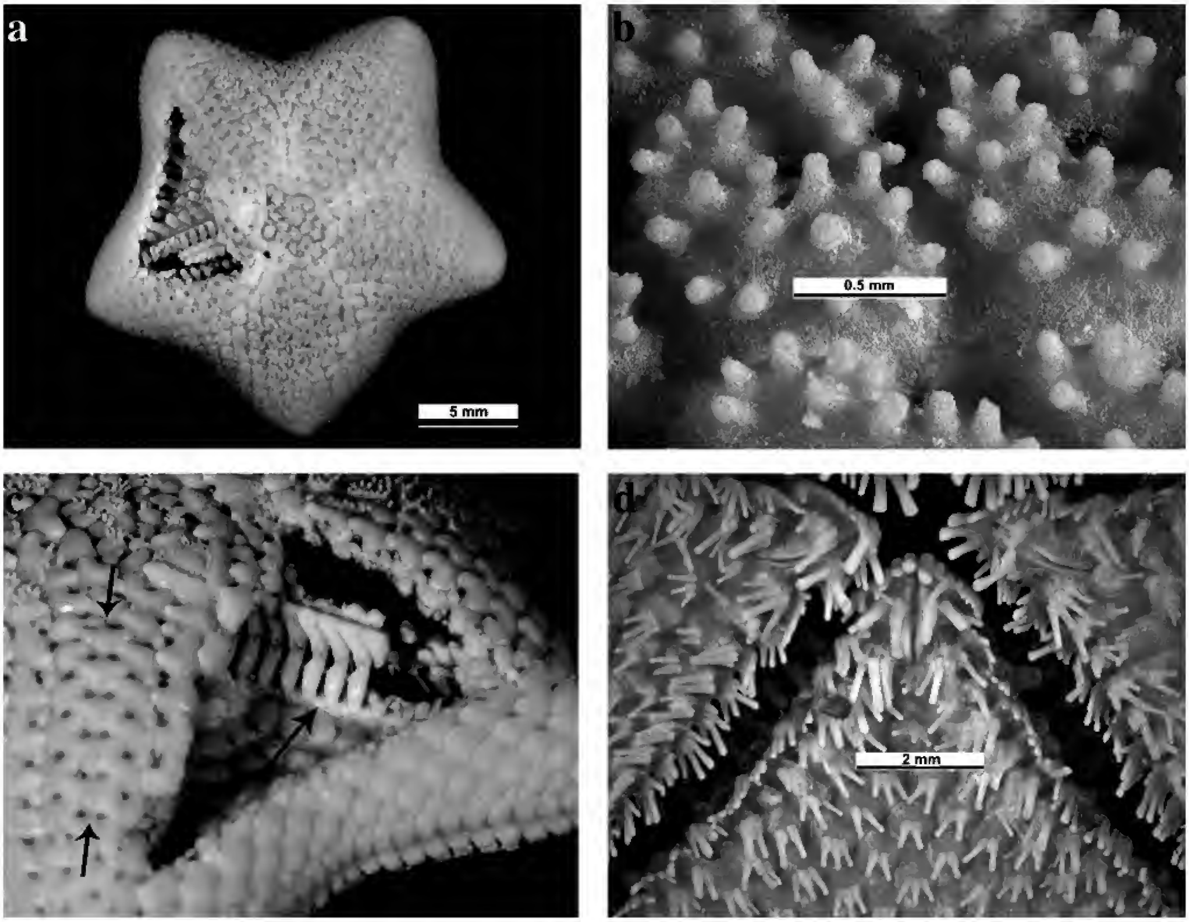

Figure 3. *Asterina hoensonae* sp. nov. (photos a, c by L. Altoff and A. Falconer; b, d by C. Rowley). Holotype, NHM 1975.10.29.47 (R = 12 mm). a, abactinal surface with section of abactinal plates removed. b, abactinal subdigitiform to subgranuliform spinelets. c, abactinal view (plates cleared, section of plates removed), showing doubly papulate carinal series of plates (left arrows) and absence of superambulacral plates (right arrow). d, oral, suboral, furrow, subambulacral and proximal actinal spines.

Kenya, Watamu, Ras Ngomeni, W.F. Humphreys, 1 Apr 1969, NHM 1979.2.5.147 (1); Watamu, rock platform, sub-littoral, W.F. Humphreys, 9 Sep 1969, NHM 1979.2.5.146 (2).

Other material. *Callopatiria cabrinovici* sp. nov. Kenya, Shimoni, J.D. Taylor, NHM 1973.10.4.48 (1); Zanzibar, Dr Kirk, NHM 68.3.6.13 (1); N Oman, Khesab Bay, coral reef, P. Cornelius, 30 Dec 1971, NHM 1972.4.10.57 (1).

Callopatiria granifera (Gray, 1847). South Africa, Western Cape Province, NMV F98049 (1, donation to NMV by A. Thandar).

Description. Rays 5, discrete, subdigitiform, narrow base, tapering to point or narrowly rounded end, broadly flat actinally, acute angular margin, sides steep, close to perpendicular, high convex abactinally; size large, rays unequal, up to R = 27–35 mm; integument evident; conspicuous single madreporite, not fissiparous; lacking pedicellariae; complete series of internal superambulacral plates; interradial margin supported by numerous internal superactinal plates; superambulacral and superactinal plates contiguous on actinal internal surface for most of ray length; inner resinous brown lining to ray; gonopores not observed.

Abactinal: plates thick, imbricate, angled; disc weakly delineated in larger specimens, disc boundary typically 5 transversely elongate radials each with narrow band of up to about 50 spinelets, 5 small interradials; lacking carinal series of plates; longitudinal band ("field") of primary and secondary upper ray plates, irregular in arrangement and form, plates with shallow concave indentation for single papula, crescentiform, not sharply notched; papulate areas extensive, papular spaces large, predominantly 1 large papula per space, secondary plates numerous, frequently 1 per papular space; up

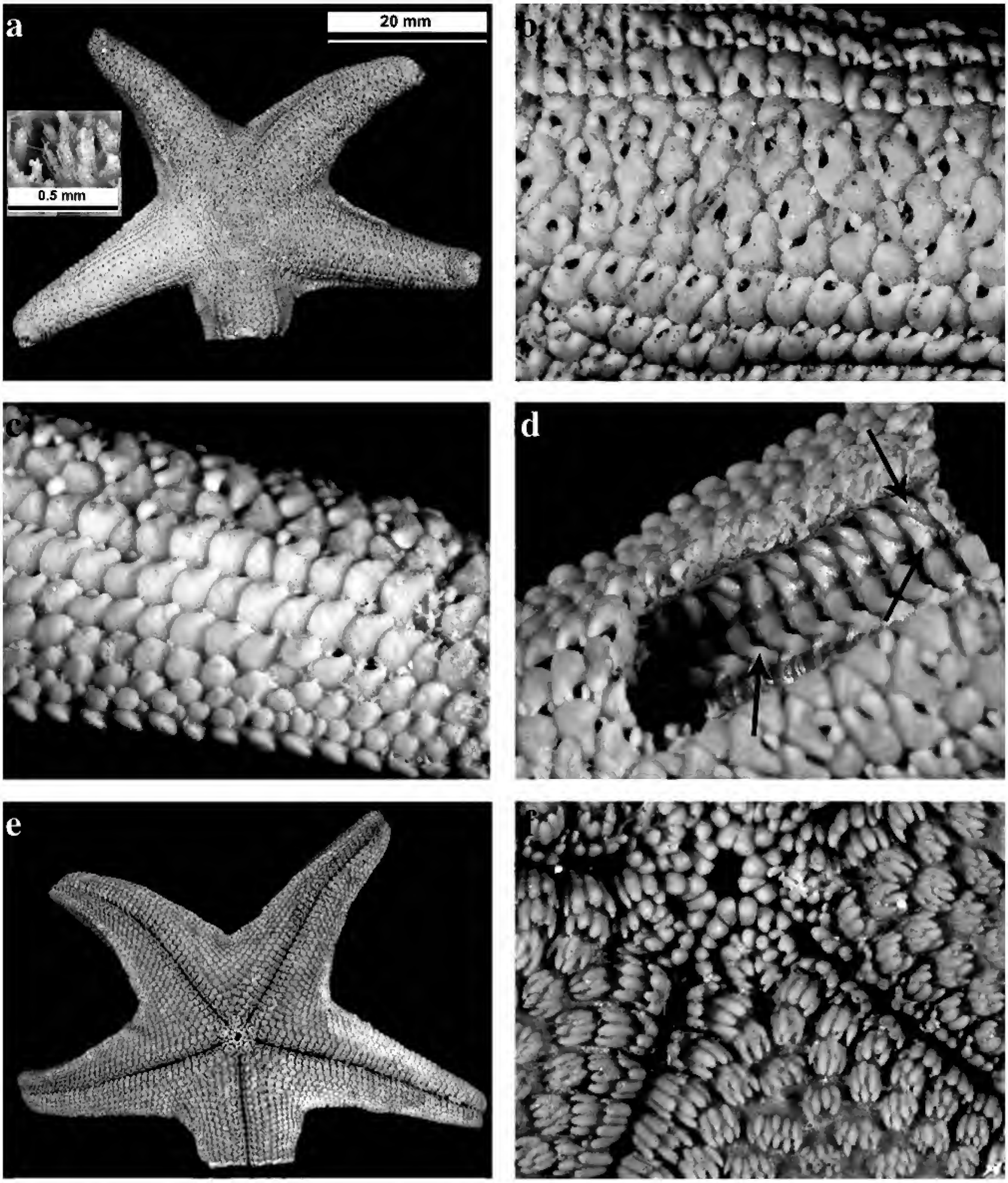

Figure 4. *Callopatiria cabrinovici* sp. nov. (photos by L. Altoff and A. Falconer). Holotype, NHM 1965.6.1.743 (R = 27–35 mm). a, abactinal view, insert showing spinelets. b, cleared proximal upper ray showing "field" of irregular singly papulate primary and few secondary plates. c, lateral view of cleared ray showing longitudinal series of plates, and superomarginal and inferomarginal series of plates. d, cleared ray with section of abactinal plates removed, showing superactinal plates (upper right arrow), superambulacral plates (lower right arrow) and ambulacral plates (left arrow). e, actinal surface showing longitudinal series of actinal plates. f, oral, suboral, furrow, subambulacral and proximal actinal spines.

to 5 longitudinal series of plates and papulae along each side of rays, frequently in transverse series also; spinelets glassy, columnar, thick to thin, splay-pointed, frequently widened terminally, some narrowed terminally; up to about 40 spinelets in narrow band 2–3 spinelets wide across projecting edge of proximal ray plates, spinelets not in discrete tufts; proximal ray spinelets up to about 0.4 mm long; distal interradius with up to about 16 splayed spinelets per plate, ends rarely overlapping those of adjacent plates; glassy convexities sometimes evident around base of plates.

Margin: superomarginal and inferomarginal plates in regular series; inferomarginals noticeably larger than superomarginals; inferomarginals project only slightly; alignment of superomarginals with inferomarginals frequently broken by presence of additional superomarginal plate; superomarginals with up to about 16 typical abactinal spinelets; inferomarginals with up to about 26 spinelets, proximally similar to superomarginal spinelets, distally stout digitiform.

Actinal: plates in longitudinal series parallel to ambulacrum; adradial actinal plates in complete series. Actinal spines per plate: oral 6, thick wedge-like proximally, slight gradation in size from proximal to distal; suboral 6–9, big gradation in size; furrow 6; subambulacral 6–8 in curved series, small at edges; adradial actinal up to about 10; interradial up to about 10 in clusters over crest of plate. Interradial spines thick digitiform and thin, opaque, rugose, bluntly rounded to pointed distally. Lacking actinal gonopores.

Distribution. East African coast, Zanzibar, Kenya, rock substrate, shallow sub-littoral; Oman, coral reef.

Etymology. Named for Andrew Cabrinovic (Natural History Museum, London), with appreciation of his gracious assistance in facilitating loans to Museum Victoria for this and previous studies.

Remarks. The generic diagnostic characters (in O'Loughlin and Waters, 2004) of *Callopatiria* Verrill, 1913 that are shared by the new species are: 5 discrete rays; rays long, stellate form; sides of rays close to perpendicular above angular margin; rays broadly flat actinally, high convex abactinally; irregular arrangement of upper ray plates; abactinal plates crescentiform; abactinal plates covered by narrow band of numerous elongate glassy spinelets; absence of pedicellariae; secondary plates in papular spaces; inferomarginals project only slightly; numerous digitiform actinal spines per plate; presence of series of superambulacral plates; numerous superactinal plates fill the interradial angular margin of the rays, contiguous with superambulacral plates for most of ray length; interior resinous body lining.

Callopatiria cabrinovici sp. nov. differs from *C. granifera* (Gray, 1847), the type species for *Callopatiria* (distribution South Africa, from Namibia to Natal), by having: small papular spaces with predominantly single papula and secondary plate per papular space (not up to about 10); superomarginal plates smaller than inferomarginals (not subequal); actinal plates in longitudinal series (not oblique); more numerous suboral spines per plate (more than up to 6); more numerous furrow and subambulacral spines per plate (more than 4). *C. cabrinovici* sp. nov. differs from *C. formosa* (Mortensen, 1933) (type locality False Bay, South Africa) by lacking the enlarged, rounded, distal abactinal plates that are mostly bare of spinelets; by having more numerous actinal spines (more than 3–4 furrow and subambulacral spines, more than 7 actinal interradial spines).

The specimen from Oman is in poor condition, but is judged with some uncertainty to belong to the new species. The other two specimens that are not nominated as types are small, and do not show the diagnostic characters as distinctively as the larger specimens, but they are also judged with some uncertainty to belong to the new species.

Rowe and Richmond (2004) discussed the occurrence of asterinid species from the western Indian Ocean. They recognized two undescribed species from Rodrigues, and these have subsequently been described by O'Loughlin and Rowe (2006) as *Aquilonastra conandae* and *Aquilonastra richmondi*. Reference was made by Rowe and Richmond (2004) to two specimens from Zanzibar, thought by A.M. Clark to be "possibly referable to *Paranepanthia* Fisher" (discussed fully in note 89 on pages 68–71 in Clark and Rowe 1971). Three NHM specimens that were examined in this work (see above) are from Watamu (Kenya) and had been determined as *Paranepanthia*. These specimens, and others from Kenya and Zanzibar (see above) that had been determined as *Asterina burtoni*, are referred here to the new species *Callopatiria cabrinovici*.

Tegulaster leptalacantha (H.L. Clark, 1916)

Figure 5a–f

Asterina leptalacantha H.L. Clark, 1916: 57–58, pl. 18 figs. 3–4.

Disasterina leptalacantha.—Livingstone, 1933: 6, 8–10, pl. 3 figs. 5–6, pl. 4 figs. 1, 4.—H.L. Clark, 1946: 139.—A.M. Clark and Rowe, 1971: 38–39, 67.—Rowe and Gates, 1995: 36.

Disasterina leptalacantha var *africana* Mortensen, 1933: 259–260, pl.12 fig. 3.—A.M. Clark and Courtman-Stock, 1976: 78.

Tegulaster leptalacantha.—O'Loughlin and Waters, 2004: 13, 35–36.

Material examined. Disasterina leptalacantha. Holotype: NE Australia, Queensland, Capricorn Group, Masthead I., littoral, Dec 1913, AM J3082.

Disasterina leptalacantha var *africana*. Syntype: South Africa, Natal, off Tugela River, 366 m, S.A.M. A22559 (1).

Other material. NE Queensland, AM J6097 (1); AM J12488 (1); Indian Ocean, Mauritius I., Cape Malheureux, down to 24 m, UF 2499 (1); La Réunion I., Saint Leu, C. Conand, 22 Mar 2003, NMV F109364 (3); NMV F109367 (4); S Madagascar, Mission Decary, MNHN EcAs11856 (1); E South Africa, Sodwana Bay, 11 m, MRAC 1746 (1); 14 m, MRAC 1744 (2); Trafalgar Marine Reserve, 14 m, MRAC 1745 (1).

Description. Thick integument body cover; rays 5, discrete, medium length, wide base, tapered, blunt to narrowly rounded distally, elevated, steep sides, acute thin margin, up to R = 24.5 mm; single madreporite; abactinal gonopores; superambulacral and superactinal plates present.

Abactinal: plates predominantly bare, thick, frequently with raised domes, generally closely imbricate, rarely spaced creating non-plated areas, upper ray plates irregular in size, form, arrangement, regular longitudinal series along sides of

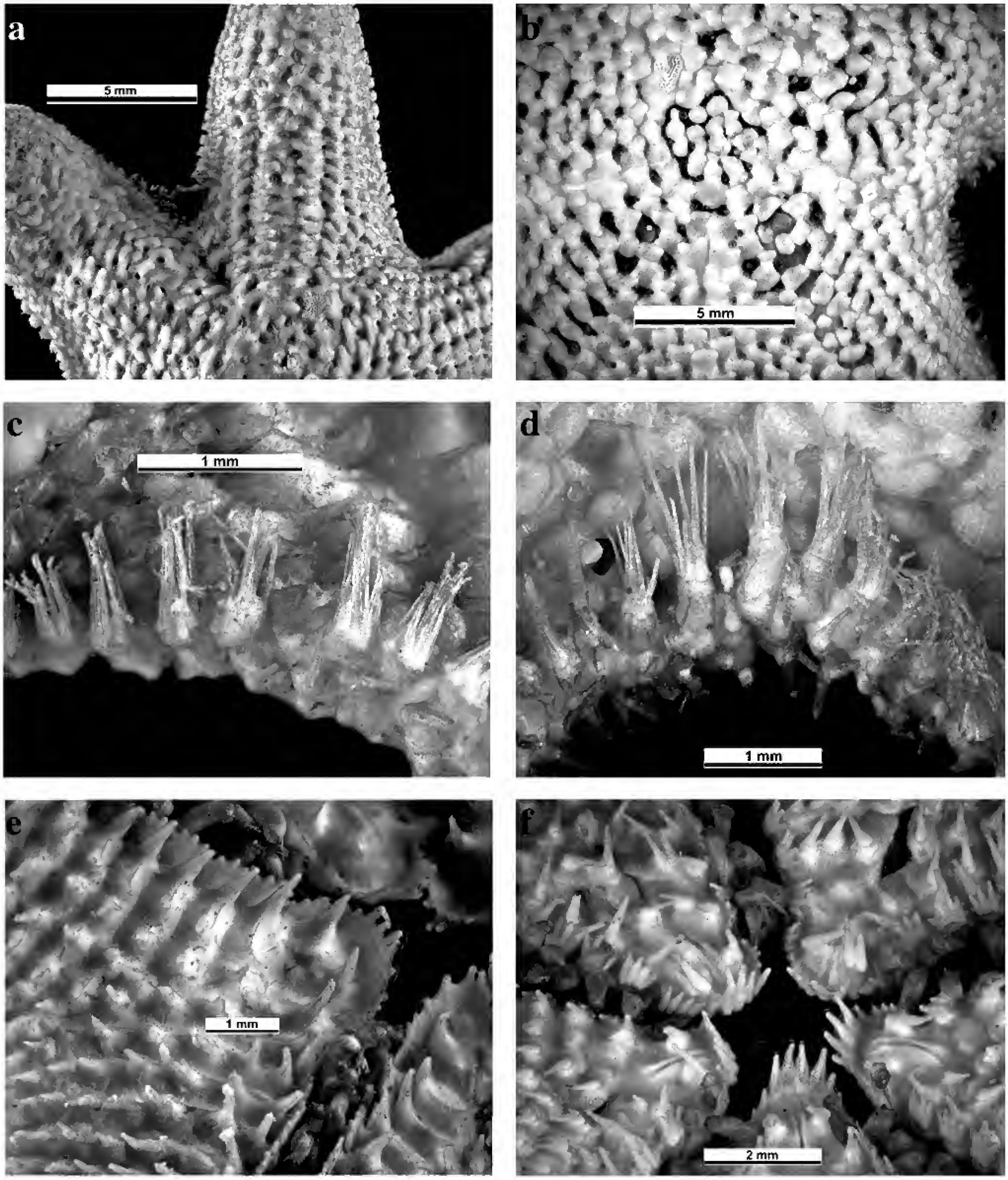

Figure 5. *Tegulaster leptalacantha* (H.L. Clark, 1916) (photos by C. Rowley). a, c, e, *Disasterina leptalacantha* var *africana* Mortensen, 1933, syntype, S.A.M. A22559 (R = 16 mm). a, abactinal surface (not cleared). c, tufts of acicular inferomarginal spinelets. e, oral, suboral, furrow, subambulacral and proximal actinal spines. *Tegulaster leptalacantha*, b, d, f, Sodwana Bay specimens. b, disc and proximal abactinal surface (not cleared; MRAC 1746; R = 17 mm). d, tufts of acicular inferomarginal spinelets (MRAC 1744; R = 18 mm). f, oral, suboral, furrow, subambulacral and proximal actinal spines (MRAC 1746; R = 17 mm)

rays, lower ray plates indented proximally for papula; lacking distinct secondary plates; papulae large, single, irregular along upper ray, sometimes doubly papulate carinal plates mid-ray, up to 3 longitudinal series long each side of ray, up to 8 longitudinal series across mid-ray; disc variably bordered by 5 radial, 5 interradial plates; small subsacciform spinelets sometimes present perianally, on disc, around madreporite; long acicular spinelets sometimes on distal interradii; up to few small granular or subsacciform or conical spinelets on abactinal plates of small specimens (R = 5 mm); glassy convexities on plates.

Margin: superomarginal plates of variable size and regularity as series, bare except small specimens with single, small, conical glassy spinelets; inferomarginal plates project, plates sometimes with constricted waist, distal tuft of up to 10 and more glassy, long, acicular subsacciform spinelets, up to 1.5 mm long.

Actinal: interradial plates in oblique series. Actinal spines per plate: oral 8–9, strongly tapered series; suboral 1 (sometimes small additional distal one); furrow 5, short; subambulacral 1, long; adradial actinal 1; actinal interradial 1; spines long, tapering to thin, sacciform.

Distribution. NE Australia, Mauritius I., La Réunion Is., Madagascar, E South Africa, 0–366 m.

Remarks. Mortensen (1933) observed only minor morphological differences between the type and the two South Africa specimens on which he based his variety. Amongst these differences he noted that there were only five oral spines in the type, but seven in the variety. The type has eight oral spines, and eight and nine were observed on the specimen of the variety from Natal. Mortensen (1933) erected the variety "mainly for zoogeographical reasons" since the type locality for *Tegulaster leptalacantha* is Queensland (NE Australia). In O'Loughlin and Waters (2004) I determined material from Mauritius as *T. leptalacantha*, and judged that the variety was not justified. I confirm that opinion here. In O'Loughlin and Waters (2004) I reassigned *Disasterina leptalacantha* to *Tegulaster* Livingsone, 1933. I confirm the morphological grounds for the reassignment here. The diagnostic characteristics of *Tegulaster leptalacantha* are: 5 discrete, high, tapered rays; thick integument evident over body; predominantly bare abactinal plates; abactinal plates frequently with rounded domes; actinal plates in oblique series; single long sacciform spines on each actinal interradial plate; inferomarginal plates with distal dense tufts of long, glassy, acicular subsacciform spinelets; superambulacral and superactinal plates present.

Tegulaster leptalacantha is distinguished from all other species of *Tegulaster* by having a tuft of long acicular sacciform spinelets on each inferomarginal plate; and is also distinguished in particular from *T. emburyi* Livingstone, 1933 (type species for *Tegulaster*; type locality Queensland) by having single suboral and actinal interradial spines per plate, from *T. alba* (H.L. Clark, 1938) (type locality Lord Howe I.) by having abactinal gonopores, and from *T. praesignis* (Livingstone, 1933) (type locality Queensland) by having bare superomarginal plates (see O'Loughlin and Waters, 2004 for these and other distinguishing characters).

Acknowledgments

I am most grateful for the generous assistance of: Leon Altoff and Audrey Falconer (Marine Research Group of the Field Naturalists Club of Victoria, for some photography); Nadia Améziane and Marc Eleaume (MNHN, for facilitating loan material); Andrew Cabrinovic (NHM, for facilitating loan material); Chantal Conand (Emeritus Professor at La Réunion University, for donation of specimens to NMV); Caroline Harding (NMV, for preparation of figures); Karen Gowlett-Holmes (colour photo of WAM paratype live); Liz Hoenson (S.A.M., for facilitating loan material); Loisette Marsh and Mark Salotti (WAM, for facilitating loan material); Gustav Paulay (UF, for facilitating loan material); Frank Rowe (formerly of the AM, for collaboration in earlier stages of this on-going research); Chris Rowley (NMV, for montage photography); Ahmed Thandar (University of KwaZulu-Natal, for donation of a specimen to NMV and facilitating communication with the S.A.M.); Didier VandenSpiegel MRAC, for facilitating loan material). I am pleased to acknowledge the Coral Reef Research Foundation, under contract to the US National Cancer Institute contract no. N01-CM-27704, for sponsorship of fieldwork by the University of Florida that yielded specimens studied in this work. I am most appreciative of the critical review of this paper by Frank Rowe.

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Memoirs of Museum Victoria 66: 215–220 (2009)

ISSN 1447-2546 (Print) 1447-2554 (On-line)
http://museumvictoria.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria

Observations of reproductive strategies for some dendrochirotid holothuroids (Echinodermata: Holothuroidea: Dendrochirotida)

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Abstract

O'Loughlin, P. M., Eichler, J., Altoff, L., Falconer, A., Mackenzie, M., Whitfield, E., Rowley, C. 2009. Observations of reproductive strategies for some dendrochirotid holothuroids (Echinodermata: Holothuroidea: Dendrochirotida). *Memoirs of Museum Victoria* 66: 215–220.

Some recently observed dendrochirotid holothuroid reproductive strategies are reported for the first time: fissiparity by *Cucuvitrum rowei* O'Loughlin and O'Hara; probable intra-coelomic brood fissiparity by *Staurothyone inconspicua* (Bell); intra-coelomic brood-protection by a species of *Parathyonidium* Heding; intra-coelomic brood auto-ingestion by *Neoamphicyclus materiae* O'Loughlin; brood-protection in anterior interradial marsupia by *Psolidiella mollis* (Ludwig and Heding). Some analysis is reported of marsupial brood-protection by Antarctic dendrochirotid holothuroids: the "*Cucumaria georgiana* group"; *Echinopsolus acanthocola* Gutt; *Echinopsolus parvipes* Massin; *Microchoerus splendidus* Gutt; *Psolidiella mollis* (Ludwig and Heding); *Psolus charcoti* Vaney. Confusion in the literature about brood-protection by the Subantarctic dendrochirotid *Cladodactyla crocea* (Lesson) is clarified.

Keywords Echinodermata, Holothuroidea, Dendrochirotida, auto-ingestion, brood-protection, fissiparity, intra-coelomic, marsupium.

Introduction

Large collections of holothuroids from coastal southern Australia and from Antarctica (Prydz Bay, the Bellingshausen Sea, the Antarctic Peninsula and the South Atlantic), most specimens held by Museum Victoria (NMV), have been studied by Mark O'Loughlin. This has resulted in many of the observations reported here. Fieldwork by John Eichler of the Marine Research Group (MRG) in Victoria has resulted in the recognition of fissiparity by a dendrochirotid species. Laboratory research on specimens by NMV volunteers Melanie Mackenzie and Emily Whitfield has contributed to observations reported in this work. John Eichler (MRG; JE), Leon Altoff and Audrey Falconer (MRG; LA), and Chris Rowley (NMV; CR) have provided photographs.

Fissiparity by *Cucuvitrum rowei* O'Loughlin and O'Hara

John Eichler collected a live specimen of *Cucuvitrum rowei* O'Loughlin and O'Hara, 1992 from Port Phillip Bay in SE Australia on 20 April 2008 (NMV F157401; variably 19 to 30 mm long live). During subsequent days peristaltic-like body contractions were observed and photographed (fig. 1a). Between April 22 and 25 the specimen divided transversely into two individuals (smaller 7 mm long). Peristaltic-like body contractions continued in both post-fissiparity individuals. Overnight on May 1 to 2 the larger individual divided transversely again (fig. 1b). Preservation and dissection of these individuals revealed that the larger post-fissiparity oral end individual had fully developed tentacles and calcareous ring, but lacked internal organs. Detached internal organ remnants were present in the smaller anal end individuals that lacked tentacles and ring. One apparent purpose of the peristaltic movements was to push the internal organs to the anal end of the coelom to provide a nutrient source for the subsequent regeneration of tentacles, ring and internal organs.

On 3 August 2008, seven smaller specimens were collected from Port Phillip Bay (NMV F161549; up to 12 mm long). After nine days none had undergone fissiparity. On 30 August 2008, five specimens were collected from Port Phillip Bay (NMV F161500; up to 16 mm long). Overnight on September

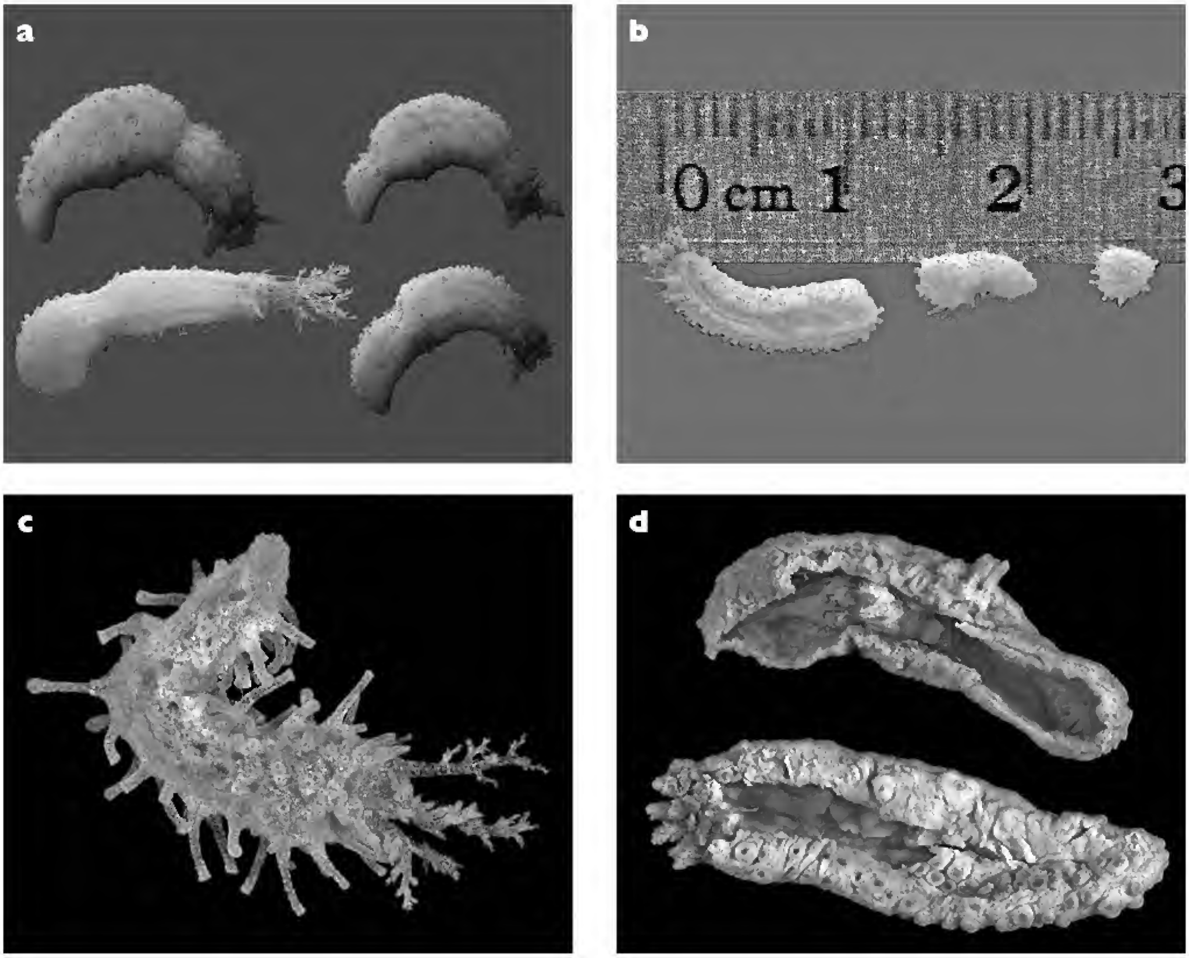

Figure 1. Fissiparity by *Cucuvitrum rowei* O'Loughlin and O'Hara. a, peristaltic contractions in live specimen (F157401; about 25 mm long; photo by JE). b, 3 live individuals resulting from fissiparity (F157401; JE). c, live specimen showing regenerating anal end (F157419; 4 mm long; LA). d, preserved specimens showing evidence of fissiparity, with fully developed tentacles and ring and lacking internal soft organs (upper), with developing tentacles and ring (lower) (F161501; LA).

6 to 7 one of the larger individuals divided transversely. During his fieldwork John Eichler frequently noticed individuals in close proximity on the undersurface of rocks. This clustering may be a consequence of fissiparity.

Leon Altoff and Audrey Falconer photographed a live specimen in the field that showed regeneration of the anal end (fig. 1c; 4 mm long; NMV F157419). Dissection by Emily Whitfield of a large collection of NMV preserved specimens of *Cucuvitrum rowei* revealed rare individuals that showed evidence of fissiparity. Post-fissiparity oral ends lacked internal organs but had withdrawn fully developed tentacles and calcareous ring (fig. 1d; NMV F161501); and post-fissiparity anal ends showed a reduced developing calcareous ring and small tentacles (fig. 1d; NMV F161501), or lacked a calcareous ring and tentacles.

O'Loughlin (1991, 1994) reported fissiparity by similar mid-body transverse constriction and division in the dendrochirotid *Squamocnus aureoruber* O'Loughlin and O'Hara, 1992 from the rocky shallows of southern Australia. This is the first record of fissiparity by the dendrochirotid *Cucuvitrum rowei*, and the first record of peristaltic body movements in a dendrochirotid holothuroid.

Coelomic fissiparity by *Staurothyone inconspicua* (Bell)

Brood juveniles (45) removed from the coelom of a female *Staurothyone inconspicua* (Bell, 1887) from Opossum Bay in SE Tasmania are of different sizes and many show mid-body constrictions (fig. 2a; NMV F58613). One coelomic juvenile from another specimen from Opossum Bay shows a deep mid-body constriction (fig. 2b; NMV F58456). For this seasonally reproducing and coelomic brood-protecting species (see Materia et al. 1991), and with an assumption of a single fertilization event, these observations suggest intra-coelomic brood fissiparity and cloning. However, dissection of coelomic juveniles has to date failed to reveal confirming evidence of a coelomic juvenile that lacks a calcareous ring.

Balser (2004) reported on cloning by larvae of echinoderms, including holothuroids. The evidence here indicates probable intra-coelomic cloning by a holothuroid.

Coelomic bro~~od~~ protection by a species of *Parathyonidium* Heding

A female specimen of an undescribed species of *Parathyonidum* Heding, 1954 from Eastern Antarctica (17 mm long, preserved; NMV F84983) has 39 differentiating coelomic juveniles of uniform size (2–3 mm long) (fig. 2c). Materia et al. (1991) reported coelomic brood-protection for *Neoamphicyclus materiae* O'Loughlin, 2007 (as *Neoamphicyclus lividus* Hickman, 1962) and *Staurothyone inconspicua* (Bell, 1887) from SE Australia. This is a third case of intra-coelomic brood-protection by a dendrochirotid holothuroid species.

Brood ~~auto~~ ingestion by *Neoamphicyclus materiae* O'Loughlin

A 20 mm long female *Neoamphicyclus materiae* O'Loughlin, 2007 from Kitty Miller Bay on the coast of Victoria, collected on 25 October 1987, has 528 small coelomic brood juveniles (fig. 2d; NMV F58592). A 30 mm long female from Cape Otway on the coast of Victoria, collected on 29 December 1985, has one large coelomic brood juvenile (fig. 2d; NMV F76371). Typically this species has small coelomic brood juveniles in October (see Materia et al. 1991), and one or a few large coelomic juveniles are present in December or January (NMV F58606; F58720; fig. 2e). These observations indicate that intra-coelomic brood auto-ingestion occurs in *Neoamphicyclus materiae*.

Byrne (1996) reported intragonadal cannibalism in the small simultaneous hermaphrodite asterinids *Parvulastra vivipara* (Dartnall, 1969) and *Parvulastra parvivipara* (Keough and Dartnall, 1978) from southern Australia. This is the first report of intra-coelomic cannibalism in a holothuroid species.

Bro~~od~~ protection by *Psolidiella mollis* (Ludwig and Heding)

Psolidiella mollis (Ludwig & Heding, 1935) is an additional species of Antarctic dendrochirotid holothuroid that brood-protects in marsupia (see Table 1). Males have a long genital papilla (NMV F157414), and females have up to five anterior interradial internal marsupia (fig. 3a; NMV F104865). One female from Bouvet Island (fig. 3b; NMV F104882) has 46 and 60 differentiated embryos (3–4 mm long) in each of two marsupia, and 52, 53, and 60 undifferentiated eggs or embryos (1.3 mm long) in each of three marsupia, evidence of two fertilization events.

Table 1. Antarctic species with 5 anterior interradial marsupia.

"*Cucumaria georgiana* (Lampert, 1886) group"
- *Cucumaria acuta* Massin, 1992
- *Cucumaria analis* Vaney, 1908
- *Cucumaria aspera* Vaney, 1908
- *Cucumaria attenuata* Vaney, 1906
- *Cucumaria georgiana* (Lampert, 1886)
- *Cucumaria joubini* Vaney, 1914
- *Cucumaria lateralis* Vaney, 1906
- *Cucumaria perfida* Vaney, 1908
- *Cucumaria periprocta* Vaney, 1908
- *Cucumaria secunda* Vaney, 1908
- *Cucumaria vaneyi* Cherbonnier, 1949

First reported: Vaney, 1925; Ekman, 1925

Echinopsolus acanthocola Gutt, 1990
First reported: De Ridder et al., 2005

Echinopsolus parvipes Massin 1992
First reported: Hétérier et al., 2004

Microchoerus splendidus Gutt, 1990
First reported: O'Loughlin, 1994

Psolidiella mollis (Ludwig and Heding, 1935)
First reported: this work

Psolus charcoti Vaney, 1914
First reported: O'Loughlin, 2001

Bro~~od~~ protection in anterior interradial marsupia

A "*Cucumaria georgiana* (Lampert, 1886) group" was created by Gutt (1988) and adopted by Massin (1992) because of the systematic confusion resulting from many Antarctic cucumariid species having similar morphological characters. O'Loughlin (in O'Loughlin et al. 2009) included *Cucumaria aspera* Vaney in this group, but removed *Cucumaria armata* Vaney. A revised list is included within Table 1. All species within this "Group", and the five other species in Table 1, have the same brood-protecting habit that is unique to Antarctic holothuroids: males have a long genital papilla between the dorsal tentacle pair (fig. 3c), and do not have marsupia; females have a short genital papilla between the dorsal tentacle pair (fig. 3c), and have up to five anterior interradial marsupia with external pores (fig. 3d). Females in all the species in Table 1 have up to five marsupia, but all five may not be present in an individual.

A "*Cucumaria georgiana* group" female specimen from Casey Station in Eastern Antarctica, collected on 3 November 1997 (fig. 3e; NMV F85853), has 41 and 66 undifferentiated eggs or embryos (1.3 mm long) in each of two marsupia, and 25, 25 and 56 differentiated embryos (3–4 mm long) in each of three marsupia, evidence of two fertilization events.

A female specimen of *Psolus charcoti* Vaney, 1914 from Prydz Bay, collected on 21 February 1987 (fig. 3f; NMV F86009) has one and seven undifferentiated eggs or embryos (1.7 to 1.8 mm long) in each of two marsupia; seven differentiated embryos (3.5 mm long) in one marsupium; and one and four marsupial juveniles (4.0 mm long) in each of two marsupia. The data are evidence of three fertilization events.

Two female specimens from amongst many (up to 35 mm long, tentacles included) belonging to the "*Cucumaria*

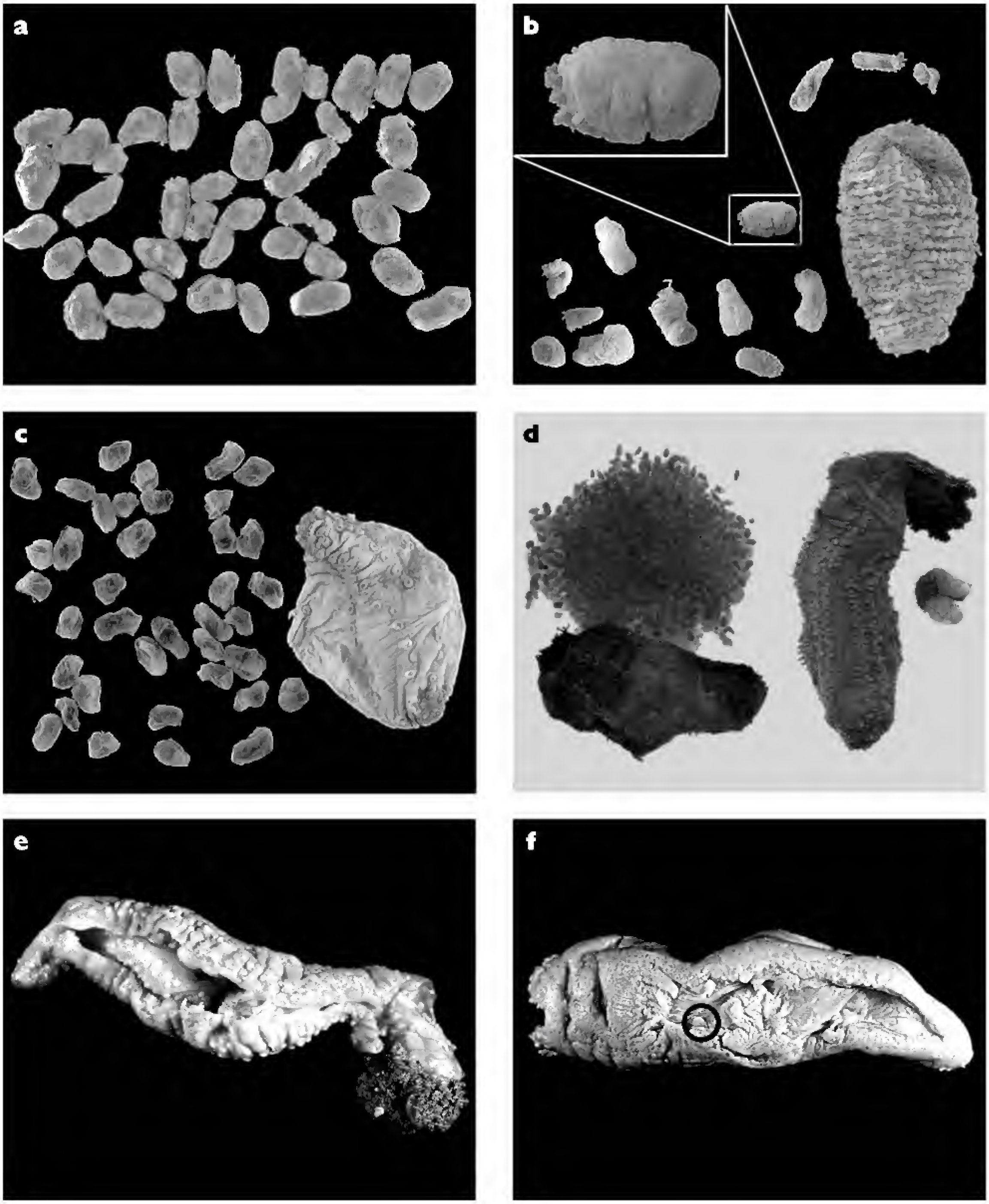

Figure 2. a, coelomic brood juveniles from a female *Staurothyone inconspicua* (Bell) showing mid-body constrictions and variable sizes (F58613; photo by CR). b, coelomic juvenile of *S. inconspicua* showing a deep mid-body constriction (F58456; CR). c, coelomic juveniles from a female *Parathyonidium* Heding species (F84983; CR). d, many small (F58592, late October; CR) and one large (F76371, late December; CR) coelomic brood juveniles of *Neoamphicyclus materiae* O'Loughlin. e, single large coelomic juvenile of *N. materiae* (F58606; late December; LA). f, invaginated body wall marsupium of *Cladodactyla crocea* (Lesson) with single remaining egg/embryo (F106967; 27 mm long; LA).

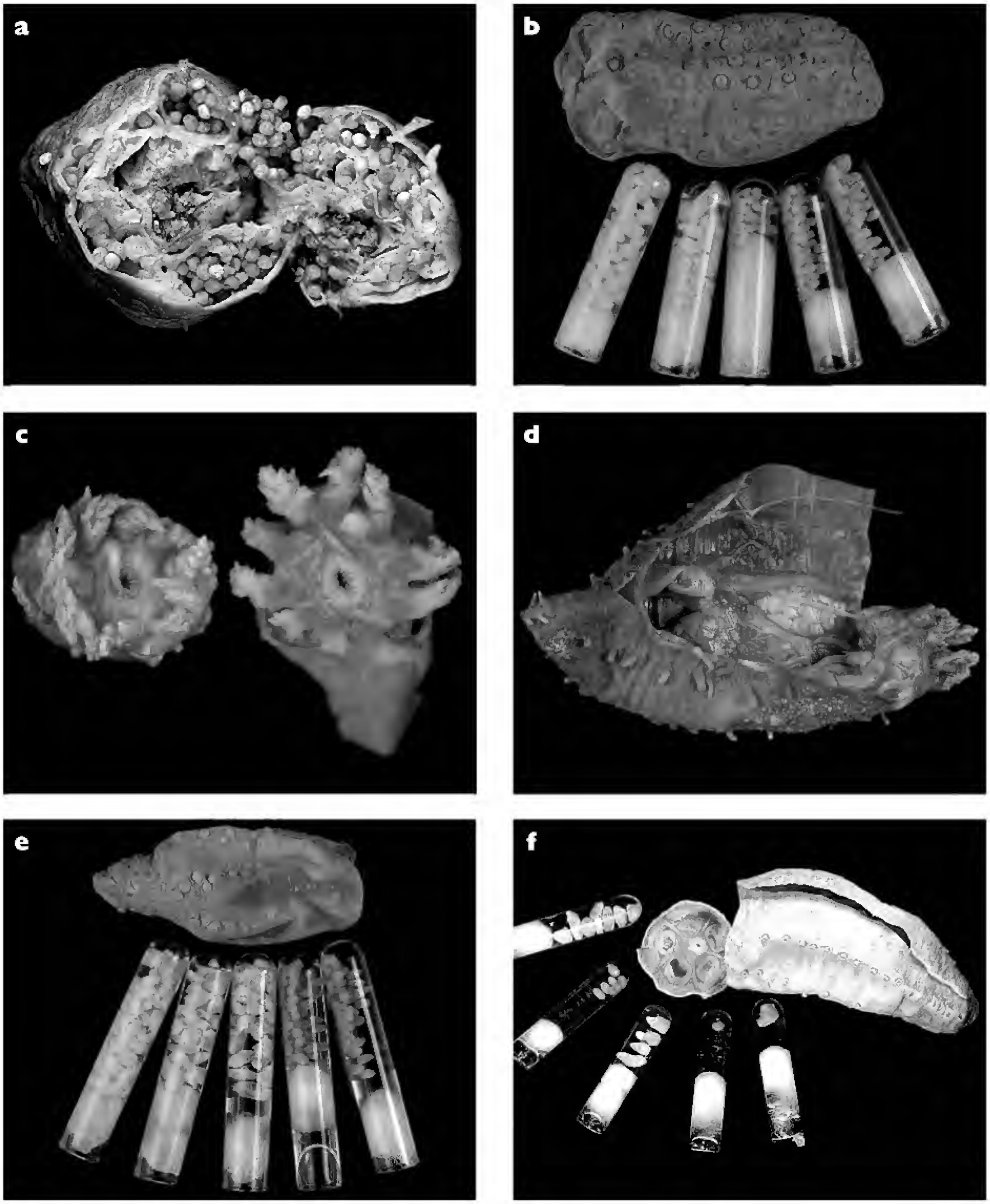

Figure 3. a, transverse section through anterior marsupia of *Psolidiella mollis* (Ludwig and Heding) (F104865; diameter about 15 mm; photo by LA). b, female *P. mollis* with differentiated embryos (3–4 mm long) from each of 2 marsupia (left), and undifferentiated eggs or embryos (1.3 mm long) from each of 3 marsupia (right) (F104882; specimen 45 mm long; CR). c, long male genital papilla of *Cucumaria acuta* Massin (F160042; left; CR); short female genital papilla of *C. acuta* (F160020; right; CR). d, internal marsupium of *C. acuta* (F160038; specimen 37 mm long; CR). e, *C. georgina* group species with differentiated embryos (3–4 mm long) from each of 3 marsupia (left), and undifferentiated eggs or embryos (1.3 mm long) from each of 2 marsupia (right) (F85853; 33 mm long; CR). f, *Psolus charcoti* Vaney with 1 and 7 undifferentiated eggs or embryos (1.7 to 1.8 mm long) from each of 2 marsupia; 7 differentiated embryos (3.5 mm long) from 1 marsupium (left); and 4 and 1 marsupial juveniles (4.0 mm long) from each of 2 marsupia (middle and right) (F86009; specimen 55 mm long; LA).

georgiana group", from Peter I Island in the Bellingshausen Sea taken at 124 m (Spanish BENTART 2003 collection; stn A5, 7–10 February), were examined. The gonad tubules had eggs 1.5 mm long. Marsupial juveniles were uniform in size (2–3 mm long). Numbers of juveniles in the marsupia were: 5, 0, 0, 0, 0 and 15, 13, 11, 0, 0. The data indicate two fertilization events.

Two female specimens from amongst many (up to 27 mm long, tentacles included) belonging to the "*Cucumaria georgiana* group", from Low Island near the Antarctic Peninsula taken at 86 m (Spanish BENTART 2006 collection; stn Low 45, 7–10 February), were examined. The gonad tubules lacked eggs. Marsupial juveniles were uniform in size (2–3 mm long). Numbers of juveniles in the marsupia were: 63, 39, 27, 0, 0 and 30, 27, 23, 17, 9. These data indicate one fertilization event.

The differing gonad and marsupial data for the same time of the year, and the significantly different sizes of the specimens from very large samples, are evidence of two different species within the specimens of the "*Cucumaria georgiana* group" from Peter I Island and Low Island.

Hétérier et al. (2004) reported that preliminary observations indicated that *Echinopsolus acanthocola* Gutt, 1990 and *Echinopsolus parvipes* Massin, 1992 "could brood". De Ridder et al. (2005) confirmed internal brood-protection for *Echinopsolus acanthocola*. Brood-protection in anterior interradial marsupia is confirmed here for both species of *Echinopsolus*.

Marsupium in *Cladodactyla crocea* (Lesson)

For the subantarctic dendrochirotid species *Cladodactyla crocea* (Lesson, 1830), Wyville-Thomson (1878) reported "no special marsupium"; Bell (1908) reported "brood pouches"; Vaney (1925) reported "two brood pouches"; and Ekman (1925) reported "sexual maturity comes late" and "no brood pouches". Museum Victoria specimens of *Cladodactyla crocea* from the Burdwood Bank (NMV F160031) and Falkland Islands (NMV F106967) that were studied in this work have a single dorsal longitudinal invaginated body wall marsupium (fig. 2f). A small and presumably young specimen from the Burdwood Bank, collected on 25 January 2004 (NMV F160031), is 8 mm long, has eggs in gonad tubules, and a dorsal invaginated marsupium with eggs/embryos. Presumably the authors referred to above were observing specimens that were not *Cladodactyla crocea*.

Acknowledgments

We are grateful to: Ben Boonen for the preparation of the figures; Susie Lockhart for the donation to Museum Victoria of AMLR R/V *Yuzhmorgeologiya* (2003) and *Icefish* (2004) holothuroid specimens from the southern Atlantic that were studied in this work; Eugenia Manjón-Cabeza for the opportunity to study the Spanish BENTART 2003 and 2006 R/V *Hesperides* collections held by the University of Málaga; Museum Victoria for the use of the facilities of the Marine Science Department, and the opportunity to undertake research on the holothuroid collections.

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Memoirs of Museum Victoria 66: 221–287 (2009)

ISSN 1447-2546 (Print) 1447-2554 (On-line)
http://museumvictoria.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria

Australian Axiidae (Crustacea: Decapoda: Axiidea)

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Abstract

Poore, G.C.B. and Collins, D.J. 2009. Australian Axiidae (Crustacea: Decapoda: Axiidea). *Memoirs of Museum Victoria* 66: 221–287.

Three new genera and nine new species of Axiidae are described from shelf and continental margins of Australia: *Acanthaxius garawa* sp. nov., *Acanthaxius gathaagudu* sp. nov., *Acanthaxius ningaloo* sp. nov., *Australocaris pinjarup* gen. and sp. nov., *Calastacus myalup* sp. nov., *Eiconaxius mallacoota* sp. nov., *Pilbaraxius kariyarra* gen. and sp. nov., *Platyaxius bardi* sp. nov.; *Michelaxiopsis* gen. nov. is erected for *Axiopsis australiensis* De Man, 1925 and *Michelaxiopsis nauo* sp. nov. New records of Indo-West Pacific species for Australia are: *Acanthaxius clevai* Ngoc-Ho, 2006, *Allaxius clypeatus* (De Man, 1888), *Axiopsis serratifrons* A. Milne-Edwards, 1873, *Axiopsis tsushimaensis* Sakai, 1992, *Bouvieraxius keiensis* Sakai, 1992 and *Planaxius brevifrons* Komai and Tachikawa, 2008. New distributional records are given for species previously recorded from Australia: *Calaxius acutirostris* Sakai and de Saint Laurent, 1989, *Dorphinaxius kermadecensis* (Chilton, 1911), and *Paraxiopsis pumilus* (Sakai, 1994). Ten genera are rediagnosed. Undescribed species of *Axius*, *Axiopsis* and *Ambiaxius* are mentioned. Photomicrographs of maxillae 1 and 2 and maxillipeds 1 and 2 of 11 species are appended. We could find very little of taxonomic value at the genus or species level in these appendages and question the value of illustrating them in future. A key is provided for the identification of all 30 Australian species.

Keywords

Crustacea; Decapoda; Axiidea; Thalassinidea; Axiidae; *Acanthaxius*; *Allaxius*; *Ambiaxius*; *Australocaris*; *Axiopsis*; *Bouvieraxius*; *Calastacus*; *Calaxius*; *Dorphinaxius*; *Eiconaxius*; *Michelaxiopsis*; *Oxyrhynchaxius*; *Pilbaraxius*; *Paraxiopsis*; *Planaxius*; *Platyaxius*; *Scytoleptus*; taxonomy; new genus; new species

Introduction

The Axiidae, a family of burrowing lobsters, have traditionally been placed in the decapod infraorder Thalassinidea (e.g., Poore, 1994) but more recent molecular and morphological evidence suggests that Thalassinidea is not a monophyletic taxon. Instead, this family falls within a smaller group, Axiidea de Saint Laurent, 1973 (Robles et al., 2009).

The Australian axiid fauna comprises 18 recognised species (Davie, 2002; Poore, 2008). Here we diagnose three new genera, add nine new species, record six Indo-West Pacific species for the first time from Australia, reidentify or synonymise material of three species and provide additional records for three species previously recorded from Australia. The taxonomy of some other known species is reassessed and updated and in the process it was necessary to redescribe some species and rediagnose ten other genera. We take the opportunity to list and provide a key to all 30 known Australian Axiidae and comment on biogeography.

Photomicrographs of maxillae 1 and 2 and maxillipeds 1 and 2 of 11 species were prepared using a Leica DM5000B microscope and Leica DC500 camera after clearing in lactic acid and staining with chlorozol black. Between 15 and 25 images were taken in different planes and merged using Automontage® software. Mandibles were also dissected and examined stereoscopically. We could find very little of taxonomic value at the genus or species level in these appendages and do not present descriptions in words. The only exceptional morphology is the absence in *Acanthaxius clevai* Ngoc-Ho, 2006 of a posterior long seta on the epipod of maxilla 2 (scaphognathite). Mouthparts of axiids have been illustrated with or without the complex of setae that ornament them by many authors. The level of detail has varied considerably probably largely because of the difficulty of rendering such complex setose structures as line drawings. For this reason comparison between species has been rarely attempted and species have never been differentiated using these characters. In spite of the detail made possible by our photographic tools, we are still unable to discover useful characters. In our view, our own and earlier efforts have not been informative and we question the value of illustrating them in future.

Much of the new material arose from recent sampling (cruises SS10-2005 and SS05-2007) by CSIRO Marine and Atmospheric Research (CMAR) and Museum Victoria along the Western Australian continental margin (Poore et al., 2008). This collection is supplemented by material from the Northern Territory, tropical Queensland, the south-eastern Australian slope, and South Australia.

Material is deposited in the Australian Museum, Sydney (AM), Museum Victoria, Melbourne (NMV), South Australian Museum, Adelaide (SAM), Museum and Art Gallery of the Northern Territory, Darwin (NTM) and Natural History Museum, London (BMNH). Measurements are of carapace length including rostrum (cl.) and total length (tl.). Most illustrations were made by the second author and prepared for publication using Adobe Illustrator and many of the recommendations of Coleman (2003).

Family **Axiidae** Huxley, 1879

Restricted synonymy.

Axiidae Huxley, 1879: 785.—Sakai and de Saint Laurent, 1989: 4–5.—Poore, 1994: 96.

Calocarididae Ortmann, 1891: 47.—Kensley, 1989: 960.—Poore, 1994: 98

Eiconaxiidae Sakai and Ohta, 2005: 69.

Diagnosis. Carapace more or less laterally compressed, moderately to well calcified; cervical groove distinct at least dorsally; linea thalassinica absent; posterior margin of carapace with lateral lobes interacting with abdominal somite 1. Rostrum present, acute. Pleuron of abdominal somite 1 more or less produced. Eyestalks cylindrical. Antenna 1 with article 3 about as long as article 2. Antenna 2 with scale-like or well produced scaphocerite. Maxilla 2 scaphognathite with a posterior whip (rarely without). Pereopods 1 chelate, equal or unequal; pereopod 2 chelate; pereopod 3 simple; pereopod 4 simple or subchelate; pereopod 5 chelate. Pleopod 1 present or absent. Pleopod 2 similar in dimensions to pleopods 3–5, biramous; pleopods 3–5 endopodal rami elongated, not laterally expanded, with or without appendix interna. Uropodal rami lamellate, endopod more or less oval.

Remarks. Axiid lobsters are recognised by the combination of a prominent rostrum ending in an acute tip, similar laminar rami on pleopods 2–5, and oval uropodal endopod. They may be confused with Strahlaxiidae which have a rostrum with an apical notch and a triangular uropodal endopod. The family Calocarididae was revived and defined by Kensley (1989) and included in the key to thalassinidean families by Poore (1994). Poore's key to genera included six genera and Poore (2008) listed two more. Kensley (1989) recognised the family on its being hermaphroditic, having unpigmented eyes and highly modified pleopod 2; in his view, axiids are gonochoristic (that is, the sexes are separate with gonopores on either coxae 3 [female] or coxae 5 [male] and pleopods 1 and 2 usually sexually dimorphic). In Kensley's cladogram (1989: fig. 1) four calocaridid genera form a clade separated from a paraphyletic clade of three representative "axiid" genera. Tsang et al.'s (2008) molecular analysis of relationships between two calocaridid species (*Calastacus crosnieri* and *Paracalocaris sagamiensis*) and three axiids found the calocaridids were sister taxa and the axiids paraphyletic. Robles et al. (2009) used eight species in another molecular study and found that another calocarid, *Calocaris caribbaeus*, was embedded within the seven species of Axiidae. In their analysis the species labelled as belonging to the calocaridid genus, *Calaxiopis*, is here reidentified as an axiid, *Pilbaraxius kariyarra* sp. nov. Cladistic support for the family is currently weak in spite of its strong morphological unity. The problem lies more with the apparent paraphyly of Axiidae than with Calocarididae itself. Similarly, Sakai and Ohta (2005) isolated *Eiconaxius* in its own family, Eiconaxiidae, on the basis of rounded spinose dactyli on pereopods 3–5. This supposed unique feature defines the genus while nothing except its absence defines remaining axiids. However, this characteristic is shown in part in another genus (see discussion of *Platyaxius* below), weakening support for this family. We prefer to synonymise Calocarididae and Eiconaxiidae with Axiidae.

We note a structure hitherto unreported in many of the new species described below. Attached to the anterolateral margin of sternite 8, at the base of the socket of pereopod 5, is an articulating flap, oval-semicircular in shape with a setose margin (e.g. figs. 7d, e). In other species the structure is reduced to a setose ridge. Its homology is unclear but it appears to be a sternal scerite that may act as a valve at the posterior of the branchial cavity.

Key to Australian species of Axiidae

This key is designed to be as practical as possible and concentrates on characters most easily determined from what can sometimes be fragmentary specimens. It does not reflect relationship nor necessarily use generic characters.

1. Pleopod 2 endopod with dominating terminal appendix masculina and digitiform appendix interna; pleopods 3–5 rami extremely thin; eyes without pigment; usually hermaphroditic (with gonopores on both coxae 3 and 5, pleopods 1 and 2 not sexually dimorphic) 2

– Pleopods 2–5 endopods laminar, similar; pleopod 2 with appendices masculina and interna (if present in male) linear and attached mesially; eyes usually pigmented; gonochoristic (sexes separate, gonopores on either coxae 3 [female] or coxae 5 [male]; pleopods 1 and 2 sexually dimorphic) 3

2. Rostrum directed upwards, about half length of postorbital carapace length; pleopod 2 article 2 elongate-triangular, mesially curved .... *Ambiaxius franklinae* Sakai, 1994

– Rostrum directed anteriorly, about quarter length of postorbital carapace length; pleopod 2 article 2 linear, 2-segmented .... *Calastacus myalup* sp. nov.

3. Uropodal exopod without transverse suture; telson tapering to rounded apex 4

– Uropodal exopod with transverse suture; telson more or less rectangular, apex truncate or rounded 8

4. Rostrum significantly depressed below level of gastric region of carapace; gastric region almost vertical anteriorly .... *Scytoleptus serripes* Gerstaecker, 1856

– Rostrum level with or slightly below gastric region of carapace; gastric region horizontal or gently sloped 5

5. Rostrum depressed between smooth marginal rim; median gastric carina smooth; submedian gastric carinae absent ... 6
– Rostrum scarcely depressed between dentate marginal rim; median gastric carina dentate; submedian gastric carinae present, usually toothed ... 7
6. Telson 1.1 times as long as wide; uropodal endopod with oblique apex ... *Eiconaxius kimbla* Kensley, 1996
– Telson 1.5 times as long as wide; uropodal endopod with rounded apex ... *Eiconaxius mallacoota* sp. nov.
7. Rostrum longer than eyestalks; scaphocerite strongly curved; lateral gastric carina with supraocular spine plus 1 spine ... *Platyaxius bardi* sp. nov.
– Rostrum shorter than eyestalks; scaphocerite straight; lateral gastric carina unarmed ... *Platyaxius brevirostris* Sakai, 1994
8. Pleopods 2–5 without appendix interna ... 9
– Pleopods 2–5 each with appendix interna ... 12
9. Scaphocerite slender, reaching more than half length of antennal article 4; rostrum with 4 or 5 lateral spines along length; lateral gastric carina unarmed; submedian gastric carina with 3 or 4 spines ... *Bouvieraxius keiensis* Sakai, 1992
– Scaphocerite plate-like, triangular or bifurcate, barely overlapping base of antennal article 4; rostrum with 1 or 2 lateral spines near base; lateral gastric carina unarmed or with 2 teeth; submedian gastric carina unarmed or with 6–8 spines ... 10
10. Submedian gastric carina with 5–8 spines ... *Paraxiopsis austrinus* (Sakai, 1994)
– Submedian gastric carina absent or unarmed ... 11
11. Lateral gastric carina with 1 or 2 spines posterior to supraocular spine; submedian gastric carina ending anteriorly as definite tooth ... *Paraxiopsis brocki* (De Man, 1888)
– Lateral gastric carina unarmed posterior to supraocular spine; submedian gastric carina weak, not well defined ... *Paraxiopsis pumilus* (Sakai, 1994)
12. Uropodal exopod with 5 prominent lateral spines, second article oval, longer than wide; uropodal endopod with broad shoulder proximally ... *Allaxius clypeatus* (De Man, 1888)
– Uropodal exopod with small lateral spines or unarmed, second article short, much wider than long; uropodal endopod evenly expanding ... 13
13. Eyestalks longer than spike-like rostrum ... *Oxyrhynchaxius manningi* Lin, Kensley and Chan, 2000
– Eyestalks shorter than rostrum or if longer, rostrum broadly triangular ... 14
14. Cheliped dactyli with row of at least 2 erect spines on upper margin (as well as on propodus upper margin) ... 15
– Cheliped dactyli without erect spines on upper margin (propodus upper margin may have erect spines) ... 18
15. Carapace densely spinose ... 16
– Carapace smooth ... 17
16. Eyestalks longer than rostrum; major cheliped propodus with tubercles and blunt spines laterally, gross tubercles mesially ... *Acanthaxius garawa* sp. nov.
– Eyestalks shorter than rostrum; major cheliped propodus with sharp spines laterally, small tubercles and few spines mesially ... *Acanthaxius ningaloo* sp. nov.
17. Lateral gastric carina with 1 prominent tooth posterior to supraocular spine; major cheliped dactylus with 2 erect spines on upper margin; telson significantly longer than wide ... *Acanthaxius clevai* Ngoc-Ho, 2006
– Lateral gastric carina with 2 prominent teeth posterior to supraocular spine; major cheliped dactylus with 5 erect spines on upper margin; telson as wide as long ... *Acanthaxius gathaagudu* sp. nov.
18. Chelipeds densely setose, setae completely obscuring tuberculation; rostrum extremely narrow, with about 6 small lateral teeth ... *Acanthaxius polychaetes* Sakai, 1994
– Chelipeds sparsely setose, ornamentation visible through setae; rostrum broadly triangular or with fewer than 6 lateral teeth if narrow ... 19
19. Rostrum strongly depressed below median gastric carina; gastric carinae with only supraocular spines and minute anterior median tooth above steeply sloping anterior ridge ... *Dorphinaxius kermadecensis* (Chilton, 1911)
– Rostrum level with or slightly below median gastric carina; gastric carinae more or less dentate or spinose ... 20
20. Abdominal pleura 2–5 acutely produced ventrally to sharp point ... 21
– Abdominal pleura 2–5 rounded ventrally ... 22
21. Carapace tuberculate; rostrum with 1 pair of lateral spines; chelipeds without spines on upper margin of carpus and propodus; uropodal endopod apically rounded, without spines ... *Pilbaraxius kariyarra* gen. and sp. nov.
– Carapace smooth; rostrum with 2 or more pairs of lateral spines; chelipeds with strong curved spines on upper margin of carpus and propodus; uropodal endopod apically truncate, with 2 distal spines ... *Calaxius acutirostris* Sakai and de Saint Laurent, 1989
22. Rostrum a triangular projection well separated from gastric region, with 10 spines each side; without supraocular spines; cheliped dactyli massive, with convex upper margin ... *Spongiaxius brucei* (Sakai, 1986)

– Rostrum triangular, not well separated from gastric region, variously dentate; with supraocular spines clearly or weakly differentiated; cheliped dactyli tapering 23

23. Scaphocerite longer than antennal peduncle, with 3 spines on lower margin and 1 spine on mesial margin; eyes unpigmented .... *Australocaris pinjarup* gen. and sp. nov.

– Scaphocerite shorter than antennal peduncle, unarmed, minutely bifurcate or with basiomesial spine; eyes pigmented 24

24. Lateral gastric carina unarmed posterior to supraocular spine; submedian gastric carina unarmed or absent 25

– Submedian and usually lateral gastric carinae denticulate posterior to supraocular spine 26

25. Median gastric carina with 2 teeth anteriorly; submedian gastric carina a simple ridge; cheliped merus upper margin unarmed .... *Axius werribee* (Poore and Griffin, 1979)

– Median gastric carina unarmed; submedian gastric carina absent; cheliped merus upper margin with 2 small teeth .... *Planaxius brevifrons* Komai and Tachikawa, 2008

26. Lateral gastric carina unarmed; submedian gastric carina a hair-pin shaped double ridge of small beads; median gastric carina with few spines and/or beads 27

– Lateral gastric carina with several teeth; submedian gastric carina of numerous teeth; median gastric carina with several teeth 28

27. Carapace smooth; telson without lateral teeth; inner row of tubercles of submedian gastric carina with wide hiatus .... *Michelaxiopsis australiensis* (De Man, 1925)

– Carapace covered with numerous short stiff setae; telson with 3 lateral teeth; inner row of tubercles of submedian gastric carina continuous .... *Michelaxiopsis nauo* gen. and sp. nov.

28. Gastric region with numerous tubercles between median and submedian rows of denticles; cheliped merus without tooth on upper margin .... *Axiopsis serratifrons* (A. Milne-Edwards, 1873)

– Gastric region with single or duplicated submedian rows of denticles; cheliped merus with subdistal tooth on upper margin 29

29. Gastric region with duplicated submedian rows of denticles; larger cheliped propodus tuberculate over distal half of lateral face ...... *Axiopsis tsushimaensis* Sakai, 1992

– Gastric region with single submedian row of denticles; larger cheliped propodus smooth over lateral face .... *Axiopsis consobrina* De Man, 1905

Acanthaxius Sakai and de Saint Laurent, 1989

Acanthaxius Sakai and de Saint Laurent, 1989: 66 (diagnosis, list of species).—Kensley, 1996d: 70–71 (diagnosis, list of species).

Type species. *Axiopsis* (*Axiopsis*) *pilocheira* Sakai, 1987 by original designation.

Diagnosis. Carapace generally smooth or spinose; cervical groove visible laterally over half distance to anterolateral margin. Rostrum spine-like, narrow, laterally obscurely denticulate, about as long as eyestalks, not depressed below level of carapace, continuous with definite lateral carinae; supraocular spines prominent (or not); lateral carina spinose; submedian carina present, spinose; median carina a spinose ridge; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 broad, anteriorly rounded, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite short, curved; distal spine on antenna article 2 anteromesially angled and acute. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; carpus-dactylus upper margins prominently spinose (or not). Pereopods 3–5 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent (or present). Pleopod 2 of male with appendix masculina. Uropodal exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex truncate-rounded.

Remarks. *Acanthaxius* is a genus of 13 nominal species, from the Pacific Ocean and Caribbean Sea. Kensley (1996d) stated that "the definition of this genus contains some uncertainties" and was supported in this by Ngoc-Ho (2006). Most of its members are unambiguously recognised by the combination of spinose rostrum, supraocular spine, spine-bearing median, submedian and lateral gastric carinae on the gastric region of the carapace, narrow chelipeds (pereopods 1) with prominently spinose upper margin and elongate fingers, absence of pleurobranchs, absence of the male pleopod 1, and anteromesially angled acute distal spine on antenna article 2.

Some species, including the type species, are known only from females and the absence of the male pleopod 1 would appear to have been assumed by the authors of the genus from the condition in *A. miyazakiensis* Yokoya, 1933 that they redescribed from abundant material. The male pleopod 1 is absent also in species described subsequently, *A. formosa* Kensley and Chan, 1998, *A. grandis* Kensley and Chan, 1998, *A. gadaletae* Ngoc-Ho, 2006, *A. clevai* Ngoc-Ho, 2006 and one of the new species described here.

Two species, *Calocaris* (*Calastacus*) *hirsutimana* Boesch and Smalley, 1972 and *Axiopsis* (*Axiopsis*) *caespitosa* Squires, 1979, both referred to *Acanthaxius* by Sakai and de Saint Laurent (1989), and *A. polychaetes* Sakai, 1994 do possess a male pleopod 1 and also differ from typical *Acanthaxius* in absence of a prominent supraocular spine, more compact propodus on the major cheliped with few lateral spines, and a prominent lateral spine on the telson. *Acanthaxius spinulicauda* (Rathbun, 1902) is also less spinose than the type species. These species may well deserve another genus whose exceptions are given in parentheses in the diagnosis above.

Acanthaxius clevai Ngoc-Ho, 2006

Figures 1–3, 37

Acanthaxius clevai Ngoc-Ho, 2006: 59–62, figs. 1, 2, 3A–C).

Material examined. WA, off Mermaid Reef, 17°11.83'S, 119°34.81'E–17°12.37'S, 119°35.00'E (stn SS05-2007 079), 435–438 m, 18 Jun 2007, NMV J55706 (female, cl. 28.8 mm, tl. 64 mm). WA, off Point Leveque, 14°58.22'S, 121°38.56'E–14°57.76'S, 121°38.26'E (stn SS05-2007 143), 232–228 m, 02 Jun 2007, NMV J55705 (juvenile male, cl. 8.3 mm, tl. 20 mm).

Diagnosis. Carapace generally smooth, with scattered setae and small tubercles dorsally. Rostrum 0.4 times length of front-to-cervical groove, acute, with 2 lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae (connecting by diverging curved ridges). Supraocular spines prominent. Lateral gastric carina with 1 spine, diverging anteriorly. Submedian gastric carina with 4 spines (last small, flattened). Median gastric carina with 3 spines. Abdominal pleuron 1 ventrally acute; pleura 2–5 posteroventrally rounded; pleuron 6 of male with small spine on anteroventral margin.

Antennal article 1 with 1 spine on lower distal margin; article 2 distal spine slender, directed inwards, reaching distally to middle of antennal article 4; scaphocerite slender, straight, reaching distally almost to end of article 4; article 3 with 1 spine on mesial lower margin. Maxilliped 3 ischium with 2 spines on lower margin; merus with 3 spines on lower margin.

Pereopods 1 well differentiated, of similar length, propodus of major cheliped more swollen than minor cheliped. Major pereopod 1 merus upper margin convex, with 2 spines, lower margin with 4 spines, lateral face spinose distally, mesial face spinose distally; carpus upper margin with 4 midline spines and 1 spine on each side, lower margin with 3 spines, mesial face tuberculate, with 1 spine; propodus upper margin with 3 midline spines and 2 spines each side, lower margin with 7 spines in lateral row and 3 spines in mesial row, lateral face tuberculate, with 5 scattered spines, mesial face tuberculate, with 4 scattered spines; fixed finger 1.2 times length of upper palm, cutting edge with large rounded teeth; dactylus upper margin with 2 erect spines, 1 submarginal spines on each side, tuberculate, cutting edge with large rounded teeth.

Minor pereopod 1 merus, carpus as in larger cheliped; propodus as in larger cheliped except narrower, lower margin with 7–9 spines in lateral row and 3 spines in mesial row; fixed finger 1.7 times length of upper palm, cutting edge straight with numerous small sharp teeth; dactylus armature as in major pereopod.

Telson rectangular, approximately parallel-sided, 1.3 times as long as wide, lateral margin with 3 spines, distal margin convex with posteromedian spine, posterolateral angle with 2 robust setae; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.4 times as long as wide, with 1 lateral spine, longitudinal ridge with 4 spines (including marginal). Uropodal exopod 1.6 times as long as wide, with 7 lateral spines, 2 longitudinal ribs (outer rib with 4 spines), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 10 spines.

Distribution. Solomon Islands; WA, North-West continental margin, 15°–17°S, 119°–122°E, 228–438 m depth.

Remarks. The new material, a female and juvenile male from north-western Australia, are barely distinguishable from Ngoc-Ho's (2006) figures and description of a similarly-sized male specimen from the Solomon Islands. We illustrate them fully and present a short diagnosis. The species is recognisable by the pattern of spination on the rostrum and carapace (two lateral rostral spines, median gastric carina with four spines, submedian with five spines including the supraorbital, and a single spine on the curved lateral gastric carina). The complex patterns of spination on the major and minor chelipeds are also virtually identical to those of the holotype. N. Ngoc-Ho illustrated the minor cheliped of a female paratype (MNHN Th1492) for us and we detect no significant differences from our male. Slight differences in proportions (the chelipeds of the Australian adult female are slightly more slender than in the male holotype) can be attributed to sexual dimorphism. We identify the small male (about one-third as long as the adult) as the same species in spite of substantial differences in the chelipeds. The chelipeds of the small juvenile male are more elongate than those of the adult female and with more prominent spination (cf. figs. 1i–l with 3c, d). The upper margin of the dactylus possesses three spines while the Australian female and male holotype have only only two. The juvenile male possesses spinules on the anteroventral corners of abdominal pleura 3–6, not present in the adult female nor in the male holotype.

Ngoc-Ho (2006) described a second similar species, *Acanthaxius gadaletae*, from the Solomon Islands and New Caledonia, based on type material about half the size of specimens of *A. clevai*. The species, apparently adult males and females, differs from *A. clevai* only in better defined gastric carinae, maxilliped 3 basis with a spine, more stout pereopod 1 with four propodal and dactylar spines on the upper margins, and abdominal pleura 3–5 slightly angled posteriorly. The cheliped spination alone (more spines than in adult and juveniles of *A. clevai*) is sufficient to differentiate *A. gadaletae*. The maxilliped 3 basis of the type of *A. clevai* was said to lack a distal spine and to differentiate the species from *A. gadaletae*; both of the Australian specimens possess a strong spine but we don't consider this difference alone diagnostic. This small species possesses spinules on the anteroventral corners of abdominal pleura 3–6 as in the small Australian male.

Acanthaxius gadaletae differs from the type species, *A. pilocheira* (Sakai, 1987) most obviously in not having a spinose carapace and in having one, not two, spines on each lateral gastric carina.

Both specimens of *A. clevai* from WA lack a long straight seta on the posterior lobe of the scaphognathite (maxilla 2 epipod; fig. 37) as was reported for this species and the similar *A. gadaletae* (Ngoc-Ho, 2006). The seta is typical of Axiidae and is found in all other species of *Acanthaxius* (Squires, 1979; Sakai, 1987; Sakai and de Saint Laurent, 1989; own observations of four species). Only *A. hirsutimana* is unknown.

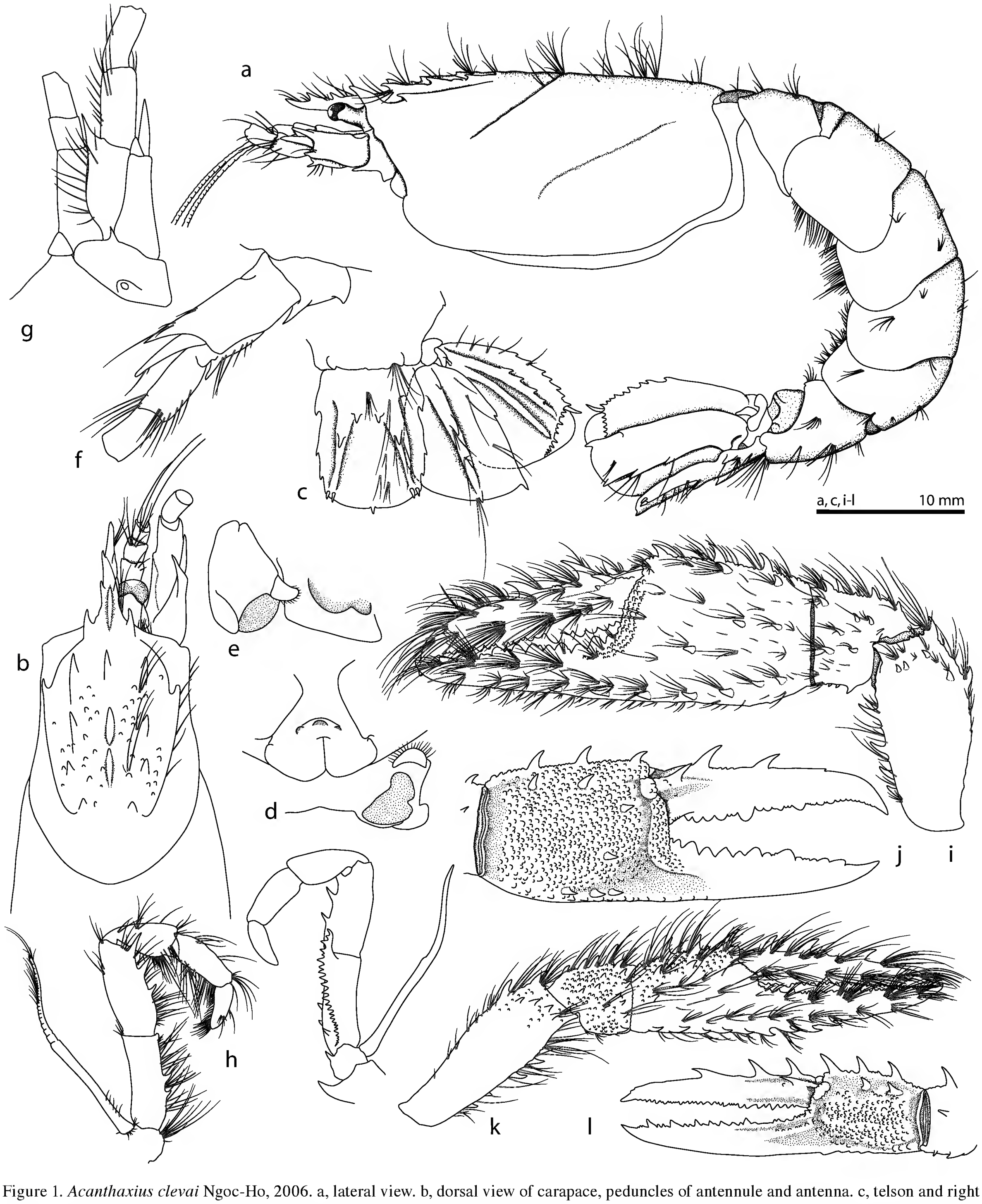

Figure 1. *Acanthaxius clevai* Ngoc-Ho, 2006. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, sternites 7 and 8. e, right sternite 8 (lateral). f, left antenna peduncle. g, epistome, left antennule and antenna (ventral). h, maxilliped 3 (anterior and posterior views); i, major pereopod 1 (left, lateral). j, same (propodus–dactylus, without setae, mesial). k, minor pereopod 1 (right, lateral). l, same (carpus–dactylus, without setae, mesial). All figures from NMV J55706.

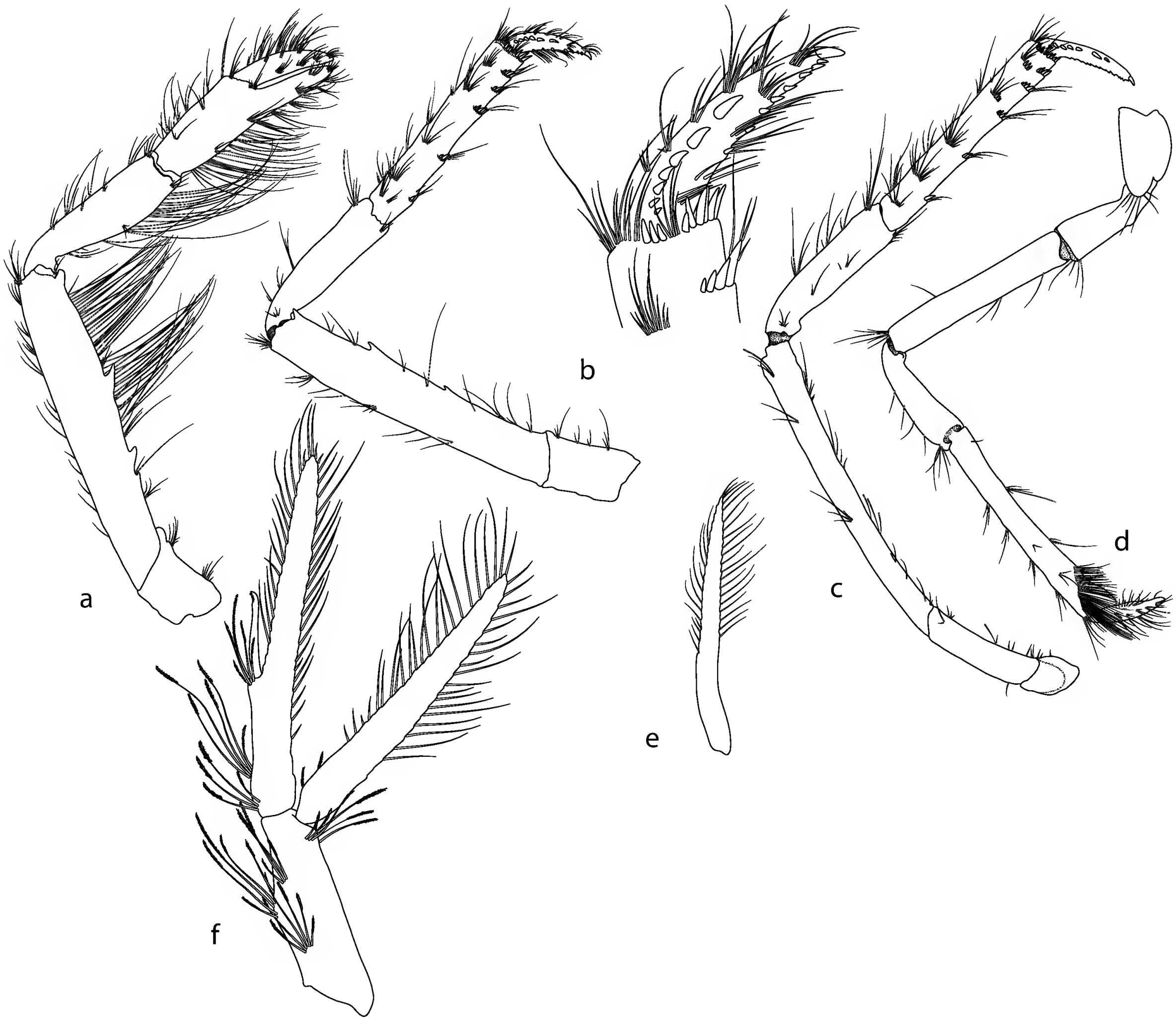

Figure 2. *Acanthaxius clevai* Ngoc-Ho, 2006. a–d, pereopods 2–5 (right except d, with detail of dactylus of pereopod 3). e, f, female pleopods 1, 2. All figures from NMV J55706.

Acanthaxius garawa sp. nov.

Figures 4, 5

Material examined. Holotype. Qld, Gulf of Carpentaria, 12°10.5'S, 139°56.7'E (stn SS05-1991 040, A.J. Bruce), 59 m, 25 Nov 1991, NTM Cr008808 (male, cl. 9.9 mm, tl. 28 mm).

Paratype. Qld, Gulf of Carpentaria, 11°25.2'S, 139°25.2'E (stn SS05-1991 054, A.J. Bruce), 49 m, 28 Nov 1991, NTM Cr009067 (male, cl. 10.0 mm, tl. 28 mm).

Description of male holotype. Carapace heavily spinulose. Rostrum 0.2 times length of front-to-cervical, acute, with 4 lateral spines anterior to supraocular spine, weakly continuous with lateral gastric carinae. Supraocular spines moderately prominent. Lateral gastric carina with 10 spines. Submedian gastric carina duplicated, external row with 10–12 spines, internal with 10–12 spines. Median gastric carina with about 20 spines. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with sharp oblique lateral ridge. Sternite 8 (pereopod 5) with setose semicircular flap on anterior face at base of leg. Abdominal pleuron 1, 1.4 times as deep as middorsal length, ventrally obtuse; pleuron 2 broad, lateral length as long as dorsal length, anteroventrally rounded; pleura 3–5 becoming more ventrally quadrate, each with small anteroventral tooth; pleuron 6 rounded, with small anteroventral tooth; pleura 1–5 without lateral crease, slightly flared laterally.

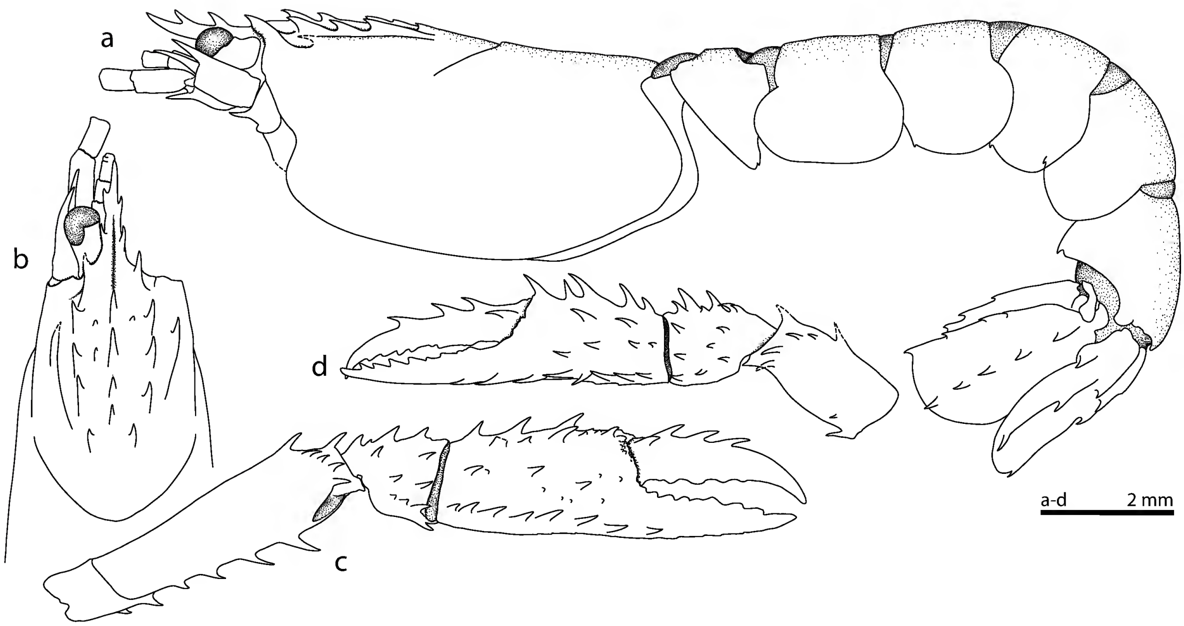

Figure 3. *Acanthaxius clevai* Ngoc-Ho, 2006. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, major pereopod 1 (left, lateral). d, minor pereopod 1 (right, lateral). All figures from NMV J55705, without setae.

Eyestalk, 1.6 length of rostrum; cornea weakly pigmented. Antennular peduncle reaching to middle of antennal article 5. Antennal article 1 with 1 spine and 3 spinules on distoventral margin; article 2 distal spine slender, directed slightly inwards, reaching distally to middle of antennal article 4; scaphocerite slightly curved, reaching distally to just beyond midpoint of article 4; article 3 with with 4 spines on mesial lower margin; article 4 about two-thirds length of article 2 (excluding distal spine), with distoventral spine; article 5 about half length of article 4. Maxilliped 3 basis with 1 spine; ischium with 2 spines on lower margin; crista dentata with ~24 teeth; merus with 3 spines; carpus with 1 spine.

Pereopods 1 asymmetrical, propodus of major more swollen, 1.15 times as long as minor. Major pereopod 1 (left) coxa lower margin with 2 spines; basis lower margin without spine; ischium lower margin with 3 spines; merus upper margin convex, with 4 spines, lower margin with 10 spines, lateral face spinose distally near upper margin, mesial face rugose distally; carpus upper margin with 6 spines, lower margin with 3 spines laterally, 1 spine mesially, lateral face tubercular, mesial face with 3 spines plus others smaller; propodus upper margin with row of 7 spines, lower margin with 12 spines in lateral row and obsolete mesial row, lateral face covered with dome-like tubercles, mesial face covered with larger distinct tubercles, with 1 spine near gape; fixed finger 1.2 times length of upper palm, cutting edge straight, with c. 20 irregular rounded teeth; dactylus upper margin with 8 spines, lateral face with row of blunt spines, mesial face with row of 6 spines and denticles, cutting edge as in fixed finger; both fingers bearing setae.

Minor pereopod 1 coxa, ischium as in larger cheliped; merus upper margin with 5 spines, lower margin with 7 spines; carpus upper margin with 6 spines, lower margin with 4 spines laterally, 1 spine mesially, lateral face weakly spinose, mesial face with 3 spines; propodus upper margin with 5 spines, lower margin with 7 spines in lateral row and 7 spines in mesial row, lateral face weakly tuberculate, mesial face grossly tuberculate, with 2 spines near gape; fixed finger 2.5 times length of upper palm, cutting edge with c. 40 irregular teeth; dactylus upper margin with 6 spines, lateral face with proximal row of 5 spines, mesial face with row of 4 denticles, cutting edge as in fixed finger; both fingers setose as in major pereopod.

Pereopod 2 ischium lower margin with 1 distal spine; merus lower margin with 4 spines; carpus about as long as chela; propodus upper margin 0.8 length of dactylus. Pereopod 3 merus lower margin with 5 strong spines; carpus with 1 spine; propodus 1.9 times as long as dactylus, with 7 marginal robust setae (some duplicated). Pereopod 4 missing. Pereopod 5 propodus 2.5 times as long as dactylus, subchelate, with short fixed finger; dactylus with broad blade on cutting edge.

Pleopods 2–5 appendix interna one quarter length of endopod; appendix masculina just exceeding appendix interna.

Telson about as long as broad, lateral margin with proximal tooth, distal margin broadly convex, with posteromedian spine, posterolateral angle with 1 minute tooth and 2 robust setae; dorsal face with 2 spines in each oblique row. Uropodal

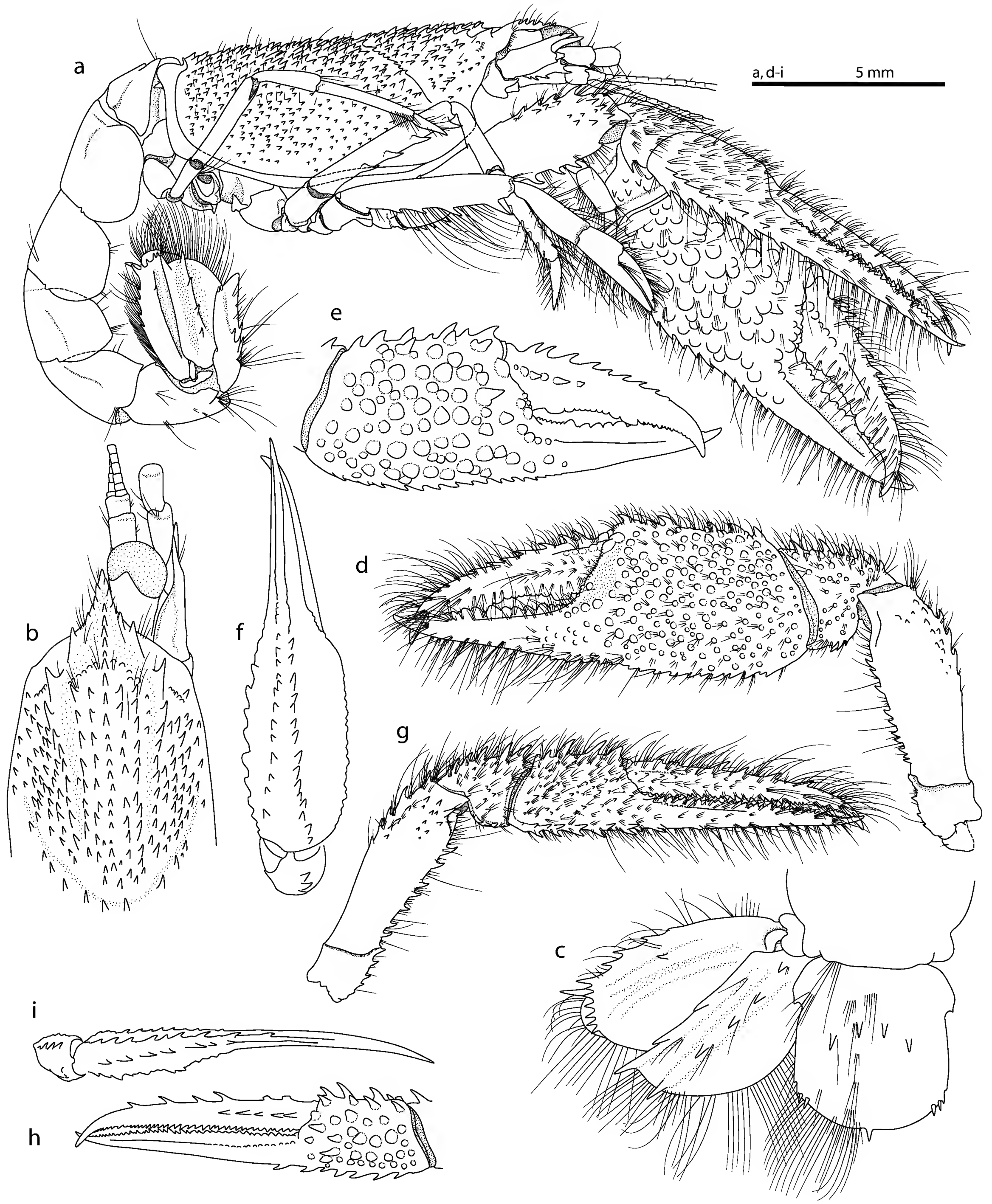

Figure 4. *Acanthaxius garawa* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and left uropod. d, major pereopod 1 (left, lateral). e, same (propodus–dactylus, without setae, mesial). f, same (carpus–propodus, without setae, lower). g, minor pereopod 1 (right, lateral). h, same (propodus–dactylus, without setae, mesial). i, same (carpus–propodus, without setae, lower). All figures from holotype.

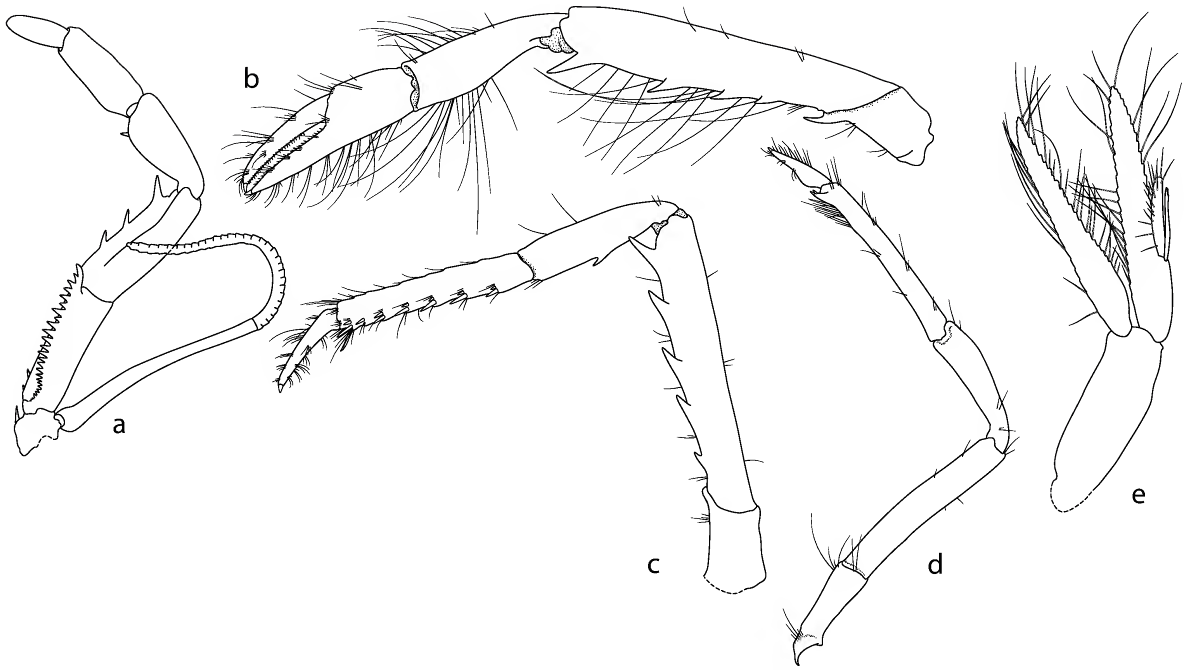

Figure 5. *Acanthaxius garawa* sp. nov. a, maxilliped 3 (without setae). b, male pleopod 2. c, pereopod 2 (right). d, pereopod 3 (right). e, pereopod 5 (right). All figures from holotype.

endopod 2.0 times as long as wide, with 2 lateral and 1 distolateral spines, longitudinal ridge with 5 spines (including marginal). Uropodal exopod 1.8 times as long as wide, with 4 lateral spines, 2 longitudinal ribs (outer rib with 1 spine), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 6 spines.

Etymology. Garawa is an Australian Aboriginal language which was spoken in the Gulf of Carpentaria region close to the Northern Territory-Queensland border.

Distribution. Qld, Gulf of Carpentaria, 12°S, 140°E, 49–59 m depth (known only from the type locality).

Remarks. With its spinose carapace, *Acanthaxius garawa* is closest to *A. ningaloo* sp. nov. described below. It differs in having tubercles rather than sharp spines on lateral and mesial faces of the chelipeds and the rostrum being shorter than the eyes. The tubercles on the mesial face of the major cheliped are strikingly prominent. See the *Remarks* following *A. ningaloo* for differences from other similar Indo-West Pacific species.

Acanthaxius gathaagudu sp. nov.

Figures 6–8

Material examined. Holotype. WA, Shark Bay, 25°55.40'S, 112°14.35'E–25°56.17'S, 112°14.46'E (stn SS10-2005 113), 404–407 m, 06 Dec 2005, NMV J53448 (female, cl. 36 mm, tl. 85 mm).

Paratype. WA, off Mermaid Reef, 17°01.09'S, 119°35.46'E–17°01.81'S, 119°35.00'E (stn SS05-2007 080), 451–440 m, 18 Jun 2007, NMV J55704 (male, cl. 22 mm, tl. 55 mm).

Description of female holotype. Carapace smooth, with few setae. Rostrum (broken in holotype, 0.4 times length of front-to-cervical groove in paratype), acute, with 3–4 lateral spines anterior to supraocular spine, weakly continuous with lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina with 2 spines. Submedian gastric carina with 4 spines. Median gastric carina with 3 anterior spines, 1 tubercle, 1 posterior spine. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with sharp oblique lateral ridge. Sternite 8 (pereopod 5) with setose semicircular flap on anterior face at base of leg. Abdominal pleuron 1 twice as deep as middorsal length, ventrally acute; pleuron 2 broad, lateral length 1.2 times dorsal length, anteroventrally rounded; pleura 3–5 becoming more ventrally quadrate; pleuron 6 rounded; pleura 1–5 without lateral crease, slightly flared laterally.

Eyestalk (broken in holotype, 0.5 length of rostrum in paratype); cornea pigmented. Antennular peduncle reaching to proximal part of antennal article 5. Antennal article 1 with 1 spine on distoventral margin; article 2 distal spine slender, directed slightly inwards, reaching distally to middle of antennal article 4; scaphocerite slightly curved, reaching distally to just beyond midpoint of article 4; article 3 with broad mesiodistal spine on lower margin; article 4 about two-

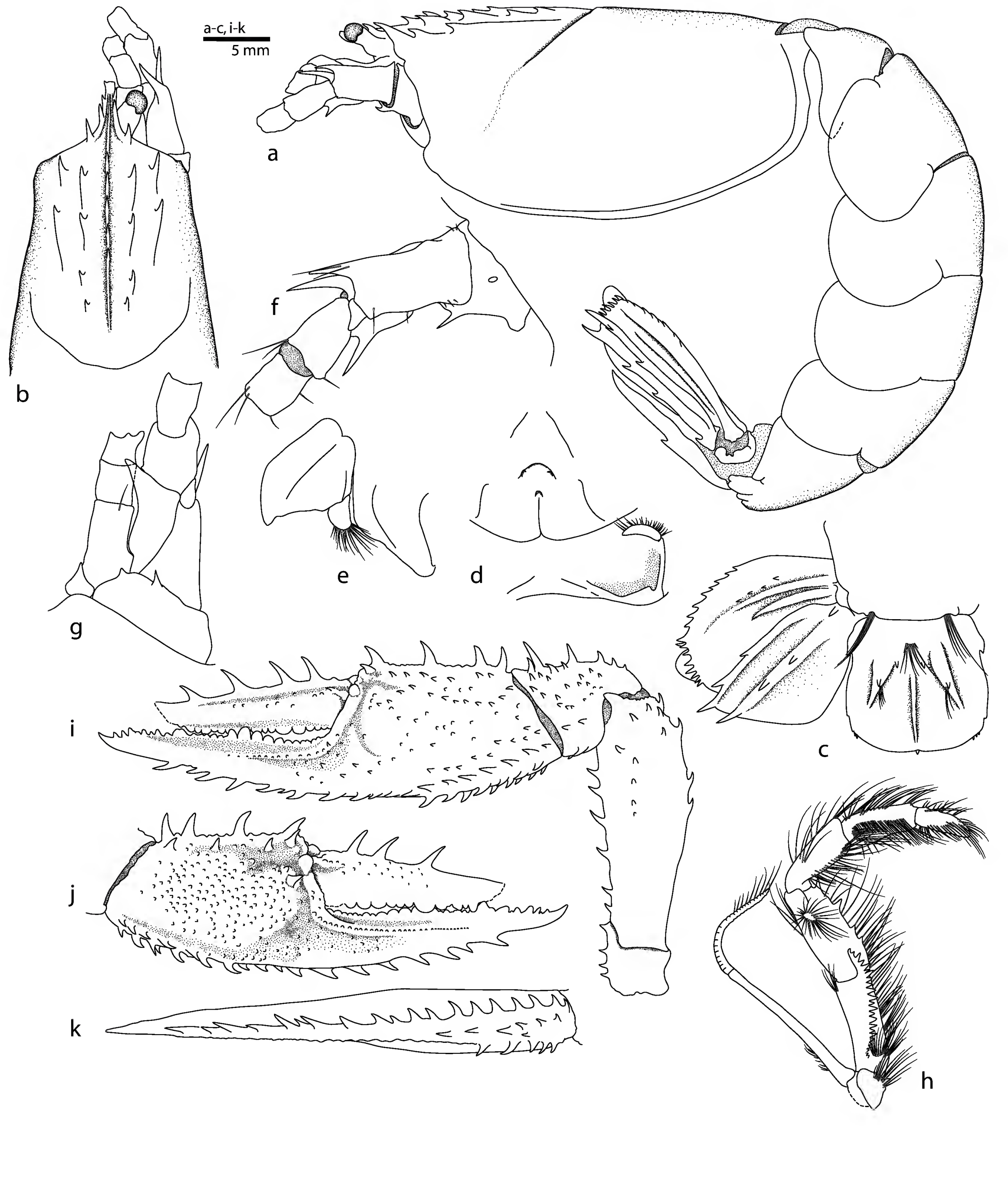

Figure 6. *Acanthaxius gathaagudu* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and left uropod. d, sternites 7 and 8. e, left sternite 8 (lateral). f, left antenna peduncle (lateral). g, epistome, left antennule and antenna (ventral). h, maxilliped 3. i, major pereopod 1 (left, without setae, lateral). j, same (propodus, dactylus, without setae), mesial. k, same (propodus, without setae, lower). All figures from holotype.

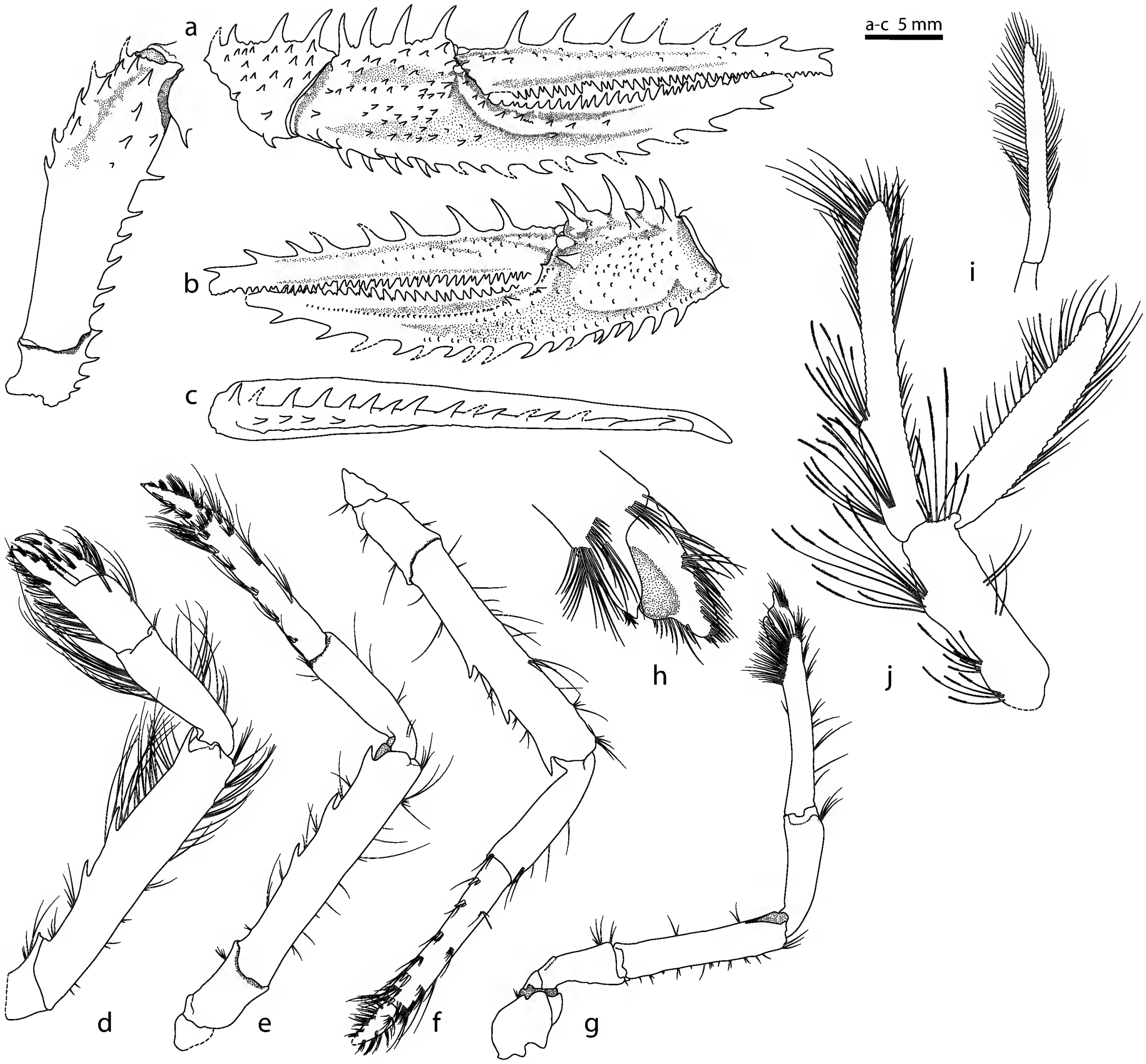

Figure 7. *Acanthaxius gathaagudu* sp. nov. a, minor pereopod 1 (right, without setae, lateral). b, same (propodus, dactylus, without setae, mesial). c, same (propodus, lower). d–g, pereopods 2–5 (left except f). h, pereopod 5 fingers. i, j, female pleopods 1, 2. All figures from holotype.

thirds length of article 2 (excluding distal spine); article 5 about half length of article 4. Maxilliped 3 basis with 1 spine; ischium crista dentata with 15–20 teeth; merus with 4 spines; carpus unarmed.

Pereopods 1 scarcely differentiated, of similar length, propodus of major more swollen. Major pereopod 1 (right) coxa lower margin with 1 spine; basis lower margin without spine; ischium lower margin with 4 spines; merus upper margin convex, with 4 spines, lower margin with 7 spines, lateral face spinose distally, mesial face smooth; carpus upper margin with 5 spines, lower margin spinulose, lateral face spinose, mesial face with 1 spine; propodus upper margin with 1 row of 4 spines, lower margin with 18 spines in lateral row, 5 spines in proximal mesial row and 7 smaller intermediate spines, lateral face spinose, mesial face tuberculate, with 5 spines concentrated near gape; fixed finger 1.5 times as long as upper palm, cutting edge straight with c. 25 irregular rounded teeth; dactylus upper margin with (est. 5) spines, lateral face with 1 small spine, mesial face unarmed, cutting edge as in fixed finger; both fingers bearing setae.

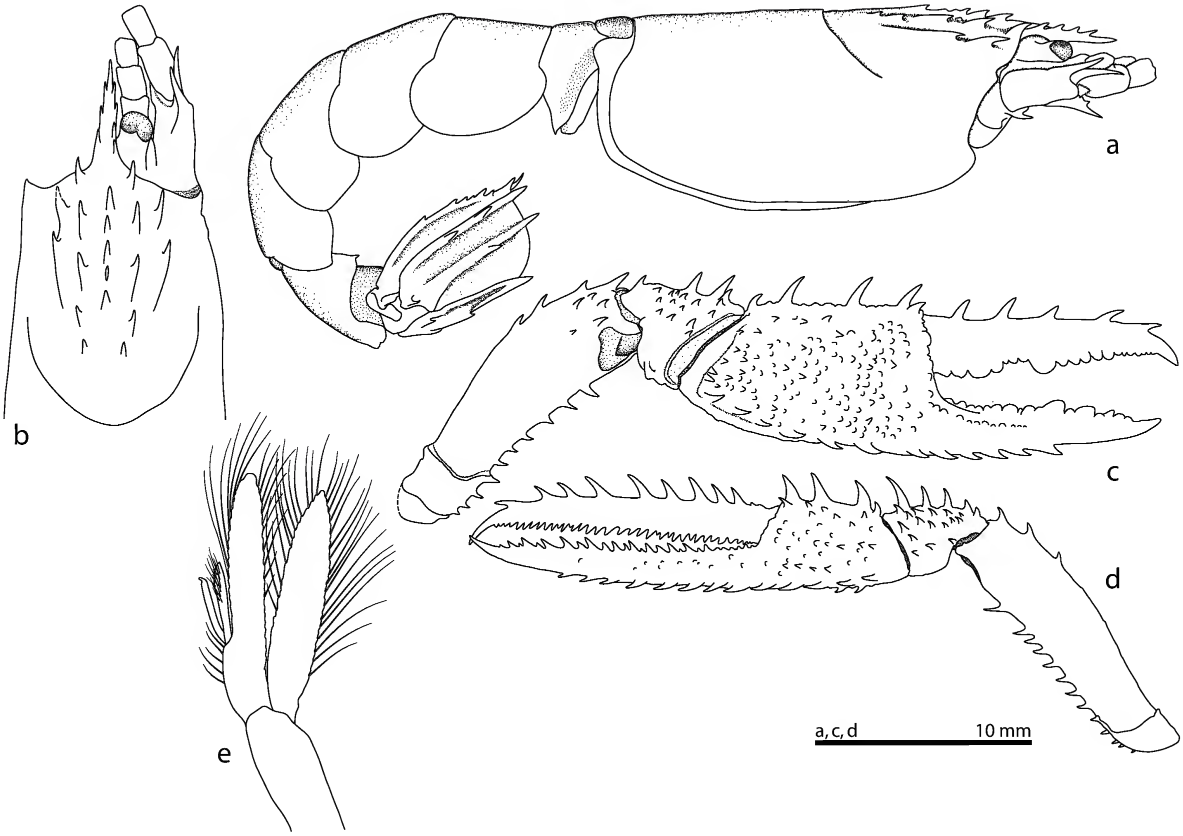

Figure 8. *Acanthaxius gathaagudu* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, major pereopod (right, lateral, without setae). d, minor pereopod (left, lateral, without setae). e, male pleopod 2. All figures from paratype, NMV J55704.

Minor pereopod 1 coxa, ischium and merus as in larger cheliped; carpus upper margin with 3 spines, lower margin with 2 spines, lateral face spinose, mesial face with 1 spine; propodus upper margin with 1 row of 4 spines, lower margin with 16 spines in lateral row and 4 spines in mesial row, lateral face spinose, mesial face tuberculate, with 2 spines near gape; fixed finger 2.8 times length of upper palm, cutting edge with c. 20 oblique sharp teeth; dactylus upper margin with 8 spines, lateral face with obsolete spine, mesial face unarmed, cutting edge as in fixed finger; both fingers setose as in major pereopod.

Pereopod 2 ischium lower margin with 1 distal spine; merus lower margin with 3 spines; carpus slightly shorter than chela; propodus upper margin 0.8 length of dactylus. Pereopod 3 merus lower margin with 3 spines; propodus 2.2 times as long as dactylus, with 7 marginal robust setae (some duplicated). Pereopod 4 merus lower margin with 3 spines; propodus 2.7 times as long as dactylus, with 6 marginal robust setae (some duplicated). Pereopod 5 propodus 4 times as long as dactylus, subchelate, with short fixed finger; dactylus with broad blade on cutting edge.

Pleopods 2–5 appendix interna one quarter length of endopod.

Telson about as long as broad, lateral margin with 2 spines, distal margin broadly convex, with posteromedian spine, posterolateral angle with 1 minute tooth and 2 robust setae; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.6 times as long as wide, with 3 lateral spines, longitudinal ridge with 3 spines (including marginal). Uropodal exopod 1.7 times as long as wide, with 9 lateral spines, 2 longitudinal ribs (outer rib with 4 spines), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 7 spines.

Male paratype. Essentially indistinguishable from female except for: maxilliped 3 merus with 3 spines, carpus with 1 spine; details of spination of chelipeds; more slender minor cheliped; pleuron 1 having a small ventral spine, a slightly more rectangular pleuron 5 and a small spine on pleuron 6. Pleopod 2 with appendix masculina about half length of distal endopod; appendix interna slightly shorter.

Etymology. Gathaagudu is the name for Shark Bay in the local Malgana language.

Distribution. WA, North West Shelf to Shark Bay, 17°–26°S, 112°–119°E, 400–450 m depth.

Remarks. Comparison of the figures of the holotype (figs. 6, 7) and paratype (fig. 8) illustrates variability in spination of the carapace, maxillipeds and chelipeds. *Acanthaxius gathaagudu* is most similar to two other species of *Acanthaxius* with two spines on the lateral gastric carina. The most significant difference between them is in the number of spines on the upper margin of the dactylus of the major cheliped, five (in both sexes) in the new species, 11 in *A. grandis* and 8–10 in *A. pilocheira*. The number of dactylar spines on the minor cheliped are similar in the three species, 8–9 in *A. gathaagudu*, 10–11 in the other two species. In *A. gathaagudu* the minor cheliped of the male is slightly more slender than in the female so any comparisons must be made between individuals of the same sex. The holotype of *A. grandis* from Taiwan is a female of carapace length 33.5 mm whose chelipeds were figured by Kensley and Chan (1998: fig. 4). The figured holotype of *A. pilocheira* is also a female of a similar size. The female major and minor chelipeds of *A. gathaagudu* are narrower (depth: dorsal length of propodus 0.85) and with more prominent marginal spines than in *A. grandis* (depth : dorsal length of propodus 1.25) whereas *A. pilocheira* is intermediate between them. *Acanthaxius gathaagudu* has narrower uropodal rami than the other species and, like *A. pilocheira*, has 8–9 marginal spines on the uropodal exopod compared to only five in *A. grandis*. Kensley and Chan (1998) remarked on the abdominal pleura, especially pleuron 5, which is posteriorly rectangular in *A. grandis*, rather than rounded as in *A. pilocheira*. We suspect that this may be a sexual difference–their figures of a paratype may be of a male whereas those of *A. pilocheira* are of female. The male of *A. gathaagudu* has a slightly more rectangular pleuron 5 than the female and a small spine on pleuron 6, absent in the female (cf. figs. 6a, 8a).

Acanthaxius ningaloo sp. nov.

Figures 9, 10, 38

Material examined. Holotype. WA, off Ningaloo North, 21°59.10'S, 113°49.12'E–21°59.47'S, 113°49.08'E (stn SS10-2005 153), 165 m, 11 Dec 2005, NMV J53446 (female, cl. 22.2 mm, tl. 56.7 mm).

Paratype. Collected with holotype, NMV J53447 (male, cl. 16 mm, complete but fragmented).

Description of female holotype. Carapace heavily spinulose. Rostrum 0.4 times length of front-to-cervical groove, acute, with 3–4 lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina with 9 spines. Submedian gastric carina duplicated, external row with 7–10 spines, internal with 12–13 spines. Median gastric carina with 21 spines. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with sharp oblique lateral ridge. Sternite 8 (pereopod 5) with setose semicircular flap on anterior face at base of leg. Abdominal pleuron 1 twice as deep as middorsal length, ventrally acute; pleuron 2 broad, lateral length 1.2 times dorsal length, anteroventrally rounded; pleura 3–5 becoming more ventrally acute; pleuron 6 with small spine on ventral margin; pleura 1–5 with lateral crease.

Eyestalk 0.8 length of rostrum; cornea weakly pigmented. Antennular peduncle reaching to proximal part of antennal article 5. Antennal article 1 with 1 spine and 2 spinules on lower distal margin; article 2 distal spine slender, directed slightly inwards, reaching distally to middle of antennal article 4; scaphocerite slender, straight, reaching distally almost to end of article 4; article 3 with 4 spines on mesial lower margin; article 4 about half length of article 2 (excluding distal spine), with distoventral spine; article 5 about two-thirds length of article 4. Maxilliped 3 basis with 1 spine; ischium with 2 spines on lower margin; crista dentata with 16 teeth; merus with 3 spines on lower margin; carpus unarmed.

Pereopods 1 scarcely differentiated, of similar length, propodus of major more swollen. Major pereopod 1 (right) coxa lower margin with 2 spines; basis lower margin with 1 spine; ischium lower margin with 4 spines; merus upper margin convex, with 4 spines, lower margin with 9 spines, lateral face spinose distally, mesial face spinose distally; carpus upper margin with 6 spines, lower margin with 4 spines laterally, 1 spine mesially, lateral face spinose, mesial face with 1 spine; propodus upper margin with 2 rows each of 4 spines, lower margin with 21 spines in lateral row and 8 spines in mesial row, lateral face spinose, mesial face tuberculate, with 8 spines concentrated near gape; fixed finger twice length of upper palm, cutting edge straight, with c. 20 irregular rounded teeth; dactylus upper margin with 9 spines, lateral face with proximal row of 5 submarginal spines, mesial face with proximal spine and row of denticles, cutting edge as in fixed finger; both fingers bearing setae.

Minor pereopod 1 coxa, ischium and merus as in larger cheliped; carpus upper margin with 4 spines, lower margin with 1 spine, lateral face spinose, mesial face with 1 spine; propodus upper margin with 2 rows each of 4 spines, lower margin with 23 spines in lateral row and 5 spines in mesial row, lateral face spinose, mesial face tuberculate, with 6 spines concentrated near gape; fixed finger 2.5 times length of upper palm, cutting edge with c. 30 oblique sharp teeth; dactylus upper margin with 10 spines, lateral face with proximal row of 5 submarginal spines, mesial face with row of denticles, cutting edge as in fixed finger; both fingers setose as in major pereopod.

Pereopod 2 ischium lower margin with 1 distal spine; merus lower margin with 3 spines; carpus slightly shorter than chela; propodus upper margin 0.8 length of dactylus. Pereopod 3 merus lower margin with 3 spines; propodus 2.8 times as long as dactylus, with 6 marginal robust setae (some duplicated). Pereopod 4 merus lower margin with 4 spines; propodus 2.6 times as long as dactylus, with 7 marginal robust setae (some duplicated). Pereopod 5 propodus 2.9 times as long as dactylus, subchelate, with short fixed finger; dactylus with broad blade on cutting edge.

Pleopods 2–5 appendix interna one third length of endopod.

Telson about as long as broad, lateral margin with 1 spine, distal margin convex with posteromedian spine, posterolateral angle with 1 or 2 minute teeth and 2 robust setae; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.6 times as long as wide, with 3 lateral spines, longitudinal ridge with 3 spines (including marginal). Uropodal exopod 1.6 times as

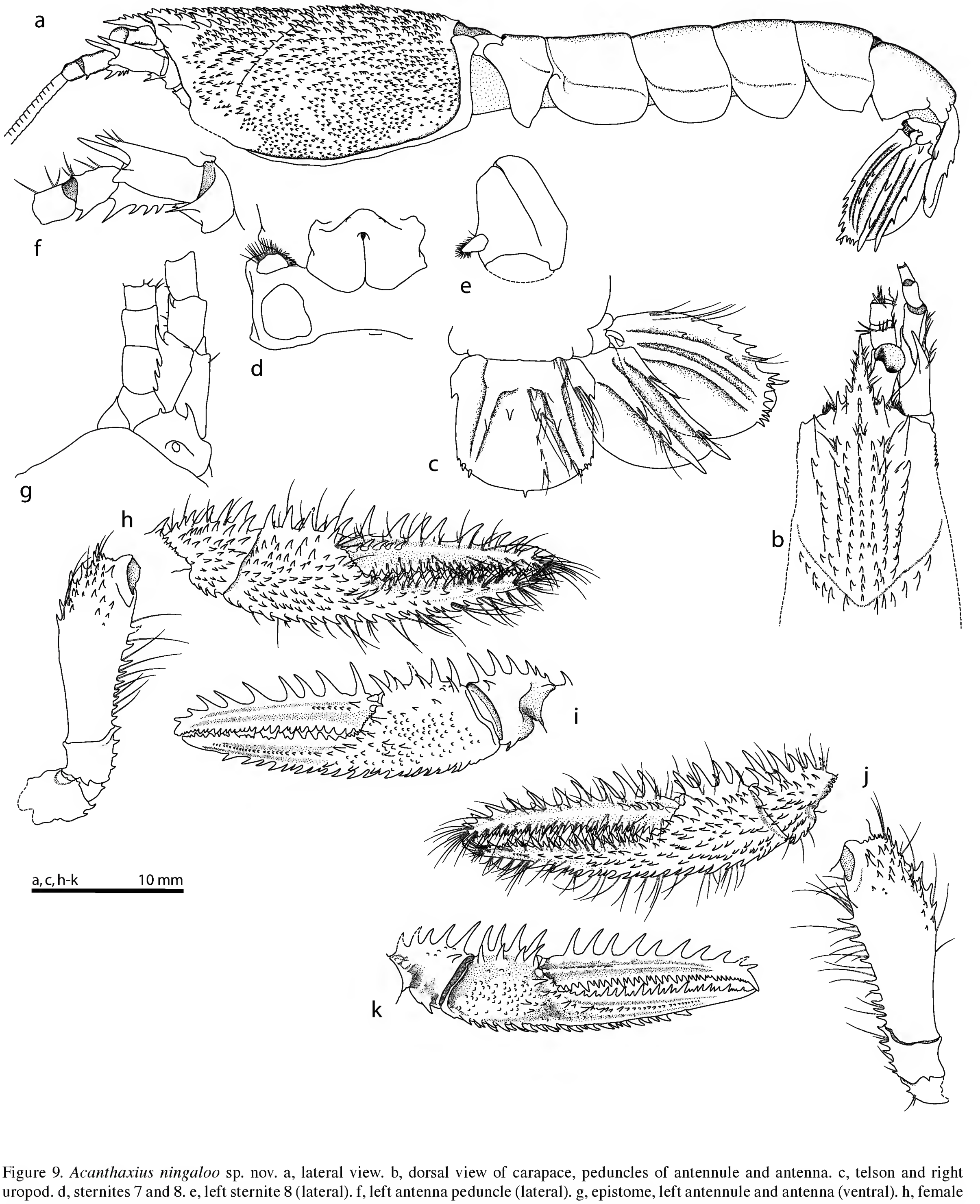

Figure 9. *Acanthaxius ningaloo* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, sternites 7 and 8. e, left sternite 8 (lateral). f, left antenna peduncle (lateral). g, epistome, left antennule and antenna (ventral). h, female major pereopod 1 (right, dislocated, lateral). i, same (carpus–dactylus, without setae, mesial). j, female minor pereopod 1 (left, dislocated, without setae, lateral). k, same (carpus–dactylus, without setae, mesial). All figures from holotype.

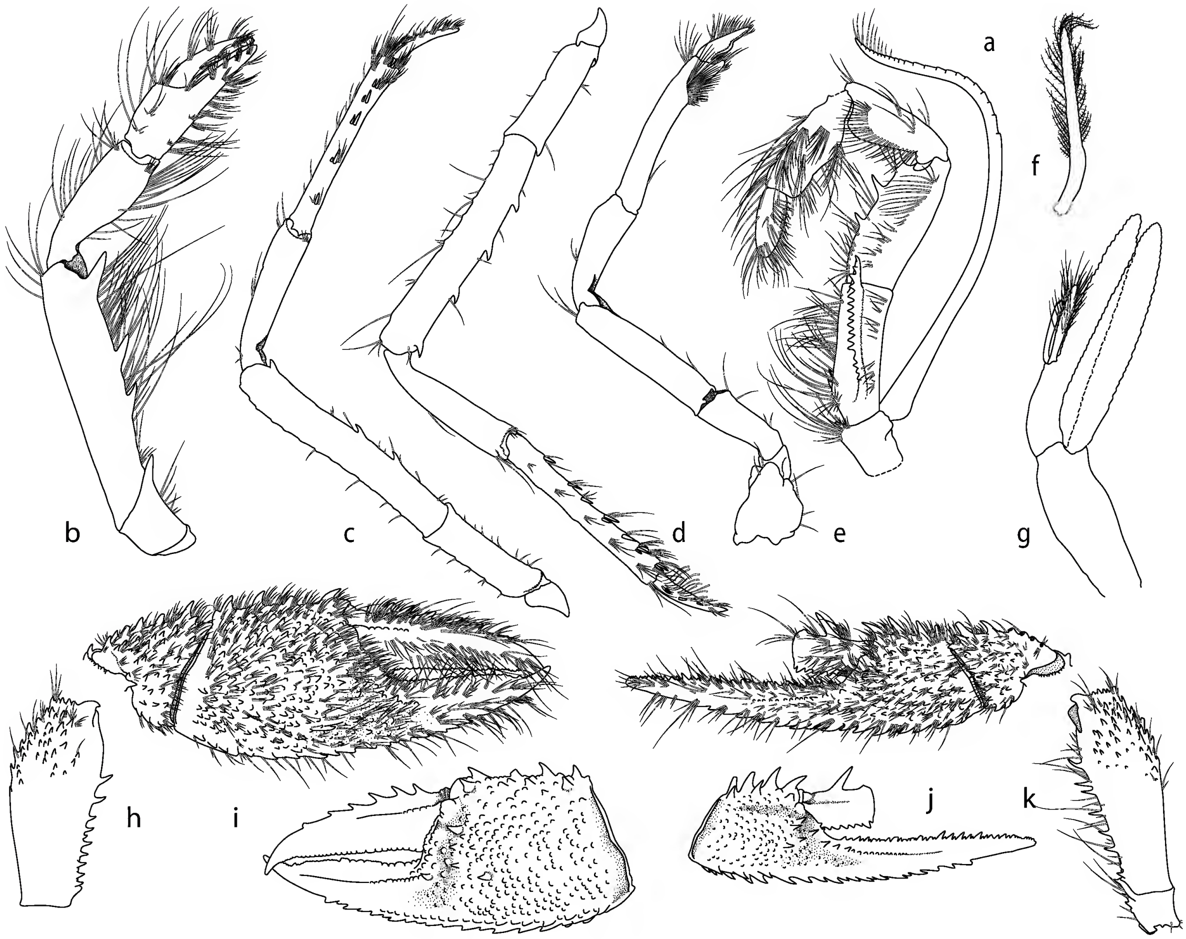

Figure 10. *Acanthaxius ningaloo* sp. nov. a, maxilliped 3. b–e, pereopods 2–5 (right except d). f, female pleopod 1. g, male pleopod 2 (rami without setae). h, male major pereopod 1 (right, dislocated, lateral). i, same (propodus–dactylus, without setae, mesial). j, male minor pereopod 1 (left, dislocated, without setae, lateral). k, same (propodus–dactylus [broken], without setae, mesial). Figs a–f from holotype; figs. g–k from paratype NMV J53447.

long as wide, with 4 lateral spines, 2 longitudinal ribs (outer rib with 2 spines), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 7 spines.

Male. Carapace spination and abdomen indistinguishable from female. Pereopods 1 grossly differentiated, of similar length, propodus of major considerably more swollen than minor. Major pereopod 1 (right) coxa lower margin with 2 small spines; basis lower margin with 1 spine; ischium lower margin with 5 spines; merus upper margin convex, with 4 spines, lower margin with 10 spines, lateral face spinose distally, mesial face spinose distally; carpus upper margin with 6 spines, lower margin with 3 spines laterally, 1 spine mesially, lateral face spinose and densely setose in upper half, mesial face with 1 spine; propodus upper margin with 2 rows each of 4 spines (mesial row obsolete), lower margin with 19 spines in lateral row and 14 spines in mesial row, diminishing, lateral face spinose and densely setose in upper half, mesial face tuberculate, with 8 spines concentrated near gape; fixed finger as long as upper palm, cutting edge straight, with c. 20 irregular rounded teeth; dactylus upper margin with 6 spines, lateral face with proximal row of 5 small submarginal spines, densely setose, mesial face with proximal spine and row of denticles, cutting edge as in fixed finger.

Minor pereopod 1 coxa, ischium and merus as in larger cheliped; carpus upper margin with 4 spines, lower margin with 3 lateral spines, 1 mesial spine, lateral face spinose and setose, mesial face with 1 spine; propodus upper margin with 2 rows of 4 lateral and 3 small mesial spines, lower margin with 20 spines in lateral row and 5 spines in mesial row, lateral face spinose and setose, mesial face tuberculate, with 6 spines concentrated near gape; fixed finger 4 times length of upper palm, cutting edge with c. 30 oblique sharp teeth; dactylus upper margin with spinose (broken).

Pleopod 2 with appendix masculina about third length of endopod, attached one-third along; appendix interna slightly shorter than appendix masculina.

Etymology. Ningaloo, the name of a major WA fringing reef, is from the local Gnulli language.

Distribution. WA, off Ningaloo North, 22°S, 114°E, 165 m depth (known only from the type locality).

Remarks. *Acanthaxius ningaloo* is most similar to *A. polyacantha* (Miyake and Sakai, 1967) described from the East China Sea, also recorded from the Solomon Islands by Ngoc-Ho (2006), and to *A. formosa* from off Taiwan (Kensley and Chan, 1998). The type specimen is a female of similar size to the holotype of the other three species; the Solomon Islands specimen is much smaller. All species share a carapace covered with spinules and duplicated submedian gastric carinae. *Acanthaxius ningaloo* has a longer rostrum with four (as in *A. formosa*, rather than two as in *A. polyacantha*) pairs of lateral spines, antenna article 3 with four spines (rather than one as in the other two species), relatively shorter telson, more pronounced spines along the margin of the cervical groove and more definite spines on the postcervical carapace. The spines along the margins of the fingers of the chelipeds are apparently longer and more erect. Further, *A. formosa* lacks denticles anterolateral to the cervical groove. *Acanthaxius miyazakiensis*, reported from Japan, Philippines and New Caledonia (Sakai and de Saint Laurent, 1989), is similar to all three but has a more elongate minor first cheliped and fewer carapace spinules.

Acanthaxius ningaloo has strongly sexually dimorphic chelipeds, the major one of the male being more setose, more swollen than the minor, and with shorter marginal spines than the female. In no species described to date has both sexes been illustrated. Most figures are of females but the male of *A. grandis*, a species with a similar cheliped but smooth carapace, would appear to be of the grossly swollen form (Kensley and Chan, 1998).

Acanthaxius polychaetes Sakai, 1994

Acanthaxius polychaetes Sakai, 1994: 193–198, figs. 11–13.—Davie, 2002: 450.

Distribution. Qld, continental slope, 260 m depth.

Remarks. *Acanthaxius polychaetes* is remarkable for the absence of spines on the upper margins of the carpus-dactylus and abundance of long setae on the chelipeds obscuring any ornamentation. Like American species of this genus and unlike the Indo-West Pacific species, the male possesses a pleopod 1. The distal spine on article 2 of the antenna is, however, characteristically anteromesially directed.

Allaxius Sakai and de Saint Laurent, 1989

Allaxius Sakai and de Saint Laurent, 1989: 73–74.

Remarks. *Allaxius*, with five species from the Indian Ocean, Indonesia and Papua New Guinea, is recognised by the uropodal exopod being spined laterally with its second article at least as long as wide and usually longer than wide, and the uropodal endopod having broadly shoulders proximolaterally. The rostrum is short, about the same length as the eyestalks, with short lateral teeth.

Allaxius clypeatus (De Man, 1888)

Axius clypeatus De Man, 1888: 470, pl. 20 fig. 2.
Axiopsis (*Axiopsis*) *clypeata*.—De Man, 1925b: 70.
Allaxius clypeatus.—Sakai and de Saint Laurent, 1989: 73–74.

Material examined. Qld, Yonge Reef, Lizard Island (14°38'S, 145°38'E), 8 Nov 1975, AM P25014 (male, cl. 4.5 mm).

Remarks. *Allaxius clypeatus* is known from reefs in Indonesia and is here reported from Lizard Island, northern Great Barrier Reef. The rostrum is narrow and as long as the eyestalks, with two pairs of lateral teeth. The median gastric carina has a blunt tooth anteriorly and a broad triangular plate posteriorly. The submedian carina comprises two blunt teeth and the lateral gastric carina just one tooth. The tapering telson has four lateral spines and a minute posterolateral one. The uropodal exopod has three spines in a longitudinal ridge, four lateral spines, three small spines along the transverse suture and a larger mesiodistal spine. A long moveable spine lies lateral to the oval second article of the exopod. The uropodal endopod has a strong lateral shoulder, four spines in a longitudinal ridge, and one lateral and two distolateral spines.

Ambiaxius Sakai and de Saint Laurent, 1989

Ambiaxius Sakai and de Saint Laurent, 1989: 54.—Poore, 1994: 99 (key).—Sakai and Ohta, 2005: 82.

Callistocaris Kensley, 1989: 961 (objective synonym: same type species).

Diagnosis. Carapace smooth; cervical groove visible laterally over most of distance to anterolateral margin. Rostrum triangular or spine-like, dentate or not, longer than eyestalks, depressed below level of carapace, continuous with lateral carinae; supraocular spines prominent; lateral carina weak; submedian carina absent; median carina smooth; postcervical carina absent. Abdominal somite 1 pleuron triangular; pleuron 2 posteriorly rectangular; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea unpigmented. Antenna, scaphocerite short. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent above pereopods 2–4; podobranchs and arthrobranchs present; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; propodus with spine on upper margin. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli 3 and 4 elongate, with scattered robust setae; dactylus 5 elongate. Pleopods 3–5, appendix interna present. Hermaphroditic. Pleopod 1 article 1 flattened; article 2 subtriangular, one-third length of first, folded obliquely, posterior part distally lobed, anterior part smaller, narrower, with distal margin oblique, with short appendix interna. Pleopod 2 endopod article 2 elongate-triangular, as long as article 1, mesial margin concave, with basal thumb-like appendix interna, appendix masculina with a row of strong spines followed by a short apical setose appendage. Uropodal exopod with transverse suture. Telson without lateral teeth, without posterolateral robust setae; apex deeply rounded and continuous with lateral margins.

Remarks. Species of *Ambiaxius* are recognised by the prominent supraocular spines, unarmed and obsolete or absent gastric carina, being hermaphroditic, triangular short second article on pleopod 1, and pleopod 2 endopod elongate-triangular, with concave mesial margin and short setose end. The genus is closest to *Calastacus* Faxon, 1893 (see below). Sakai and Ohta (2005) distinguished their new genus *Briancaris* from *Ambiaxius* on the shape of the rostrum, the former having a broad triangular toothed rostrum while the latter has a styliform rostrum that is barely toothed if at all. These differences are slight and otherwise the two genera, each of three species, have virtually identical pleopods.

Ambiaxius franklinae, from the Coral Sea, is the only Australian species known so far. A specimen of another species, too incomplete to describe, is recorded below.

Ambiaxius franklinae Sakai, 1994

Ambiaxius franklinae Sakai, 1994: 177–180, figs. 1, 2.—Davie, 2002: 451.

Distribution. WA, continental slope, 1300 m depth

Remarks. The species is distinguished from others in the genus and from all other Australian axiids in the possession of a narrow styliform upturned rostrum.

Ambiaxius sp.

Material examined. WA, off Cape Leveque, 14°36.89'S, 121°19.65'E–14°36.25'S, 121°20.74'E (stn SS05-2007 147), 700–698 m, 02 Jun 2007, NMV J54313 (hermaphrodite, cl. 10 mm, tl. 31 mm).

Remarks. The single individual lacks chelipeds and has a neat U-shaped excision at the anterior of the gastric region where the rostrum and supraocular spines, typical of species of *Ambiaxius*, might attach. Pleopods 1 and 2 are typical of the genus. *Ambiaxius franklinae*, from the Coral Sea, has similar maxilliped 3, pleopods 1 and 2, fused triangular eyestalks, and telson and uropods, but has a shorter scaphocerite, quite linear in this specimen.

Australocaris gen. nov.

Type species. *Australocaris pinjarup* sp. nov., here designated.

Diagnosis. Carapace smooth; with weakly defined short cervical groove. Rostrum styliform, elongate, laterally denticulate, 3 times as long as eyestalks, level with carapace, continuous with definite lateral gastric carinae; supraocular spines (spine at anterior end of lateral gastric carina and base of rostrum) prominent; lateral gastric carina unarmed except for anterior supraocular spine; submedian gastric carina present, obsolete; median gastric carina as weak ridge; postcervical carina absent. Abdominal somite 1 pleuron produced; pleuron 2 broad, anterioirly rounded, ventrally flat, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea unpigmented. Antenna, scaphocerite extending beyond antennal peduncle, with basal mesial spine and spines on lower margin. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent above pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 symmetrical, with propodus laterally flattened, broad, carinate on upper and lower margins; carpus-dactylus upper and lower margins with strong spines. Pleopods 3–5, appendix interna present. Pleopod 1 of male minute. Pleopod 2 of male without appendix masculina. Uropodal exopod with transverse suture.

Etymology. A combination derived from Australia and *karis* (Greek), a shrimp (feminine).

Remarks. It is unfortunate that the only individual of the type species is a male of uncertain development. It has a pair of simple pleopods 1 and lacks an appendix masculina on pleopod 2. These limbs may develop at a later instar. Nevertheless, the unique form of the rostrum and associated gastric carinae, the long spinose scaphocerite, and the form of the chelipeds distinguish the species from all other axiids and a new genus is justified. Poore's (1994) key leads this species to *Calocarides* Wollebaek, 1908 (uropodal exopod with suture, epipods present, appendix interna present, pleurobranchs absent, scaphocerite well developed, carapace smooth, eyestalks not more than half length of rostrum, eyes weakly pigmented). Differences are in the absence of the male pleopod 1 (minute in the new genus but not considered of generic importance—see discussion of *Paraxiopsis* below) and presence of the appendix masculina (absent in the new species). *Calocarides* was reviewed by Kensley (1996c). The gastric carinae of all its 11 species are more or less armed; apart from the supraocular spine and rostral dentition, gastric carinae in the new species are obsolete and unarmed. The first pereopods of species of *Calocarides* are asymmetrical, narrow, cylindrical and linear with teeth concentrated on the upper margins of the propodus and dactylus while in the new species the chelipeds are symmetrical, broad, flattened, with strong spines on the upper and lower margins of the carpus-dactylus. These chelipeds set the new species apart from all other axiid genera. Genera without an appendix masculina are *Axiorygma* Kensley and Simmons, 1988, *Bouvieraxius* Sakai and de Saint Laurent, 1989 (some species), *Parascytoleptus* Sakai and de Saint Laurent, 1989, and *Paraxius* Bate, 1888 but the new genus bears little resemblance to these genera. All except *Bouvieraxius* are monotypic.

The spinose scaphocerite is unique to axiids but similar spination is seen in the unrelated *Neaxius acanthus* Milne-Edwards, 1878 (Strahlaxiidae).

Australocaris pinjarup sp. nov.

Figures 11, 12, 39

Material examined. Holotype. WA, off Bunbury, 33°00.35'S, 114°34.12'E–32°59.37'S, 114°34.55'E (stn SS10-2005 067), 423–397 m, 29 Nov 2005, NMV J53443 (male, cl. 10.1 mm, tl. 27 mm, damaged).

Description of holotype. Carapace smooth except for slight rugosity at base rostrum, with few setae on gastric region and

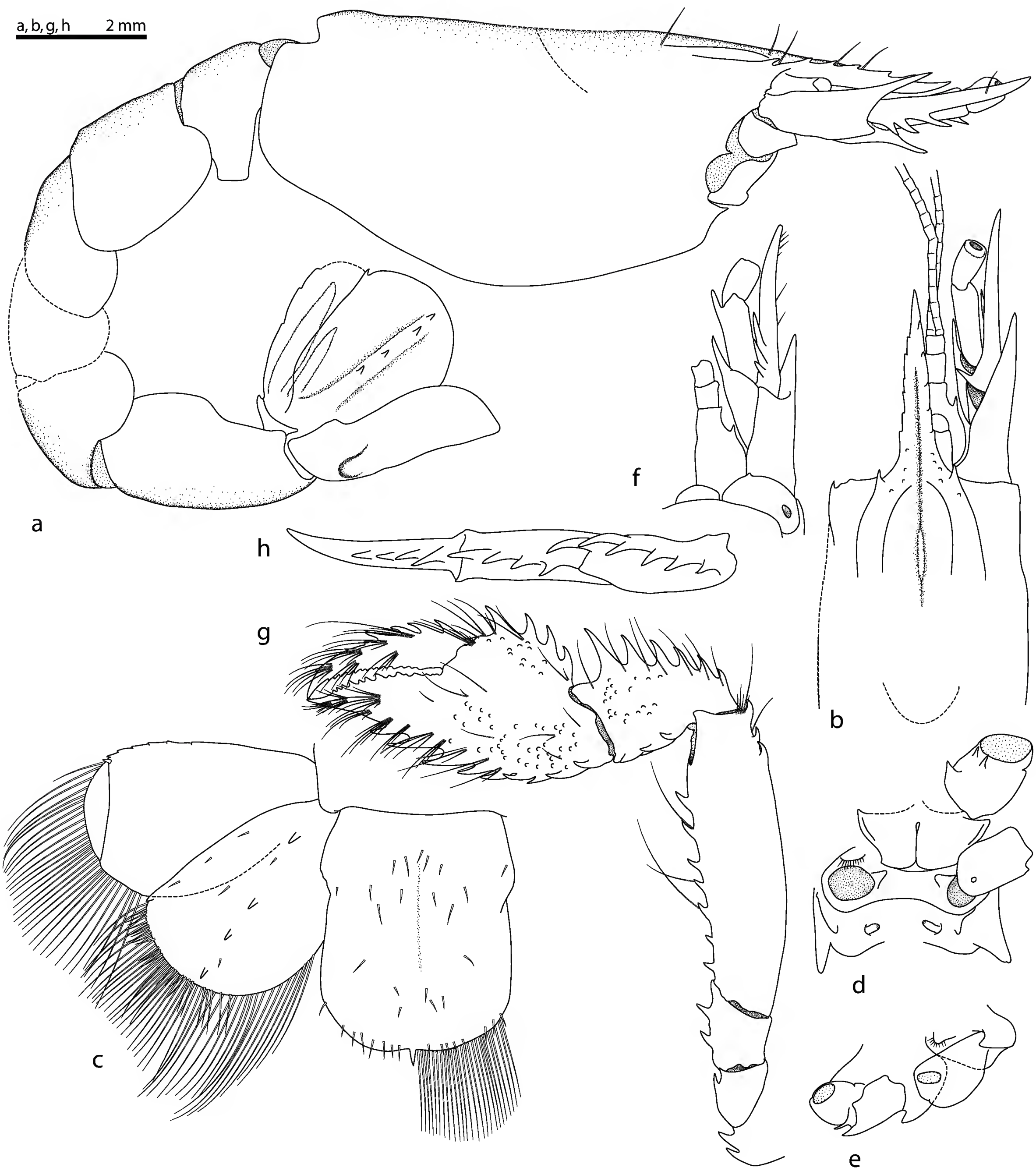

Figure 11. *Australocaris pinjarup* gen. and sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna and antennae. c, telson and right uropod. d, sternites 7 and 8, abdominal somite 1 and pleopods 1 (ventral). e, pereopod 4–5 coxa (left, lateral). f, epistome, left antennule and antenna (ventral). g, pereopod 1 (left, lateral). h, same (carpus–dactylus, without setae, upper). All figures from holotype.

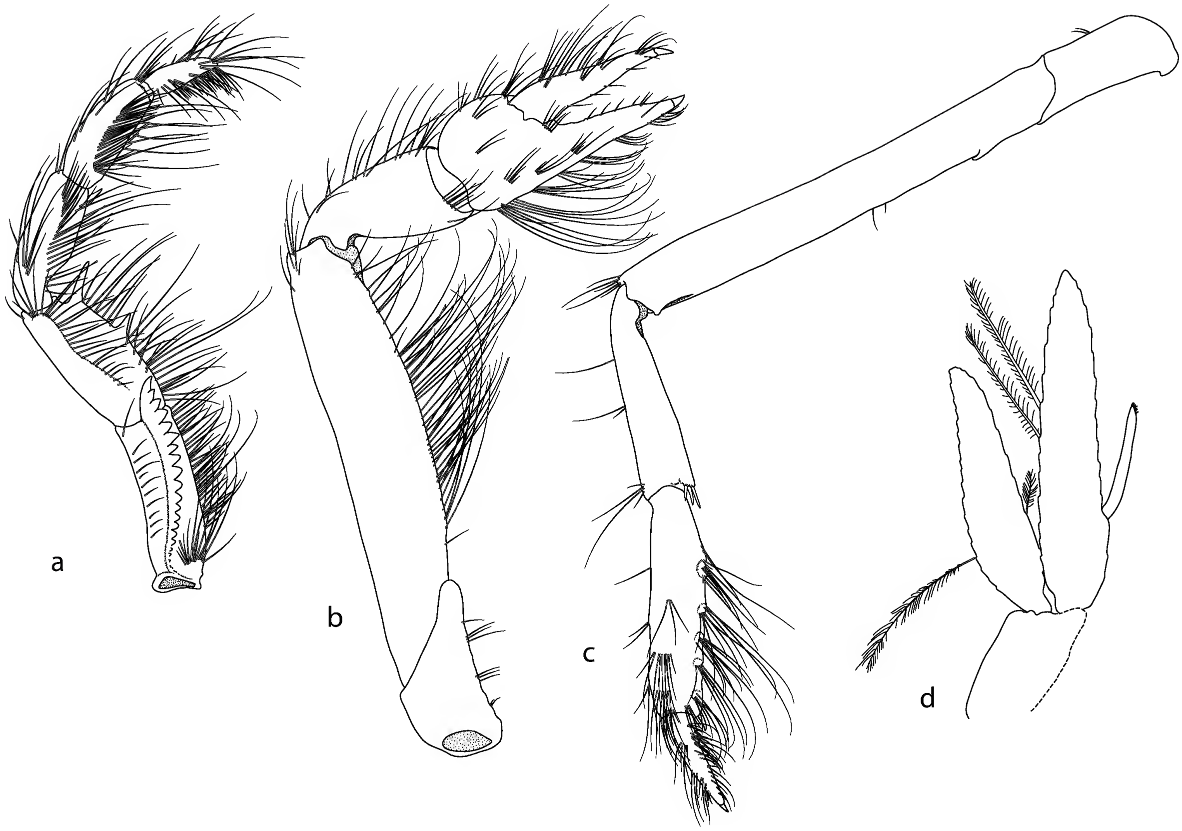

Figure 12. *Australocaris pinjarup* gen. and sp. nov. a, maxilliped 3. b, c, pereopods 2 (right), 3 or 4 (left). e, pleopod 2. All figures from holotype.

rostrum. Rostrum 0.75 times length of front-to-cervical groove, narrow, with 5–6 short oblique lateral spines anterior to supraocular spine, continuous with lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina unarmed. Submedian gastric carina obsolete, curved mesially between supraocular spines. Median gastric carina sharp on rostrum, unarmed. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with sharp oblique lateral ridge. Sternite 8 (pereopod 5) with setose ridge on anterior face at base of leg. Abdominal somite 1 pleuron ventrally truncate; pleuron 2 asymmetrical, posteriorly rounded; pleura 3–5 rounded; pleura 6 rounded.

Eyestalk, 0.3 length of rostrum; cornea unpigmented. Antennular peduncle reaching to midpoint of antennal article 4; article 1 swollen proximally, with small lateral spinule. Antennal article 1 unarmed; article 2 distal spine slender, directed slightly upwards, reaching distally to middle of antennal article 4; scaphocerite reaching distally beyond distal margin of article 5, with 3 strong spines on lower margin, 1 spine on mesial margin; article 3 with sharp mesiodistal spine on lower margin; article 4 about as long as article 2 (excluding distal spine), with mesial distal spine (left side only); article 5 about half length of article 4. Maxilliped 3 coxa and basis lower margin each with distal spine; ischium unarmed; crista dentata of about 20 teeth; merus with 2 spines; carpus with 1 spine.

Pereopods 1 symmetrical, flattened, carinate; coxa lower margin with 2 spines; basis lower margin with 1 spine; ischium lower margin with 2 spines; merus upper margin barely convex, with 3 distal spines, lower margin with 7 spines, lateral face smooth, mesial face smooth; carpus upper margin with 6 spines, lower margin with 3 spines laterally, mesial face smooth; propodus upper margin with 1 row of 4 spines, lower margin convex, with 9 spines, lateral face tuberculate, mesial face smooth; fixed finger 1.2 times as long as upper palm, cutting edge convex, with c. 15 irregular triangular teeth; dactylus upper margin with 4 spines along proximal half, lateral face smooth, mesial face smmoth, cutting edge denticulate; both fingers bearing setae.

Pereopod 2 ischium lower margin unarmed; merus lower margin unarmed; carpus 0.7 length of chela; propodus upper margin 0.5 length of dactylus. Pereopod 3 or 4 merus lower margin with 1 spine; propodus 2.3 times as long as dactylus, with oblique rows of simple setae but without robust setae except for one distally. Pereopod 5 missing.

Pleopod 1 minute, cylindrical. Pleopod 2 without appendix masculina; appendix interna third length of endopod.

Telson 1.2 times as long as wide, widest proximally, then approximately parallel-sided, lateral margin unarmed, distal margin truncate-convex, with posteromedian spine, posterolateral angle rounded, unarmed; dorsal face without oblique ridges or spines. Uropodal endopod 1.5 times as long as wide, without lateral spines, longitudinal ridge with 4 spines (none marginal). Uropodal exopod 1.6 times as long as wide, with 6 obscure lateral spines, no longitudinal ribs, posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture unarmed.

Etymology. Pinjarup is the name of the Australian Aboriginal people inhabiting the coast close to the type locality (noun in apposition).

Distribution. WA, off Bunbury, 33°S, 114°E, c. 400 m depth (known only from type locality).

Remarks. The type specimen is in poor condition but sufficient features can be ascertained to enable the species to be described as a new genus and species. The single article of the male pleopod 1 is enigmatic and may not reflect the adult state.

Axiopsis Borradaile, 1903

Axiopsis Borradaile, 1903: 538.—Sakai and de Saint Laurent, 1989: 76.—Komai et al., 2002: 29–30.

Type species. *Axius affinis* De Man, 1888.

Diagnosis. Carapace smooth; cervical groove visible laterally almost to anterolateral margin. Rostrum triangular, broad, laterally denticulate, longer than eyestalks, not depressed below level of carapace, continuous with definite lateral carinae; supraocular spines not differentiated from other spines; lateral carina spinose; submedian carina present, spinose; median carina a spinose ridge; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 broad, anteriorly rounded, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite long, acute. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; carpus-dactylus upper margins smooth. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male with appendix masculina. Uropodal exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex truncate-rounded.

Remarks. *Axiopsis* is defined by the absence of a male pleopod 1, a triangular rostrum with marginal teeth running uninterupted on to lateral gastric carinae, similar even denticles along the lateral, submedian and median gastric carinae, absence of pleurobranchs and the presence of the appendix masculina on the male pleopod 2 and appendices internae (Komai et al., 2002). We rediagnose *Axiopsis* here so as to differentiate it from the new genus, *Michelaxiopsis* gen. nov., below.

Axiopsis tsushimaensis Sakai, 1992 differs from others in that the submedian gastric carinae are each duplicated but in *A. serratifrons* (Milne-Edwards, 1873) irregular intermediate tubercles occupy the space between median and submedian gastric carinae.

Axiopsis consobrina De Man, 1905

Axiopsis consobrina De Man, 1905: 595–596.—Sakai and de Saint Laurent, 1989: 77–78.—Sakai, 1994: 198–201, fig. 14.—Davie, 2002: 451.

Axiopsis (Axiopsis) consobrina.—De Man, 1925b: 69, 80–84, pl. 6 figs. 13–13c.—Ngoc-Ho, 2005: 55–57, fig. 4.

Distribution. Indo-West Pacific, WA, North West Shelf.

Remarks. *Axiopsis consobrina* possesses a distal spine on the upper margin of the merus of the major cheliped; the lateral face of the propodus is tuberculate only distally. The gastric submedian gastric carina is a single row of teeth without surrounding tubercles. Poore and Griffin's (1979) Queensland record of this species is of *A. serratifrons*. Sakai (1994) recorded *A. consobrina* from the North West Shelf.

Axiopsis serratifrons (A. Milne-Edwards, 1873)

Limited synonymy. *Axia* [sic.] *serratifrons* A. Milne-Edwards, 1873: 263, pl. 13.

Axiopsis (*Axiopsis*) *serratifrons*.—De Man, 1925b: 68, 72–80, pl. 6 figs. 12–12i.

Axiopsis serratifrons.—Sakai and de Saint Laurent, 1989: 76–77.—Ngoc-Ho, 2005: 53, fig. 3.—Komai and Tachikawa, 2008: 20–22, fig. 1 (synonyms).

?*Axiopsis* (*Axiopsis*) *consobrina*.—Poore and Griffin, 1979: 230–232, fig. 4.

Distribution. Indo-West Pacific, Caribbean, Brazil; Qld, Gulf of Carpentaria.

Remarks. Milne-Edwards (1873) reported his species from Upolu, Samoa (specimen now in Zoological Museum, Hamburg) and Hawaii (specimen now in Muséum national d'Histoire naturelle, Paris), the latter being assumed by some to be the type locality (Kensley, 1981; Sakai and de Saint Laurent, 1989). De Man (1925b) described the "cotype" from Upolu and illustrated marked tuberculation on the lateral face of the propodus of the cheliped. Ngoc-Ho (2005) redescribed what she called the "holotype" from Hawaii with this face being smooth. It is possible that more than one species is involved which is significant because the species has been reported many times and has at least two synonyms (Kensley, 1981; Sakai and de Saint Laurent, 1989; Komai and Tachikawa, 2008). No lectotype has been selected and Ngoc-Ho's use of "holotype" does not constitute lectotype designation (ICZN 74.7).

The Australian record of *A. consobrina* (Poore and Griffin, 1979) is another species (M. de Saint Laurent, pers. comm., 1990), potentially *A. serratifrons*. The material has not been re-examined for this study. Until the identity (or identities) of this widespread species is decided, *A. serratifrons* is best distinguished from other Australian species of *Axiopsis* by the absence of a spine on the upper margin of the merus and the numerous tubercles that ornament the space between the denticulate median and submedian gastric carinae.

Axiopsis tsushimaensis Sakai, 1992

Figures 13, 40

Axiopsis tsushimaensis Sakai, 1992: 173–175, figs. 14, 15.—Sakai, 1994: 198.—Komai et al., 2002: 19–30, figs. 1–3.

Material examined. WA, off Bald Island, 35°11.26'S, 118°38.42'E–35°11.15'S, 118°39.00'E (stn SS10-2005 035), 157–157 m, 24 Nov 2005, NMV J55437 (male, cl. 6.8 mm, tl. 19 mm). WA, Jurien Bay, 29°48.25'S, 114°25.52'E–29°48.33'S, 114°25.55'E (stn SS10-2005 083), 113–114 m, 02 Dec 2005, NMV J55444 (juvenile, cl. 3.0 mm).

Diagnosis. Carapace generally smooth except in gastric region. Rostrum 0.4 times length of front-to-cervical groove, broadly acute, with 4–5 lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines not differentiated from others in row. Lateral gastric carina with 9–10 low spines. Submedian gastric carina duplicated, each row of 6–8 low spines. Median gastric carina with 9–10 low spines.

Antennal article 2 distal spine slender, directed slightly upwards, reaching distally to quarter of antennal article 4; scaphocerite reaching distally to end of article 4, simple; article 3 with sharp mesiodistal spine on lower margin.

Pereopods 1 significantly differentiated. Major pereopod 1 ischium lower margin with 5 denticles and 1 spine; merus upper margin convex, with 1 spine, lower margin with 7 spines, last longest, and sublateral proximal row of denticles, lateral face smooth, mesial face smooth; carpus upper margin unarmed, lower margin unarmed; propodus upper margin with ridge of 11 low blunt teeth, lower margin with ridge of 11 low blunt teeth, lateral face with low tubercles concentrated near margins on distal two-thirds (absent proximally and from fixed finger), mesial face with low tubercles concentrated near margins on distal two-thirds (absent proximally and from fixed finger); fixed finger 0.5 length of upper palm, cutting edge with irregular rounded teeth, largest at midpoint; dactylus upper margin tuberculate, lateral face tuberculate proximally, mesial face tuberculate proximally, cutting edge with major tooth at midpoint and notch proximally; both fingers bearing setae.

Minor pereopod 1 coxa, ischium, merus and carpus as in major cheliped but narrower; propodus upper margin with sharp ridge, lower margin ridge of 11 low blunt teeth, lateral face mostly smooth, mesial face with few tubercles; fixed finger as long as upper palm, cutting edge with c. 25 short sharp teeth; dactylus upper margin unarmed, lateral face smooth, mesial face with few denticles, cutting edge obscurely denticulate.

Telson 1.1 times as long as wide, lateral margin with 3 spines, distal margin convex, with posteromedian spine, posterolateral angle with 4 robust setae well separated; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.5 times as long as wide, with 2 lateral spines, longitudinal ridge with 5 spines (including marginal). Uropodal exopod 1.4 times as long as wide, with 6 lateral spines, 2 longitudinal ribs unarmed, posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 10 spines.

Male. Pleopod 2 appendix interna 0.3 length of endopod; appendix interna 0.7 length of appendix interna.

Distribution. Tsushima Strait (Korea Strait), southern Japan; Sulu Sea, Philippines; WA, south-western coast; 34°N–35°S, 114°–130°E, 102–157 m depth.

Remarks. Sakai (1992) based his description of *Axiopsis tsushimaensis* on a juvenile female (tl. 18 mm) without a larger cheliped. Komai et al.'s (2002) detailed description and illustrations were likewise based on a small female. We illustrate for the first time an adult male and show in particular the strongly dimorphic chelipeds and pleopod 2. We could not detect differences in the carapace armature, abdomen, tail fan or antennae between our material and the type. The species is similar to *A. consobrina* De Man, 1905 in having a spine on the upper margin of the merus of the chelipeds and the proximal lateral surface of the larger cheliped smooth. *Axiopsis tsushimaensis* differs principally in having a double (rather than single) gastric submedian gastric carina and scaphocerite without a basal mesial spine (obvious to De Man, 1925b). While *A. consobrina* was described from slightly larger specimens (tl. 21, 29.5 mm), these differences would not appear to be size related as evidenced by our examination of a size range of the similar *A. serratifrons* (Milne-Edwards, 1873) in NTM collections (Cr0009886, Cr010271).

Axiopsis sp. aff. *serratifrons* (A. Milne-Edwards, 1873)

Material examined. Vic., eastern Bass Strait, 11.7 km W of Pt Ricardo (37°49.53'S, 148°30.08'E), 27 m (stn MSL-EG), NMV J31777 (female, tl. 28 mm)

Remarks. The single female without pereopods has four spines on the rostrum, 13 teeth on the lateral gastric carina, numerous setae in the submedian region, some in longitudinal rows, and 15 teeth on the median gastric carina. A description awaits the discovery of more complete specimens.

Axius Leach, 1815

Axius Leach, 1815: 343.—Sakai and de Saint Laurent, 1989: 26.—Ngoc-Ho, 2003: 447.

Remarks. Axius was diagnosed most recently by Ngoc-Ho (2003). Three species are known, the type species, *A. stirhynchus* Leach, 1815, from the eastern North Atlantic (Ngoc-Ho, 2003) and two from the western North Atlantic, *A. serratus* Stimpson, 1852, and *A. armatus* Smith, 1881 (Kensley, 2001). Species of *Axius* are recognised by having a triangular, laterally armed rostrum, undifferentiated supraocular spine, unarmed submedian gastric carina anteriorly flexed towards the midline, uropodal exopod with a transverse suture, pleurobranchs present above pereopods 2–4 and sometimes 5, male pleopod 1 present, and pleopods 2–5 with an appendix interna. We confirmed Ngoc-Ho's (2003) observation that the male pleopod 1 of *A. stirhynchus* is simple but with an obsolete suture between two articles and a ridge that hints at an obsolete appendix interna (fig. 14a). Kensley reported

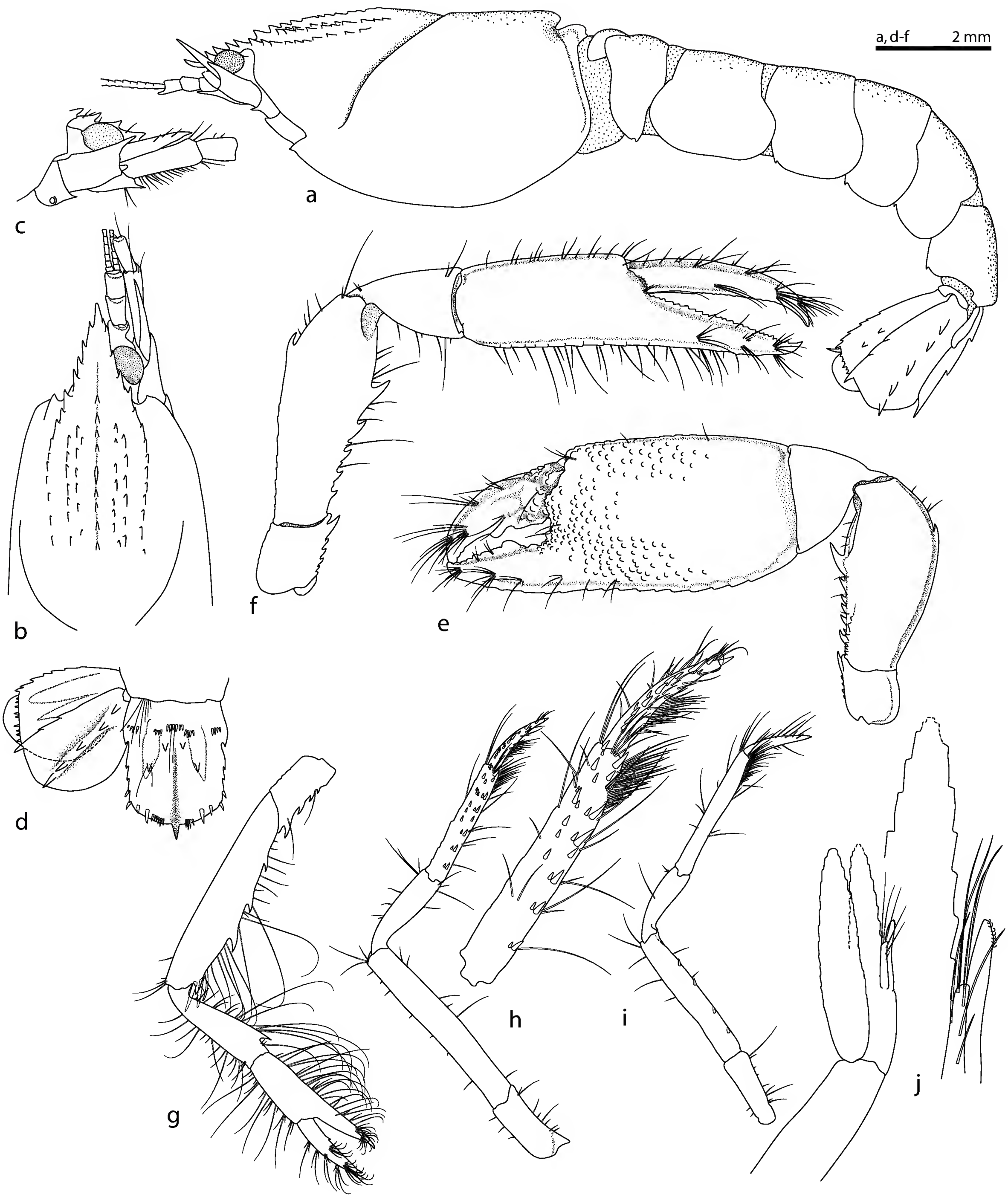

Figure 13. *Axiopsis tsushimaensis* Sakai, 1992. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, right antenna peduncle (lateral). d, telson and left uropod. e, major pereopod 1 (left). f, minor pereopod 1 (right). g, h, i, pereopods 2, 4, 5 (left except g, with detail of perepod 4). j, male pleopod 2, with detail of appendices interna and masculina. All figures from NMV J55437.

for *A. serratus* the "pleopod 1 in both sexes consisting of single slender setose ramus." We include *Axiopsis* (*Axiopsis*) *werribee* Poore and Griffin, 1979 (and possibly another species, see below) in this genus, the only ones outside the North Atlantic.

Sakai and de Saint Laurent (1989) listed *Axiopsis australiensis* as a member of *Axius* but this species lacks a male pleopod 1 and appendix masculina and possesses more complex gastric armature. It is here redescribed in a new genus, *Michelaxiopsis* gen. nov.

Axius werribee (Poore and Griffin, 1979)

Figure 14b

Axiopsis (*Axiopsis*) *werribee* Poore and Griffin, 1979: 232–235, figs. 5, 6.—Gowlett-Holmes, 2008: 217 (colour photo).

Calocarides werribee.—Sakai and de Saint Laurent, 1989: 84.—Sakai, 1994: 175, 201.—Davie, 2002: 452.

Axiopsis werribee Poore, 2004: 174, figs. 45c, d, 46b, pl. 11h.

Distribution. Tas., Vic. SA, 2–25 m depth.

Remarks. *Axius werribee* has five gastric carinae unornamented except for two teeth on the median gastric carina at the base of the rostrum. The triangular rostrum has five pairs of lateral teeth from which the supraocular tooth is not differentiated. Poore and Griffin (1979) misinterpreted the pleopods. Reexamination of type material in Museum Victoria has revealed that the male pleopod is present, two-articled, with the second article triangular and bearing a thumb-like appendix interna (Poore and Griffin, 1979: fig. 6h). The male pleopod 2 has both appendices interna and masculina. These characters together place the species clearly in *Axius* rather than *Axiopsis* or *Calocarides*. Both have spinose lateral carinae and lack pleurobranchs. The presence of this species in SA relies on Gowlett-Holmes (2008).

Of the three species of *Axius*, *A. werribee* most closely resembles *A. armatus* redescribed by Kensley (2001). These two species alone share two teeth on the median gastric carina and two pairs of spines dorsally on the telson and lack a pleurobranch over pereopod 5. The chelipeds of *A. werribee* lack a meral spine (present in *A. armatus*) and are more compact. The male pleopod 1 (fig. 14b) is more complex than in *A. stirhynchus* (fig. 14a; see too Ngoc-Ho, 2003: fig. 2E); that of *A. armatus* is unknown and of *A. serratus* slender and setose (Kensley, 2001).

Figure 14. Male pleopods 1. a, *Axius stirhynchus* Leach, 1815 (France, NMV J34093). b, *Axius werribee* (Poore and Griffin, 1979) (holotype, NMV J280).

Axius* sp. aff. *werribee (Poore and Griffin, 1979)

Material examined. NSW, 44 km E of Nowra (34°55.47'S–34°56.04'S, 151°08.04'E–151°07.52'E), 429 m, (stn SLOPE 56), G.C.B. Poore on RV *Franklin*, 22 Oct 1988, NMV J16793 (juvenile male, cl. 4.0 mm; juvenile, cl. 2.9 mm)

Remarks. These two specimens from the continental slope lack all pereopods except one pereopod 3 on the smaller one. The rostrum and gastric carinae are exactly as in *Axius werribee* but article 4 and the scaphocerite of the antenna are significantly more elongate than in the subtidal species. They were compared with similarly sized individuals of *A. werribee* from Port Phillip Bay in NMV collections whose antenna is as described for the larger adults. The larger specimen has visible male gonopores but lacks pleopod 1 and appendix masculina as do small males of *A. werribee*. The more elongate antenna and the ecological separation (slope depths vs subtidal) suggest a second Australian species of *Axius* similar to *A. werribee* (and to *A. armatus*). A description awaits the discovery of adults.

Bouvieraxius Sakai and de Saint Laurent, 1989

Bouvieraxius Sakai and de Saint Laurent, 1989: 45.—Sakai, 1992: 165–166.—Poore, 2008: 161–162.

Posthonocaris Kensley, 1989: 964.

Type species. *Axius longipes* Bouvier, 1905, by original designation.

Diagnosis. Carapace smooth; cervical groove visible laterally over almost half distance to anterolateral margin. Rostrum triangular, acute, laterally denticulate, longer than eyestalks, not depressed below level of carapace, continuous with definite lateral carinae; supraocular spines barely differentiated from other spines; lateral carina smooth; submedian carina present, spinose; median carina smooth; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 broad, anteriorly rounded, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite long, acute. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs present over pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 subequal, with propodus cylindrical; carpus-dactylus upper margins smooth, with distal tooth on propodus. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna absent. Pleopod 1 of male present, of 3 articles, second lobed and with field of hooks (appendix interna remnant). Pleopod 2 of male with appendix masculina elongate and with appendix interna. Uropodal exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex truncate-rounded.

Remarks. The genus has been discussed but not recently redefined. It is defined by the combination of uropodal exopod with a transverse suture, three pairs of pleurobranchs, toothed triangular rostrum, male pleopods 1 and 2 present and, importantly, pleopods 3–5 without an appendix interna (not 'with' as in the key of Poore, 2008).

Bouvieraxius keiensis Sakai, 1992

Bouvieraxius keiensis Sakai, 1992: 166–168, figs. 8, 9.

Bouvieraxius rudis.—Sakai, 1994: 177 (not *Axius rudis* Rathbun, 1906).

Bouvieraxius michelae Poore, 2008: 162–164, fig. 1. (**syn. nov.**)

Figures 15, 16, 41

Material examined. WA, off Kalbarri, 27°48.48'S, 113°18.40'E–27°49.06'S, 113°18.43'E (stn SS10-2005 102), 96–98 m, 05 Dec 2005, NMV J55441 (male, cl. 9.8 mm; female, cl. 10.0 mm). Off Zuytdorp, 27°03.06'S, 113°13.19'E–27°02.56'S, 113°06.00'E (stn SS10-2005 104), 97 m, 05 Dec 2005, NMV J53445 (damaged carapace with chelipeds, abdomen missing). Off Shark Bay, 25°54.27'S, 112°49.23'E–25°54.26'S, 112°49.44'E (stn SS10-2005 035), 100 m, 06 Dec 2005, NMV J53444 (2 ovigerous females, cl. 10.0 mm; male with bopyrid parasite, cl. 8.3 mm). S of Shark Bay, (SS10-2005 stn not recorded), NMV J55471 (male, cl. 10.8 mm). Off Barrow I., 21°02.15'S, 114°53.28'E–21°01.99'S, 114°53.14'E (stn SS05-2007 008), 90–100 m, 10 Jun 2007, NMV J55709 (damaged male, cl. 6.0 mm). North West Shelf, 19°50.0'S 115°34.0'E, 80 m, NTM Cr000886 (ovigerous female, cl. 8.0 mm, tl. 23.5 mm, determined as *Bouvieraxius rudis* by Sakai, 1994).

Diagnosis. Carapace smooth. Rostrum 0.3 times length of front-to-cervical groove, narrowly triangular, with 3 (sometimes fourth obsolete) lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines similar in size to other rostrum spines. Lateral gastric carina unarmed behind supraocular spine. Submedian gastric carina with 3 or 4 spines. Median gastric carina unarmed. Abdominal pleura 3–6 each with small anteroventral tooth in male only (female pleura rounded).

Eyestalk 0.5 length of rostrum; cornea pigmented. Antennular peduncle reaching to proximal part of antennal article 5. Antennal article 1 with 1 spine and 2 spinules on lower distal margin; article 2 distal spine slender, directed distally, reaching distally to one third of antennal article 4; scaphocerite slender, straight, reaching distally to 0.7 length of article 4; article 3 with 1 or 2 spines on mesial lower margin; article 4 about half length of article 2 (excluding distal spine), without spine, article 5 about two-thirds length of article 4. Maxilliped 3 basis with 1 spine; ischium with 3 spines on lower margin; crista dentata with 18 teeth; merus with 4 spines on lower margin; carpus with 1 spine on lower margin.

Pereopods 1 unequal, of similar length, propodus of major cheliped more swollen than in minor. Major pereopod 1 coxa lower margin with 1 spine; basis lower margin with 1 spine; ischium lower margin with 2–4 spines; merus upper margin convex, with 2 or 3 spines, lower margin with 5–9 spines, lateral face smooth, mesial face smooth; carpus smooth and unarmed; propodus upper margin with 1 row of c. 27 blunt truncate teeth, lower margin with obsolete scale-like teeth, lateral face tuberculate, especially distally near upper and lower margins, mesial face tuberculate, especially near upper margin; fixed finger 1.4–1.6 length of upper palm, cutting edge weakly toothed; dactylus upper margin smooth—weakly tuberculate, lateral face smooth, mesial face smooth, cutting edge irregularlly toothed.

Minor pereopod 1 spination and tuberculation as in larger cheliped (numbers of spines on merus show same range of values but pair often asymmetrical); propodus less swollen, slightly narrower, fixed finger as long as upper palm.

Male pleopod 1 article 2 with distal lobe bearing hooks proximally, mesial lobe reaching halfway along article 3. Male pleopod 2 appendix masculina about as long as endopod, extending beyond endopod by half its length. Pleopods 2–5 appendix interna one third length of endopod.

Telson 1.3 times as long as broad, lateral margin with 3 spines, distal margin convex with posteromedian spine, posterolateral angle with 1 robust seta; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.3 times as long as wide, with 2 lateral spines, longitudinal ridge with 5 spines (including marginal). Uropodal exopod 1.4 times as long as wide, with 1 or 2 lateral spines, 2 longitudinal ribs (ribs with 7 scattered denticles), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 16–20 spinules.

Distribution. Indonesia (Kei Island), 245 m; Timor Sea, 18 m; Mauritius, 73 m; WA, North West Shelf to Shark Bay, 20°–27°S, 113°–115°E, 80–100 m depth.

Remarks. *Bouvieraxius keiensis* was described from material from Kei Island, Indonesia (type locality) and Mauritius. The new material from the region of Shark Bay, central WA, totals nine specimens that vary in the number of lateral spines on the rostrum anterior to the supraocular spine (two or three, the last often obsolete), teeth on the submedian gastric carina (usually four, three in two individuals, five on one side in one individual), spines on the merus of the cheliped (two or three on the upper margin, 6–9 on the lower margin, usually asymmetrical), and extent of tuberculation on the propodus of the cheliped (from one third to two thirds of the lateral surface). Sakai's (1994)

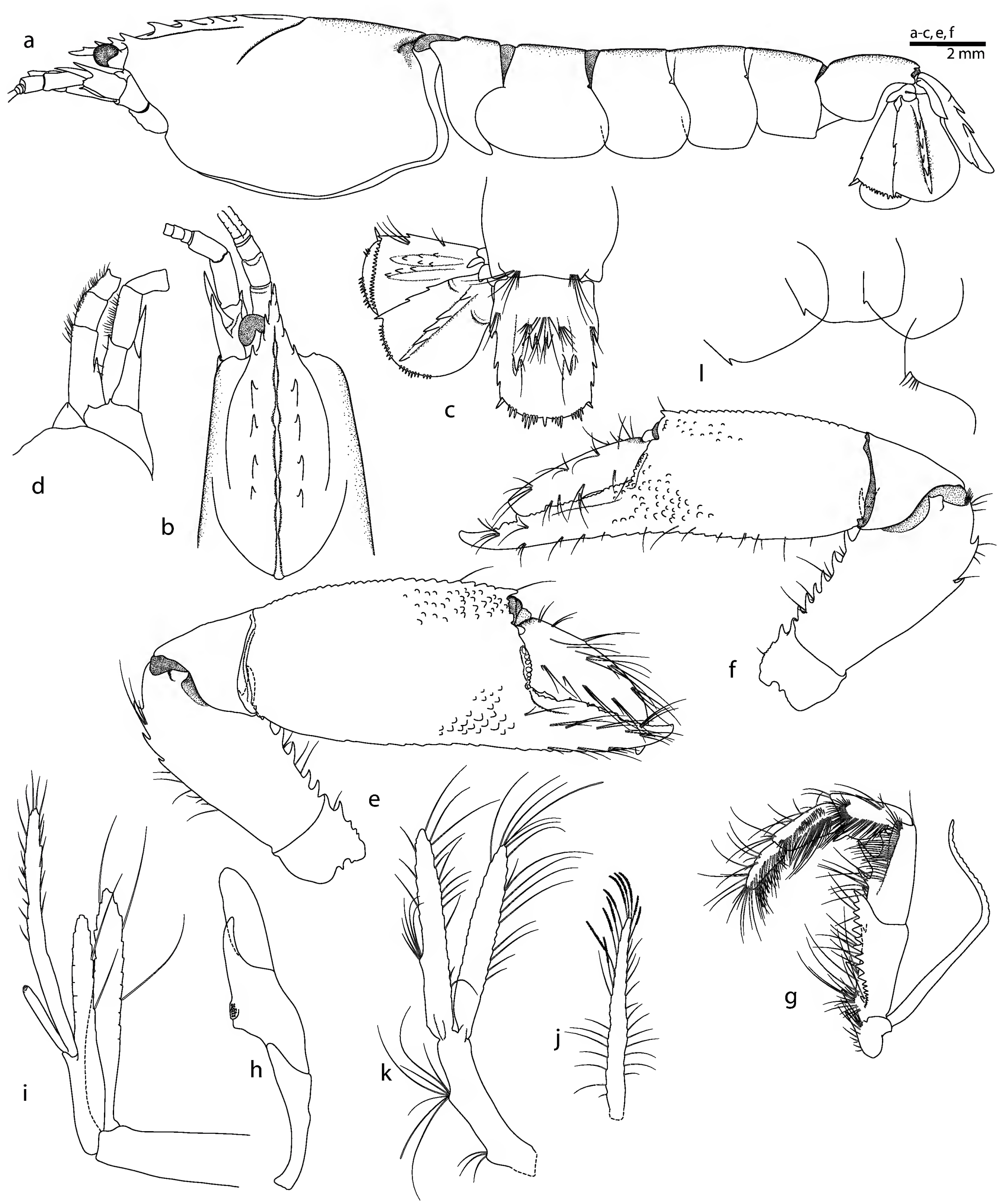

Figure 15. *Bouvieraxius keiensis* Sakai, 1992. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and left uropod. d, epistome, left antennule and antenna (ventral). e, major pereopod 1 (right). f, minor pereopod 1 (left). g, maxilliped 3. h, i, male pleopods 1, 2. j, k, female pleopods 1, 2. l, left pleura of abdominal somites 3–6. Figs a–e, j, k from NMV J55441 female; figs. h, i, l from male, NMV J55441.

Figure 16. *Bouvieraxius keiensis* Sakai, 1992. a–d, pereopods 2–5 (right except d). All figures from female, NMV J55441.

illustrations (taken from three individuals) show two lateral spines on the rostrum, four teeth on the submedian gastric carina, four upper and five lower spines on the merus of the cheliped, and extensive tuberculation on the propodus of the cheliped. While the spination of the cheliped meri of the holotype falls outside the range of the Australian material we can see no other differences; otherwise, the tail fan and male pleopods seem identical. We illustrate an ovigerous female of a size similar to Sakai's specimens; both show the inequality in the female chelipeds that is mirrored in males.

Bouvieraxius michelae was described on the basis of a small male (cl. 4.2 mm) from the Timor Sea. The holotype lacks chelipeds. Dorsal spination is essentially the same as in the figures of *B. keiensis*; its more elongate telson could be attributed to its small size. The male pleopod 1 of *B. michelae* lacks a mesial lobe overlapping an apical third article, apparently less developed than that figured for the new material (cf. fig. 15h with Poore, 2008: fig. 1). The pleopod 2 of the small male of *B. michelae* has a shorter and less setose appendix masculina and rami than those of the larger specimen figured here but male pleopods 1 and 2 of both specimens are consistent with those figured for *B. keiensis* (Sakai, 1992: fig. 9). We conclude that *B. michelae* is a junior synonym of *B. keiensis*.

Sakai (1994) identified a small female from the North West Shelf, WA, as the Hawaiian species, *Bouvieraxius rudis* (Rathbun, 1906). We examined his specimen (NTM Cr000886) and noted three teeth on the submedian gastric carina as reported for *B. rudis* (the types of *B. keiensis* have four). Two males (J55471, J55709) from our new collections also have only three pairs of submedian teeth but are otherwise identical. Sakai noted that the rostrum has three rostral spines (including the supraocular) while *B. rudis* has two (Rathbun said "three or four" and Sakai and de Saint Laurent illustrated two or three). The cheliped merus of the NTM specimen has 2+6 spines, different from the types of both species but within the range of our new Australian material. Sakai (1994) differentiated *B. keiensis* from *B. rudis* on the number of teeth on the submedian gastric carina (4 or 5 vs 3) and the number of mesiodistal spinules on article 1 of the antenna (2 vs 4 or 5 in *B. rudis* from New Caledonia). The identity of the New Caledonian specimens (Sakai and de Saint Laurent, 1989) is uncertain (M. de Saint Laurent, pers. comm., 1990). The mesiodistal angle of article 1 of the antenna in our material varied from barely angular to two or three spinules.

The synonymy or otherwise of *B. rudis* and *B. keiensis* remains uncertain and until this is resolved we prefer to use the name associated with a species from the region.

Calastacus Faxon, 1893

Calastacus Faxon, 1893: 194. —Schmitt, 1921: 112. —de Saint Laurent, 1972: 353. —Sakai and de Saint Laurent, 1989: 59. —Kensley, 1989: 961. —Kensley, 1996: 158, 159.

Calocaris (*Calastacus*). —Alcock, 1901: 191. —Borradaile, 1903: 539. —De Man, 1925b: 115.

Type species. *Calaxius stilirostris* Faxon, 1893, by monotypy.

Diagnosis. Carapace smooth; cervical groove visible laterally over most of distance to anterolateral margin. Rostrum spine-like, laterally weakly dentate, longer than eyestalks, depressed below level of carapace, continuous with lateral carinae; supraocular spines prominent; lateral carina weak; submedian carina absent; median carina smooth; postcervical carina absent. Abdominal somite 1 pleuron triangular; pleuron 2 posteriorly rectangular; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea unpigmented. Antenna, scaphocerite short. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent above pereopods 2–4; podobranchs rudimentary on maxilliped 3–pereopod 3, arthrobranchs present; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; propodus with spine on upper margin. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli 3 and 4 elongate; dactylus 5 elongate. Pleopods 3–5, appendix interna present. Hermaphroditic. Pleopod 1 article 1 flattened; article 2 subtriangular, two-thirds length of first, folded longitudinally, posterior part distally lobed, anterior part larger, broader, with short appendix interna. Pleopod 2 endopod article 2 elongate, twice length of article 1, mesial margin straight, with basal digitiform appendix interna, appendix masculina divided into 2 equal parts bearing rows of strong setae. Uropodal exopod with transverse suture. Telson without lateral teeth, without posterolateral robust setae; apex deeply rounded and continuous with lateral margins.

Remarks. *Calastacus* is a genus of six species, *C. stilirostris* Faxon, 1893 from the central eastern Pacific, *C. laevis* de Saint Laurent, 1972 from the eastern Atlantic and Mediterranean, *C. colpos* Kensley, 1996 and *C. mexicanus* Kensley, 1996 from the Gulf of Mexico (Kensley, 1996e), *C. crosnieri* Kensley and Chan, 1998 and *C. inflatus* Komai, Lin and Chan, 2009 from the north-western Pacific. The genus was diagnosed by de Saint Laurent (1972) whose concept has been followed by later authors. The genus differs from *Ambiaxius* only in the characteristic pleopods 1 and 2. Pleopod 1 is more elongate than in *Ambiaxius* and pleopod 2 has a long second segment on the endopod. A seventh species, first from the Indian Ocean, is described below.

Calastacus myalup sp. nov.

Figures 17, 42

Material examined. Holotype. WA, off Bunbury, 33°00.35'S, 114°34.12'E–32°59.37'S, 114°34.55'E (stn SS10-2005 067), 423–397 m, 29 Nov 2005, NMV J53460 (hermaphrodite, cl. 8.0 mm, tl. 19 mm; carapace damaged, pereopods 1 missing, 1 egg case on pleopod 3).

Paratype. Collected with holotype, NMV J58382 (hermaphrodite, cl. 8.0 mm, tl. 19 mm; most pereopods missing).

Description of hermaphrodite holotype. Carapace smooth except for slight rugosity between supraocular spines. Rostrum 0.5 times length of front-to-cervical groove, acute, unarmed anterior to supraocular spine, not continuous with lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina absent. Submedian gastric carina absent. Median gastric carina unarmed. Abdominal pleuron 1 twice as deep as middorsal length, short, ventrally rounded; pleuron 2 broad, lateral length 1.3 times dorsal length, anteroventrally rounded; pleura 3–5 rounded; pleura 6 rounded.

Eyestalk 0.4 length of rostrum; cornea unpigmented. Antennular peduncle reaching two-thirds along antennal article 4. Antennal article 1 with 1 sharp spine and spinule on lower distal margin; article 2 distal spine slender, directed slightly inwards, reaching distally to middle of antennal article 4; scaphocerite slender, directed slightly upwards, reaching distally to middle of antennal article 4; article 3 with sharp distal spine on lower margin; article 4 little longer than article 2 (excluding distal spine); article 5 about half length of article 4. Maxilliped 3 basis unarmed; ischium unarmed on lower margin; crista dentata with 20 teeth; merus with 2 long spines on lower margin; carpus unarmed.

Pereopods 1 coxa with 1 spine; basis unarmed; remainder missing.

Pereopod 2 ischium unarmed; merus unarmed; carpus 0.7 length of chela. Pereopod 3 merus unarmed; propodus 3 times as long as dactylus, with oblique rows of simple setae but without robust setae. Pereopod 4 unarmed; propodus 3 times as long as dactylus, with oblique rows of simple setae distally but without robust setae. Pereopod 5 unarmed; propodus with oblique rows of simple setae distally but without robust setae, with short rounded fixed finger; dactylus broken.

Pleopod 1 article 2 0.8 length of article 1, leaf-like, concave posteromesially, hooks representing the appendix interna on a blunt lobe on broad triangular anterior fold, lateral fold almost semicircular, the pair together forming a broad open tube joined anteriorly by the hooks. Pleopod 2 endopod of 2 articles (third weakly differentiated), all articles more or less in line with peduncle, with thumb-like appendix interna at base of article 2, setae of appendix masculina not well differentiated from more distal setae (as in other species); exopod half length of endopod.

Telson 1.6 times as long as wide, widest proximally, then approximately parallel-sided, lateral margin unarmed, distal margin semicircular without posteromedian spine, posterolateral region rounded; dorsal face without spines on obsolete oblique row. Uropodal endopod 2.0 times as long as wide, without lateral spines, longitudinal ridge unarmed. Uropodal exopod 2.0 times as long as wide, without lateral spines, 2 obsolete longitudinal ribs unarmed, posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 11 robust setae of varying lengths.

Etymology. Myalup is a settlement on the coast close to the type locality (noun in apposition).

Distribution. WA, south-western coast, 400 m depth.

Remarks. The new species differs from *C. crosnieri* and *C. inflatus*, the two West Pacific species, in having narrower uropods.

Calaxius Sakai and de Saint Laurent, 1989

Calaxius Sakai and de Saint Laurent, 1989: 84 (diagnosis, list of species).—Sakai, 1994: 192 (diagnosis).—Clark et al., 2007: 64 (diagnosis).

Manaxius Kensley, 2003: 367–368.

Type species. *Calaxius acutirostris* Sakai and de Saint Laurent, 1989, by original designation.

Figure 17. *Calastacus myalup* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, maxilliped 3. e–h, pereopods 2–4 (right except e). i, j, right and left pleopod 1 (right from anterolateral view, left from mesial view). k, pleopod 2. All figures from holotype.

Diagnosis. Carapace smooth or tuberculate; cervical groove visible laterally over third distance to anterolateral margin. Rostrum acutely triangular, with 2 or 3 pairs of lateral spines, longer than eyestalks, not depressed below level of carapace, continuous with definite lateral carinae; supraocular spines prominent; lateral carina with at least 1 spine; submedian carina present, with 1 or few spines; median carina a weak ridge, with 1 or few spines; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 acute or rounded, pleura 3–5 acute, sometimes with anteroventral tooth, or rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite long. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs present above pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 slightly asymmetrical, with propodus flattened; carpus-propodus upper margin with strong curved spines (rarely obsolete), densely covered with long setae. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male with appendix masculina. Uropodal endopod with lateral and distolateral spines; exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex rounded.

Remarks. Sakai and de Saint Laurent (1989) listed eight species. Subsequently, six species have been described, including one originally in the synonymised genus *Manaxius* Kensley, 2003 (Clark et al., 2007). While Clark et al.'s (2007) diagnosis serves to enable species to be recognised, it should be added that pleopods 3–5 each possess an appendix interna. Most species can be recognised by the long rostrum, pattern of gastric spines and chelipeds with long spines and dense mat of long setae. The chelipeds of *Calaxius euophthalmus* (De Man, 1905) would appear to lack strong spines and setae. Here, we redescribe the type species from Australian material and erect a new genus, *Pilbaraxius*, for a similar axiid with affinities to *Calaxius* (see below).

Calaxius acutirostris Sakai and de Saint Laurent, 1989

Figures 18–20, 43

Calaxius acutirostris Sakai and de Saint Laurent, 1989: 86–92, fig. 25 (probably not figs. 23, 24).—Sakai, 192–193, fig. 10.

Material examined. WA, off Zuytdorp, 27°08.01'S, 112°45.04'E–27°08.48'S, 112°45.43'E (stn SS10-2005 105), 414–405 m, 05 Dec 2005, NMV J53450 (female, cl. 20 mm, tl. 48 mm). WA, north-west slope, 16°45.3S, 119°46.4'E, 502–504 m, NTM Cr004234 (male, cl. 22.2, tl. 56.0). Qld, off Mackay, 22°55.1'S, 153°00.5'E, 338–325 m, NTM Cr007158 (male, cl. 26.5, tl. 65.0).

Description of female NMV J53450. Carapace smooth (with scattered setae). Rostrum 0.5 times length of front-to-cervical groove, acute, with 2 lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina with 1 prominent spine posterior to supraocular spine. Submedian gastric carina with 2 spines. Median gastric carina present as a ridge with 3 small spines. Faint postcervical carina present, becoming stronger posteriorly. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with sharp oblique lateral ridge. Sternite 8 (pereopod 5) with setose semicircular flap on anterior face at base of leg. Abdominal pleuron 1 2.5 times as deep as middorsal length, ventrally acute; pleura 2–5 broad, lateral length 1.3 times dorsal length, tapering posteroventrally to a point, pleura 4 and 5 with small anteroventral tooth; pleuron 6 rounded.

Eyestalk 0.3 length of rostrum; cornea pigmented. Antennular peduncle reaching to end of antennal article 4. Antennal article 1 with 2 spines on lower distal margin; article 2 distal spine slender, reaching distally to middle of antennal article 4; scaphocerite slender, straight, reaching distally 0.8 length of article 4; article 3 with 1 spine on mesial lower margin; article 4 about 1.3 length of article 2 (excluding distal spine), article 5 about two-thirds length of article 4. Maxilliped 3 basis with 1 spine; ischium with 2 spines on lower margin; crista dentata with 18 teeth; merus with 3 spines on lower margin; carpus unarmed.

Pereopods 1 scarcely differentiated, of similar length, major slightly more swollen than minor, merus of major slightly broader. Major pereopod 1 (right) coxa lower margin with 1 spine; basis lower margin with 1 spine; ischium lower margin with 1 spine; merus upper margin convex, with 2 spines, lower margin with 3 spines, lateral face with 1 distal spine, mesial face smooth; carpus upper margin with 3 spines, lower margin with 2 spines laterally, lateral face smooth, mesial face smooth; propodus upper margin with 4 spines (2 in midline, 1 on each side), lower margin with 8 spines in lateral row, lateral face with row of 4 spines, mesial face with 1 spine and few tubercles near lower margin; fixed finger 1.5 times upper palm, cutting edge with 5 sharp spine-like teeth; dactylus unarmed, cutting edge denticulate; distal articles bearing clusters of stiff setae.

Minor pereopod 1 coxa, ischium, merus and carpus as in larger cheliped; propodus as in larger cheliped except mesial face with 2 spines and few tubercles near lower margin; fixed finger 1.8 times length of upper palm, cutting edge with uneven blunt teeth; dactylus unarmed, cutting edge denticulate; distal articles bearing clusters of stiff setae.

Pereopod 2 ischium lower margin unarmed; merus lower margin with 3 spines; carpus slightly shorter than chela; propodus upper margin 0.8 length of dactylus. Pereopod 3 merus lower margin with 2 spines; propodus 2.7 times as long as dactylus, with 4 marginal robust setal rows. Pereopod 4 merus lower margin with 1 spine; propodus 2.8 times as long as dactylus, with 3 marginal robust setal rows. Pereopod 5 propodus 5 times as long as dactylus, subchelate, with short fixed finger; dactylus twisted.

Pleopod 1 article 2, 3 times article 1. Pleopods 2–5 appendix interna 0.3 length of endopod.

Telson 1.3 times as long as broad, lateral margin with 1 robust seta on proximal lobe, distal margin convex without posteromedian spine, posterolateral angle with 2 robust setae; dorsal face with 2 small spines in each oblique row. Uropodal endopod 1.6 times as long as wide, with 1 distolateral spine, longitudinal ridge with 2 spines (including marginal). Uropodal exopod 1.7 times as long as wide, with 2 obsolete lateral spines, 2 longitudinal ribs unarmed, posterolateral angle with minute

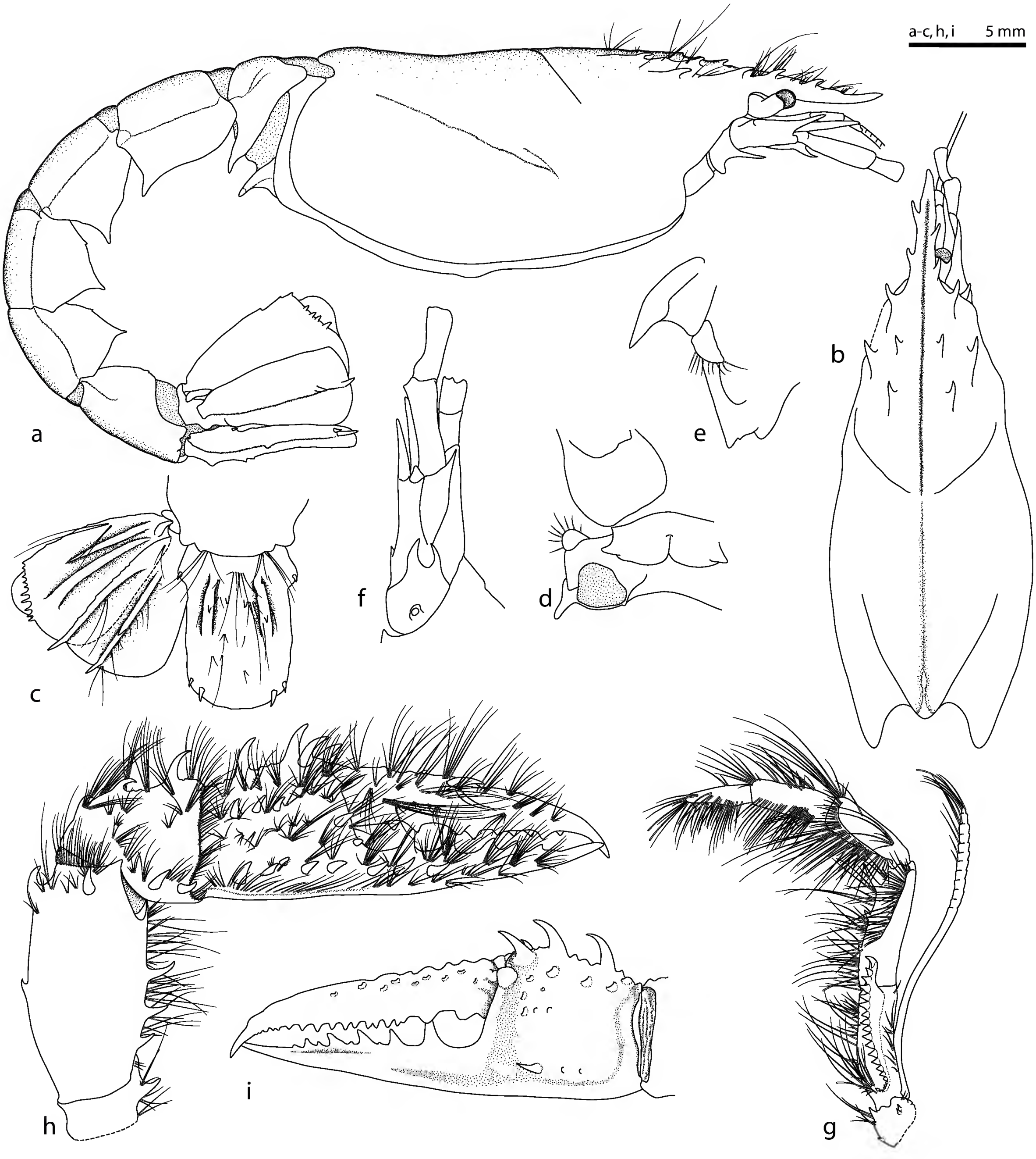

Figure 18. *Calaxius acutirostris* Sakai and de Saint Laurent, 1989. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and left uropod. d, sternites 7 and 8. e, right sternites 7 and 8 (lateral). f, epistome, left antennule and antenna (ventral). g, maxilliped 3. h, major pereopod 1 (right, lateral). i, same (propodus–dactylus, without setae, mesial). All figures from NMV J53540.

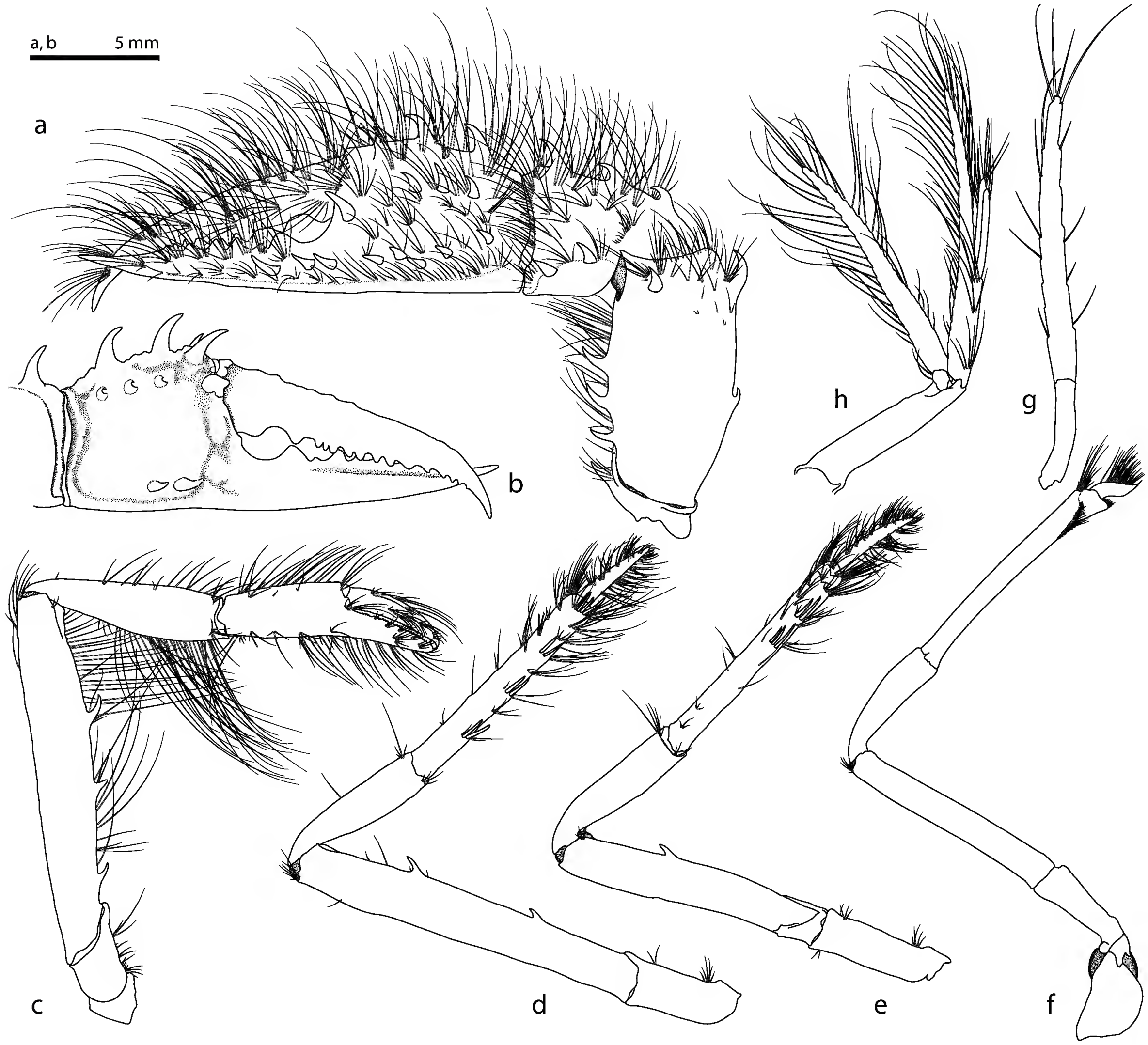

Figure 19. *Calaxius acutirostris* Sakai and de Saint Laurent, 1989. a, minor pereopod 1 (left, lateral). b, same (carpus–dactylus, without setae, mesial). c–f, pereopods 2–5 (right). g, female pleopod 1. h, male pleopod 2. Figs a–g from NMV J53540, fig. h from NTM Cr007158.

fixed spine (robust seta probably lost); transverse suture with 6–10 uneven spines.

Description of male NTM Cr007158. Essentially as female except: rostrum with 3 and 4 lateral spines anterior to supraocular; major cheliped more swollen, propodus mesial face more obviously tuberculate; pleopod 1 absent; pleopod 2 with appendices interna and masculina of similar lengths, each about third length of endopod; telson lateral margin with fixed spine (in place of robust seta) on proximal lobe and robust seta at midpoint; uropodal exopod posterolateral angle with minute fixed spine and robust seta.

Distribution. Madagascar (type locality); Australia, central and northern WA, central Qld, to 27°S, 325–505 m depth.

Remarks. De Saint Laurent (pers. comm., 1990) informed GCBP that, in her view, only figure 25 of *C. acutirostris* in the original description (Sakai and de Saint Laurent, 1989) refers to this species whose holotype is from Madagascar; the other figures and part of the description refer to another species from the Philippines. This would appear to differ only in the degree of spination of the chelipeds. Sakai (1994: 192, fig. 10) recorded *Calaxius acutirostris* from off Queensland and Western Australia, and illustrated and

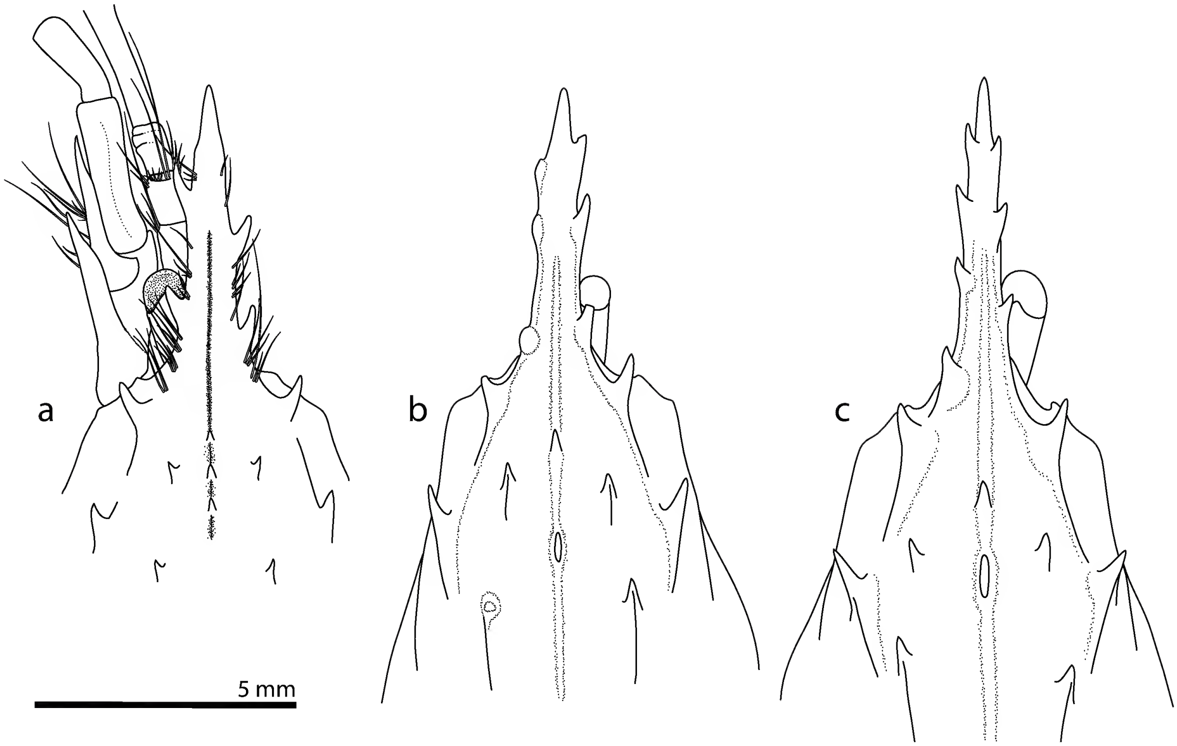

Figure 20. *Calaxius acutirostris* Sakai and de Saint Laurent, 1989. Detail of rostum (and left antennae) of three specimens. a, female, cl. 20 mm, NMV J53540. b, male, cl. 22.2 mm, NTM Cr004234. c, male, cl. 26.5 mm, NTM Cr007158.

described maxilla 2 and maxillipeds 1–3. We examined his material and found it, like our own, more resembled figure 25 of the type specimen than figure 24 of the Philippines specimen. We figure dorsal views of all Australian specimens to illustrate the elongation of the rostrum with increased size (fig. 20).

The original diagnosis and description were extensive and covered all limbs (Sakai and de Saint Laurent, 1989) but apart from pereopod 1 no limbs were illustrated. Because of the confusion about which species was referred to, we provide figures and another description based on the Australian material. We note differences in the number of rostral spines (between individuals and between left and right sides)—two to four spines possible, in degree of spination and tuberculation of chelipeds, and in armature of the telson.

Calaxius acutirostris, is similar to *C. euophthalma* (De Man, 1905), *C. manningi* Kensley et al., 2000 and *C. tungi* Zhong, 2000 in the possession of two well defined spines on each lateral and sublateral gastric carina. All possess two to four asymmetrical spines on each lateral margin of the rostrum. *Calaxius acutirostris* and *C. manningi* also have a similar spination pattern on the chelipeds while *C. tungi* has fewer and weaker spines. *Calaxius euophthalma* lacks prominent cheliped spines. Also belonging to this group of Indo-West Pacific species with two or three asymmetrical rostral spines are *C. mimasensis* (Sakai, 1967) and *C. sibogae* (De Man, 1925b) but these species have less spinose chelipeds than *C. acutirostris*.

Dorphinaxius Sakai and de Saint Laurent, 1989

Dorphinaxius Sakai and de Saint Laurent, 1989: 33–34.—Poore, 2004: 175.

Type species. Axiopsis (*Paraxiopsis*) *appendiculis* Poore and Griffin, 1979 by original designation.

Diagnosis. Carapace smooth; cervical groove visible laterally over half distance to anterolateral margin. Rostrum triangular, broad, laterally obscurely denticulate, about as long as eyestalks, depressed below level of carapace, continuous with definite lateral carinae; supraocular spines prominent; lateral carina unarmed; submedian carina present, with blunt anterior tooth; median carina a weak ridge, with one blunt tubercle; postcervical carina absent. Abdominal somite 1 pleuron rounded; pleuron 2 broad, anteriorly rounded, ventrally flat, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite short, curved. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs present above pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 slightly asymmetrical, with propodus cylindrical; carpus-dactylus upper and lower margins unarmed. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row or robust setae. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male with appendix masculina. Uropodal exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex rounded.

Remarks. Sakai and de Saint Laurent (1989) likened their new genus to *Scytoleptus* Gerstaecker, 1856, the two sharing a depressed rostrum, broad foliaceous epipods on pereopods 1–4, and sexually dimorphic pleopods 2–5. The epipods of these two genera seem not different from those of many other axiids and pleopods are scarcely sexually dimorphic (cf. figs. 23g, h). According to their account, *Scytoleptus* has a shorter cervical groove than *Dorphinaxius*. They erroneously differentiated the two genera on pleurobranchs above pereopods 2–4 (present in both genera). Here, we rediagnose the genus and confirm the taxonomy of the type and only species.

Dorphinaxius kermadecensis (Chilton, 1911)

Figures 21–23

Iconaxiopsis kermadecensis Chilton, 1911: 550–551, figs. 1, 2.

Axius (*Eiconaxius*) *kermadecensis*.—De Man, 1925b: 4, 10, 15.

Axiopsis (*Paraxiopsis*) *appendiculis* Poore and Griffin, 1979: 224–226, fig. 1.

Eiconaxius kermadecensis.—Sakai and de Saint Laurent, 1989: 23.

Dorphinaxius appendiculis.—Sakai and de Saint Laurent, 1989: 34.—Sakai, 1994: 200.

Dorphinaxius kermadecensis.—Davie, 2002: 452.—Poore, 2004: 175, figs. 45e, f, 46c.

Material examined. *Iconaxiopisis kermadecensis* Chilton, 1911. Syntypes. New Zealand, Kermadec Islands, Meyer I. and Coral Bay, rock pools at Sunday I. [= Raoul I.] (29°16'S, 177°55'W), Captain Bollons, BMNH 1912.5.25.44–46 (fragments of 5 chelipeds, 1 body with only abdominal segments identifiable, 1 body with anterior carapace, 1 right uropod; annotated "Cotypes Pres. Prof. Chilton. The specimens came back from Godstowe very macerated—only fragments left. I. G[ordan] v/46.").

Axiopsis (*Paraxiopsis*) *appendiculis* Poore and Griffin, 1979. Holotype. Australia, NSW, Shellharbour, under stones between tide marks, G. McAndrew, 1926, AM P9359 (ovigerous female, cl. 14 mm). Paratypes. Australia, central NSW: Grafton, Collaroy, Port Jackson and Shellharbour (29°47.0'S–34°35'S, 151°12'E–153°18'E), AM, 12 of 19 paratype lots (6 males, cl. 10–19 mm; 14 females, 6 ovigerous, cl. 6.5–21 mm).

Other material. Australia, Norfolk I., Emily Bay, Point Hunter (29°03.8'S, 167°57.3'E), 0–0.25 m, H. Larsen, 18 Apr 1984, NTM Cr001666 (juvenile, cl. 4.0 mm).

Description. Carapace smooth except for slight rugosity at base rostrum, with few setae on gastric region and rostrum. Rostrum 0.25 times length of front-to-cervical groove, broadly triangular, without or with 2 or 3 lateral tubercles anterior to supraocular spine, depressed below level of median carina, anteriorly directed or directed slightly upwards, continuous with lateral carinae. Supraocular spines prominent, broadly triangular. Lateral carina unarmed. Submedian carina smooth, with 1 anterior blunt tooth. Median carina obsolete, with single tooth, sloping down at 20–40°. Abdominal somite 1 pleuron ventrally rounded; pleuron 2 asymmetrical, posteriorly rounded; pleura 3–5 rounded; pleura 6 rounded.

Eyestalk, 0.5 length of rostrum; cornea pigmented. Antennular peduncle reaching to midpoint of antennal article 4; article 1 with mesial and distal spinule. Antennal article 1 unarmed; article 2 stylocerite obsolete; scaphocerite one third length of article 4, curved downwards; article 4, 1.5 times length of article 2; article 5 about half length of article 4. Maxilliped 3 coxa and basis lower margin each with distal spine; ischium unarmed; crista dentata of about 17 teeth; merus with 3 spines; carpus with 1 spine.

Pereopods 1 asymmetrical, robust, not sexually dimorphic. Major cheliped coxa to ischium unarmed; merus upper margin strongly convex, unarmed, lower margin with 1 small spine; carpus unarmed; propodus unarmed; fixed finger 0.5 times as long as upper palm, cutting edge with 1 triangular tooth; dactylus distally curved, cutting edge unevenly toothed.

Minor cheliped similar to major, propodus narrower, fixed finger 0.6 times as long as upper palm, cutting edge with 2 blunt teeth.

Pereopod 2 ischium lower margin unarmed; merus lower margin unarmed; carpus slightly shorter than chela; propodus upper margin 1.1 times length of dactylus. Pereopod 3 merus unarmed; propodus 2.0 times as long as dactylus, with 5 transverse rows each of 3–9 robust setae; dactylus tapering, with 8 large robust setae plus longitudinal row of 7 smaller robust setae on inner face, plus unguis. Pereopod 4 propodus 2.4 times as long as dactylus, distally densely setose, with 5 transverse rows each of 3–10 robust setae; dactylus tapering, with 11 large robust setae plus longitudinal row of 7 smaller robust setae on inner face, plus unguis. Pereopod 5 propodus 2.5 times as long as dactylus, weakly subchelate, distally densely setose, with distal transverse row of 7 robust setae; dactylus spoon-shaped, with 2 robust setae mesially, plus unguis.

Pleopods 2–5 each with appendix interna 0.2 length of endopod. Pleopod 1 of male absent. Pleopod 2 of male appendix masculina 1.1 times as long as appendix interna. Pleopod 1 of female a single narrow article.

Telson 1.2 times as long as wide, widest proximally, then tapering, lateral margin with 4 teeth and 2 robust setae, distal margin convex between distolateral spines and robust setae, without posteromedian spine; dorsal face with oblique ridges bearing 2 spines. Uropodal endopod 1.7 times as long as wide, with 3 or 4 lateral spines, longitudinal ridge with 2–4 spines (last submarginal). Uropodal exopod 1.5 times as long as wide, with 3 or 4 lateral spines, longitudinal rib with 3 or 4 spines, posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture 3–5 spines, two most medial strongest, adjacent and diverging.

Distribution. New Zealand: Kermadec Is; Australia: Norfolk I., central NSW. Intertidal to 8 m depth.

Remarks. Chilton (1911) based his new species on "several specimens," the largest with a carapace length of 17 mm and

Figure 21. *Dorphinaxius kermadecensis* (Chilton, 1911). Fragments of 5 chelipeds, abdominal segments, anterior carapace, rami of right uropod. All from syntypes of *Iconaxiopisis kermadecensis* Chilton, 1911. BMNH 1912.5.25.44–46. Top scale bar refers to carapace, abdomen and uropod; bottom scale bar refers to chelipeds.

abdomen to end of telson, 29 mm. The "cotypes" at the BMNH are the remains of only three specimens; no material could be found at the Canterbury Museum, Christchurch, New Zealand, where Chilton placed other species, nor at the National Museum of New Zealand (Te Papa). His description was brief, mentioning only the rostrum, the gastric region of the carapace and the chelipeds; he illustrated only the left and right chelipeds of one individual. He likened the species to "*Iconaxiopsis*" *andamanensis* Alcock, 1901 now placed in *Eiconaxius* Bate, 1888.

In his key, De Man (1925b) correctly assumed that the species possessed pleurobranchs and placed it in the subgenus *Axius* (*Eiconaxius*). Sakai and de Saint Laurent (1989) failed to report the pleurobranchs above pereopods 3–4 of the species they called *D. appendiculis* in spite of having examined material and noting their presence in the generic diagnosis.

The synonymy of *I. kermadecensis* and *A. appendiculis* was first proposed by Davie (2002) on the advice of the late Brian Kensley but we are unaware of how he reached this conclusion. We have carefully examined what remains of the types of *I. kermadecensis* and compared them with types of *A. appendiculis*, both reillustrated here. We can detect no differences and agree with Kensley. The attitude of the rostrum varies remarkably (cf. figs. 22a, g), as does the number of lateral spines on the uropodal rami. A submedian tubercle sits between those on the median and lateral gastric carinae on some specimens, for example, on three of six individuals in one sample. The difference is not of taxonomic significance.

Although the species occurs at the Kermadec Islands north of New Zealand, at Norfolk Island in the Tasman Sea, and in the Sydney region, Australia, it has not been recorded from the main islands of New Zealand (S. Ahyong, R. Webber, pers. comm.).

Eiconaxius Bate, 1880

Eiconaxius Bate, 1888: 40.—Sakai and de Saint Laurent, 1989: 15–16.—Sakai and Ohta, 2005: 69–70 (list of species).

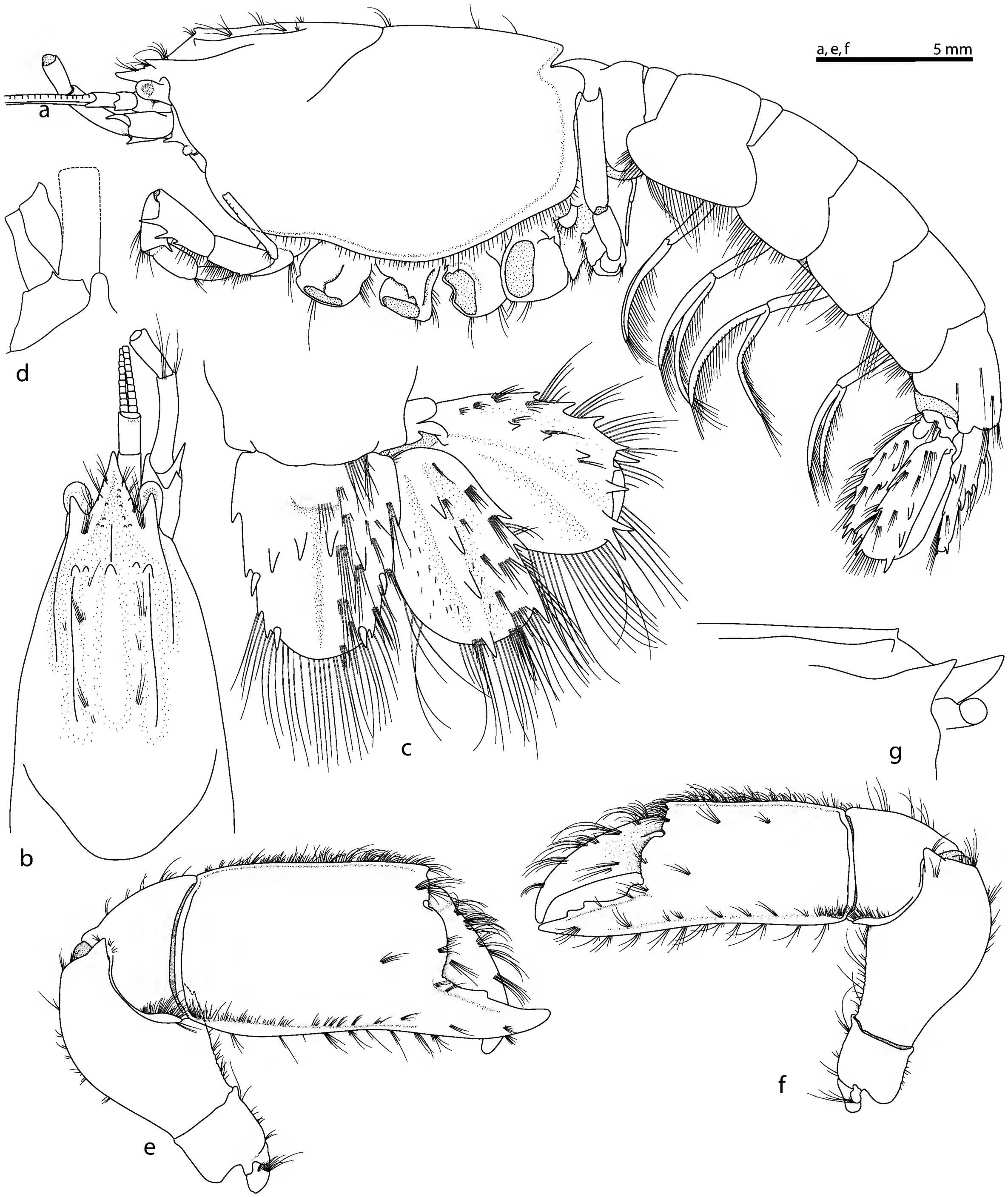

Figure 22. *Dorphinaxius kermadecensis* (Chilton, 1911). a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, epistome, bases of right antennule and antenna (ventral). e, major pereopod 1 (right, lateral). f, minor pereopod 1 (left). g, lateral anterior carapace and rostrum. a–f from holotype of *Axiopsis* (*Paraxiopsis*) *appendiculis* Poore and Griffin, 1979 (AM P9359, ovigerous female, cl. 14 mm); g from female, cl. 21 mm (AM P1511).

Figure 23. *Dorphinaxius kermadecensis* (Chilton, 1911). a, maxilliped 3. b–e, pereopods 2–5. f, g, female pleopods 1, 2. h, male pleopod 2. a–g from holotype of *Axiopsis* (*Paraxiopsis*) *appendiculis* Poore and Griffin, 1979 (AM P9359, ovigerous female, cl. 14 mm). h from male, cl. 19 mm (AM P18557).

Iconaxiopsis Alcock, 1901: 193–195.—Borradaile, 1903: 537.—Balss, 1925: 210 (type species: *Eiconaxius kermadeci laccadivensis* Alcock and Anderson, 1894, subsequent designation by Borradaile, 1903.

Axius (*Eiconaxius*).—Borradaile, 1903: 537–538.—De Man, 1925b: 8–9 (synonymy of *Iconaxiopsis*), 14.

Type species. *Eiconaxius acutifrons* Bate, 1888, subsequent designation by Borradaile, 1903.

Diagnosis. Carapace smooth; cervical groove weak to inconspicuous. Rostrum triangular, broad, laterally smooth or obscurely denticulate, longer than eyestalks, depressed below level of carapace, continuous with definite lateral carinae; supraocular spines absent; lateral carina unarmed; submedian carina present, converging anteriorly and joining median carina; median carina a weak ridge on rostrum only, armed or not; postcervical carina absent. Abdominal somite 1 pleuron rounded; pleuron 2 posteriorly acute; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented or not. Antenna, scaphocerite blade-like. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs present above pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; carpus-dactylus upper and lower margins smooth or toothed, propodus at least with distal tooth on upper margin. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli spatulate, with row of robust setae along oblique margin. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male with appendix interna and appendix masculina. Uropodal exopod without transverse suture. Telson with lateral teeth, without posterolateral robust setae; apex rounded or truncate.

Remarks. *Eiconaxius* is a well-characterised genus of 25 similar species from deep waters in the Indo-Pacific, Caribbean and Gulf of Mexico. Sakai and Ohta (2005) erected a family, Eiconaxiidae, for the genus defining it mainly using typical generic characters. They believed the family "is conspicuously different from all other genera of the family Axiidae" citing the chelate pereopod 2, rounded dactyli with robust marginal setae on pereopods 3–5, indistinct cervical groove and absence of the male pleopod 1. Chelate pereopods 2 are found in all axiideans. A similar "rounded" or spatulate dactylus is found on pereopod 5 of *Platyaxius* Sakai, 1994 (see below) but not on pereopods 3 and 4. *Platyaxius* also has an oval telson and uropodal rami, the exopod without a transverse suture, similar to those of species of *Eiconaxius*. In the telson and uropod (but not the male pleopod 1) these two genera are similar to *Scytoleptus* Gerstaecker, 1856. Several axiid genera lack a male pleopod 1. Many genera lack a pleopod 1 and have an indistinct cervical groove. These similarities suggest a more complex relationship between the genera than proposed by Sakai and Ohta (2005) and we include the genus in Axiidae for now.

The median carina has been described as bifurcating posteriorly in species of *Eiconaxius*. We interpret the bifurcation as the two submedian gastric carinae converging anteriorly on the median carina and look to axiid genera such as *Axiopsis* Borradaile, 1903 for homology (see for example Ngoc-Ho, 2005).

Eiconaxius kimbla Kensley, 1996

Eiconaxius kimbla Kensley, 1996b: 481–483, fig. 8.—Davie, 2002: 453.

Distribution. Qld, c. 150 m depth.

Remarks. In this species the rostral rim is unarmed and uropodal rami are obliquely truncated. No material was examined.

Eiconaxius mallacoota sp. nov.

Figure 24

Material examined. Holotype. Australia, Victoria, S of Point Hicks (38°19.36'S, 149°24.18'E–38°19.00'S, 149°27.18'E, 930–951 m (stn SLOPE 33), M.F. Gomon et al. on RV *Franklin*, WHOI epibenthic sled, 23 Jul 1986, NMV J15061 (male, cl. 5.7 mm, tl. 15.0 mm).

Paratypes. Collected with holotype, NMV J53161 (male, cl. 4.1 mm, tl. 11.0 mm); NMV J53162 (male, cl. 6.2 mm, tl. 16.8 mm). S of Point Hicks (38°21.90'S, 149°20.00'E, 1000 m (stn SLOPE 32), G.C.B. Poore et al. on RV *Franklin*, WHOI epibenthic sled, 23 Jul 1986, NMV J15060 (juvenile, cl. 2.0 mm, abdomen damaged).

Description of male holotype. Carapace smooth. Rostrum 0.25 times length of front-to-posterior margin of carapace, concave dorsally, parallel-sided over eyes, then tapering to acute tip, with 10 marginal lateral tubercles on oblique margins, depressed below level of median carina, anteriorly directed, continuous with lateral carinae. Supraocular spines absent. Lateral carina unarmed. Submedian carina smooth, together semicircular and converging on median carina. Median carina obsolete, on base of rostrum only. Abdominal somite 1 pleuron ventrally rounded-truncate; pleuron 2 oblique angled, posteroventrally acutely produced; pleura 3–4 posteroventrally acutely produced, pleuron 5 less so, all with anteroventral tooth; pleura 6 subacute; abdominal somite 6 dorsal posterior margin with pair of lateral teeth at base of telson, with (3 uneven) denticles along dorsal posterior margin.

Eyestalk 0.5 length of rostrum; cornea unpigmented. Antennular peduncle reaching to end of antennal article 4; article 1 unarmed. Antennal article 1 unarmed; article 2 stylocerite a vertical blade, reaching to midpoint of article 5; scaphocerite a vertical blade, reaching beyond end of article 5; article 3 lower margin with mesial tooth; article 4 as long as article 2; article 5 about half length of article 4. Maxilliped 3 coxa–ischium unarmed; crista dentata of about 15 similar teeth; merus and carpus unarmed.

Pereopods 1 asymmetrical, robust. Major cheliped coxa with 1 spinule; basis unarmed; ischium lower margin with few irregular teeth; merus upper margin strongly convex, with 2 small teeth, lower margin with 6 small teeth; carpus lower margin with 1 distal tooth; propodus greatest depth equal to upper margin length; upper margin with distal tooth, lower margin with 5 small teeth on lateral submarginal ridge; fixed finger 0.7 times as long as upper palm, cutting edge with irregular teeth in shallow proximal concavity, irregular tooth distally; dactylus distally curved, cutting edge smooth.

Minor cheliped more slender than major; coxa with 1 spinule; basis unarmed; ischium lower margin with few

Figure 24. *Eiconaxius mallacoota* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, epistome, right antennule and antenna (ventral). e, maxilliped 3. f, major pereopod 1 (left, lateral). g, minor pereopod 1 (right). h–k, pereopods 2–5 (with details of dactyli of pereopods 3 and 4). l, male pleopod 2. All figures from holotype.

irregular teeth; merus upper margin strongly convex, with 2 small teeth, lower margin with 5 small teeth; carpus lower margin with 1 distal tooth; propodus greatest depth 1.1 times upper margin length; upper margin with distal tooth, lower margin with 4 small teeth on lateral submarginal ridge; fixed finger 1.2 times as long as upper palm, with lateral ridge parallel to cutting edge, cutting edge straight,with irregular teeth; dactylus tapering, cutting edge smooth.

Pereopod 2 ischium lower margin unarmed; merus lower margin unarmed; carpus slightly shorter than chela; propodus upper margin 3 times as long as dactylus. Pereopod 3 merus unarmed; propodus 2.5 times as long as dactylus, with 6 rows of robust setae, of 1 or 2 setae; dactylus spatulate, with 13 robust setae along oblique margin, plus unguis. Pereopod 4 virtually identical to pereopod 3; propodus 2.5 times as long as dactylus, with 6 rows of robust setae, of 1–3 setae; dactylus spatulate, with 11 robust setae along oblique margin, plus unguis. Pereopod 5 propodus 2.8 times as long as dactylus, simple, distally densely setose, without robust setae; dactylus spatulate, with 8 robust setae along oblique margin, plus unguis.

Pleopods 2–5 each with appendix interna 0.25 length of endopod. Pleopod 2 of male appendix masculina 0.7 times as long as appendix interna.

Telson 1.5 times as long as wide, widest proximally, then tapering more steeply distally, lateral margin with 8–10 small teeth, distal margin a shallow obtuse angle between weak distolateral teeth, without posteromedian spine; dorsal face with obsolete longitudinal ridges. Uropodal endopod 2.35 times as long as wide, oval, with 12 small irregular lateral teeth, last tooth distal, without longitudinal ridge. Uropodal exopod 1.6 times as long as wide, oval with 14–20 small irregular lateral teeth over distal two-thirds, last tooth distal, without longitudinal rib.

Variation. Paratype male, cl. 6.2 mm, NMV J53162. Abdominal somite 6 posterodorsal margin with pair of lateral teeth and 2 pairs of submedian denticles. Telson with 7 small lateral teeth.

Paratype male, cl. 4.1 mm, NMV J53161. Rostrum with 5 sharp lateral teeth. Abdominal somite 6 posterodorsal margin with pair of lateral teeth, 1 pair of submedian denticles, 1 median tooth. Minor cheliped merus upper margin with 3 teeth, lower margin with 2 teeth; propodus upper margin with 2 teeth; dactylus upper margin with 1 tooth. Telson with 7 small lateral teeth.

Paratype juvenile, cl. 2.0 mm, NMV J15060. Major cheliped merus upper margin with 2 teeth, lower margin with 2 teeth; propodus upper margin with 2 teeth, lower margin with 4 teeth (all more prominent than in larger specimens). Minor cheliped merus upper margin with 1 tooth, lower margin with 1 tooth; propodus upper margin with 4 teeth, lower margin with 3 teeth; dactylus upper margin unarmed.

Etymology. Mallacoota, a township and estuary not far from the type locality (noun in apposition).

Distribution. Australia, off eastern Vic., 930–1000 m depth.

Remarks. The new species is represented by three males and one juvenile. The males vary only slightly but the juvenile has more prominent spination on the chelipeds than the others. *Eiconaxius mallacoota* is similar to *E. kermadeci* (Bate, 1888) from a depth of 1100 m at the Kermadec Islands, north of New Zealand. The latter was redescribed by Sakai and de Saint Laurent (1989: 16–18, fig. 5) and a lectotype designated. The acute rostrum and gastric region of *E. kermadeci* are similarly weakly ornamented but the rostrum is shorter, not reaching to article 3 of the antennule, and less acutely tapering. The telson and uropodal rami of *E. kermadeci* are relatively broader than in the new species and the fixed finger of the larger cheliped is basally strongly toothed and gaping. At 37 mm long (according to Bate, or 23 mm according to Sakai and de Saint Laurent) *E. kermadeci* is larger than the new species but few specimens are available for either species.

Another similar species is *E. parvus* (Bate, 1888), known from a single 12 mm long ovigerous female (holotype, not lectotype as stated by Sakai and de Saint Laurent) taken at 950 m also near the Kermadec Islands. Bate's short description and simple drawing do not allow a comparison but Paul Clark (Natural History Museum, London) kindly figured the holotype for us (fig. 25). The rostrum of *E. parvus* is not so clearly tapered as in *E. mallacoota*, the telson is relatively broader and the chelipeds slightly more elongate.

A third similar species is *E. demani* Sakai, 1992 from Indonesia and the Arafura Sea (just outside Australia's EEZ) but its rostrum is apically rounded rather than acute. The only other Australian species is *E. kimbla* Kensley, 1996b, which differs from the new species in having an irregularly ornamented tapering rostrum, shorter telson, asymmetrical uropodal rami, and more massive elongate chelae with short fingers.

Michelaxiopsis gen. nov.

Type species. Axiopsis (*Axiopsis*) *australiensis* De Man, 1925, herein designated.

Diagnosis. Carapace and abdomen smooth or covered with numerous stiff setae; cervical groove visible laterally over most of distance to anterolateral margin. Rostrum triangular, broad, laterally denticulate, longer than eyestalks, slightly depressed below level of carapace, continuous with definite lateral carinae; supraocular spines barely differentiated from other spines; lateral carina beaded; submedian carina present, beaded, duplicated as hair-pin shape; median carina toothed and beaded; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 broad, anteriorly rounded, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite long, acute. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs present above pereopod 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical (in male), with propodus cylindrical; carpus-dactylus upper margins smooth. Pereopods 3–4 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male without appendix masculina. Uropodal exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex truncate-rounded.

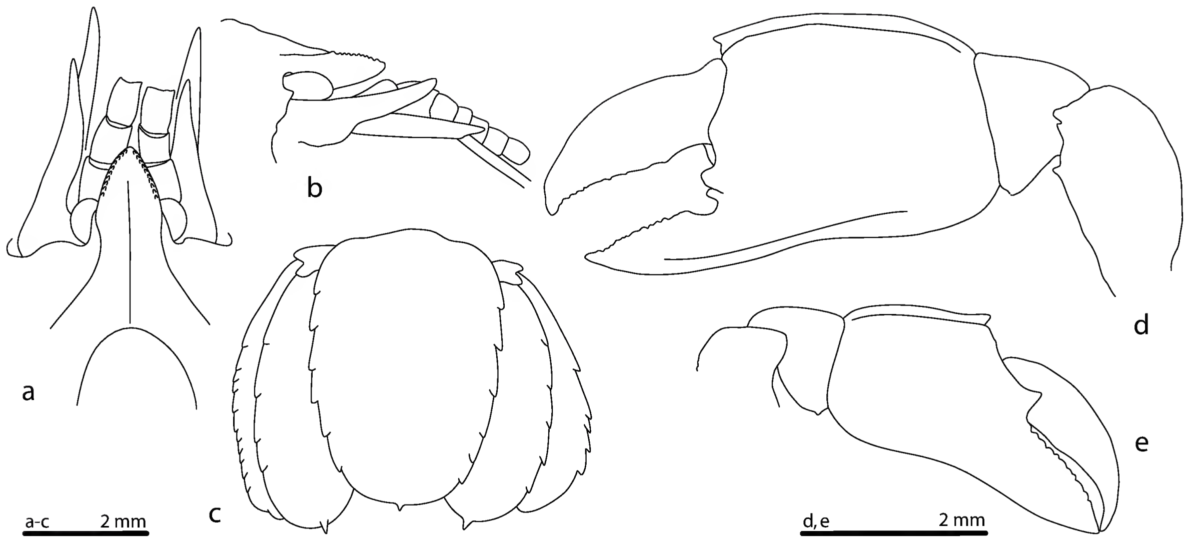

Figure 25. *Eiconaxius parvus* (Bate, 1888). a, b, dorsal and lateral views of anterior carapace, peduncles of antennule and antenna. c, telson and right uropod. d, major cheliped (left). e, minor cheliped (right). All figures prepared for publication by DJC from pencil drawings of the holotype by Paul Clark.

Etymology. This species is dedicated to the late Michèle de Saint Laurent (1926–2003) who in 1990 alerted the first author to the probability that the type species belonged to a new genus.

Remarks. Although superficially similar to species of *Axiopsis*, the type species and the second described below differ in two important characters. Pleurobranchs are present and well developed over pereopods 2–4 (absent and probable apomorphy in *Axiopsis*) and the male pleopod 2 lacks an appendix masculina (present and probable plesiomorphy in *Axiopsis*).

Michelaxiopsis australiensis (De Man, 1925) comb. nov.

Figure 26

Axiopsis (*Axiopsis*) *australiensis* De Man, 1925a: 127–132, fig. 4.—De Man, 1925b: 69.—Poore and Griffin, 1979: 226–228, fig. 2.

Axiopsis australiensis.—Poore, 2004: 174, figs. 45a, b, 46a.

Axius australiensis.—Sakai and de Saint Laurent, 1989: 26, 29.—Sakai, 1992: 165, fig. 7.—Davie, 2002: 451.—Sakai, 1994: 200.

Material examined. NSW, Long Reef, W end of reef (33°44'S, 151°19'E), I. Bennett, Apr 1964, AM P24699 (2 ovigerous females, cl. 20.0, 24.7 mm). Port Jackson, Watsons Bay (33°50.8'S, 151°16.8'E), McIntosh and Whitelegge, Mar 1908, AM P15036 (1 male, cl. 11.7 mm; 2 females, cl. 13.6, 15.0 mm).

Vic., Shoreham (38°26'S, 145°03'E), AM P1757 (2 juvenile males, cl. 7.2, 8.5 mm).

Diagnosis. Carapace smooth, with scattered long setae. Rostrum 0.25 times length of front-to-cervical groove, broadly acute, rugose dorsobasally, with 5 lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines barely differentiated from others in row. Lateral gastric carina with 3 or 4 obscure low beads fading posteriorly. Submedian gastric carina duplicated, outer row of 12–15 tubercles curving inwards at anterior end, beading fading posteriorly, inner row of 3–5 tubercles anteriorly, 3–4 posteriorly and clear hiatus between. Median gastric carina with 18–22 tubercles, scarcely taller anteriorly, fading posteriorly.

Antennule article 1with sharp stylocerite. Antennal article 2 distal spine slender, directed anteriorly, reaching distally to quarter of antennal article 4; scaphocerite reaching two-thirds length of article 4, simple; article 3 with short mesiodistal spine on lower margin.

Major pereopod 1 ischium lower margin with 1 spine; merus upper margin convex, unarmed, lower margin with 5 spines, last longest, lateral face smooth, mesial face smooth; carpus upper margin unarmed, lower margin unarmed; propodus upper margin tuberculate, lower margin smooth, lateral face with squamous tubercles concentrated on distal two-thirds along lower margin, few along upper margin, mesial face with squamous tubercles concentrated on distal two-thirds along lower margin, few along upper margin; fixed finger 0.8 length of upper palm, cutting edge with 1 blunt tooth and 1 triangular tooth; dactylus upper margin smooth, lateral face smooth, mesial face smooth, cutting edge with blunt tooth at midpoint and notch proximally, with subapical robust setae prominent.

Minor pereopod 1 of similar length and ornamentation as major cheliped but narrower.

Telson 1.2 times as long as wide, lateral margin unarmed (rarely 1 spine), distal margin convex, with posteromedian

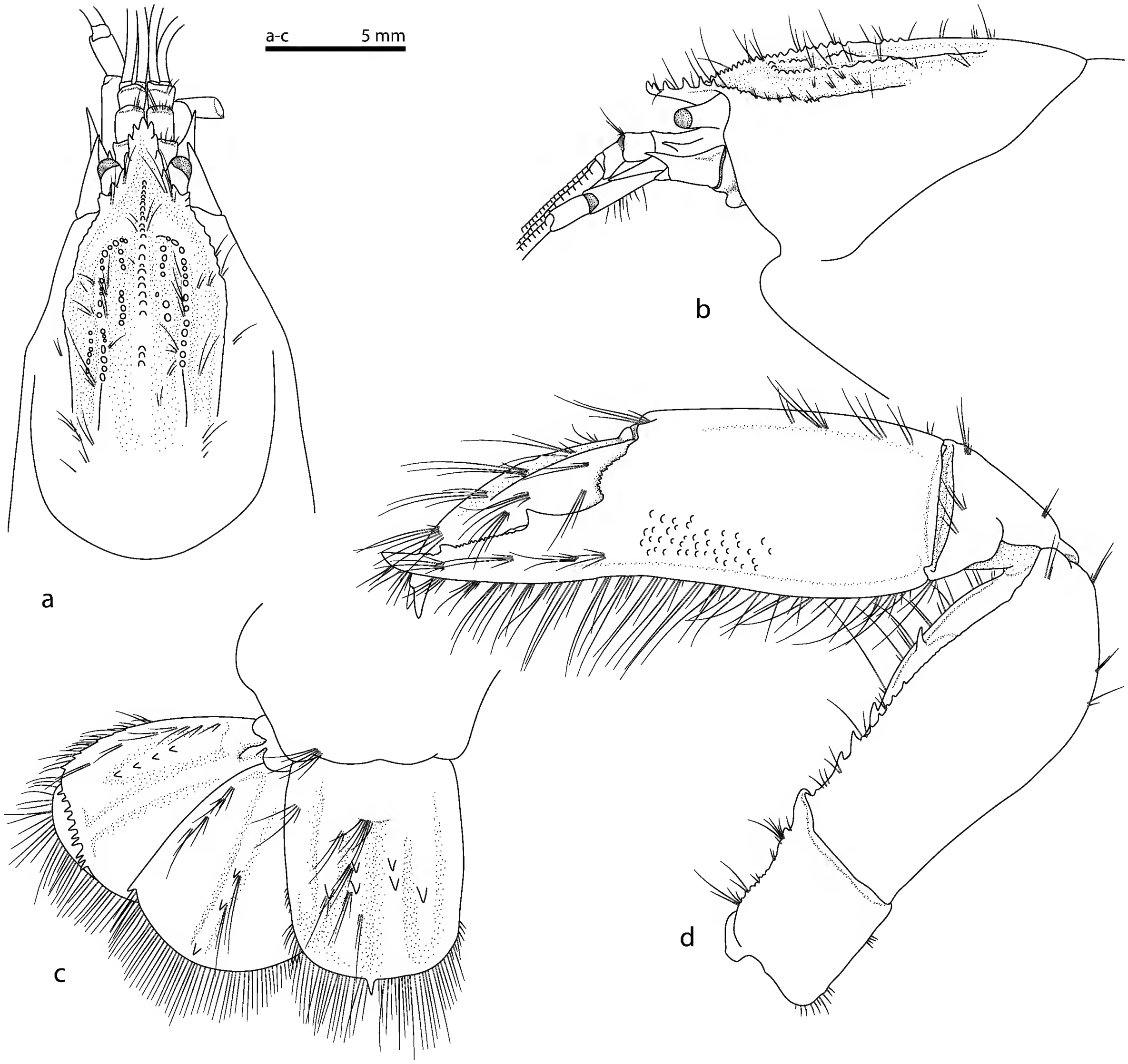

Figure 26. *Michelaxiopsis australiensis* (De Man, 1925). a, b, lateral and dorsal view of anterior carapace, peduncles of antennule and antenna. c, telson and left uropod. d, cheliped (left). All figures from female (AM P24699).

spine, posterolateral angle with inconspicuous robust setae; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.2 times as long as wide, with or without lateral spine and 1 distolateral spine, longitudinal ridge with 4–5 spines. Uropodal exopod 1.3 times as long as wide, with 5–6 lateral spines, 2 longitudinal ribs with 3–4 on outer rib, posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 6–10 spines.

Distribution. NSW, Vic., intertidal-subtidal.

Remarks. Michelaxiopsis australiensis is differentiated from *M. nauo* by the absence of short stiff setae on the carapace and abdomen. The submedian gastric carina is duplicated, the outer row of tubercles continous and the inner one of three anterior and three or four posterior tubercles separated by a distinct hiatus. The median gastric carina is composed largely of bead-like tubercles, the anteriormost ones only slightly more elevated than posterior ones. The lateral margin of the telson is usually smooth, and only rarely with a small tooth. The absence of the male pleopod 1 and gastric ornamentation exclude this species from *Axius* to which it has been assigned. Poore and Griffin (1979) listed numerous specimens from central NSW, a few of which where re-examined for this study.

The two small specimens from Victoria are in poor condition. They differ from the others in that the gastric carinae are almost smooth, with only vestiges of the beads or tubercles of larger specimens. The hiatus in the inner submedian row is quite evident.

Michelaxiopsis nauo sp. nov.

Figures 27, 28

Material examined. Holotype. SA, Sir Joseph Banks Group: Roxby I. (34°35'S, 136°19'E), 6 m, in burrow under rocks, N. Holmes, 9 Jan 1988, SAM C6811 (ovigerous female, cl. 24.5 mm).

Paratypes. SA, Reevesby I. (34°31'S, 136°16'E), offshore from Northwest Point, 3 m, under rocks, W. Zeidler, 13 Jan 1984, SAM C6812 (male, 9.0 mm); Marum I., North Point (34°30'S, 136°15'E), 5–6 m, under rocks, K. Gowlett, 22 Jan 1985, SAM C6813 (male, 14.5 mm); between Reevesby and Partney Is., opposite Nicholas Bay, 6 m, under dead *Pinna* shells, K. Gowlett and N. Holmes, 23 Jan 1985, NMV J59765 (female, cl. 11.0 mm).

Description of female holotype. Carapace covered with short stiff setae, often in small bunches, and scattered longer setae. Rostrum 0.25 times length of front-to-cervical groove, broadly acute, with 4 lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines barely differentiated from others in row. Lateral gastric carina with obscure low beads fading posteriorly. Submedian gastric carina duplicated in form of a hair-pin, of 20–25 beads in each row, fading posteriorly. Median gastric carina with about 5 erect spines near base of rostrum and about 15 beads fading posteriorly. Abdominal somite 1 pleuron ventrally rounded; pleuron 2 rounded anteriorly and posteriorly; pleura 3–4 posteroventrally rounded, pleuron 5 less so; pleuron 6 rounded.

Eyestalk, 0.5 length of rostrum; cornea pigmented. Antennular peduncle reaching almost to end of antennal article 4; article 1 with sharp stylocerite. Antennal article 2 distal spine slender, directed anteriorly, reaching distally to quarter of antennal article 4; scaphocerite reaching two-thirds length of article 4, simple; article 3 with sharp mesiodistal spine on lower margin. Maxilliped 3 coxa–ischium unarmed; crista dentata of about 20 similar teeth; merus with 4 spines, largest distal; carpus with 1 spine.

Pereopods 1 symmetrical; ischium lower margin with 1 spine; merus upper margin convex, unarmed, lower margin with 6 spines; propodus upper margin tuberculate, lower margin smooth, lateral face with squamous tubercles concentrated on distal two-thirds (absent proximally and from fixed finger), mesial face with squamous tubercles concentrated on distal two-thirds (absent proximally and from fixed finger); fixed finger 0.7 length of upper palm, cutting edge with 1 blunt bicuspid tooth; dactylus upper margin smooth, lateral face smooth, mesial face smooth, cutting edge with blunt tooth at midpoint and notch proximally.

Pereopod 2 ischium lower margin unarmed; merus lower margin unarmed; carpus slightly longer than chela; propodus upper margin 1.2 times as long as dactylus. Pereopod 3 merus lower margin unarmed; propodus 2.5 times as long as dactylus, with 7 transverse rows of 2 or 3 robust setae; dactylus with 2 longitudinal rows of robust setae. Pereopod 4 merus unarmed; propodus 2.1 times as long as dactylus, with 8 transverse rows of 1–4 robust setae; dactylus with 2 longitudinal rows of robust setae. Pereopod 5 propodus 2.2 times as long as dactylus, subchelate, with short fixed finger; dactylus with row of 6 robust setae.

Pleopod 1 a simple, setose article. Pleopods 2–5 each with appendix interna 0.25 length of endopod.

Telson 1.2 times as long as wide, lateral margin with 3 spines, distal margin convex, with posteromedian spine, posterolateral angle with 2 robust setae; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.5 times as long as wide, with 1 lateral spine and 1 distolateral spine, longitudinal ridge with 4–6 spines. Uropodal exopod 1.3 times as long as wide, with 4 lateral spines, 2 longitudinal ribs with 6 and 2 spines, posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 7–11 spines.

Male. Pereopods 1 significantly differentiated. Major pereopod 1 ischium lower margin with 1 spine; merus upper margin convex, with 2 spines, lower margin with 5 spines, last longest, lateral face smooth, mesial face smooth; carpus upper margin unarmed, lower margin unarmed; propodus upper margin tuberculate, lower margin smooth, lateral face with squamous tubercles concentrated on distal two-thirds (absent proximally and from fixed finger), mesial face with squamous tubercles concentrated on distal two-thirds (absent proximally and from fixed finger); fixed finger 0.6 length of upper palm, cutting edge with 1 blunt bicuspid tooth and 1 triangular tooth; dactylus upper margin smooth, lateral face smooth, mesial face smooth, cutting edge with blunt tooth at midpoint and notch proximally.

Minor pereopod 1 of similar length and ornamentation as major cheliped but narrower (85% of width) and merus upper margin unarmed.

Etymology. The species is named for the Nauo people of the southern part of the Eyre Peninsula, South Australia, close to the Sir Joseph Banks Group of islands (noun in apposition).

Distribution. SA, Sir Joseph Banks Group of islands; 5–6 m depth.

Remarks. *Michelaxiopsis nauo*, from South Australia, differs from *M. australiensis*, from NSW and Victoria, most obviously in having a setose carapace and abdomen. The submedian gastric carina is duplicated, both rows of tubercles continous and fading posteriorly. The anterior-most tubercles of the median gastric carina are decidedly more elevated than posterior ones. The lateral margin of the telson always has three teeth, absent in *M. australiensis*.

Oxyrhynchaxius Parisi, 1917

Remarks. *Oxyrhynchaxius* is characterised by elongate eyestalks, longer than the spike-like rostrum and a carapace covered with spinules (Lin et al., 2000). The Australian species is only the second known.

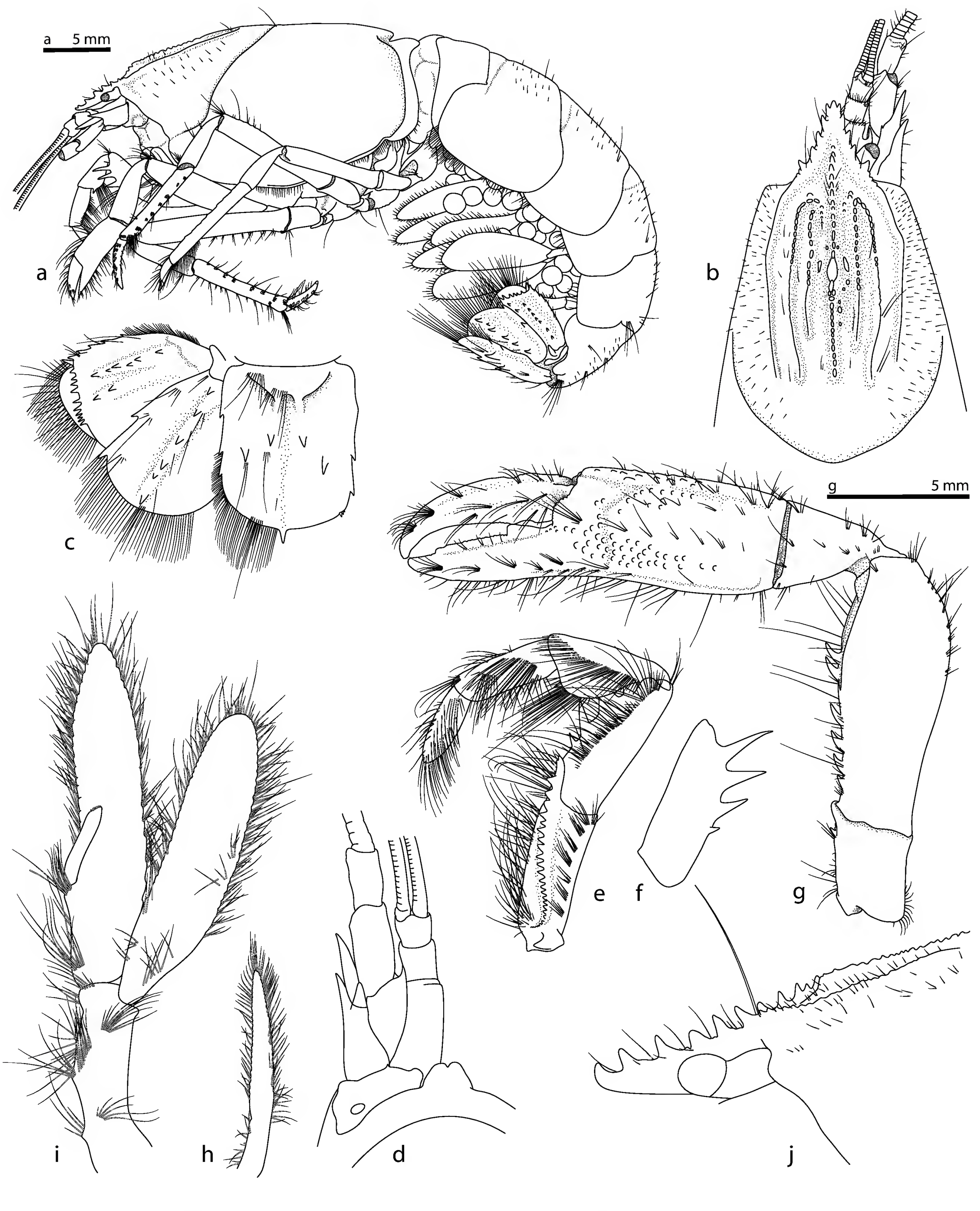

Figure 27. *Michelaxiopsis nauo* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and left uropod. d, epistome, right antennule and antenna (ventral). e, f, maxilliped 3. g, pereopod 1 (left, lateral). h, i, female pleopods 1, 2. j, lateral anterior carapace and rostrum. a–i from holtype; j from paratype male (SAM C6813).

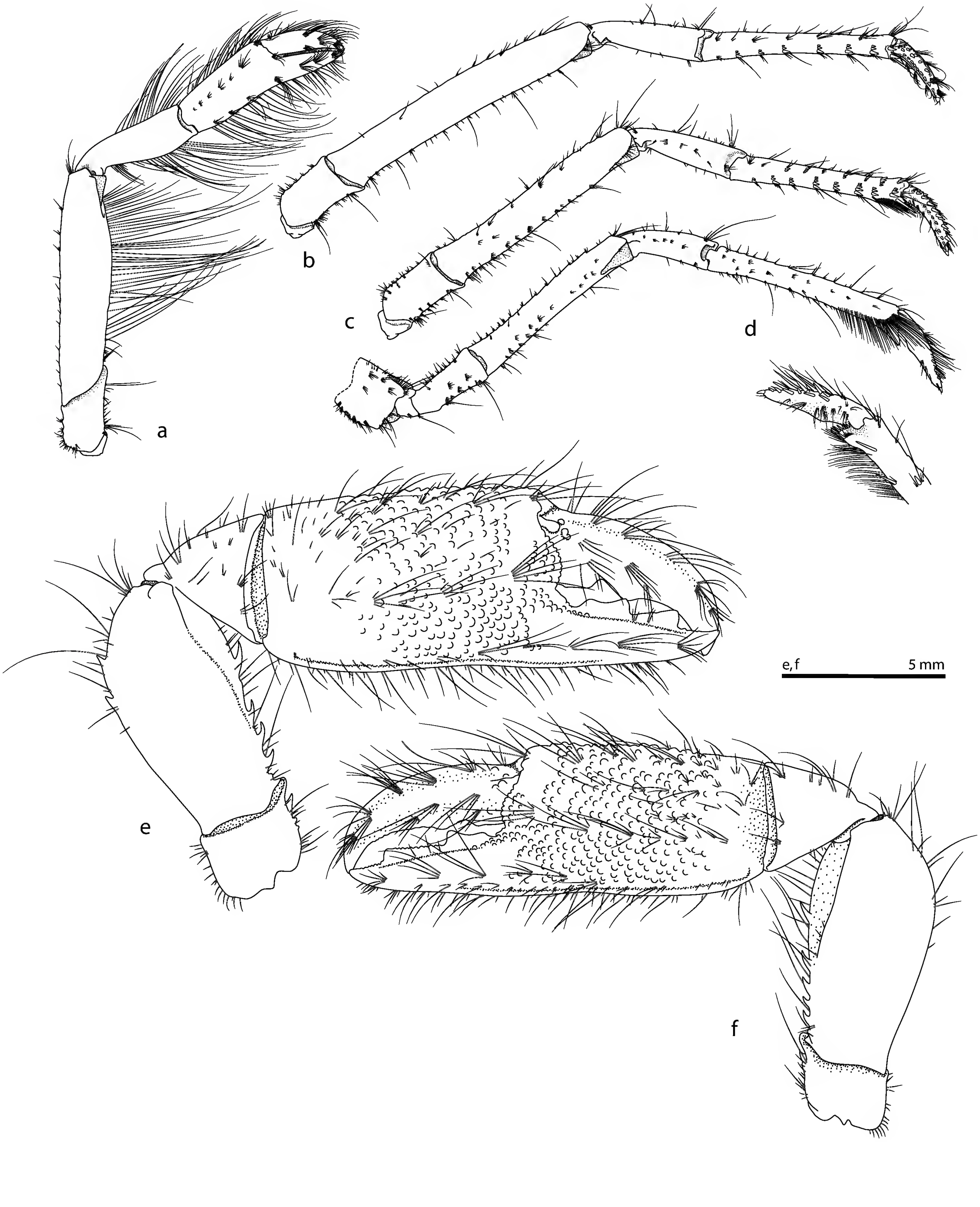

Figure 28. *Michelaxiopsis nauo* sp. nov. a–d, pereopods 2–f (with detail of dactylus of pereopod 5). e, major pereopod 1 (right, lateral). f, minor pereopod 1 (right, lateral). a–d from holotype; e, f from paratype male (SAM C6813).

Oxyrhynchaxius manningi Lin, Kensley and Chan, 2000

Oxyrhynchaxius manningi Lin et al., 2000: 203–205, figs. 3, 4.—Davie, 2002: 453.

Distribution. WA, North West Shelf, 134 m depth.

Remarks. The generic characters immediately identify the species in Australia.

Paraxiopsis De Man, 1905

Axiopsis (*Paraxiopsis*) De Man, 1905: 597.
Paraxiopsis.—Kensley, 1996a: 709–712.
Eutrichocheles.—Sakai and de Saint Laurent, 1989: 51 (part).

Diagnosis. Carapace and abdomen smooth or covered with numerous stiff setae; cervical groove visible laterally over half distance to anterolateral margin. Rostrum triangular, broad, laterally denticulate or unarmed, longer than eyestalks, slightly depressed below level of carapace, continuous with definite lateral carinae; supraocular spines barely differentiated from other spines; lateral carina spinose or smooth; submedian carina present, dentate or smooth; median carina smooth; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 broad, anteriorly rounded, posteriorly rounded; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite short, acute or asymmetrically bifid. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; carpus-dactylus upper margins smooth. Pereopods 3–4 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna absent. Pleopod 1 of male absent or minute article. Pleopod 2 of male without appendix interna, with appendix masculina. Uropodal exopod with transverse suture. Telson without lateral fixed spines and with posterolateral robust setae; apex rounded.

Remarks. The subgenus *Paraxiopsis* De Man, 1905 was synonymised with *Eutrichocheles* Wood-Mason, 1876 by Sakai and de Saint Laurent (1989) but later resurrected at full genus status (Kensley, 1996a). Kensley (2003) brought the number of species to fourteen. The two genera share several features, male pleopod 1 lacking or reduced, absence of appendix interna on pleopods 2–5, and similar gastric carinae. Kensley (1996a) listed several characteristics distinguishing *Paraxiopsis* from *Eutrichocheles*, notably the absence of a postcervical carina, absence of a gape and tubercle on fingers of the cheliped, presence of a spine and absence of a notch on the telson, and small size (maximum cl. 8 mm). His differentiation was accepted with minor discrepancies by Ngoc-Ho et al. (2005) who redescribed *E. modestus* Wood-Mason, 1876, type species of *Eutrichocheles*. Kensley (1996a) diagnosed *Paraxiopsis* as lacking male pleopod 1 but one male of *P. pumilus* displays minute digitiform male pleopods 1 (see fig. 30e) as in species of *Eutrichocheles* (Ngoc-Ho et al., 2005). The female pleopod 1 is typically a uniramous appendage but in *P. pauleyi* Kensley, 1996a, *P. majuro* Kensley, 1996a, *P. austrinus* (fig. 29b) and *P. pumilus* pleopod 1 is a minute conical articulating projection similar to that seen in some males. Kensley (1996a) noted the presence of an appendix masculina on the male pleopod 2 (in spite of few species of the genus actually being documented) and this is confirmed for *P. pumilus* below.

Paraxiopsis austrinus (Sakai, 1994)

Figure 29

Eutrichocheles austrinus Sakai, 1994: 185, figs. 6, 7.
Paraxiopsis austrinus.—Kensley, 2003: 373

Material examined. NT, Bullocky Point, Darwin, 12°26'S, 130°50'E, low water rocky outcrops with muddy pools, A.J. Bruce, 3 Dec 1982 (stn AJB-10), NTM Cr003173 (2 females, cl. 8.3 mm, 6.8 mm; juvenile, cl. 3.4 mm). NT, Shell Island, Darwin, 12°30'S, 130°45'E, reef pools, D. Sachs, 18 Mar 1988 (stn AJB-38), NTM Cr006384 (female, cl. 10 mm).

Distribution. NT, Darwin region, 12°S, 130°E, low intertidal.

Remarks. Kensley (2003) differentiated this species from nine other species of *Paraxiopsis*. It is recognisable by the presence of a tomentum of long and short setae over much of the body and limbs. The rostrum has three close-set spines on the lateral margins running towards three more on the lateral gastric carina. The submedian gastric carinae each has usually six spines but in the female illustrated here there are eight on one side only. Sakai based his species on two females only. One of the females in the new collection, with gonopores on coxae 3, has a minute pair of pleopods 1 while the others do not.

Paraxiopsis brocki (De Man, 1888)

Restricted synonymy.

Axius Brocki De Man, 1888: 475, pl. 20 fig. 3.
Axiopsis (Paraxiopsis) brocki.—De Man, 1925b: 101, pl. 8 figs. 19–19f.—Poore and Griffin, 1979: 228, fig. 3.—Tirmizi, 1983: 88, fig. 3.—Morgan, 1990: 6, 63.
Eutrichocheles brocki.—Sakai and de Saint Laurent, 1989: 52, fig. 4B.—Ngoc-Ho, 1998: 365, fig. 1.
Paraxiopsis brocki.—Kensley, 1996a: 712, figs. 1, 2.—Poore, 2004: 176, figs. 45g, h, 46d.—Ngoc-Ho et al., 2005: 200.

Material examined. WA, near Mermaid Reef, 17°46.10'S, 120°43.15'E–17°45.95'S, 120°42.94'E (stn SS05-2007 097), 97–109 m, 20 Jun 2007, NMV J155708 (ovigerous female lacking most pereopods, cl. 6 mm).

Distribution. Indo-West Pacific from Japan and Hawaii in north, Tuamotu in east, through Indonesia, to southwestern Australia, and to Kenya; to 100 m depth.

Remarks. Paraxiopsis brocki has been redescribed and illustrated several times recently. It has been recorded from WA and NT in Australia by Poore and Griffin (1979) and Morgan (1990). The new specimen has prominent rostral spines like that figured by Poore and Griffin (1979), more prominent than on the specimen from Tuamotu figured by Ngoc-Ho (1998). The female has prominent uniramous first pleopods.

Paraxiopsis pumilus (Sakai, 1994)

Figures 30, 31, 44

Eutrichocheles pumilus Sakai, 1994: 188–192, figs. 8, 9.

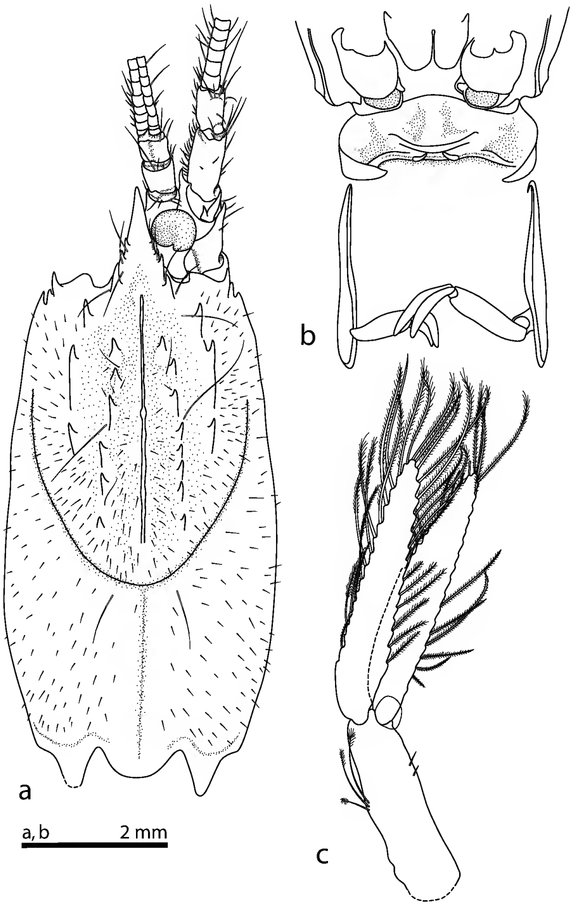

Figure 29. *Paraxiopsis austrinus* (Sakai, 1994). a, dorsal view of carapace, peduncles of antennule and antenna. b, thoracic sternites 7 and 8, abdominal sternites 1 and 2 showing pleopods 1, 2. c, pleopod 2. All figures from female, cl. 8.3 mm, NTM Cr003173.

Paraxiopsis pumilus.—Kensley, 2003: 373
Paraxiopsis dianae Poore, 2008: 165–168: fig. 2. (**syn. nov.**)

Material examined. WA, off Barrow I., 20°59.05'S, 114°54.25'E–20°59.40'S, 114°54.32'E (stn SS10-2005 170), 101–100 m, 13 Dec 2005, NMV J53449 (male, cl. 8.3 mm, tl. 21.5 mm). WA, Bonaparte Archipelago, Port George IV (15°23.474'S, 124°37.793'E), 10–16 m, 8 Oct 2007, J. James (stn P23), NMV J59647 (4 juvenile females, cl. 4.8–6.0 mm; female, cl. 7.3 mm)

NT. W side of Barrow Bay, Port Essington (11°22.0'S, 132°12.0'E), low water, J.R.Hanley, 18 Sep 1985 (stn CPV8), NTM Cr013204 (1 female), NTM Cr013205 (1 female). Arafura Sea, 09°36.63'S, 134°10.95'E–09°36.59'S, 134°10.87'E (stn SS05-2005 BS014), 95 m, 25 May 2005, AM P74506 (1 juvenile).

Distribution. NT, Cobourg Penisula, Arafura Sea; WA, Barrow Island—Dampier Archipelago, c. 9°–21°S, 115°–132°E, 6–100 m depth.

Remarks. The species is distinguished from other species of *Paraxiopsis* by the possession (in adults) of two pairs of spines at the base of the tapering rostrum and none on the submedian gastric carina (Kensley, 2003). Poore (2008) compared his new species, *Paraxiopsis dianae*, with several descriptions of the similar species, *P. brocki* De Man, 1888, and concluded that probably more than one species over a wide geographical range had been referred to the latter name. He did not compare it with *P. pumilus* (Sakai, 1994), described as a species of *Eutrichocheles*, from the Northern Territory and north-western WA. For this paper, topotypic material was compared with the WA material. Sakai figured the tail fan, gastric region and rostrum of two individuals of *P. pumilus*. The number of lateral spines on the rostrum differed between these two and between individuals in the new collections from WA and NT. On small individuals lateral spines are absent, in others there is one spine on one or both sides, in addition to the supraocular spine (fig. 31). The two individuals of *P. dianae* fall within this range of variability and the species must be synonymised with *P. pumilus*.

Most species of *Paraxiopsis* and *Eutrichocheles* possess a bifid scaphocerite and illustrations of type material of both *Paraxiopsis pumilus* and *P. dianae* show this. Some specimens possess a simple comma-shaped scaphocerite on both antennae, a difference we do not consider of specific importance (cf. figs. 30b, 31g, h). *Paraxiopsis johnstoni* Edmondson, 1925 from Hawaii was also illustrated with a simple scaphocerite but has a different carapace.

Type material of the two nominal Australian species was collected at 6–40 depth; the new specimen is from 100 m depth but at a similar latitude.

Pilbaraxius gen. nov.

Type species. *Pilbaraxius kariyarra* sp. nov., herein designated.

Diagnosis. Carapace smooth or tuberculate; cervical groove visible laterally over third distance to anterolateral margin. Rostrum acutely triangular, with pair of lateral spines, longer than eyestalks, not depressed below level of carapace, continuous with definite lateral carinae; supraocular spines prominent; lateral carina with 1 spine; submedian carina present, with 1 spine; median carina a weak ridge, unarmed; postcervical carina absent. Abdominal somite 1 pleuron acute; pleuron 2 acute, pleura 3–5 acute, with anteroventral tooth. Eyestalk cylindrical, articulating; cornea weakly pigmented. Antenna, scaphocerite long. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs present above pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 slightly asymmetrical, with propodus flattened; carpus-propodus upper margin unarmed, sparsely setose. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli tapering, with longitudinal row of robust setae. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male without appendix masculina. Uropodal endopod without lateral and distolateral spines; exopod with transverse suture. Telson with lateral fixed spines and posterolateral robust setae; apex rounded.

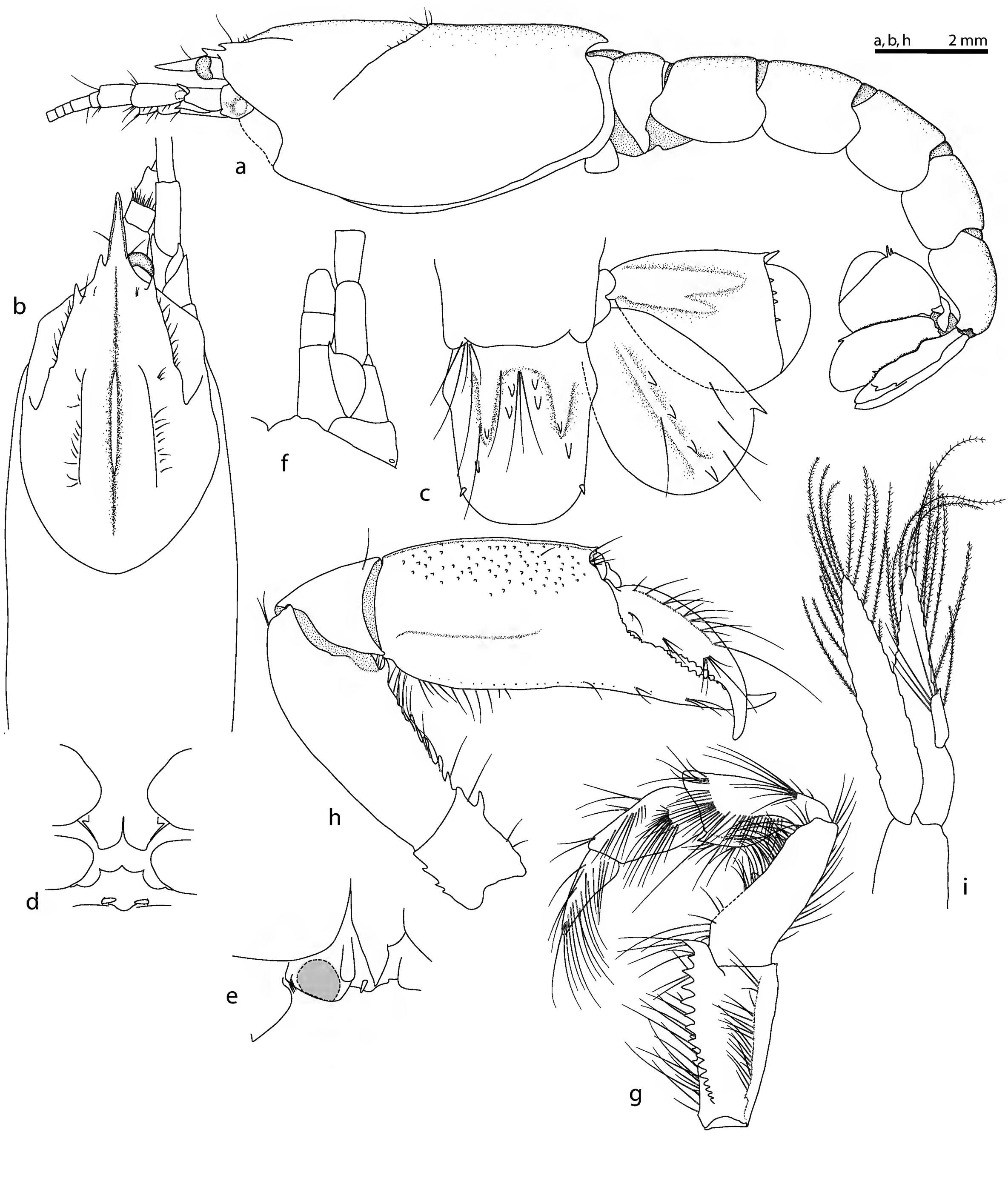

Figure 30. *Paraxiopsis pumilus* (Sakai, 1994). a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, thoracic sternites 7 and 8, abdominal somite 1 with pleopods 1. e, left thoracic sternites 7 and 8, abdominal somite 1 with pleopod 1 (lateral). f, epistome, left antennule and antenna (ventral). g, maxilliped 3. h, major pereopod 1 (right, lateral). i, male pleopod 2. All figures from male, cl. 8.3 mm, NMV J53449.

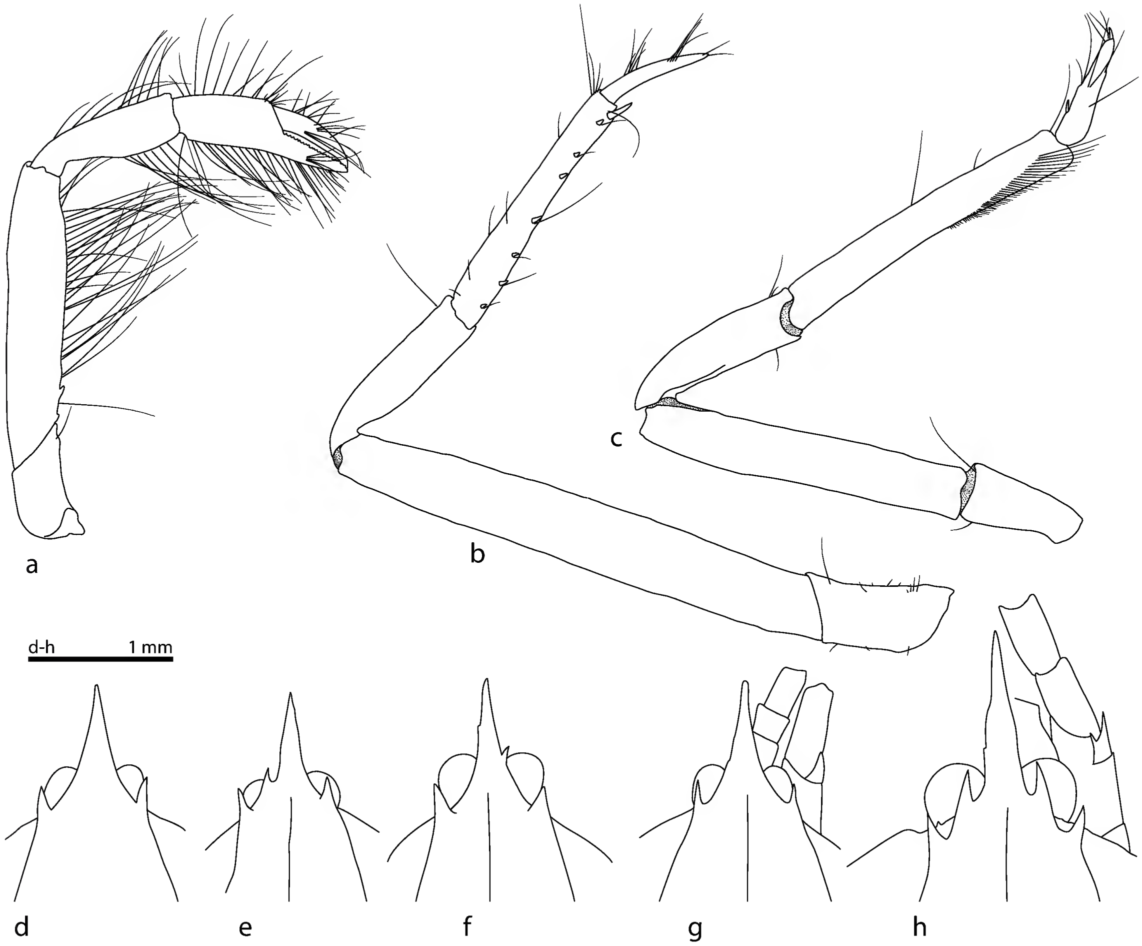

Figure 31. *Paraxiopsis pumilus* (Sakai, 1994). a–c, pereopods 2–4. d–h, anterior carapace, peduncles of antennule and antenna and rostrum of five individuals, cl. 4.8, 4.8, 5.2, 6.0, 7.3 mm. Figs a–c from male, cl. 8.3 mm, NMV J53449; figs. d–e from male, 7.3 mm, NMV J59647.

Etymology. Pilbara is the name of the region of North-western Australia close to the type locality of the type species.

Remarks. The problematic generic placement of the type species highlights issues with the family Axiidae. The spinose rostrum, diverging palm and long fingers on the chelipeds and abdominal pleura with prominent ventral spination closely resemble those of *Calaxiopsis serrata* Sakai and de Saint Laurent, 1989, a species belong to the "calocaridid" group. The new species differs from all in this group in possessing pleurobranchs and lacking the modified pleopods 1 and 2. The new species also resembles species of *Calaxius* but these usually have highly setose chelipeds and rows of prominent spines on the upper margin of the chelipeds (as in *C. acutirostris* redescribed above). Neither of these conditions characterises the new species. In addition, the uropodal endopod is apically rounded and lacking lateral and distolateral spines typical of *Calaxius* and many other axiid genera. Further, pleopod 2 lacks an appendix masculina, a state seen in few axiids. In summary, a new genus seems warranted.

Pilbaraxius kariyarra sp. nov.

Calaxiopsis sp.—Robles et al., 2009: 314, 316 (molecular phylogeny, GenBank numbers).

Figures 32, 33, 45

Material examined. Holotype. WA, off Port Hedland, 18°34.19'S, 117°27.86'E–18°34.06'S, 117°28.63'E (stn SS05-2007 052), 405–401 m, 14 Jun 2007, NMV J55576 (male, cl. 6.8, tl. 15.7 mm).

Description of male holotype. Carapace covered in small tubercles. Rostrum 0.4 times length of front-to-cervical groove, acute, elongate, with 1 long lateral spine anterior to

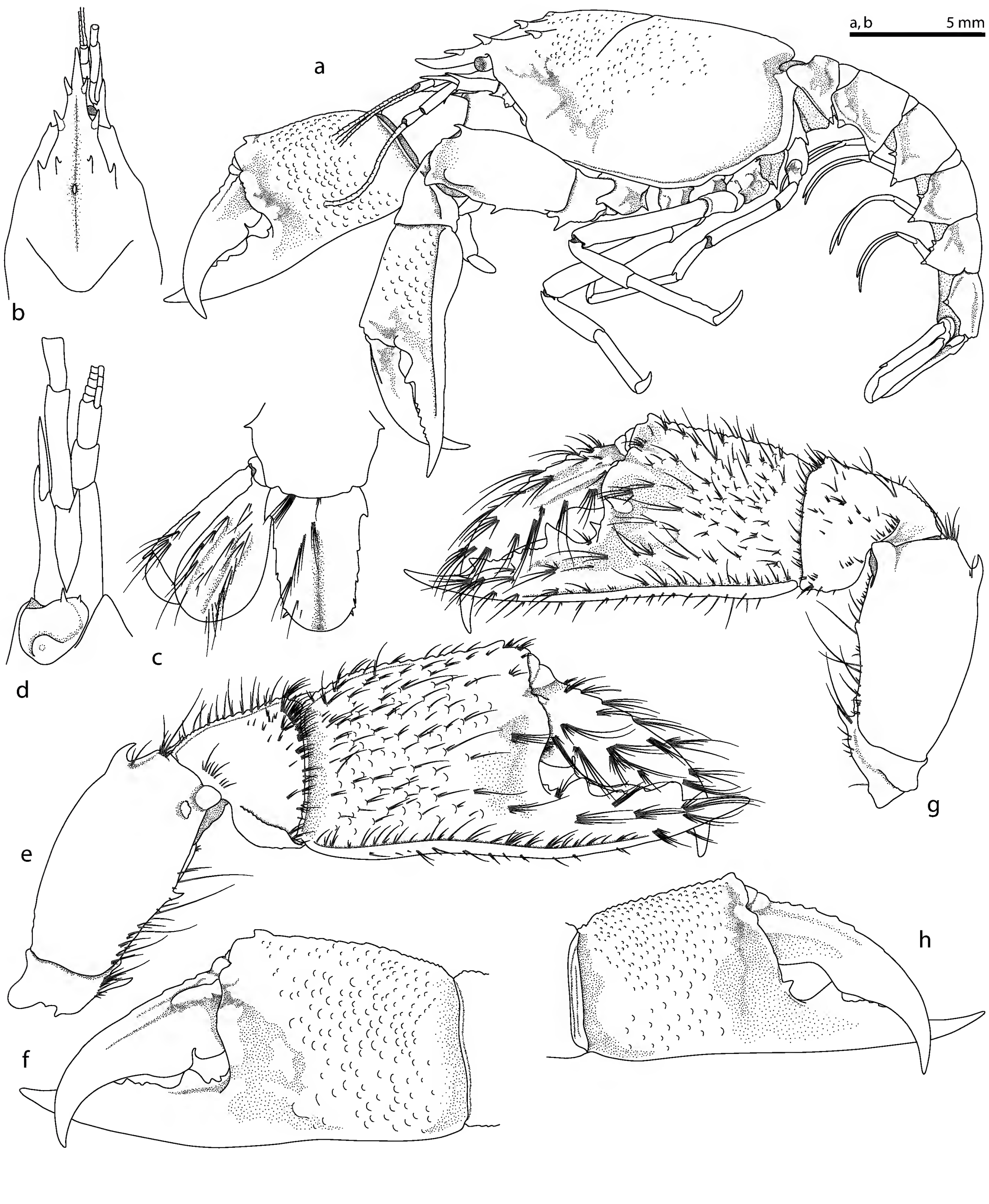

Figure 32. *Pilbaraxius kariyarra* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and left uropod. d, epistome, left antennule and antenna (ventral). e, major pereopod 1 (right, lateral). f, same (propodus–dactylus, mesial, setae not shown). g, minor pereopod 1 (left, lateral). h, same (propodus–dactylus, mesial, setae not shown). All figures from holotype.

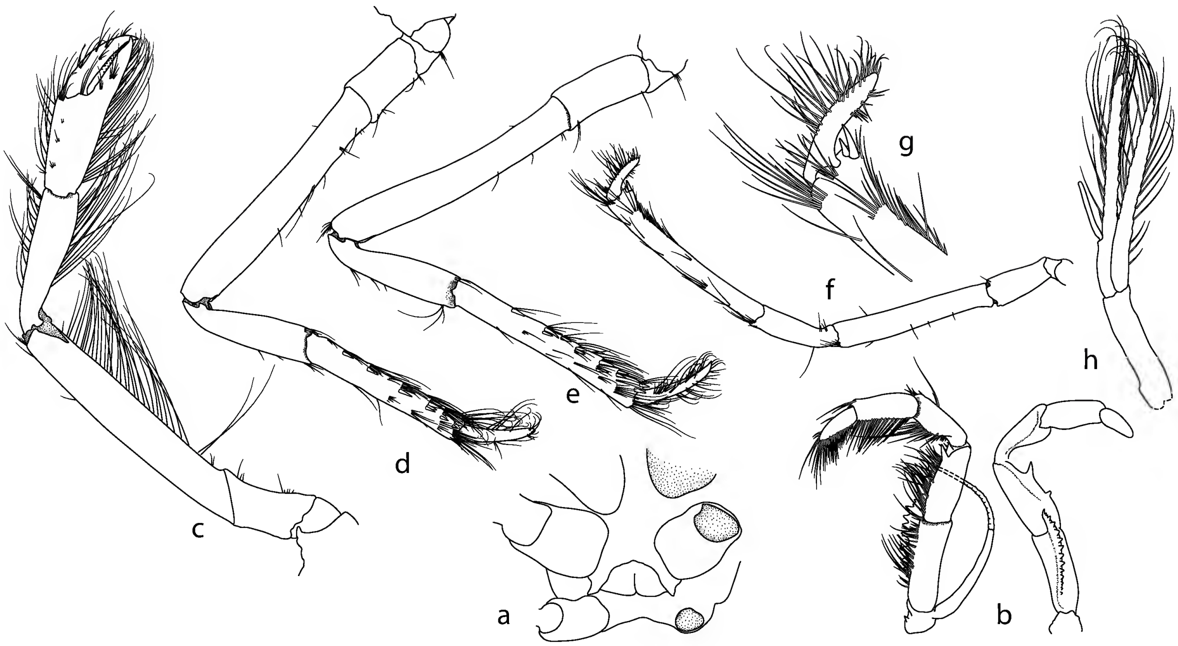

Figure 33. *Pilbaraxius kariyarra* sp. nov. a, thoracic sternites 7 and 8. b, maxilliped 3. c–f, pereopods 2–5 (c, f right; d, e left). g, pereopod 5 distal propodus and dactylus. h, female pleopod 2. All figures from holotype.

supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina with 1 spine. Submedian gastric carina with 1 spine. Median gastric carina present as a ridge extending anteriorly onto rostrum, with 1 tubercle located midway between rostrum and cervical groove. Postcervical carina on carapace absent. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with oblique lateral ridge ending in sharp spine. Sternite 8 (pereopod 5) with setose semicircular flap on anterior face at base of leg. Abdominal pleuron 1, 2.6 times as deep as middorsal length, with small ventral spine; pleuron 2 asymmetrical, lateral length 1.3 times dorsal length, concave ventrally, with 2 distinct ventral spines; pleura 3 and 4 tapering to a ventral spine, with another spine located anteroventrally; pleuron 5 tapering to a ventral spine, with another 2 spines located anteroventrally; pleuron 6 with 1 ventral spine.

Eyestalk 0.25 length of rostrum; cornea weakly pigmented. Antennular peduncle reaching to end of article 4 of antenna. Antennal article 1 with 2 small spines on distal margin; article 2 distal spine straight, approximately half length of article 2; scaphocerite simple, straight, reaching distally almost to end of article 4; article 3 with 1 spine on lower margin; article 4 about as long as article 2 (excluding distal spine); article 5 about half as long as article 4. Maxilliped 3 basis with 1 spine; crista dentata with 15 teeth; merus with 2 spines on lower margin (1 large, 1 small); carpus unarmed.

Pereopods 1 differentiated, propodus of major cheliped longer and more swollen than minor. Major pereopod 1 (right) coxa lower margin with 1 spine; basis lower margin unarmed; ischium lower margin with 1 spine; merus upper margin convex, with 1 hooked spine, lower margin with 1 spine and obsolete tubercle laterally, lateral face with broad tubercle distally, mesial face smooth; carpus upper margin tuberculate, lower margin unarmed, lateral face tuberculate, mesial face smooth; propodus upper margin with 1 distal spine, lower margin with low lateral carina, lateral face tuberculate, mesial face smooth; fixed finger 1.2 times length of upper palm, cutting edge with 4 large irregular rounded teeth; dactylus upper margin smooth, lateral face smooth, mesial face smooth, cutting edge with narrow proximal notch.

Minor pereopod 1 coxa, ischium, merus and carpus as in larger cheliped; propodus similar except mesial face with spine near gape; fixed finger about as long as upper palm, cutting edge with 2 large triangular teeth and smaller intermediate denticles; dactylus cutting edge excavate proximally.

Pereopod 2 unarmed; carpus slightly shorter than chela; propodus upper margin as long as dactylus. Pereopod 3 unarmed; propodus 2.2 times as long as dactylus, with 6 marginal robust setae (some duplicated). Pereopod 4 unarmed; propodus 2.2 times as long as dactylus, with 7 marginal robust setae (some duplicated). Pereopod 5 propodus 3.9 times as long as dactylus, subchelate, with short fixed finger bearing 5 distinct robust setae; dactylus slightly flattened.

Pleurobranchs present above pereopods 2–4; arthrobranchs on maxilliped 2 (rudimentary) to pereopod 4; epipods with well developed podobranchs (with up to 10 gill filaments) on maxilliped 2 to pereopod 3

Pleopod 1 absent. Pleopod 2 appendix masculina absent; appendix interna slender, about quarter length of endopod.

Telson 1.3 times as long as broad, lateral margin with 4 spines, distal margin convex without posteromedian spine, posterolateral angle with 1 robust seta; dorsal face without spines on each oblique row. Uropodal endopod 1.9 times as long as wide, without lateral spines, longitudinal ridge unarmed. Uropodal exopod 1.9 times as long as wide, without lateral spines, longitudinal ribs unarmed, posterolateral angle with 1 robust seta; transverse suture unarmed.

Etymology. Kariyarra is the name of the Australian Aboriginal people inhabiting the coast close to the type locality (noun in apposition).

Distribution. WA, off Port Hedland, 18°S, 118°E, c. 400 m depth (known only from type locality).

Remarks. See the discussion for the genus *Pilbaraxius*. Unfortunately, the species was placed in a molecular analysis as *Calaxiopsis* sp. by Robles et al. (2009).

Planaxius Komai and Tachikawa, 2008

Planaxius Komai and Tachikawa, 2008: 22–24.

Remarks. *Planaxius* is recognised by the combination of the absence of submedian gastric carinae, uropodal exopod with a transverse suture, pereopodal epipods present, three pairs of pleurobranchs, toothed triangular rostrum, male pleopods 1 and 2 present and pleopods 3–5 with an appendix interna. It is the absence of submedian gastric carinae and presence of appendices internae that distinguishes the genus from *Bouvieraxius* whose species have five gastric carinae and lack appendices internae (Komai and Tachikawa, 2008). These authors described the type and only species as lacking a median gastric carina. The single individual from Australia referred to this species below has a definite median gastric carina at the base of the rostrum extending as far back as the lateral gastric carinae.

Planaxius brevifrons Komai and Tachikawa, 2008

Planaxius brevifrons Komai and Tachikawa, 2008: 24–29, figs. 2–6.

Figures 34, 46

Material examined. WA, off Jurien Bay, 29°48.33'S, 114°25.52'E–29°48.33'S, 114°25.55'E (stn SS10-2005 083), 113–114 m, 02 Dec 2005, NMV J55445 (male, cl. 3.3 mm, tl. 9.5 mm, without pereopods 3–5).

Description of male. Carapace smooth, cervical groove short. Rostrum 0.3 times length of front-to-cervical groove, triangular, with 2 or 3 short oblique lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines prominent. Lateral gastric carina unarmed. Submedian gastric carina absent. Median gastric carina low, sharp, unarmed. Branchiostegal angle produced, lobe-like, with 2 minute marginal teeth. Sternite 8 (pereopod 5) with setal ridge on anterior face at base of leg. Abdominal pleuron 1, 3 times as deep as middorsal length, ventrally acute; pleuron 2 broad, lateral length 1.8 times dorsal length, anteroventrally rounded; pleura 3–5 becoming more posteroventrally square, each with anteroventral tooth; pleuron 6 with small tooth on ventral margin.

Eyestalk 0.5 length of rostrum; cornea pigmented. Antennular peduncle reaching to proximal part of antennal article 5. Antennal article 1 with 2 spinules on lower distal margin; article 2 distal spine slender, directed slightly inwards, reaching distally one third of antennal article 4; scaphocerite slender, straight, reaching distally two-thirds of article 4; article 3 with 1 spine on mesial lower margin; article 4 about 1.3 times length of article 2 (excluding distal spine), article 5 about one-third length of article 4. Maxilliped 3 basis with 1 spine; ischium with 3 spines on lower margin; crista dentata with 13 teeth; merus with 4 spines on lower margin; carpus with 1 spine.

Pereopods 1 asymmetrical, propodus of major longer, more swollen. Major pereopod 1 (right) coxa lower margin with 1 spine; basis lower margin unarmed; ischium lower margin with 3 spines; merus upper margin convex, with 2 spines, lower margin with 6 spines, lateral face smooth, mesial face smooth; carpus unarmed, smooth; propodus upper margin carinate, with small distal spine, lower margin smooth, lateral face smooth, mesial face smooth; fixed finger half length of upper palm, cutting edge unevenly denticulate; dactylus smooth, cutting edge as in fixed finger.

Minor pereopod 1 coxa as in larger cheliped; ischium lower margin with 1 spine; merus upper margin convex, with 2 spines, lower margin with 6 spines, lateral face smooth, mesial face smooth; carpus unarmed, smooth; propodus upper margin carinate, with small distal spine, lower margin smooth, lateral face smooth, mesial face smooth; fixed finger as long as upper palm, cutting edge unevenly denticulate; dactylus smooth, cutting edge scarcely denticulate.

Pereopod 2 ischium lower margin unarmed; merus lower margin unarmed; carpus as long as chela; propodus upper margin 0.8 length of dactylus. Pereopods 3–5 missing.

Pleopod 1 of 2 fused articles; article 2 blade-like, apex unevely bilobed, appendix interna represented by few hooks. Pleopod 2 with appendix masculina as long as remaining endpod; appendix interna third length of endopod, 0.6 length of appendix masculina. Pleopods 2–5 appendix interna one third length of endopod.

Telson 1.5 times as long as wide, lateral margin with 3 spines, distal margin convex without posteromedian spine, posterolateral angle with 2 robust setae, one much larger; dorsal face with 2 small spines in each oblique row. Uropodal endopod 1.8 times as long as wide, with 1 lateral spine, longitudinal ridge with 4 spines (including marginal). Uropodal exopod 1.6 times as long as wide, with 4 lateral spines, 2 longitudinal ribs (outer rib with 2 spines), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture with 4 spines.

Distribution. Japan, Kii Peninsula, Ogasawara Is, 47–100 m; WA, south-western coast, 114 m depth.

Remarks. The single male is virtually indistinguisable from slightly larger specimens reported from Japan by Komai and

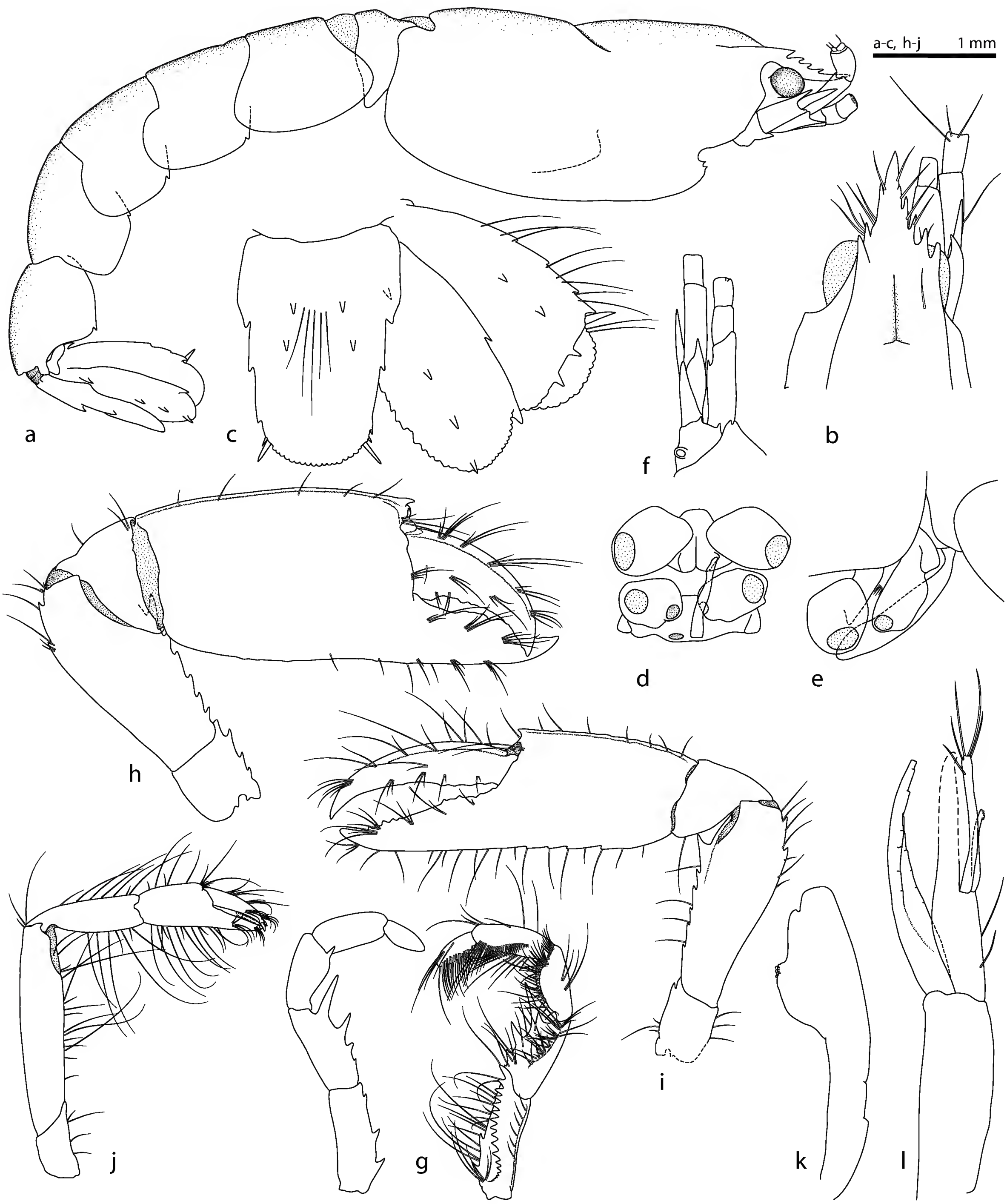

Figure 34. *Planaxius brevifrons* Komai and Tachikawa, 2008. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, telson and right uropod. d, sternites 7 and 8, pleonite 1 with left pleopod 1 in situ. e, sternites 7 and 8, pleonite 1 with left pleopod 1 in situ (lateral). f, epistome, right antennule and antenna (ventral). g, maxilliped 3. h, major pereopod 1 (right, lateral). i, minor pereopod 1 (left). j, pereopod 2. k, l, male pleopods 1, 2. All figures from NMV J55445.

Tachikawa (2008). Dr Komai kindly re-examined the type material at our request and confirmed the presence of a median gastric carina, more clear and sharp in the paratypes than in the illustrated holotype, as in the WA specimen. While the ischium of maxilliped 3 of the Australian specimen has blunt teeth along the lower margin some of the Japanese specimens have one or two minute spinules obscured by stiff setae. Dr Komai confirmed that the two minute teeth on the anterior branchiostegal lobe of the Australian specimen are absent in the Japanese material. The uropodal endopod of the holotype lacks the lateral and distolateral spines seen in the Australian specimen. While we have only one specimen, none of these differences argues strongly for a separate species but the record is a considerable range extension.

Platyaxius Sakai, 1994

Platyaxius Sakai, 1994: 180–181.

Diagnosis. Carapace smooth, with scattered long setae; cervical groove visible laterally over half or more of distance to anterolateral margin. Rostrum triangular, broad, laterally weakly dentate, as long as or slightly longer than eyestalks, slightly depressed below level of carapace, continuous with definite lateral carinae; supraocular spines absent; lateral carina weakly dentate or unarmed; submedian carina dentate; median carina, dentate; postcervical carina absent. Abdominal somite 1 pleuron triangular; pleuron 2 posteriorly rectangular; pleura 3–5 posteriorly rounded. Eyestalk cylindrical, articulating; cornea pigmented. Antenna, scaphocerite short. Maxilliped 3 exopod not clearly bent at base of flagellum. Pleurobranchs absent above pereopods 2–4; podobranchs and arthrobranchs well developed; epipods present on maxilliped 2 to pereopod 4. Pereopods 1 asymmetrical, with propodus cylindrical; carpus-dactylus upper and lower margins smooth, propodus with obsolete distal tooth on upper margin. Pereopods 3–5 propodi with transverse rows of robust setae; dactyli 3 and 4 triangular, with scattered robust setae; dactylus 5 spatulate, with row of robust setae along oblique margin. Pleopods 3–5, appendix interna present. Pleopod 1 of male absent. Pleopod 2 of male with appendix interna and appendix masculina. Uropodal exopod without transverse suture. Telson with lateral teeth, with posterolateral robust setae; apex deeply rounded and continuous with lateral margins.

Remarks. The type species, *Platyaxius brevirostris* Sakai, 1994 from the Australian North West Shelf, is recognised by the absence of a suture on the uropodal exopod, absence of the male pleopod 1 and lateral teeth on the rostrum. Sakai compared his new genus to species of *Eiconaxius* Bate, 1888 (see Sakai, 1992 for descriptions of five species) and the two genera share similar uropods, pleopods, swollen chelipeds and a rounded telson, differing largely in the dentition of the rostrum. The dactyli of pereopods 3–5 of species of *Eiconaxius* are spatulate, non-tapering and with a row of robust setae on the oblique distal margin. See, for example, *E. farreae* Ortmann, 1891 figured by Sakai and Ohta (2005) and *E. mallacoota* sp. nov. (fig. 24). The same unusual form is seen only on pereopod 5 of the new species described here; dactyli of pereopods 3 and 4 are tapering with several facial robust setae. Sakai (1994) illustrated only pereopod 3 of *P. brevirostris* and did not mention pleurobranchs in his diagnosis. The new species described below differs from all species of *Eiconaxius* in lacking pleurobranchs above pereopods 2–4.

Axius odontorhynchus De Man, 1905 was included in *Spongiaxius* by Sakai and de Saint Laurent (1989) but is better placed in *Platyaxius*. It too has denticulate rostrum margins, swollen chelipeds and non-tapering dactylus only on pereopod 5 (De Man, 1925b: pl. 1 figs. 1l, m).

Sakai and Ohta (2005) removed *Eiconaxius* from Axiidae and placed it in its own family, Eiconaxiidae, on the basis of 'P3–5 dactyli … rounded in shape … and their ventral margins spinulate …' and other features that are shared with one or more other axiid genera. *Eiconaxius and Platyaxius* are clearly related but whether or not they belong in a clade separate from another containing all other axiids remains to be investigated.

Platyaxius bardi sp. nov.

Figures 35, 36, 47

Material examined. Holotype. WA, near Mermaid Reef, 17°29.23'S, 120°27.64'E–17°29.72'S, 120°28.07'E (stn SS05-2007 091), 187–184 m, 20 Jun 2007, NMV J55707 (male, cl. 5.9 mm, tl. 17.2 mm).

Paratypes. WA, North-west Shelf, between Port Hedland and Dampier, 18°36'S, 118°02'E–18°39'S, 118°04'E (stn NWA-24), 184 m, 06 Jun 1983, NMV J15420 (2 ovigerous females, cl. 5.7 mm).

Description of male holotype. Carapace smooth. Rostrum 0.3 times length of front-to-cervical groove, narrowly triangular, with 4 weak lateral spines anterior to supraocular spine, continuous with definite lateral gastric carinae. Supraocular spines similar size to other rostrum spines. Lateral gastric carina with 2 prominent spines in addition to supraocular spine. Submedian gastric carina with 4 spines. Median gastric carina with 6 spines. Sternite 7 (pereopod 4) deeply divided in midline over posterior two-thirds and with sharp oblique lateral ridge. Sternite 8 (pereopod 5) with setose semicircular flap on anterior face at base of leg. Abdominal pleuron 1, 2.6 times as deep as middorsal length, ventrally acute; pleuron 2 asymmetrical, lateral length 1.2 times dorsal length, posteroventrally quadrate; pleura 3–5 posteroventrally angled, each with small anteroventral spine; pleuron 6 with small spine on ventral margin.

Eyestalk 0.8 length of rostrum; cornea pigmented. Antennular peduncle reaching to distal part of antennal article 4. Antennal article 1 with 2 spinules on lower distal margin; article 2 distal spine well developed, reaching to proximal part of antennal article 5; scaphocerite strongly curved downwards, reaching distally almost to end of article 4; article 3 with spine on lower margin; article 4 approximately as long as article 2 (excluding distal spine); article 5 about two-thirds length of article 4. Maxilliped 3 basis with 1 spine; ischium with 1 spine on lower margin; crista dentata with numerous small, even teeth; merus with 3 spines on lower margin; carpus unarmed.

Pereopods 1 differentiated, propodus of major cheliped longer and more swollen than minor. Major pereopod 1 (left) coxa lower margin with 1 spine; basis lower margin unarmed;

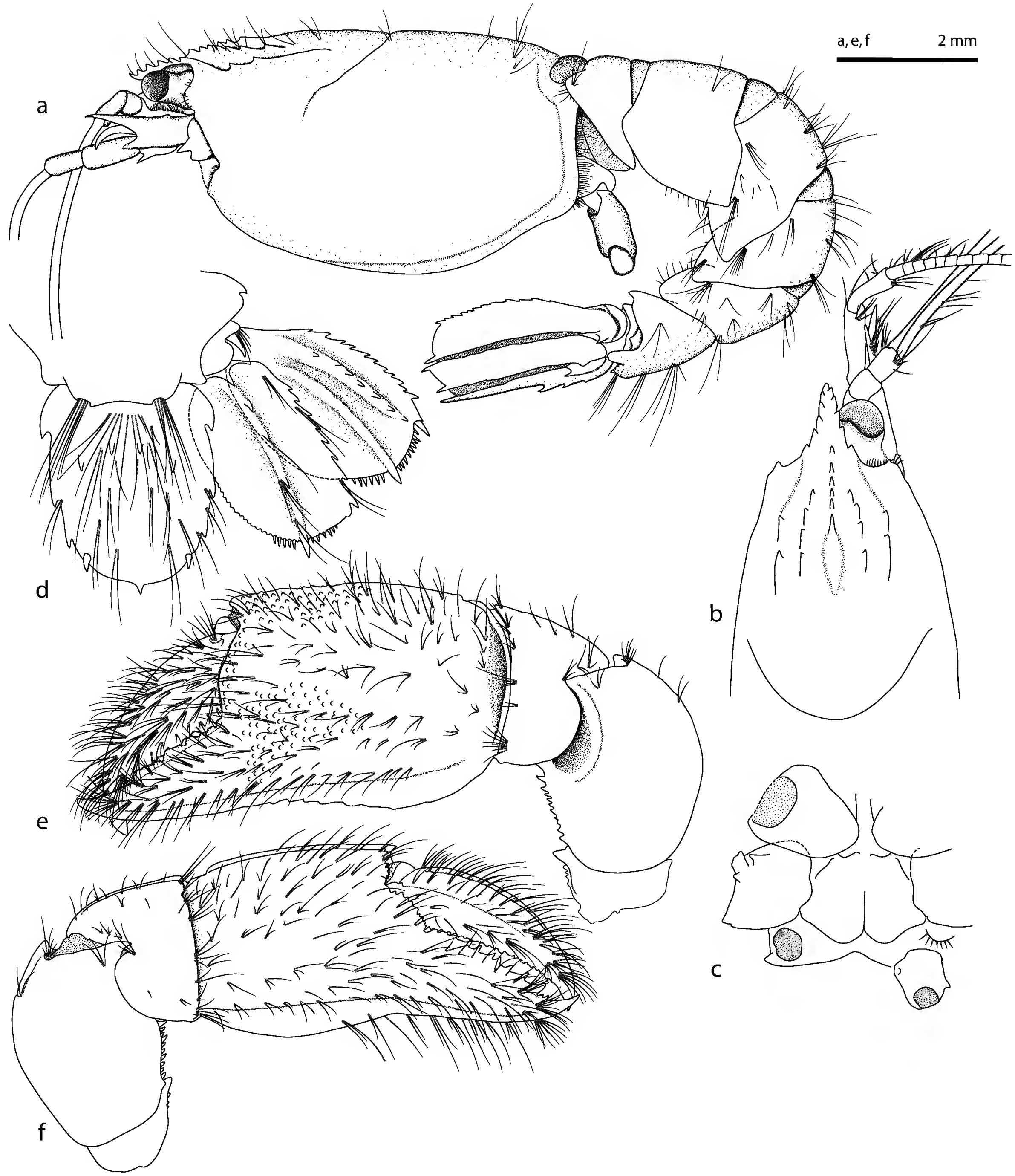

Figure 35. *Platyaxius bardi* sp. nov. a, lateral view. b, dorsal view of carapace, peduncles of antennule and antenna. c, thoracic sternites 6–8. d, telson and right uropod. e, major pereopod 1 (left, lateral). f, minor pereopod 1 (right, lateral). All figures from holotype.

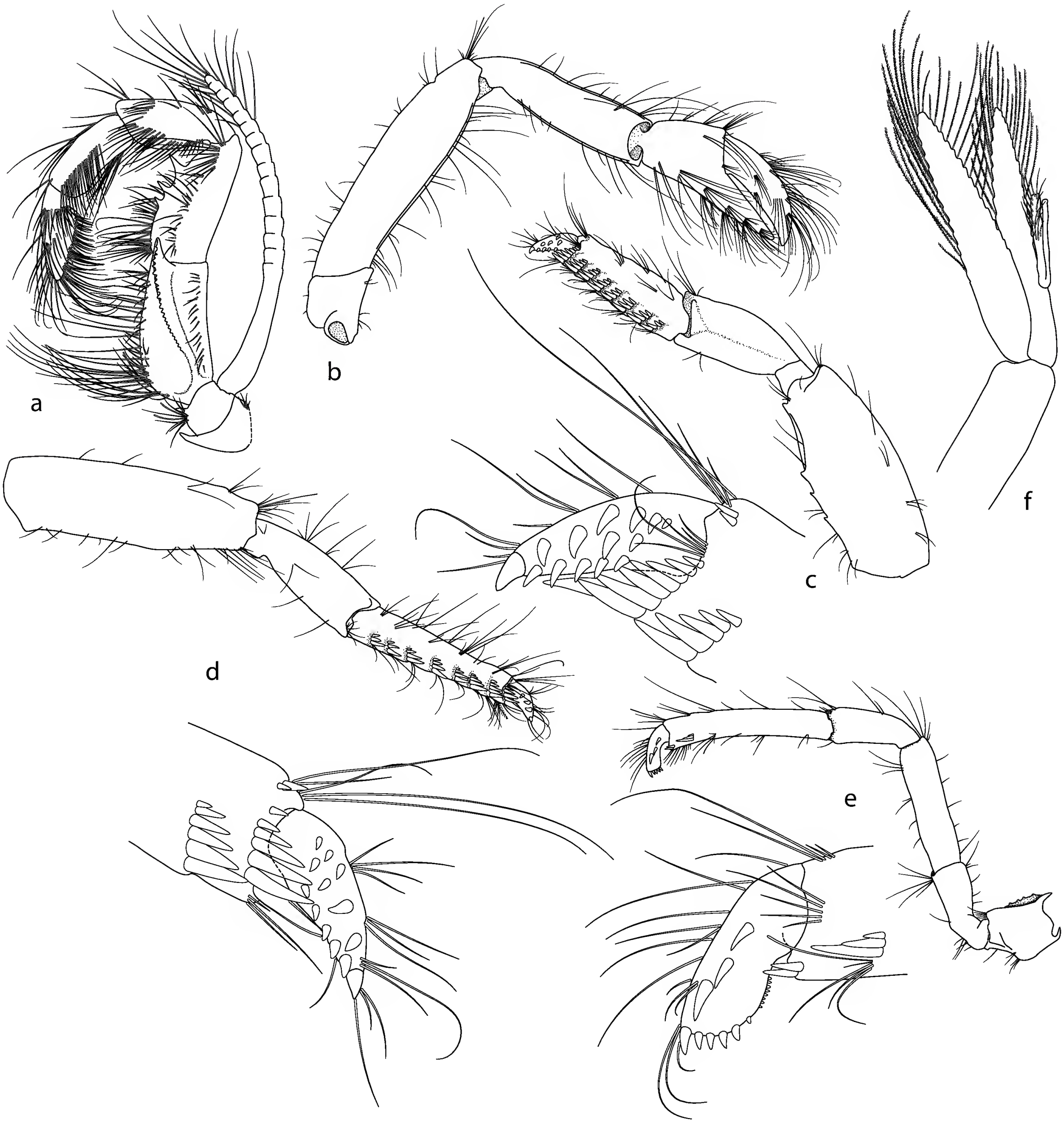

Figure 36. *Platyaxius bardi* sp. nov. a, maxilliped 3. b–e, pereopods 2–5 (b, e right; c, d left; each with details of dactylus). f, male pleopod 2. All figures from holotype.

ischium lower margin with 4 small spines and 1 larger; merus upper margin strongly convex, unarmed, lower margin with 10 teeth, lateral face smooth, mesial face smooth; carpus upper margin carinate, lower margin unarmed, lateral face smooth, mesial face smooth; propodus upper margin carinate, with blunt distal tooth, lower margin with weak lateral carina, better defined on finger, lateral face tuberculate over upper and lower distal third, mesial face tuberculate near base of finger; fixed finger 0.6 length of upper palm, cutting edge straight,; dactylus margins and faces smooth, cutting edge with few blunt teeth.

Minor pereopod 1 coxa, ischium, merus and carpus as in larger cheliped, narrower; propodus upper margin carinate, with blunt distal tooth, lower margin with weak lateral carina, better defined on finger, lateral face with few tubercles, mesial face with few tubercles near base of finger; fixed finger as long as upper palm, cutting edge with regularly spaced sharp teeth; dactylus margins and faces smooth, cutting edge denticulate.

Pereopod 2 ischium lower margin unarmed; merus lower margin unarmed; carpus slightly longer than chela; propodus upper margin 0.4 length of dactylus. Pereopod 3 merus lower margin with 3 weak spines; propodus 2.9 times as long as dactylus, with 8 transverse rows each of 4–7 robust setae; dactylus with 13 robust setae on inner face plus unguis. Pereopod 4 propodus 4.1 times as long as dactylus, with 8 transverse rows each of 3–8 robust setae; dactylus with 12 robust setae on inner face plus unguis. Pereopod 5 propodus 3.5 times as long as dactylus, weakly subchelate, distally with 2 transverse rows each of 2 or 3 robust setae; dactylus with 6 robust setae on distal margin, 3 robust setae on inner face.

Pleopods 2–5 appendix interna one third length of endopod. Pleopod 2 appendix masculina as long as appendix interna.

Telson ovate, slightly tapering posteriorly, 1.1 times as long as wide, lateral margin with 3 spines, distal margin convex with posteromedian spine, posterolateral curve with 1 robust seta; dorsal face with 2 spines in each oblique row. Uropodal endopod 1.7 times as long as wide, with 7 lateral spines, longitudinal ridge with 4 spines (including marginal). Uropodal exopod 1.6 times as long as wide, with 11 lateral spines, 2 longitudinal ribs (inner rib ending in marginal spine, outer rib with 7 spines), posterolateral angle with 1 fixed spine and 1 robust seta; transverse suture absent.

Female (2 paratypes). As male except: rostrum with 4–6 lateral spines anterior to supraocular spine; lateral gastric carina with 2 or 3 prominent spines in addition to supraocular spine; submedian gastric carina with 4 or 5 spines; median gastric carina with 5–7 spines; pleura 3–5 posteroventrally angled, each with small anteroventral spine (as male); pleuron 6 with small spine on ventral margin; major and minor chelipeds fixed finger and dactylus with lateral ridge; pleopod 1 uniramous, article 2, 3 times length of article 1; ovigerous with at least 6 eggs.

Etymology. Bardi is the name of the Aboriginal Australian people inhabiting Cape Leveque close to the type locality (noun in apposition).

Distribution. WA, continental slope of North-west Shelf, 17°–19°S, 118°–120°E, 180–184 m depth.

Remarks. The three individuals of *Platyaxius bardi* vary in the numbers and size of spines/teeth on the rostrum and gastric carinae. The species differs from *P. brevirostris* and *P. odontorhynchus* (from Indonesia) in the more pronounced dentition on the rostrum and gastric carina (obsolete in the other two). The rostrum exceeds the eyestalks in the new species (does not in the other two species) and uropodal rami are broader. The scaphocerite of *P. bardi* is strongly curved while it is straight in the other two species. *Platyaxius bardi* and *P. brevirostris* have both been taken from similar limited latitudes and depths on the north-western Australian shelf. *Platyaxius bardi* has teeth on the lateral gastric carina while *P. brevirostris* does not.

Platyaxius brevirostris Sakai, 1994

Platyaxius brevirostris Sakai, 1994: 181–185, figs. 4, 5.—Davie, 2002: 454.

Distribution. WA, North West Shelf, 141 m depth.

Remarks. See comments under *P. bardi* above.

Scytoleptus Gerstaecker, 1856

*Remarks.*The steep margin of the median gastric carina, falling almost vertically to the short rostrum, and with three small teeth, immediately differentiate the genus and its only species.

Scytoleptus serripes Gerstaecker, 1856

Scytoleptus serripes Gerstaecker, 1856: 158, pl. 6 figs. 1–4. De Man, 1925b: 49, pl 4 figs. 9–9h.—Poore and Griffin, 1979: 243–245, fig. 11.—Sakai and de Saint Laurent, 1989: 37–39, fig. 9.—Sakai, 1994: 200.—Davie, 2002: 454.

Distribution. Indo-West Pacific, NT, WA, northern and central coast, to 36 m depth

Remarks. Scytoleptus serripes is recognised by the characteristic median gastric carina that defines the genus.

Spongiaxius Sakai and de Saint Laurent, 1989

Spongiaxius Sakai and de Saint Laurent, 1989: 41.—Sakai and Ohta, 2005: 88–89.

Sakaiocaris Kensley, 1989: 964 (objective synonym: same type species).

Remarks. The rostrum with its margin of erect spines, separated by a constriction from the carapace, serves to recognise species of *Spongiaxius.*

Spongiaxius brucei (Sakai, 1986)

Axiopsis brucei Sakai, 1986: 12–20, figs. 1–6.

Spongiaxius brucei.—Sakai and de Saint Laurent, 1989: 44–45.—Davie, 2002: 454.—Sakai and Ohta, 2005: 89–90, fig. 11.—Poore, 2008: 168.

Sakaiocaris brucei.—Kensley, 1989: 964–965.

Distribution. WA, slope of North West Shelf, Sulu Sea, 450–690 m depth.

Remarks. Spongiaxius brucei is a large species with erect spines on the five gastric carinae, the carinae themselves separated by a constriction from the elevated rostrum surrounded by about 20 erect spines. The massive dactylus of the major cheliped is also distinctive. Unlike most axiids from deep water, numerous specimens have been taken, including more than those already reported in NTM collections.

Biogeographical commentary

In earlier reviews, Poore and Griffin (1979) recognised only six species of Axiidae and Sakai (1994) thirteen (plus species now placed in Strahlaxiidae). Now, 30 are known with others probable. Eleven of these have also been reported from elsewhere in the Indo-West Pacific, some as far away as Japan or Madagascar (Table 1). These include both shallow-water, shelf and deep-water species whose distribution in WA range as far south as 35°S. This generalisation is subject to the proviso that identifications of Australian specimens as species known from elsewhere depend on subjective judgements of morphological similarity between material at hand and published descriptions. Poore (2008) has already tabulated differences between six published descriptions of the seemingly widespread *Paraxiopsis brocki*. A further 12 species are now known only from tropical Australia, most from WA (Table 1). Nine are known only from the type locality. It is reasonable to assume that some of these could subsequently be found north of Australia. Nine species are found in southern temperate Australia south of 30°S (Table 1). Two of these are Indo-West Pacific species and another occurs also in New Zealand. Of the southern species six could be treated as endemic. Three are shallow-water species from south-eastern Australia reported from narrow geographic ranges. The other three are species from the continental slope taken only once. The distribution of these is unknown until these burrowing cryptic animals from deep water can be reliably sampled. Three genera, monotypic *Australocaris* and *Dorphinaxius*, and *Michelaxiopsis* with two species, are confined to southern Australia-New Zealand. Most others are widespread in the Indo-West Pacific. *Axius* and *Calastacus*, with species in the North Atlantic and southern Australia appear to have anomalous global distributions.

Acknowledgements

Some of the collections on which this project was based were made during expeditions organised by CSIRO Marine and Atmospheric Research (CMAR). We thank co-Principal Investigators, Alan Williams and Rudy Kloser, CMAR, for the organisation and management of the voyages, and to Karen Gowlett-Holmes and Mark Lewis for help on board RV *Southern Surveyor*. For financial support we acknowledge the Commonwealth Department of the Environment and the CSIRO Wealth from Oceans Flagship that provided funds for the field and laboratory components of the "Voyages of Discovery" program, and the Commonwealth Environmental Research Facilities (CERF) Marine Biodiversity Hub. We thank Jane Jelbart, University of Newcastle, Newcastle, Buz Wilson and Helen Stoddart, Australian Museum, Sydney, Suzanne Horner, Museums and Art Gallery of the Northern Territory, Darwin, Thierry Laperousaz, South Australian Museum, Adelaide, and Miranda Lowe, Natural History Museum, London, for the loan of material. At Museum Victoria, we appreciate the efforts of Joanne Taylor in organising and registering the material and of Anna McCallum in providing new animals for study.

We thank too Colin McLay, Christchurch, Simon Pollard, Canterbury Museum, Christchurch, Rick Webber, National Museum of New Zealand (Te Papa), and Shane Ahyong, National Institute of Water and Atmosphere, Wellington, who attempted to chase down types and other material in New Zealand.

This paper benefited from discussions between the first author and the late Michèle de Saint Laurent in the 1990s and some of her thoughts are incorporated here. We are grateful too for valuable comments on a first draft by Tomoyuki Komai, Chiba, Japan, and for his willingness to re-examine specimens in his care.

This paper is a contribution to the Census of Marine Life project COMARGE (Continental Margins Ecosystems).

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Table 1. Distributions of Australian Axiidae. Species are divided into three groups: (1) those distributed elsewhere in the Indo-West Pacific; (2) those known only from northern tropical and subtropical Australia; and (3) those known from southern temperate Australia.

Taxa grouped by distribution and ranked by depth range	Depth range (m)	Australian distribution: state and southern (Indo-West Pacific and subtropical species) or northern (temperate species) latitudinal limit
Indo-West Pacific		
Allaxius clypeatus	0	Qld, 15°S
Axiopsis serratifrons	0–30	Qld, 15°S
Scytoleptus serripes	0–36	NT, WA, 22°S
Paraxiopsis brocki	0–100	WA, 32°S
Bouvieraxius keiensis	18–245	WA, 27°S
Planaxius brevifrons	47–114	WA, 30°S
Axiopsis consobrina	75–113	WA, 19°S
Axiopsis tsushimaensis	102–157	WA, 35°S
Acanthaxius clevai	228–438	WA, 17°S
Calaxius acutirostris	325–505	Qld, 27°S
Spongiaxius brucei	450–690	WA, 17°S
Tropical and subtropical Australia only		
Paraxiopsis austrinus	0	NT, 12°S
Paraxiopsis pumilus	6–100	NT, WA, 9°–21°S
Acanthaxius gawara	49–59	Qld, 12°S
Oxyrhynchaxius manningi	134	WA, 19°S
Platyaxius brevirostris	141	WA, 19°S
Eiconaxius kimbla	150	Qld, 27°S
Acanthaxius ningaloo	165	WA, 22°S
Platyaxius bardi	180	WA, 19°S
Acanthaxius polychaetes	260	Qld, 18°S
Pilbaraxius kariyarra	400	WA, 18°S
Acanthaxius gathaagudu	400–450	WA, 17–26°S
Ambiaxius franklinae	1300	WA, 17°S
Temperate only		
Dorphinaxius kermadecensis	0–8	New Zealand, NSW, 32–34°S
Michelaxiopsis australiensis	0–5	Central NSW, Vic., 29–38°S
Michelaxiopsis nauo	5–6	SA, 34°S
Axius werribee	2–25	Tas., Vic. SA, 35°S
Australocaris pinjarup	400	WA, 33°S
Calastacus myalup	400	WA, 33°S
Eiconaxius mallacoota	930–1000	Vic., 38°S

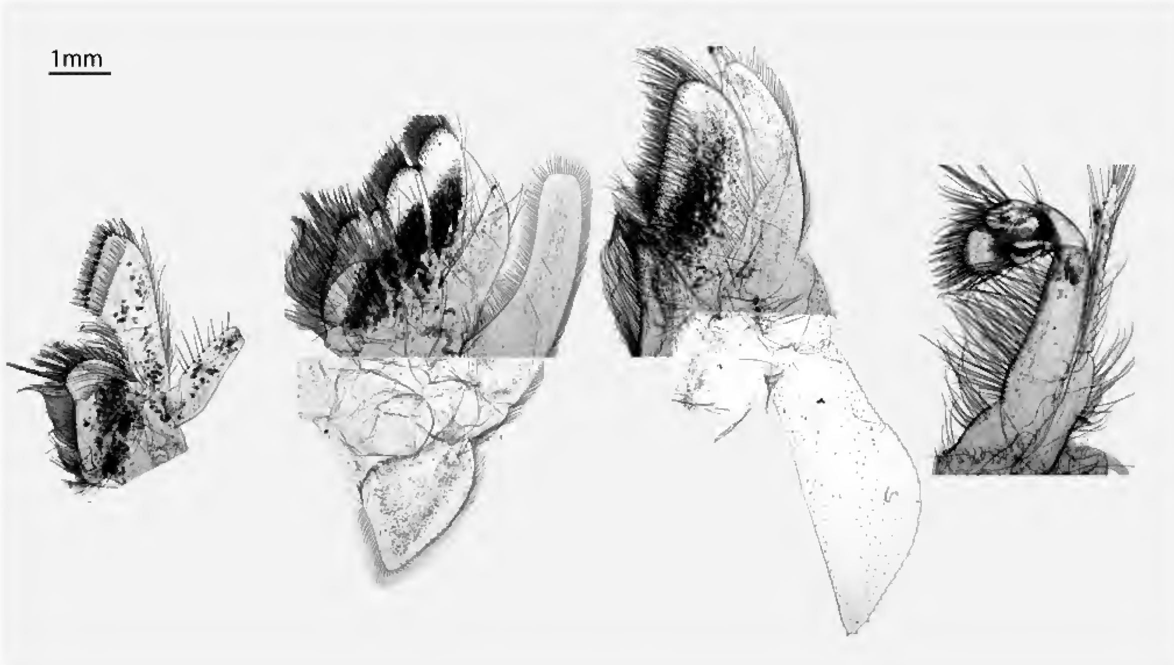

Figure 37. *Acanthaxius clevai* Ngoc-Ho, 2006. Photomicrographs of (left to right) maxilla 1, maxilla 2, maxilliped 1, maxilliped 2.

Figure 38. *Acanthaxius ningaloo* sp. nov. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta missing), maxilliped 1, maxilliped 2.

Figure 39. *Australocaris pinjarup* gen. and sp. nov. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

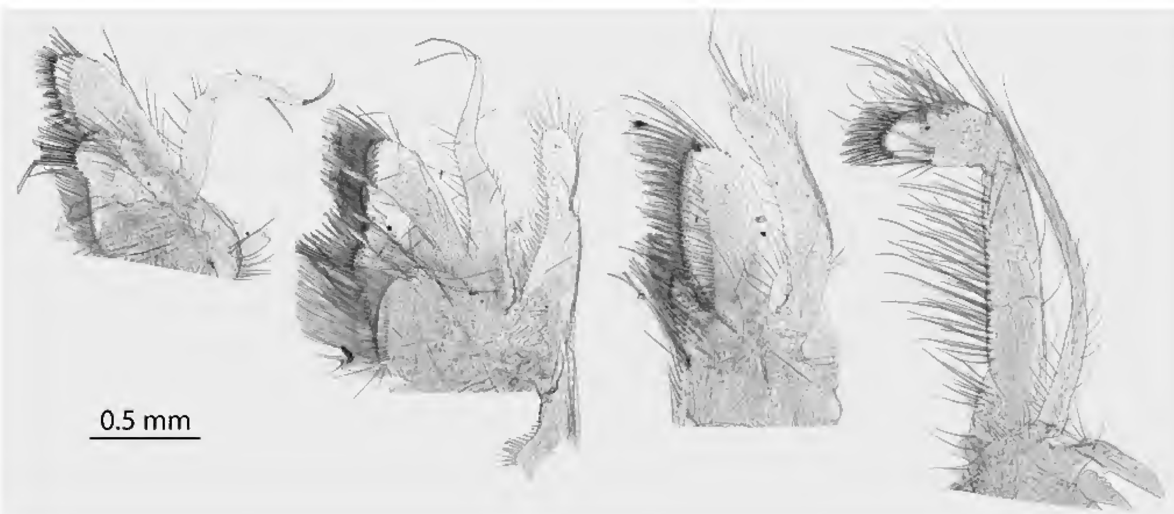

Figure 40. *Axiopsis tsushimaensis* Sakai, 1992. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

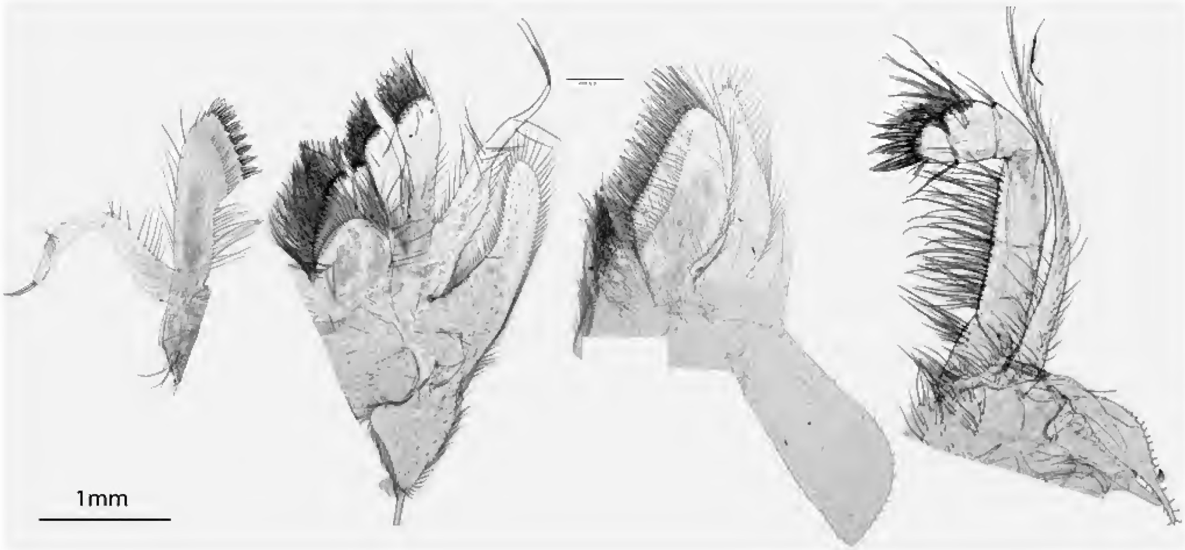

Figure 41. *Bouvieraxius keiensis* Sakai, 1992. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

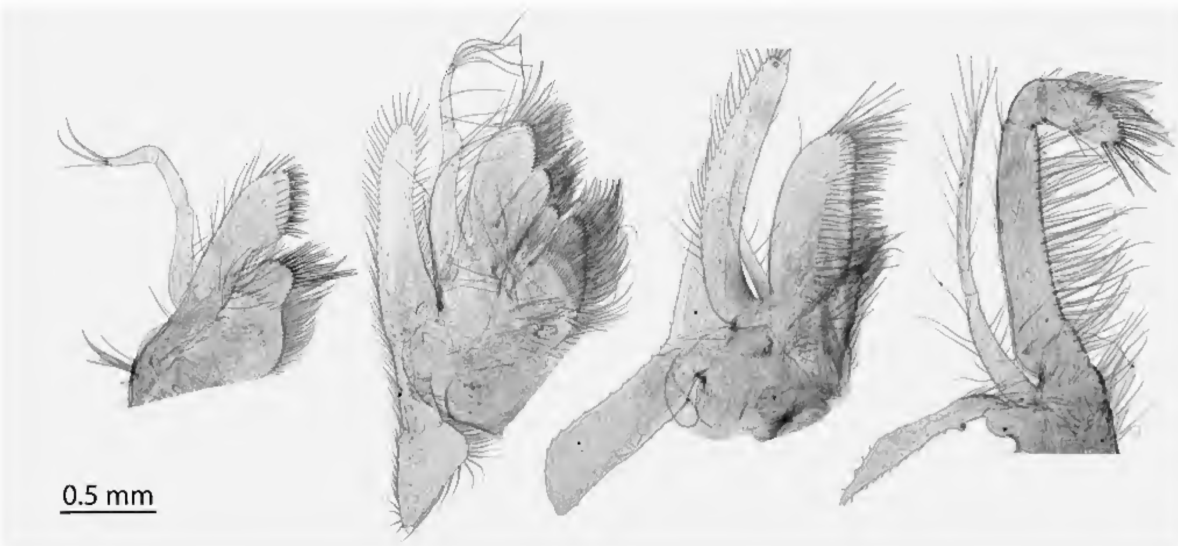

Figure 42. *Calastacus myalup* sp. nov. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta missing), maxilliped 1, maxilliped 2.

Figure 43. *Calaxius acutirostris* Sakai and de Saint Laurent, 1989. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

Figure 44. *Paraxiopsis pumilus* (Sakai, 1994). Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

Figure 45. *Pilbaraxius kariyarra* sp. nov. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

Figure 46. *Planaxius brevifrons* Komai and Tachikawa, 2008. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta truncated), maxilliped 1, maxilliped 2.

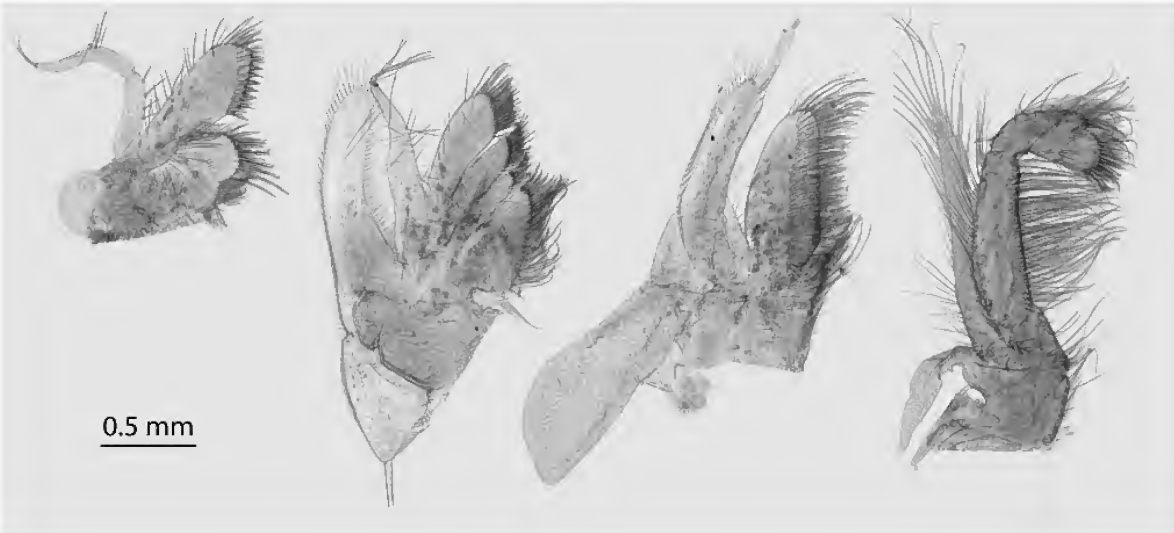

Figure 47. *Platyaxius bardi* sp. nov. Photomicrographs of (left to right) maxilla 1, maxilla 2 (posterior epipod seta missing), maxilliped 1, maxilliped 2.

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Memoirs of Museum Victoria 66: 289–329 (2009)

ISSN 1447-2546 (Print) 1447-2554 (On-line)
http://museumvictoria.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria

New species of Pauropoda (Myriapoda) from Tasmanian temperate rainforests

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Abstract

Scheller, U. 2009. New species of Pauropoda (Myriapoda) from Tasmanian temperate rainforests. *Memoirs of Museum Victoria* 66: 289–329.

Seventeen species new to science belonging to five genera in two families are described from a collection of Pauropoda made during an intensive survey of temperate rainforest in Tasmania. The new species are *Allopauropus fraterculus* sp. nov., *Allopauropus inusitatus* sp. nov., *Decapauropus heis* sp. nov., *Decapauropus attenuatus* sp. nov., *Decapauropus ungulatus* sp. nov., *Decapauropus convexus* sp. nov., *Decapauropus saltuarius* sp. nov., *Decapauropus terrestris* sp. nov., *Nesopauropus tasmaniensis* sp. nov., *Stylopauropoides erectus* sp. nov., *Stylopauropoides rounsevelli* sp. nov., *Stylopauropoides quadripartitus* sp. nov., *Stylopauropoides scissus* sp. nov., *Stylopauropoides hetaeros* sp. nov., *Stylopauropoides eximius* sp. nov., *Pauropus vandiemi* sp. nov. and *Borneopauropus dignus* sp. nov. The high level of local endemism in Tasmanian rainforest is emphasised.

Keywords biodiversity, *Allopauropus*, *Decapauropus*, *Nesopauropus*, *Stylopauropoides*, *Pauropus*, *Borneopauropus,* Australia, endemism

Introduction

An intensive survey of invertebrates of rainforest in Tasmania was carried out between 1989 and 1990 funded by the National Rainforest Conservation Programme (Coy et al., 1993). Several higher taxa collected during the survey were distributed to specialist taxonomists for study. A large number of Pauropoda formed part of this collection. It contained seventeen new species and two already described species (Greenslade, 2008). The current paper describes the new species from this collection and reports the collecting sites for all the species studied. Other Arthropoda were described or recorded by Clark and Greenslade (1996) and Greenslade (2008).

The Pauropoda are a little known group of soil organisms being small, cryptic Myriapoda but they are widespread in distribution and can be abundant (Scheller, 1990). The fauna often exhibits a high level of local endemism in forest soils as is demonstrated by the collection described here. Pauropods can inhabit strata from litter to the subsoil in a variety of plant communities and soil types, even agricultural habitats (Scheller, 1990).

Materials and Methods

Specimens were collected from 19 rainforest sites in different regions of Tasmania and at different altitudes. The sites covered four different rainforest types. A number of collection methods were used to collect specimens. They included funnel extraction of leaf litter, soil and moss, pitfall trapping and pyrethrin knockdown from tree trunks. The collecting methods and sites are described in detail by Coy et al. (1993) and documented by Greenslade (2008) as localities 1 to 19.

All specimens were preserved in ethanol. In the descriptions below, individuals have been classified as adults, subadults and juveniles according to the number of pairs of legs. The sex of adults and subadults was recorded.

Holotypes have been lodged in the Australian National Insect Collection, CSIRO, Canberra; paratypes and other material are deposited in the Queen Victoria Museum, Launceston, Tasmania.

Abbreviations

Deposition: ANIC, Australian National Insect Collection, CSIRO, Canberra, ACT, Australia; QVM, Queen Victoria Museum, Launceston, Tasmania, Australia.

Morphology: ad., adult; subad., subadult; juv., juvenile with number of pairs of legs as indicated.

Collectors: ATW, A.Trumbull-Ward; DR, D. Rounsevell; HM, H. Mitchell; JD, J. Diggle; MN, M. Neyland; PG, P. Greenslade; RC, R. Coy; SS, S. Smith.

GR = grid reference; NRCP, National Rainforest Conservation Programme; PKD, pyrethrin knock down collecting method.

Systematics

The characters studied to identify species are those used by previous workers, in particular Hansen (1902), Remy (1931, 1952a, 1956c) and Scheller (1985, 1988, 1993). The setal nomenclature used here follows these publications. All setal names are in italics. The length of body, excluding the antennae, is given and the range of variation in adult paratypes (subadult in *Decapauropus convexus*) is provided in brackets in mm and other measurements are given in micrometres. For most measurements the range for adult paratypes is given in brackets either before (lower figure) or after (higher figure) the mean measurement. Lengths and ratios of lengths of setae are given in the descriptions. Distances between setae are given as eg. a_1–a_1=... if distance between same seta on left and right side of body is measured and as eg. a_1–a_2= if distance between setae on the same side of the body is measured. The number of pairs of legs, either nine or less, is given before the specimen details.

Checklist of Tasmanian Pauropoda

Pauropodidae

- *Allopauropus* Silvestri, 1902
  - *Allopauropus fraterculus* sp. nov.
  - *Allopauropus inusitatus* sp. nov.
  - *Decapauropus heis* sp. nov.
  - *Decapauropus attenuatus* sp. nov.
  - *Decapauropus ungulatus* sp. nov.
  - *Decapauropus convexus* sp. nov.
  - *Decapauropus saltuarius* sp. nov.
  - *Decapauropus terrestris* sp. nov.
- *Nesopauropus* Scheller, 1997
  - *Nesopauropus tasmaniensis* sp. nov.
- *Stylopauropoides* Remy, 1956
  - *Stylopauropoides ringueleti* Remy, 1962
  - *Stylopauropoides erectus* sp. nov.
  - *Stylopauropoides rounsevelli* sp. nov.
  - *Stylopauropoides quadripartitus* sp. nov.
  - *Stylopauropoides scissus* sp. nov.
  - *Stylopauropoides hetaeros* sp. nov.
  - *Stylopauropoides eximius* sp. nov.
- *Pauropus* Lubbock, 1867
  - *Pauropus dolosus* Remy, 1956
  - *Pauropus vandiemeni* sp. nov.

Brachypauropodidae

- *Borneopauropus*, Scheller, 1994
  - *Borneopauropus dignus* sp. nov.

Systematics

Genus *Allopauropus* Silvestri

Type species: *Allopauropus brevisetus* Silvestri, 1902: Fasc. 95, no. 12, pl. 5.

Allopauropus fraterculus sp. nov.

(Figs. 1–11)

Material Examined. Holotype. Ad. 9 (female), Bruny Island, Mount Mangana, Loc. 12 (43°22.1'S, 147°17.0'E), moss on dead log, 4–9. iv.1989 (JD,PG).

Paratypes. Big Sassy Creek, Loc. 7, (42°08.5'S, 147°54.3'E), rainforest, rotten log, 6 ad. 9 (2 males, 4 females), 17.v.1989 (JD). Rivaux Creek, (41°15'S, 146°40'E), litter, 1 ad. 9 (female), 20.xii.1988 (PG).

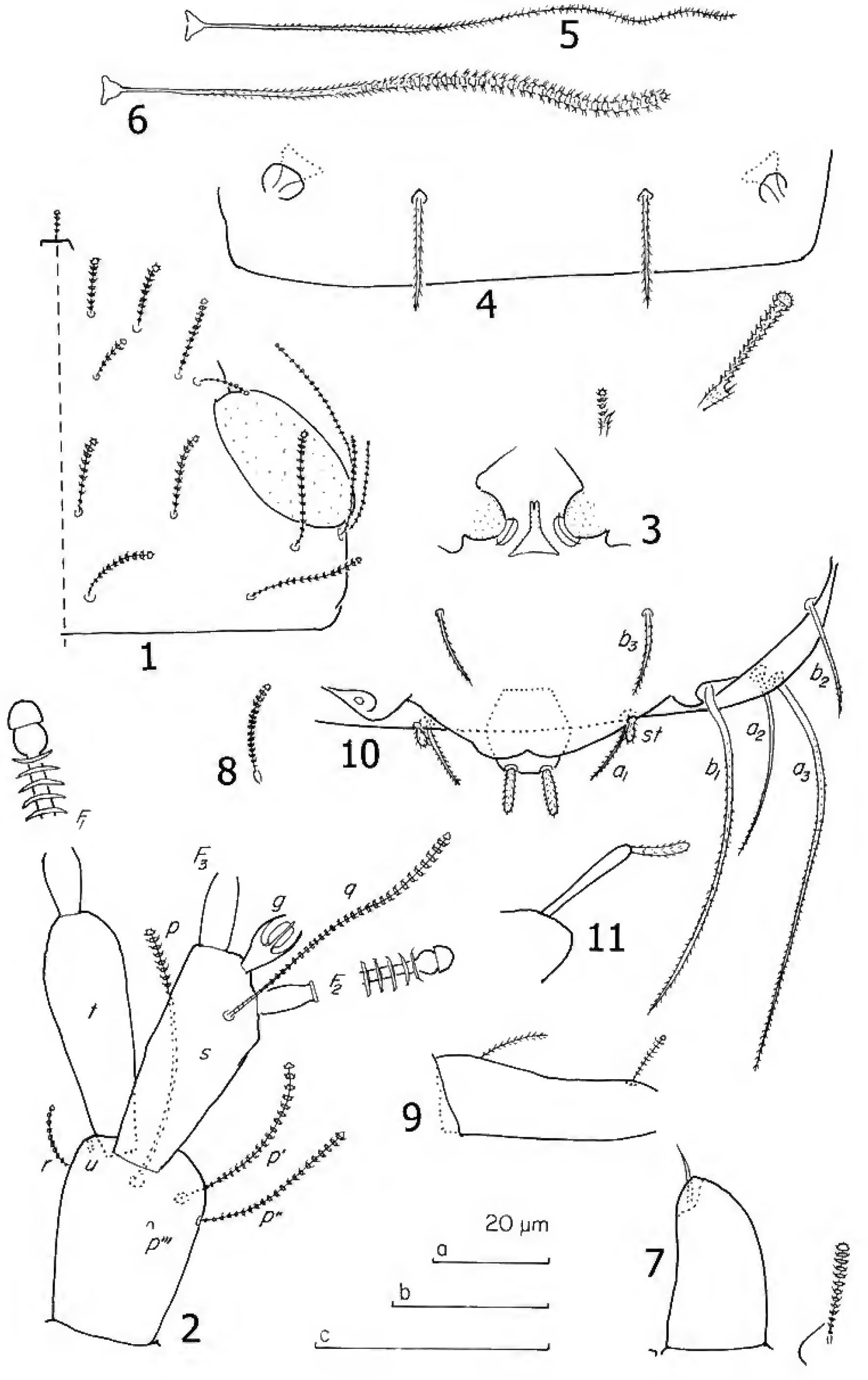
Other material (185 specimens). Loc. 1, moss on *Nothofagus*, 1 subad. 8 (female), 1.iv.1989 (JD) and moss on dead trunk, 1 ad. 9 (female), 31. iv. 1989 (PG). Loc. 2, moss on ground, 1 ad. 9 (female), 1 juv. 6, 21. iv.1989 (HM,JD). Loc. 4, litter, 1 ad. 9 (male), (HM) and soil core, 1 subad. 8 (female), 1 juv. 5, 3–8.xi. 1989 (RC). and moss on log, 2 ad. 9 (female), 18.xi.1989 (HM). Loc. 6, moss on tree trunk, 1 ad. 9 (male), 1 subad. 8 (female), 3 juv. 6, 11.vi.1990 (ATW). Loc. 7, rotten log, 119 ad. 9 (27 male, 56 female, 36 sex?), 30 subad. 8 (2 female, 28 sex?), 10 juv. 6, 8 juv. 5, 17.v.1989 (JD). Loc. 12, moss on dead log, 1 ad. 9 (female), 4–9.iv.1989 G) and moss on log, 1 ad. 9 (female), 9. xi.1989 (PG). Loc. 13, litter, 2 ad. 9 (male, female), 27.ii.1989 (SS).

Diagnosis. The new species is very close to *A. maoriorum* Remy described from New Zealand (Remy1956a), in natural habitats also known from New Caledonia and southern Chile, but can be distinguished in the following manner. The antennal globulus *g* has a thin stalk, only 4–5 bracts and longish capsule in *fraterculus* but has a thick stalk, several bracts, and spherical capsule in *maoriorum*; the 4th antennal segment has the seta *u* (not mentioned by Remy in *maoriorum*); the anal plate is an almost regular hexagon in *fraterculus*, but is 5-sided with posterior margin in a long curve in *maoriorum*.

Description. Length. -(0.55-) 0.69(-0.72) mm.

Head. -Tergal setae of medium lengths, sublateral and lateral ones fairly long, subcylindrical-cylindrical, annulate, blunt. Relative lengths of setae, 1st row: a_1=10, a_2=(10-)11(-12); 2nd row: a_1=(8-)9(-11), a_2=14(-16), a_3=(9-)10(-12); 3rd row: a_1=(9-)11, a_2=(14-)16(-17); 4th row: a_1=(12-)16, a_2=(20-)21(-26), a_3=(18-)21, a_4=(18-)19(-20); lateral group setae: l_1=l_2=(17-)19(-21), l_3=(32-) 40(-45). The ratio a_1/a_1-a_1 in 1st row 0.7(-0.8), 2nd row 0.6(-0.7), 3rd row (1.3-)1.5(-1.6) and 4th row 1.3(-1.5). Temporal organs small, their length in tergal view 0.6(-0.7) of their shortest distance apart, posterior aperture absent. Head cuticle almost glabrous.

Antennae. -Segment 4 with 5 subcylindrical annulate blunt setae; their relative lengths: *p*=100, *p*'=(58-)61(-66), *p*''=(54-)56(-59), *r*=(22-)23, *u*=(3-)4. The *p*''' rudimentary. Tergal seta *p* (1.1-)1.2 times as long as tergal branch *t*. The latter somewhat clavate, (2.7-)3.0(-3.1) times as long as its greatest diameter and as long as (-1.1 times as long as) sternal branch *s*, that branch (2.2-)2.4 times as long as its greatest diameter; anterodistal corner of *s* distinctly truncate. Seta *q* as seta *p* of 4th segment, (as long as-) 1.2 times as long as *s*. Relative lengths of flagella (basal segments included) and



Figs. 1–11. *Allopauropus fraterculus* sp.nov., holotype 1–6, 8–11; paratype 7: 1, head, median and right part, tergal view; 2, right antenna, sternal view; 3, collum segment, median and left part, sternal view; 4, tergite VI, posterior part; 5, T_1; 6, T_3; 7, right genital papilla and seta on coxa of 2nd pair of legs, anterior view; 8, seta on trochanter of 9th pair of legs; 9, tarsus of 9th pair of legs; 10, pygidium, posterior and left part, sternal view; 11, anal plate, lateral view. Scale line a for figures 5, 6, 8, 9; b for figures 1–3, 4, 7; c for figures 10, 11.

basal segments: F_1=100, bs_1=8(-12); F_2=42(-54), bs_2=(6-)7(-9); F_3=85(-100), bs_3=10(-11). The F_1 (2.7-)3.1 times as long as t, F_2 and F_3 1.4(-1.5) and (2.7-)2.8(-2.9) times as long as s respectively. Distal calyces hemispherical; distal part of flagellar axes between last lamella and calyx strongly widened, ball-shaped. Globulus g (1.5-)1.8(-1.9) times as long as wide; (4-)5 bracts, capsule ovoid, distinctly longer than wide; width of g 0.5 of the greatest diameter of t. Antennae glabrous.

Trunk.-Setae of collum segment somewhat clavate, dense but distinctly annulate, blunt, furcate but with rudimentary glabrous pointed secondary branches; sublateral setae 3.0(-3.1) times as long as submedian ones; sternite process triangular, with anterior lengthening narrow and with apical incision; appendages barrel-shaped, caps with collar; process and basal segment of appendages with minute pubescence.

Setae on tergites subequal in length; on anterior tergites as on tergal side of head, on posterior tergites cylindrical and with oblique pubescence. There are 4+4 setae on tergite I, 6+6 on II–IV, 6+4 on V, 4+2 on VI. Submedian posterior setae on VI 0.5(-0.6) of their distance apart and (2.4-)2.5 times as long as pygidial setae a_1. Tergites almost glabrous.

Relative lengths of bothriotricha: T_1=100, T_2=(98-)101(-105), T_3=102(-106), T_4=(116-)128(-134), T_5=(124-)135(-141). They have simple, straight axes, thin in all but T_3, the latter with thicker axes, in proximal half compact and in distal half annulate, each annulus with a whorl of erect hairs. Pubescence hairs on T_1, T_2, T_4 and T_5 oblique in proximal 1/3, more outwards erect.

Genital papillae (paratypes) glabrous, conical, with inner sides only a little curved, outer sides strongly convex, 1.4(-1.8) times as long as their greatest diameter; seta (0.3-)0.4 of the length of organ.

Legs. –Setae on coxa and trochanter of leg 9 similar, simple, subcylindrical, annulate, blunt, those more anteriorly with glabrous blunt, rudimentary secondary branches. Coxal seta on leg 2 in male as other coxal setae but somewhat clavate. Legs short, tarsus of leg 9 subcylindrical, 2.9(-3.4) times as long as its greatest diameter. Proximal seta thin and with oblique pubescence, its length (0.3-)0.4 times length of tarsus and (1.3-)1.5 times as long as distal seta; the latter somewhat clavate, annulate, blunt. Cuticle of tarsus almost glabrous.

Pygidium. Tergum.-Posterior margin between *st* straight (or somewhat convex). Relative lengths of setae: a_1=10, a_2=(25-)27(-30), a_3=(56-)73, *st*=(2-)3. The a_1, a_2 and a_3 shortly pubescent, subcylindrical, tapering, pointed, curved inwards, a_1 also pointing inwards; *st* straight and clavate, with distinct pubescence, pointing inwards. Distance a_1-a_1 (2.2-)2.7 times as long as a_1; distance a_1-a_2 (3.5-)5.0 times as long as distance a_2-a_3; distance *st-st* (6.4-)9.0 times as long as *st* and (as long as-)1.1 times as long as distance a_1-a_1. Cuticle minutely granular.

Sternum.-Posterior margin between b_1 with broad and low lobe below anal plate; hind area divided into two rounded parts by a posteromedian incision. Relative lengths of setae (a_1=10): b_1=(38-)50, b_2=(14-)18, b_3=(9-)12, all setae tapering, pointed and with very short oblique pubescence; b_1 about as long as their distance apart, sometimes with distal swelling; b_2 (0.8-)0.9 of the length of distance b_1-b_2, b_3 0.3 of their distance apart. Anal plate somewhat longer than broad, glabrous, hexagonal, with anterior and posterior margins subequal in length; two cylindrical, blunt appendages with short oblique pubescence protrude from posterosternal margin, 0.6(-0.7) of the length of plate, somewhat pointing outwards.

Subad. 8.-Setae d_1 on pygidial tergum 0.5 of their distance apart; setae d_2 0.7 of the length of d_1 and 0.8 of distance d_1-d_2.

Etymology—From Latin *frater, fratris* = brother (of *A. maoriorum*).

Distribution in Tasmania. Most specimens were collected from a rotten log at Big Sassy Creek but the species seems to be very widely distributed in the State.

Allopauropus inusitatus sp.nov.

(Figs. 12–24)

Material Examined. Holotype. Ad. 9 (female), Bruny Island, Mount Mangana, (43°22.1'S, 147°17.0'E), litter, 9.iv.1989 (PG).

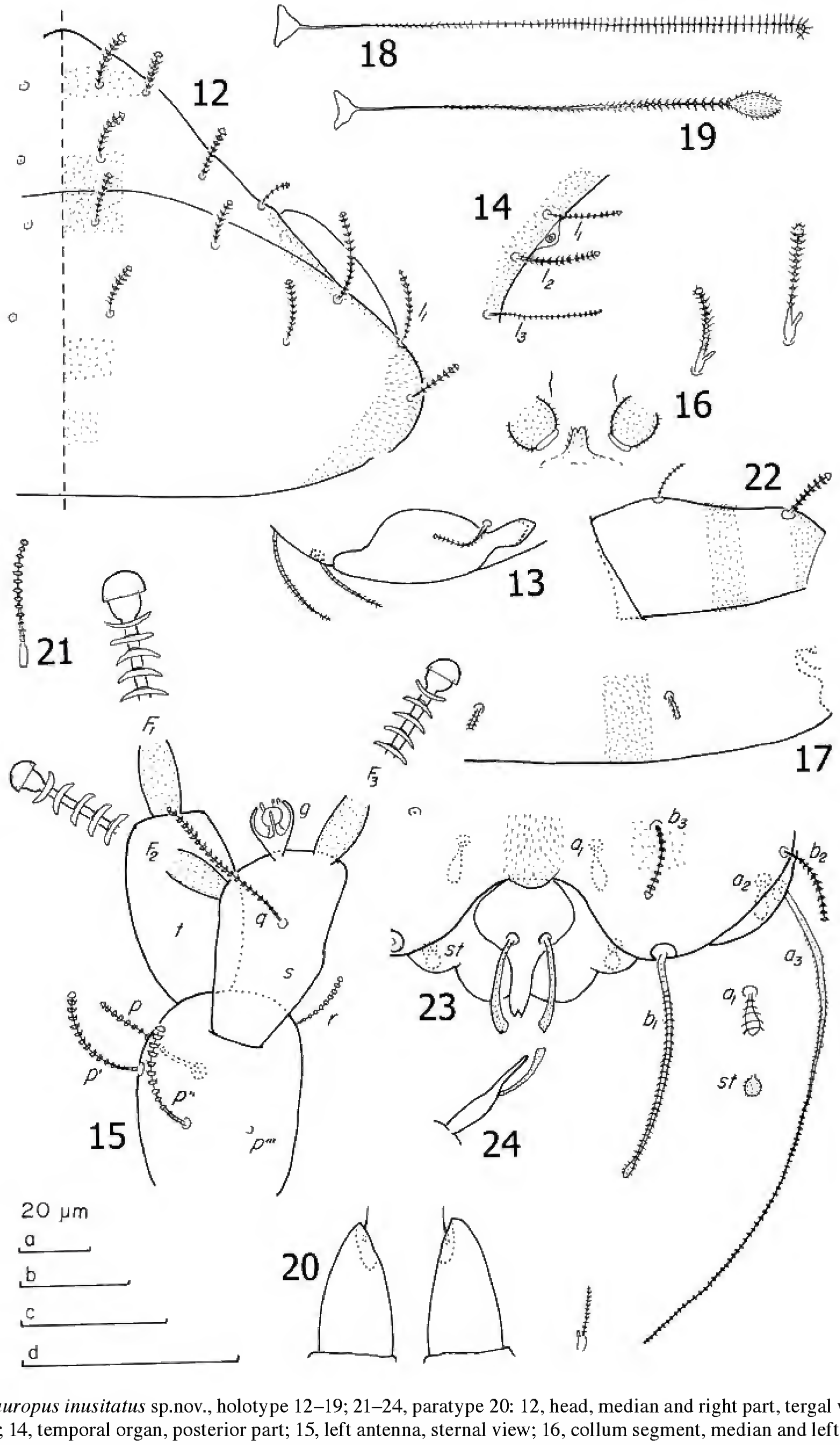
Paratypes. Same data as holotype, 2 ad. 9 (male, female), 1 juv. 6, 2 juv. 3. Loc. 8, Sandspit River, (42°42.1'S, 147°51.5'E), litter, 11 ad. 9 (5 male, 6 female), 1 juv. 6, 1 juv. 3, 22.v.1989 (PG).

Other material (7 specimens). Loc. 7, moss on log, 1 ad. 9 (female), 17.v.1989 (HM). Loc. 12, leaf litter, 1 juv. 3, 9.iv.1989 (PG), and in moss, 1 ad. 9 (female), 9.iv.1989 (JD), and in moss on dead log, 1 ad. 9 (female), 1 juv. 6, 2 juv. 3, 4.iv.1989 (JD, PG).

Diagnosis. Allopauropus inusitatus is easily recognised and well delineated by the combination of good characters in the shape of the temporal organs, anal plate, the T_3, the antennae and legs. It is closest to *A. sphaeruliger* Remy, described from the Ivory Coast (Remy, 1948) and later found in Gambia, Gabon, Angola, Madagascar, Réunion and Mauritius and also in Asia, Pondichéry, Sri Lanka and Japan and in South America in Brazil. It is distinguished from that species by the shape of the temporal organs (only slightly visible in tergal view in *inusitatus*; but clearly visible in *sphaeruliger*), the shape of the tergal antennal branch (1.4-)1.6 times as wide as long; not 2.0(-2.8), the number of tergal setae on tergite V (6+6; not 6+4), trichobothrium T_3 (with simple pubescence and distal ovoid swelling, not with branched pubescence and distal swelling absent) and some pygidial characters (setae a_1 clavate, not cylindrical; the proportion a_2/a_3 about 0.1, not 0.5–0.8; appendages of the anal plate directed posteriorly and with short pubescence, not club-shaped, strongly pointing outwards, with long pubescence hairs).

Description. Length.-(0.96-)1.23(-1.24) mm.

Head.-Tergal setae short to medium length, somewhat clavate, annulate, blunt; lateral ones subcylindrical, annulate. Relative lengths of setae, 1st row: a_1=10, a_2=(9-)10(-12); 2nd row: a_1=(9-)10(-11), a_2=9(-12), a_3=6(-9); 3rd row: a_1=9(-12), a_2=9(-13); 4th row: a_1=10(-14), a_2=10(-15), a_3=(13-)15(-16), a_4=10(-14); lateral group setae: l_1=(13-)14(-16), l_2=13(-16), l_3=(16-)19(-20). The ratio a_1/a_1-a_1 in 1st row (0.7-)0.8(-0.9), 2nd row (0.6-)0.7(-0.9), 3rd row (0.7-)0.8(-0.9) and 4th row 0.6(-0.9). Temporal organs small and laterosternal with narrow anterosternal extension the distal part of which raised from



Figs. 12–24. *Allopauropus inusitatus* sp.nov., holotype 12–19; 21–24, paratype 20: 12, head, median and right part, tergal view; 13, left temporal organ, sternal view; 14, temporal organ, posterior part; 15, left antenna, sternal view; 16, collum segment, median and left part, sternal view; 17, tergite VI, posterior part; 18, T_1; 19, T_3; 20, genital papillae and seta on coxa of 2nd pair of legs; 21, seta on coxa of 9th pair of legs; 22, tarsus of 9th pair of legs; 23, pygidium, posteromedian and left part, sternal view, to the right setae a_1 (above) and *st*; 24, anal plate, lateral view. Scale line a for figure 20; b for figures 18,19; c for figures 12–14, 16, 17, 21, 22; d: 15, 23, 24.Figs. 39–43.

head surface; their length in tergal view 0.4(-0.5) of their shortest distance apart; small aperture at posterior margin between l_1 and l_2. Head cuticle distinctly granular and with transverse suture anterior of 3rd row of setae.

Antennae. Segment 4 with 4 subcylindrical annulate blunt setae; their relative lengths: p=100, p'=(85-)96(-104), p''=(85-)92(-96), r=(48-)53(-62). The p''' seta rudimentary, u absent. Tergal seta p (0.6-)0.8 of the length of tergal branch t. The latter fusiform, (1.4-)1.6 times as long as its greatest diameter and (0.8-)0.9 of the length of sternal branch s, that branch (1.4-)1.7 times as long as its greatest diameter; anterodistal corner of s truncate. Seta q subcylindrical, annulate, blunt, (almost as long as-)1.0(-1.2) times as long as s. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=9(-10); F_2=(43-)47(-49), bs_2=7(-8); F_3=(83-)87(-95), bs_3=7(-9). The F_1 (4.2-)4.6(-4.8) times as long as t, F_2 and F_3 which are thinner than F_1 are 1.5(-1.9) and (3.5-)4.2(-5.0) times as long as s respectively. Distal calyces subhemispherical; distal part of flagellar axes widened only just below calyces. Globulus g (1.2-)1.3(-1.4) times as long as wide; 5(-6) bracts, capsule small, bottom convex; width of g 0.4(-0.5) of the greatest diameter of t. Antennae almost glabrous, minute pubescence on basal segments of flagella only.

Trunk.-Setae of collum segment (subcylindrical-) somewhat clavate, annulate, blunt, furcate but with rudimentary glabrous blunt secondary branches; sublateral ones (1.2-)1.4 times as long as submedian ones; sternite process short, with shallow anterior incision (or almost blunt); appendages barrel-shaped with flat caps; process and basal segment of appendages with distinct, almost erect pubescence.

Setae on tergites thin, cylindrical, annulate, blunt decreasing in length posteriorly. There are 4+4 setae on tergite I, 6+6 on II-V, 4+2 on VI. Submedian posterior setae on VI 0.1(-0.2) of their distance apart and (0.9-)1.0(-1.1) times as long as pygidial setae a_1. Tergites with short dense pubescence.

Relative lengths of bothriotricha: T_1=100, T_2=(82-)?(-118), T_3=(75-)82(-98), T_4=(90-)101(-110), T_5=(81-)95(-100). They have thin, simple, straight axes, T_3 with distal swelling. Pubescence hairs on T_1, T_2, T_4 and T_5 oblique in proximal 1/3, more outwards erect; T_3 with oblique hairs, very short on proximal half, longer and in whorls on nodulated axis below distal swelling.

Genital papillae (paratypes) glabrous, conical, with convex inner and outer sides, 1.4–1.7 times as long as their greatest diameter; seta 0.4–0.5 of the length of organ.

Legs.-Setae on coxa and trochanter of leg 9 similar, simple, subcylindrical, annulate, blunt. More anteriorly, these setae with glabrous blunt rudiments of secondary branches. Coxal seta on leg 2 in male not divergent. Tarsus of leg 9 short, thick, barrel-shaped, (1.9-)2.1(-2.2) times as long as its greatest diameter. Setae subcylindrical, annulate, proximal seta thin, its length 0.2 of the length of tarsus and (0.6-)0.7(-0.8) of the length of distal seta; the latter distinctly thicker than proximal seta. Cuticle of tarsus with short but distinct pubescence.

Pygidium. Tergum.-Posterior margin between st rounded and with shallow median indentation. Relative lengths of setae a_1=10, a_2=10(-15), a_3=(106-)107(-129), st=5(-7). The a_1 and st straight and clavate, the former striate and the latter with short pubescence; a_2 cylindrical, annulate, somewhat curved inwards; a_3 thin, subcylindrical, tapering, striate-annulate, pointing outwards and curved inwards. Distance a_1-a_1 (2.5-)2.7(-4.8) times as long as a_1; distance a_1-a_2 (2.2-)2.3(-3.7) times as long as distance a_2-a_3; distance st-st (7.6-)9.5(-11.0) times as long as st and (1.0-)1.1(-1.5) times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin between b_1 with a broad indentation and a small posteromedian lobe below anal plate. Relative lengths of setae (a_1=10): b_1=(43-)47(-55), b_2=(17-)18(-23), b_3=(14-)15(-33). The b_1 subcylindrical, tapering, striate, distally annulate; b_2 and b_3 subcylindrical annulate. The b_1 about as long as their distance apart; b_2 (0.4-)0.6 times as long as distance b_1-b_2, b_3 (0.3-)0.4 of their distance apart. Anal plate (1.1-)1.2 times as broad as long, glabrous, spatulate, anteriorly constricted and posteriorly protruding into a median lobe being somewhat longer than broad, lobe with small posteromedian incision, lateral margins of plate anterior of posterior lobe strongly convex; two appendages protrude from sternal side at the base of the posterior lobe, being 0.7 of the length of plate, cylindrical but with small distal swelling, curved inwards and shortly pubescent.

Etymology.-From Latin *inusitatus* = unusual, extraordinary (shape of the temporal organs).

Distribution in Tasmania. Allopauropus inusitatus was found at three sites only, indicating a south-eastern range.

Genus Decapauropus Remy

Type species: *Decapauropus cuenoti* Remy, 1931: 67–83, Figs. 1–3, 6–12.

Decapauropus heis sp.nov.

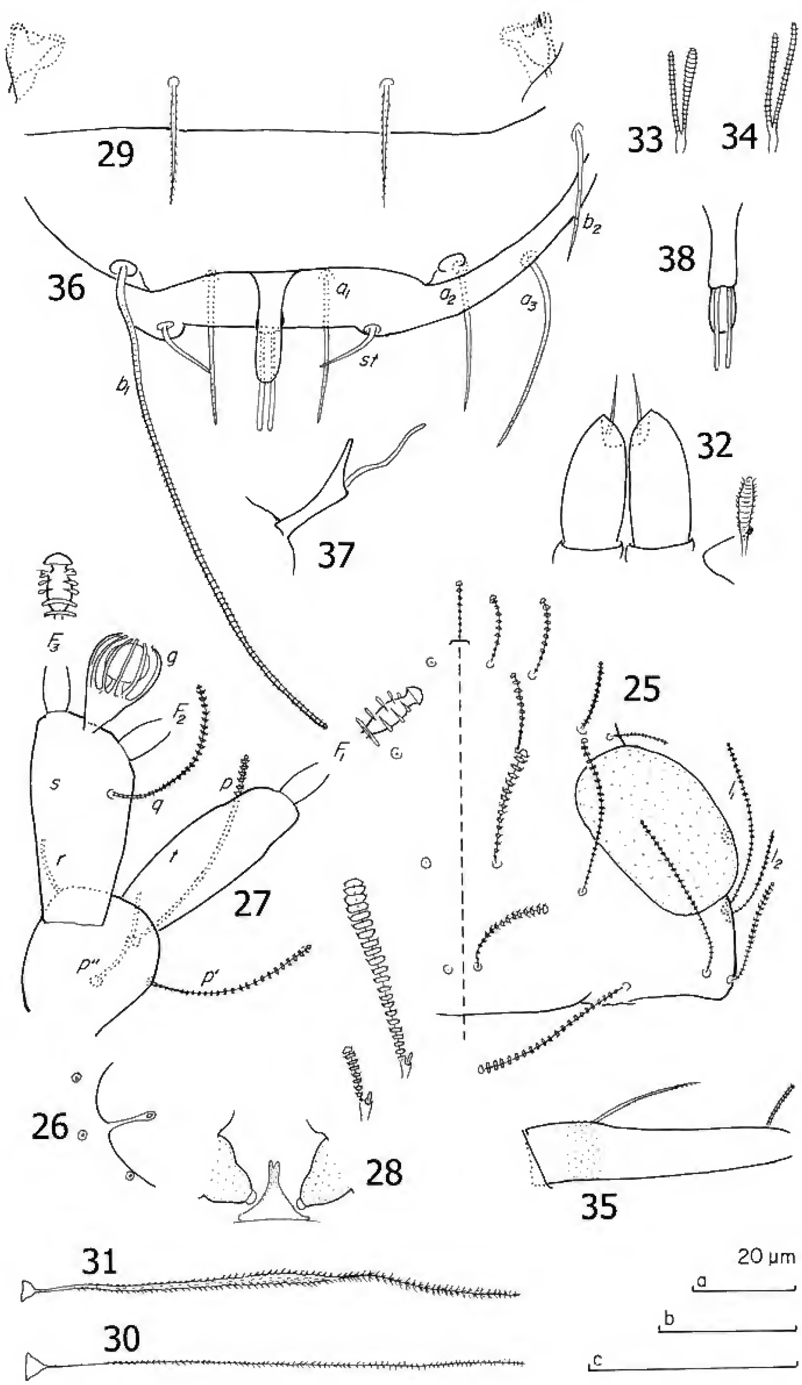
(Figs. 25–38)

Material Examined. Holotype. Ad. 9 (female), Bruny Island, Mount Mangana, Loc. 12, (43°22.1'S, 147°17.0'E), litter, 9.iv.1989 (PG).

Paratypes. Same data as holotype, 1 ad. 9 (female). Sandspit River, Loc. 8, (147°51.5'S, 42°42.1'E), leaf litter, 3 ad. 9 (1 male, 2 female), 22.v.1989 (PG).

Other material. 50 specimens. Loc. 2, soil core, 1 ad. 9 (female), 21.iv.1989 (JD,HM). Loc. 7, leaf litter, 1 ad. 9 (female), 12.v.1989 (PG). Loc. 8, soil core, 2 ad. 9 (female), 22.v.1989 (PG). Loc. 11, south track, leaf litter, 1 ad. 9 (female), 21.iii.1989 (PG,JD). Loc. 12, litter, 16 ad. 9 (7 male, 9 female), 3 subad. 8 (1 male, 2 female), 9.iv.1989, and leaf litter, 6 ad. 9 (female), 1 subad. 8 (female), 9.iv.1989 (PG), and leaf litter, 1 ad. 9 (female), 4.iv.1989 (JD,PG), and in moss, 3 ad. 9 (1 male, 2 female), 9.iv.1989 (JD). Loc. 13, litter, 3 ad. 9 (1 male, 2 female), 27. ii.1989 (SS). Loc. 16, litter, 4 ad. 9 (2 male, 2 female), 1 subad. 8 (female), 1 juv. 6, 20.xii.1988 (PG). Loc. 18, leaf litter, 2 subad. 8 (female), 1 juv. 6, xii.1987 (MN). Loc. 19, leaf litter, 3 ad. 9 (female), 20.vi.1989 (PG).

Diagnosis. The species may be closest to *D. acer* Scheller from Central Amazon (Scheller 1994). They are similar in the antennal morphology, the process of the collum segment, the bothriotricha, the pygidial chaetotaxy and the singular shape of the anal plate. Reliable distinguishing characters are the thick



Figs. 25–38. *Decapauropus heis* sp.nov., holotype 25–31, 33–38; paratype 32: 25, head, median and right part, tergal view; 26, posterior part of temporal organ; 27, right antenna, sternal view; 28, collum segment, median and left part, sternal view; 29, tergite VI, posterior part; 30, T_1; 31, T_3; 32, genital papillae and seta on coxa of 2nd pair of legs, anterior view; 33, seta on coxa of 9th pair of legs, 34, seta on trochanter of 9th pair of legs; 35, tarsus of 9th pair of legs; 36, pygidium, posterior part, sternal view; 37, anal plate, lateral view; 38, anal plate, tergal view. Scale line a for figures 30–35; b for figures 25, 28; c for figures 26, 27, 29, 36–38.

annulate setae on the collum segment and the proportionately longer collum appendages in *D. heis*, also the posterosternal lobe of the anal plate, which is absent in *D. acer* and the shape of the anal plate appendage.

Description. Length.-(0.51-)0.61(-0.65) mm.

Head.-Tergal setae annulate and of different lengths, in 1st and 2nd rows of medium lengths, in 3rd and 4th rows rather long; anterior and submedian ones somewhat clavate, sublateral and lateral ones cylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=10(-11); 2nd row: a_1=11(-12), a_2=10(-12), a_3=7; 3rd row: a_1=17(-20), a_2=20(-23); 4th row: a_1=15(-16), a_2=(23-)24, a_3=25(-26), a_4=(13-)16; lateral group setae: l_1=(17-)25, l_2=(12-)14, l_3=(16-)19. The ratio a_1/a_1-a_1 in 1st row (1.1-)1.2, 2nd row 0.6(-0.8), 3rd row 1.7(-2.1) and 4th row (3.4-)3.7(-3.8). Temporal organs oval in tergal view, their length 0.8(-0.9) of their shortest distance apart; small aperture near surface in median part at level of l_2 aperture with thin interior canal backwards. Head cuticle almost glabrous; temporal organs with delicate pubescence.

Antennae.-Segment 4 with four subcylindrical, annulate, blunt setae; their relative lengths: *p*=100, *p*'=(69-)73(-81), *p*''=(40-)41(-52), *r*=(24-)25(-26). Neither *p*''', nor *u*. Tergal seta *p* (as long as-) 1.2 times as long as the length of tergal branch *t*. The latter fusiform, (2.4-)2.6(-2.9) times as long as its greatest diameter and about as long as sternal branch *s*, that branch 1.8(-2.3) times as long as its greatest diameter; anterodistal corner of *s* truncate. Seta *q* subcylindrical, annulate, blunt, 0.8 (-as long as) *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=(6-)7(-8); F_2=(70-)82(-85), bs_2=(7-)8; F_3=(76-)86, bs_3=8. The F_1 (3.2-)3.6 times as long as *t*, F_2 and F_3 2.2(-2.5) and (2.6-)2.8(-2.9) times as long as *s* respectively. Distal calyces somewhat flattened; distal part of flagella axes fusiform. Globulus *g* 1.5(-1.6) times as long as wide; 12(-13) bracts; capsule spherical; width of *g* 0.9(-as wide as) the greatest diameter of *t*. Antennae almost glabrous.

Trunk.-Setae of collum segment somewhat clavate, distinctly annulate, blunt, furcate but with rudimentary glabrous blunt secondary branches; sublateral ones (1.8-)2.1(-2.5) times as long as submedian ones; sternite process narrow, with anterior lengthening with apical incision; appendages conical strongly narrowing distally and with proportionately very small caps; process and basal segment of appendages very delicately granular.

Setae of about the same length on all tergites, on anterior ones subcylindrical, annulate, blunt, on posterior tergites cylindrical, tapering, pointed, with short oblique pubescence. There are 4+4 setae on tergite I, 6+6 on II–IV, 6+4 on V, 4+2 on VI. Submedian posterior setae on VI 0.6(-0.7) of their distance apart and 0.8(-0.9) of the length of pygidial setae a_1. Tergites glabrous. Relative lengths of bothriotricha: T_1=100, T_2=(103-)109(-121), T_3=(97-)100(-119), T_4=(115-)119(-130), T_5=(169-)180(-182), axes simple, straight, in all but T_3 being very thin, with proximal 2/3 somewhat fusiform and distal 1/3 thin. Pubescence hairs very short and thin on all but T_3, on the latter stronger.

Genital papillae (paratypes) glabrous, fusiform, (1.9-)2.1 times as long as their greatest diameter; seta 0.5(-0.6) the length of organ.

Legs.-Setae on coxa and trochanter of leg 9 similar, furcate, branches subequal in length, striate, blunt; they are cylindrical except the main branch of coxal seta somewhat clavate, more anteriorly, these setae with rudimentary secondary branches, setae on trochanter longest, those on coxae somewhat clavate. Coxal seta on leg 2 in male not divergent. Tarsus of leg 9 slender, (3.7-)4.4 times as long as its greatest diameter. Proximal seta tapering, pointed, with very short oblique pubescence; distal seta cylindrical striate blunt. The former 0.4 of the length of tarsus and 2.0(-2.2) times as long as the latter. Cuticle of tarsus with delicate pubescence.

Pygidium. Tergum.-Posterior margin between *st* somewhat indented, straight. Relative lengths of setae: a_1=100, a_2=(86-)93(-98), a_3=(136-)137(-157), *st*=53(-71). These setae thin, tapering, almost glabrous, a_1 and a_2 almost straight, a_3 and *st* curved inwards, the latter one also pointing inwards. Distance a_1-a_1 0.7(-0.8) of the length of a_1; distance a_1-a_2 (1.4-)1.8 times as long as distance a_2-a_3; distance *st*-*st* (2.3-)2.5(-2.6) times as long as *st* and (1.7-)1.8(-2.0) times as long as distance a_1-a_1. Cuticle somewhat granular.

Sternum.-Posterior margin between b_1 with broad shallow indentation. Relative lengths of setae (a_1=100): b_1=(335-)338(-381), b_2=(87-)90(-108). The b_1 thin, subcylindrical, striate; b_2 as a_1 and a_2 of pygidial tergum. The b_1 (1.6-)1.8 times as long as their distance apart; b_2 0.8(-0.9) times as long as distance b_1-b_2. Anal plate broadest anteriorly, glabrous, linguiform with parallel lateral margins and rounded posteriorly; about three times longer than broad; from the thickened median part protrudes posteriorly from sternal side a narrow, and in the vertical plane undulated appendage about as long as plate; lateral margins of appendage thickened or curved, so it looks like two thread-like parallel structures.

Etymology.-From Greek *heis* = one (the appendage of the anal plate).

Distribution in Tasmania. The range is wide but it has not been collected from the central and north-eastern parts.

Decapauropus attenuatus sp.nov.

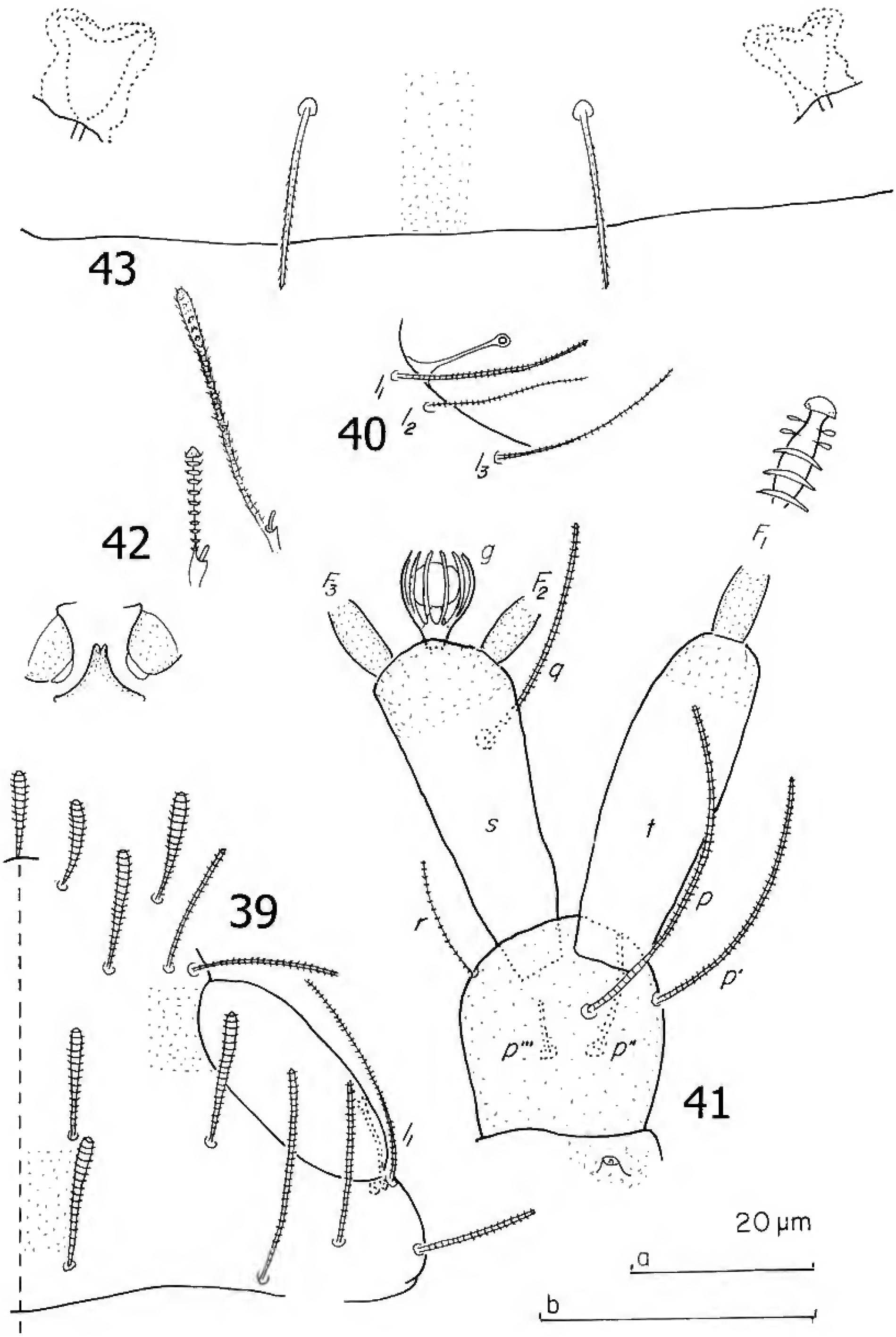
(Figs. 39–50)

Material Examined. Holotype. Ad. 9 (female), Bruny Island, Mount Mangana, Loc. 12, (43°22.1'S, 147°17.0'E), litter, 4.iv.1989 (PG).

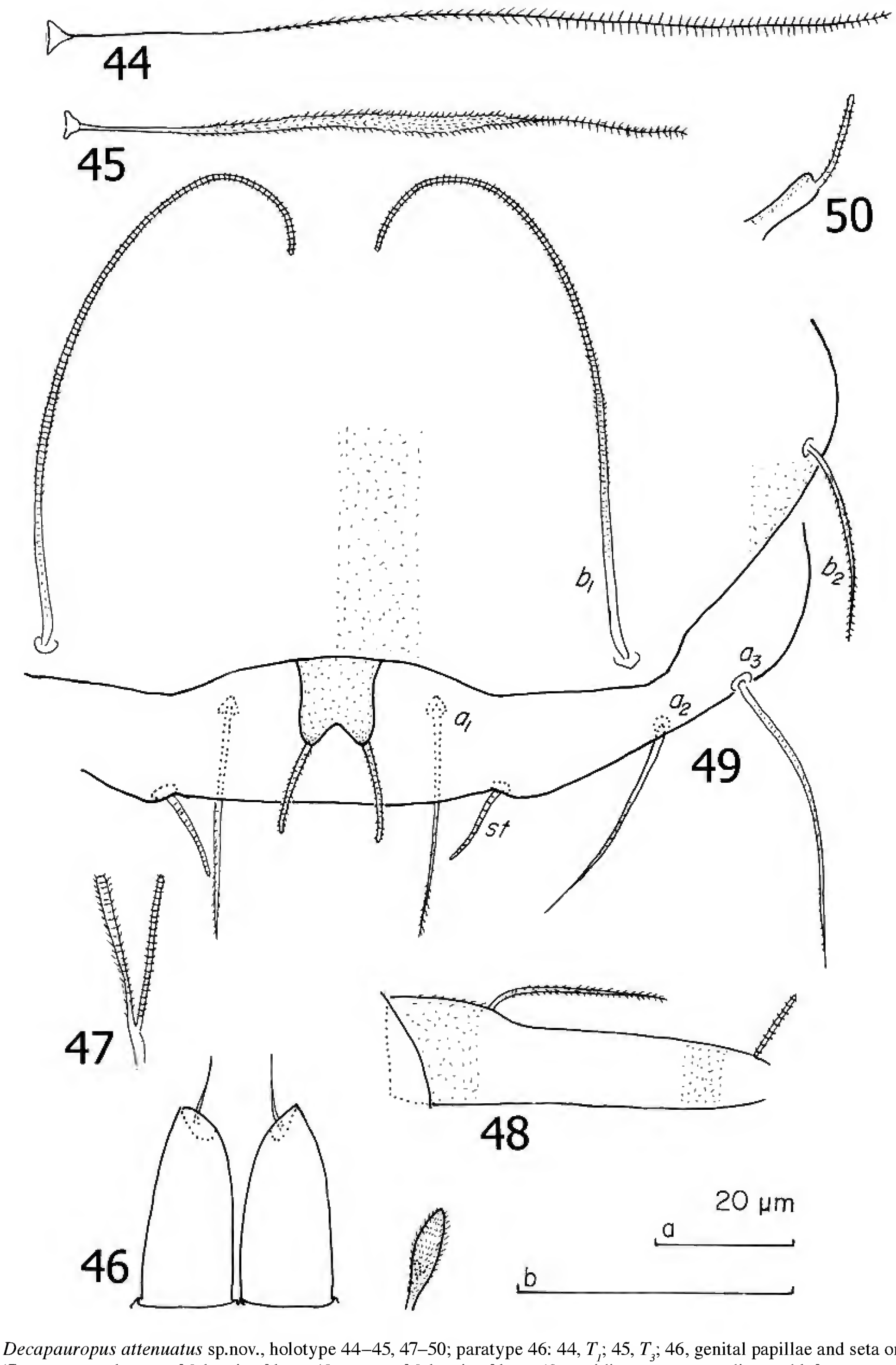
Paratypes. Locality as for holotype, in moss, 3 ad. 9 (2 male, 1 female), 1 subad. 8 (female), 9.iv.1989 (JD).

Other material. 10 specimens. Loc. 4, moss on log, 1 ad. 9 (female), 1 subad. 8 (female), 18.xi.1989 (HM). Loc. 7, rotten log, 1 ad. 9 (female), 17.v.1989 (JD). Loc. 11, moss on dead log, 1 ad. 9 (female), 21.iii.1989 (JD). Loc. 12, moss on log, 1 juv. 3, 9.xi.1989, and leaf litter, 2 ad. 9 (female), 9.iv.1989, and moss on dead log, 2 ad. 9 (male, female), 9.iv.1989 (PG), and in moss, 1 ad. 9 (female), 9.iv.1989 (JD).

Diagnosis. The affinities are difficult to trace but the species is well delineated by the combination of the following characters: rather long tergal head setae, anterior ones clavate; the T_3 with proximal 2/3 fusiform but very thin distally; the shape of the



Figs. 39–43. *Decapauropus attenuatus* sp.n., holotype: 39, head, median and right part, tergal view; 40, right temporal organ, posterior part, lateral view; 41, left antenna, tergal view; 42, collum segment, median and left part, sternal view; 43, tergite VI, posterior part. Scale line a for figures 39, 40, 42; b for figures 41, 43.



Figs. 44–50. *Decapauropus attenuatus* sp.nov., holotype 44–45, 47–50; paratype 46: 44, T_1; 45, T_3; 46, genital papillae and seta on coxa of 2nd pair of legs; 47, seta on trochanter of 9th pair of legs; 48, tarsus of 9th pair of legs; 49, pygidium, posteromedian and left part, sternal view; 50, anal plate, lateral view. Scale line a for figures 44–48; b for figures 49, 50.

anal plate with concave lateral margins, distal incision and two long appendages which are curved inwards.

Description. Length.-(0.56-)0.63(-0.74) mm.

Head.-Most tergal setae of medium length, some posterolateral rather long, anterior and submedian ones somewhat clavate, others cylindrical, striate, blunt but lateral group setae pointed. Relative lengths of setae, 1st row: a_1=10, a_2=10(-12); 2nd row: a_1=(11-)13, a_2=(14-)16(-18), a_3=(13-)16; 3rd row: a_1=11(-12), a_2=13(-15); 4th row: a_1=(14-)15(-16), a_2=19(-23), a_3=(17-)19, a_4=(13-)15(-16); lateral group setae: l_1=(22-)25, l_2=13(-18), l_3=?(22). The ratio a_1/a_1-a_1 in 1st row 1.0(-1.1), 2nd row (0.6-)0.7, 3rd row 1.0(-1.2) and 4th row 1.4(-1.7). Length of temporal organs 0.7(-0.9) of their shortest distance apart; small aperture in posterior part anterior of l_1. Head cuticle somewhat granular, temporal organs glabrous.

Antennae.-Segment 4 with five thin cylindrical striate setae; their relative lengths: p=100, p'= (71-)76(-78), p''=(22-)24(-28), p'''=11(-18), r=24(-27), u absent. Tergal seta p (1.4-)1.5(-1.6) times as long as tergal branch t. The latter fusiform, 2.8(-3.6) times as long as its greatest diameter and as long as sternal branch s, that branch (2.0-)2.2(-2.6) times as long as its greatest diameter; anterodistal corner of s truncate. Seta q cylindrical, striate, as long as (-1.2 times as long as) s. Antennal flagella often broken; relative lengths (basal segments included) and basal segments: F_1=100, bs_1=(6-)8; F_2=(78-81), bs_2=7; F_3=(80-92), bs_3=(6-)8. The F_1 2.8(-3.4) times as long as t, F_2 and F_3 ?(1.8-2.7) and (2.0-2.9) times as long as s respectively. (Antennal flagella broken in holotype). Distal calyces somewhat flattened; distal part of flagellar axes fusiform. Globulus g (1.2-)1.3 times as long as wide; nine bracts, capsule spherical; width of g 0.6(-0.8) of the greatest diameter of t. Antennae with short pubescence.

Trunk.-Setae of collum segment somewhat clavate, annulate, blunt, furcate, but with rudimentary glabrous blunt secondary branches; sublateral ones (1.8-)2.1(-2.6) times as long as submedian ones; sternite process triangular with small anterior incision; appendages obliquely barrel-shaped with flattened caps; process and basal segment of appendages with delicate pubescence.

Setae on anterior tergites cylindrical, annulate, blunt; on posterior tergites somewhat shorter, subcylindrical, tapering, with oblique pubescence. 4+4 setae on tergite I, 6+6 on II–IV, 6+4 on V, 4+2 on VI. Submedian posterior setae on VI (0.6–)0.7 of their distance apart and (0.8-)0.9 of the length of pygidial setae a_1. Tergites with short minute pubescence.

Relative lengths of bothriotricha: T_1=100, T_2=95(-101), T_3=(97-)112(-113), T_4=(107-)108(-130), T_5=(165-)167(-187), with simple straight axes, in all but T_3 very thin; the latter with proximal 2/3 thickened, fusiform, tapering into a thin distal 1/3. Pubescence hairs on T_1, T_2 and T_4 similar, hairs thin, straight, rather sparse, on proximal halves short and oblique, erect and longer distally. The T_5 with very short oblique pubescence.

Genital papillae (paratypes) subcylindrical, glabrous, 2.2(-2.3) times as long as their greatest diameter; seta 0.3(-0.4) of the length of organ.

Legs.-Setae on coxa and trochanter of leg 9 similar, furcate; branches striate, blunt, subequal in length, primary branch somewhat clavate, secondary branch cylindrical, these seta more anteriorly with blunt glabrous rudimentary secondary branches; setae on trochanter somewhat widened distally, those on coxa clavate. Coxal seta on leg 2 in male clavate too. Tarsus of leg 9 slender, 3.8(-4.3) times as long as its greatest diameter. Setae thin, proximal one tapering pointed, with oblique pubescence; distal one cylindrical, blunt, striate; proximal seta (0.4-)0.5 of the length of tarsus and (2.2-)2.5(-2.6) times as long as distal seta. Cuticle of tarsus with distinct pubescence.

Pygidium. Tergum.-Posterior margin between st rounded and with shallow median indentation. Relative lengths of setae: a_1=100, a_2=(100-)106(-113), a_3=(135-)137(-160), st=(60-)62(-80), setae thin, tapering, pointed, indistinctly striate, somewhat curved inwards, a_1 and a_3 with short pubescence distally; a_1 directed posteriorly, a_2 and st pointing inwards, a_3 somewhat pointing outwards. Distance a_1-a_1 0.9(-1.2) times as long as a_1; distance a_1-a_2 (1.5-)1.8 times as long as distance a_2-a_3; distance st-st (2.1-)2.4 times as long as st and (1.4-)1.6(-1.7) times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin between b_1 with a broad shallow indentation. Relative lengths of setae (a_1=100): b_1=(343-)362(-404), b_2=(80-)94(-100), setae thin, b_1 subcylindrical, tapering, striate, blunt; b_2 tapering, pointed, striate. The b_1 (1.3-)1.4(-1.5) times as long as their distance apart; b_2 (0.8-)0.9 of distance b_1-b_2. Anal plate as long as (-1.2 times as long as) broad, granular, broadest anteriorly, with somewhat indented lateral margins and posterior margin divided into two rounded lobes by a broadly V-shaped indentation; from posterosternal margin of the lobes protrude backwards two pointing outwards appendages slightly curving inwards, being 1.3(-1.6) times as long as the length of plate.

Stage subad. 8. The setae d_2 of pygidial tergum thin, straight, cylindrical, striate, 0.4 of the length of pygidial setae a_1; d_2-d_2 about 10 times longer than d_2.

Etymology.-From Latin *attenuatus* = drawn out, thin (T_3; setae of the pygidial tergum).

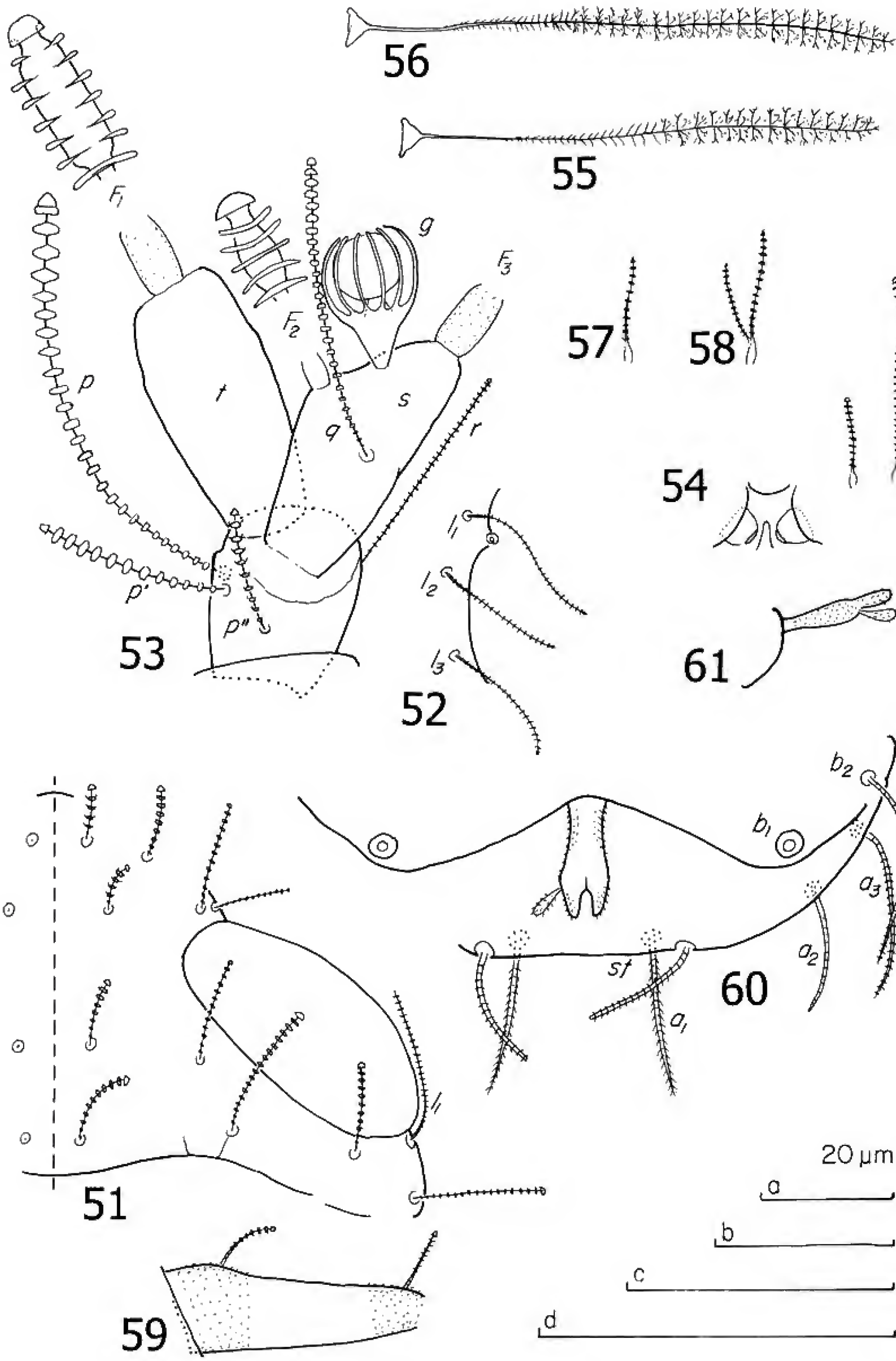
Distribution in Tasmania. Seems to be a rare species collected in the eastern parts only.

Decappauropus ungulatus sp. nov.

(Figs. 51–61)

Material Examined. Holotype. Ad. 9 (female), Rivaux Creek, Loc. 16, (43°10'S, 146°38.6'E), litter, 20.xii.1988 (PG).

Diagnosis. A single adult specimen is available but the singular shape of the anal plate in combination with the unusual shape of the antennal setae, the very small collum process and appendages and the arrangement and shape of the pubescence on the bothriotricha, make it well defined. It has some similarity with *D. fibratus* Scheller from Sri Lanka (Scheller 1970), but the T_3 and the anal plate are dissimilar (the former with distal swelling in *D. fibratus*, not in *D. ungulatus*; the appendages of the anal plate short, cylindrical and glabrous in *D. fibratus*, distinctly longer, clavate and pubescent in *D. ungulatus*).



Figs. 51–61. *Decapauropus ungulatus* sp.nov., holotype: 51, head, median and right part, tergal view; 52, temporal organ, posterolateral part, lateral view; 53, left antenna, sternal view; 54, collum segment, median and left part, sternal view; 55, T_1; 56, T_3; 57, seta on coxa of 9th pair of legs; 58, seta on trochanter of 9th pair of legs; 59, tarsus of 9th pair of legs; 60, pygidium, posterior and left part, sternal view; 61, anal plate, lateral view. Scale line a for figures 55, 56; b for figures 51, 52, 54, 57–59; c for figures 60, 61; d: 53.

Description. Length.-0.66 mm.

Head.-Tergal setae annulate, blunt, submedian ones somewhat clavate, lateral ones cylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=13; 2nd row: a_1=8, a_2=20, a_3=15; 3rd row: a_1=12, a_2=20; 4th row: a_1=a_3=17, a_2=26, a_4=19: lateral group setae: l_1=30, l_2=l_3=27. The ratio a_1/a_1-a_1 in 1st row 1.0, 2nd row 0.5, 3rd row 0.9, 4th row 1.7. Temporal organs oval in tergal view, their length 1.1 times as long as their distance apart; small aperture outside posterior margin anterior of l_1. Head cuticle and temporal organs glabrous.

Antennae.-Segment 4 with 4 annulate setae: *p*, *p*' and *p*'' somewhat clavate and distinctly annulate, *r* cylindrical; their relative lengths: *p*=100, *p*'=44, *p*''=30, *r*=52. Neither *p*''', nor *u*. Tergal seta *p* 1.7 times as long as the length of tergal branch *t*. The latter somewhat fusiform, 2.1 times as long as its greatest diameter and as long as sternal branch *s*, that branch twice as long as its greatest diameter; anterodistal corner of *s* deeply truncate. Seta *q* subcylindrical, annulate, blunt, 1.2 times as long as *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=7; F_2=34, bs_2=4; F_3=?, bs_3=7. The F_1 4.3 times as long as *t*, F_2 1.3 times as long as *s*. Distal calyces of F_1 subhemispherical, those of F_2 flattened. Distal part of flagella axes thickened, cylindrical in F_1, fusiform in F_2. Globulus *g* proportionally large, 1.5 times as long as wide; 10 bracts; capsule spherical; width of *g* 0.8 of the greatest diameter of *t*. Antennae glabrous.

Trunk.-Setae of collum segment cylindrical, annulate, blunt; rudiments of secondary branches not clear. Sublateral setae 2.3 times as long as submedian ones; sternite process very small and narrow; appendages subcylindrical with small flattened caps. Process and appendages glabrous.

Setae on tergites not studied.

Relative lengths of bothriotricha: T_1=100, T_2=108, T_3=117, T_4=127, T_5=148; with simple, straight axes, somewhat thickened in T_3 only. Pubescence on proximal half of T_1-T_4 simple, oblique, increasing in length outwards, more distally longer, branched, arranged in whorls; T_5 with short oblique pubescence of simple hairs.

Legs.-Setae on coxa and trochanter of leg 9 cylindrical, annulate, pointed; the former simple and the latter furcate with secondary branch somewhat shorter than primary branch, these setae of legs 1-8 simple. Tarsus of leg 9 distinctly tapering, 2.9 times as long as its greatest diameter. Setae cylindrical, annulate, blunt; proximal one 0.3 of the length of tarsus and 1.1 times as long as distal seta. The latter more densely annulate than the former. Cuticle of tarsus with short pubescence.

Pygidium. Tergum.-Posterior margin between *st* straight. Relative lengths of setae: a_1=100, a_2=83, a_3=126, *st*=79, setae thin, cylindrical, striate, all but *st* directed posteriorly, pointed; *st* blunt, pointing inwards; a_1 curved outwards and somewhat pointing outwards, a_2 and a_3 curved inwards. Distance a_1-a_1 0.8 of the length of a_1; distance a_1-a_2 1.3 times as long as distance a_2-a_3; distance *st*-*st* 1.6 times as long as *st* and 1.5 times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin between b_1 with deep broadly V-shaped indentation. Relative lengths of setae (a_1=100): b_1=?, b_2=125. The b_2 as pygidial a_3, 1.9 times as long as distance b_1-b_2. Anal plate 2.4 times as long as broad with concave lateral margins and decreasing in width in distal 1/3, posterior margin with a deep median incision with parallel sides; two clavate pointing outwards appendages protrude posteriorly from sternal side; their length 0.3 of the length of plate; lateral margins and appendages with short pubescence.

Etymology.-From Latin *ungula* = hoof (shape of the anal plate).

Distribution in Tasmania. Probably rare, distribution outside the type locality unknown.

Decapauropus convexus sp. nov.

(Figs. 62–71)

Material Examined. Holotype. Subad. 8 (female), Savage River, Loc. 1, (41°18.5'S, 145°16.3'E), soil core, 21.iv.1989 (JD).

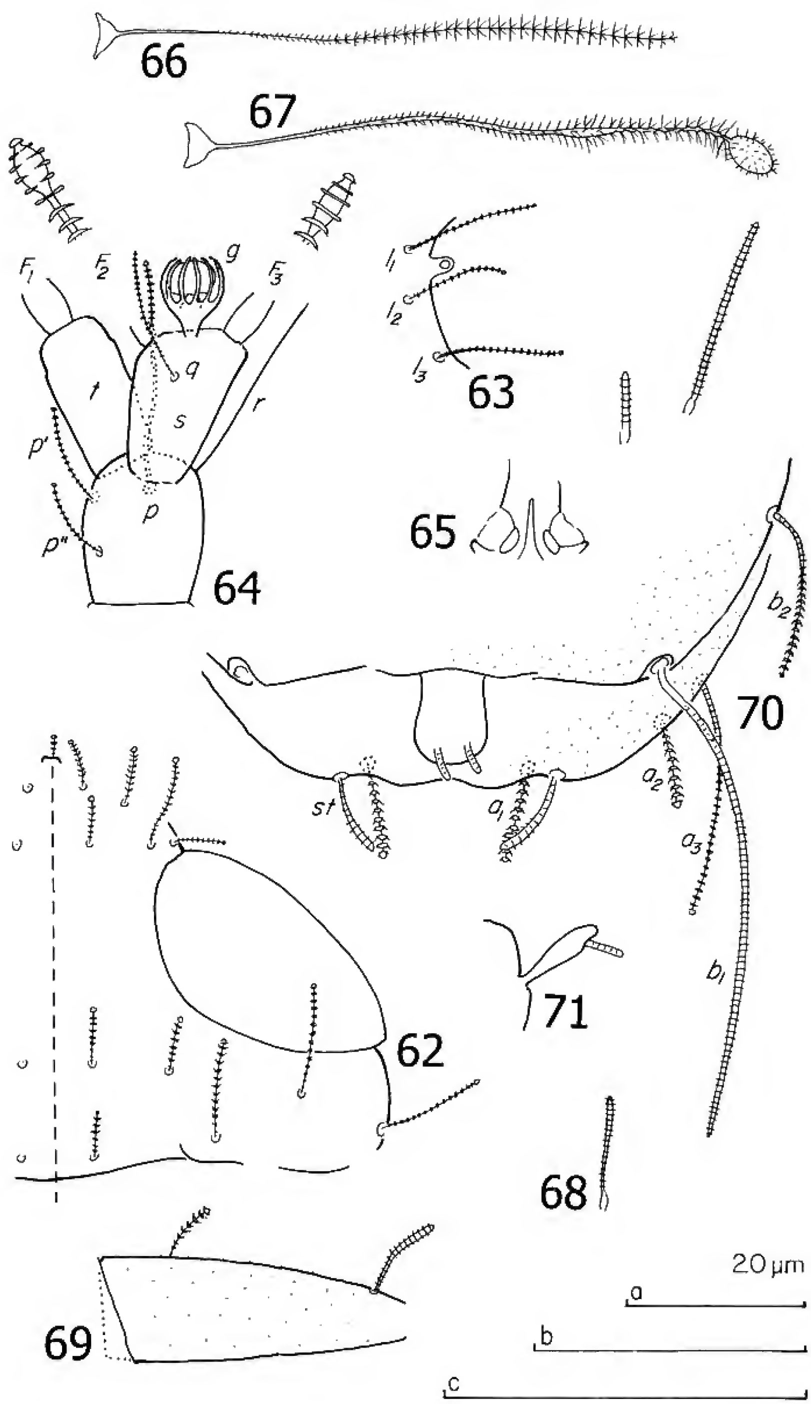
Paratype. Same data as holotype, 1 subad. 8 (male).

Diagnosis. Decapauropus convexus shows superficial similarities in the shape of the T_3 and some pygidial characters with three species described by Remy: *D. burghardti* (1941) from France, *D. pachypus* (1948) from the Ivory Coast and *D. zaianus* (1952a) from Spain and Morocco. Good distinguishing characters in relation to *burghardti* are the tergal antennal branch 1.7–1.8 times longer than wide, not long and slender; the distal swelling of T_3 well delineated from the bothriotrix axis, axis not slowly becoming thicker distally; the posterior margin of the pygidial tergum has a shallow median indentation between the *st*, not a distinct rounded lobe. *Decapauropus convexus* can be distinguished from *D. pachypus* by the subspherical antennal globulus, not longish, the proportionately longer tarsi, by the posteromedian indentation in the pygidial tergum, not a triangular projection; and by the thin appendages of the anal plate, not thick and clavate. Distinguishing characters in relation to *D. zaianus* are the size of the antennal globulus, the length of which is about half of the length of sternal branch *s*, not 0.7 of that length, the shape of the distal swelling of the T_3 which is ovoid, not longish and subcylindrical; and the number of appendages of the anal plate, being two not four. *D. convexus* has some similarity too with *D. insignis* Remy, 1961 from India, but is distinguished especially by the much smaller antennal globulus, the proportionately shorter and thicker tergal antennal branch and by the the shape of the seta *st* which are curved and somewhat clavate, rather than straight and lanceolate.

Description. Length.-0.48(-0.50) mm.

Head.-Most tergal setae short, posterolateral ones of medium length, subcylindrical, densely annulate, blunt; relative lengths of setae (holotype only), 1st row: a_1=10, a_2=12; 2nd row: a_1=10, a_2=20, a_3=12; 3rd row: a_1=10, a_2=13; 4th row: a_1=10, a_2=23, a_3=a_4=24; lateral group setae: l_1=30, l_2=24, l_3=32. The ratio a_1/a_1-a_1 0.8 in 1st row, 0.6 in 2nd and 4th rows and 0.7 in 3rd row. Temporal organs large; their length in tergal view 1.2 times as long as their shortest distance apart; small aperture in posterior margin on a level with l_1. Head cuticle glabrous.

Antennae.-Segment 4 with four subcylindrical annulate setae, *p*, *p*' and *p*'' blunt, *r* pointed; their relative lengths: *p*=100,



Figs. 62–71. *Decapauropus convexus* sp.nov., holotype: 62, head, median and right part, tergal view; 63, temporal organ, posterior part, lateral view; 64, left antenna, sternal view; 65, collum segment, median and left part, sternal view; 66, T_1; 67, T_3; 68, seta on trochanter of 9th pair of legs; 69, tarsus of 9th pair of legs; 70, pygidium, posterior and left part, sternal view; 71, anal plate, lateral view. Scale line a for figures 62, 63, 66, 67; b for figures 64, 65, 68, 69; c for figures 70, 71.

p'=44(-47), p''=28(-30), r=(72-)75 and 80. The p''' rudimentary, u absent. Tergal seta p 1.6(-1.8) times as long as tergal branch t. The latter subcylindrical, (1.7-)1.8 times as long as its greatest diameter and 0.9 of the length of sternal branch s; that branch 1.7 times as long as its greatest diameter; anterodistal corner of s truncate. Seta q subcylindrical, annulate, blunt, 0.8(-0.9) of the length of s. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=7; F_2=(41-)42, bs_2=4; F_3=(79-)81, bs_3=7(-8). The F_1 4.9(-5.4) times as long as t, F_2 and F_3 (1.8-)1.9 and (3.6-)3.7 times as long as s respectively. Distal calyces small subhemispherical; distal part of flagella axes somewhat fusiform in F_1 and F_3, distinctly fusiform in F_2. Globulus g spherical with thin stalk, 1.2 times as long as wide; about nine bracts, capsule subspherical with somewhat flattened bottom; width of g 0.5 of the greatest diameter of t. Antennae glabrous.

Trunk.-Setae of collum segment cylindrical, striate, blunt, rudiments of secondary branches probably absent; sublateral setae 2.5 times as long as submedian ones; sternite process very narrow; appendages small with rounded caps; process and appendages glabrous.

Setae on tergites thin, cylindrical, annulate, blunt and of the same length on all tergites; 4+4 setae on tergite I, 6+6 on II–IV, 4+4 on VI. Relative lengths of bothriotricha (holotype only): T_1=T_3=100, T_2=107, T_5=135, with thin, simple, straight axes, T_3 with distal swelling. Pubescence hairs on T_5 and on proximal 1/3 of T_1, T_2, T_3 and on T_4 oblique; on T_1, T_2 and T_4 pubescence erect, sparse and whorled in outer 2/3; also on outer half of T_3, pubescence on distal swelling somewhat shorter than on the axis below it.

Genital papillae (paratype) small, conical, blunt.

Legs.-Setae on coxa and trochanter of leg 8 simple, cylindrical, striate, blunt; more anteriorly similar but coxal setae somewhat thicker than those on trochanter. Tarsus of leg 8 short, strongly tapering, (2.8)3.0 times longer than its greatest diameter. Setae cylindrical, blunt, proximal one annulate, distal one striate; proximal seta 0.2 of the length of tarsus and 0.6 of the length of distal seta. Tarsus with very delicate pubescence.

Pygidium. Tergum.-Posterior margin between st with two low submedian lobes separated by a shallow median indentation. Relative lengths of setae: a_1=100, a_2=93(96), a_3=241(250), st=93(115), setae blunt, a_1 and a_2 subcylindrical, straight, annulate, the former pointing inwards, the latter pointing outwards; a_3 and st curved inwards, the former cylindrical and annulate, the latter somewhat clavate, striate, pointing inwards. Distance a_1-a_1 (1.4)1.6 times as long as a_1; distance a_1-a_2 (2.3)2.6 times as long as distance a_2-a_3; distance st-st (2.1)2.2 times as long as st and 1.3(1.6) times as long as distance a_1-a_1. Cuticle almost glabrous.

Sternum.-Posterior margin between b_1 somewhat indented. Relative lengths of setae (a_1=100): b_1=463(490), b_2=185(192). The b_1 cylindrical, densely striate, blunt; b_2 as a_3 of pygidial sternum. The b_1 (1.1)1.2 times as long as their distance apart; b_2 0.9 of distance b_1-b_2. Cuticle sparsely pubescent. Anal plate subrectangular with slightly concave lateral margins and rounded posterolateral corners, 1.2 times as long as broad, glabrous; two parallel cylindrical and blunt appendages protrude backwards from posterior part of sternal side; length of appendages 0.5 of the length of the plate.

Etymology.-From Latin *convexus* = well rounded (at the top, posterior part of the anal plate).

Distribution in Tasmania. Known from a single site in north-eastern Tasmania.

Decapauropus saltuarius sp. nov.

(Figs. 72–81)

Material Examined. Holotype. Ad.9 (male), Bruny Island, Mount Mangana, Loc. 12, (147°17.0'S, 43°22.1'E), in moss, 9.iv.1989 (JD).

Paratypes. 3 specimens. Cradle Mountain, Loc. 4, (41°35.4'S, 145°55.9'E), in moss on log, 1 ad. 9 (female), 1 juv. 6, 18.xi.1989 (HM).

Diagnosis. This species is well defined by the shape of the anal plate and the combination of good characters in the antennae (t and s of the same length, anterior truncation of s inconsiderable) and the last pair of legs (tarsus somewhat bow-shaped, pubescent and with very thin setae). Since many of these characters are widespread and shared with several other species, the relationships are difficult to discern.

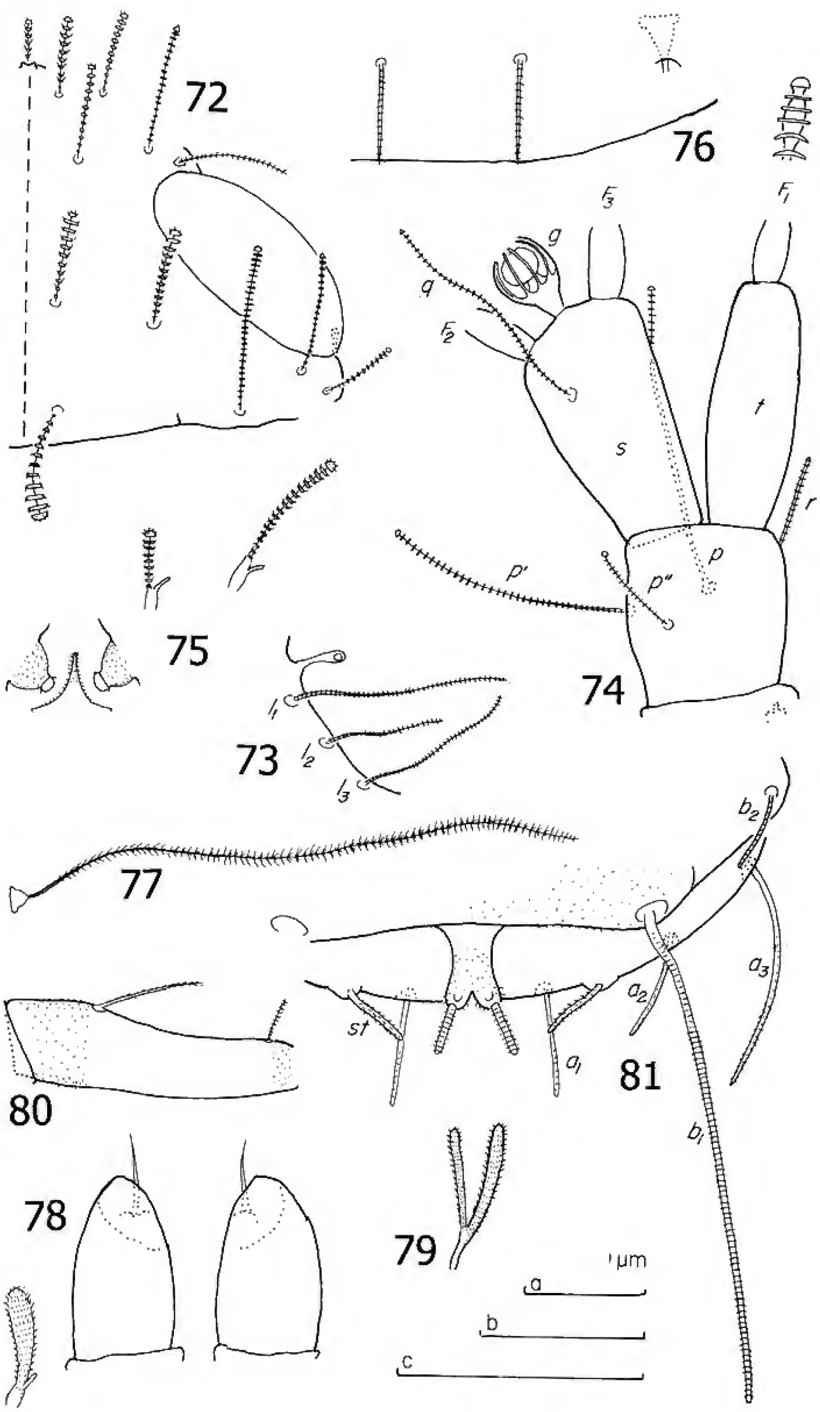
Description. Length.-0.64 mm.

Head.-Tergal setae annulate blunt, of medium length, a_2 of 4th row long; lateral and sublateral ones subcylindrical, submedian ones clavate. Relative lengths of setae, 1st row: a_1=10, a_2=11; 2nd row: a_1=12, a_2=a_3=15; 3rd row: a_1=11, a_2=12; 4th row: a_1=14, a_2=20, a_3=14, a_4=10; lateral group setae: l_1=32, l_2=15, l_3=20. The ratio a_1/a_1-a_1 in 1st row 1.4, 2nd row 1.0, 3rd row 1.4 and 4th row 1.5. Temporal organs oval in tergal view, as long as their distance apart; small aperture in an anterior position of l_1. Head cuticle almost glabrous.

Antennae.-Segment 4 with five cylindrical setae, all but p''' annulate-striate blunt; p''' very thin with delicate pubescence. Relative lengths of setae: p=100, p'=84, p''=34, p'''=10, r=32; u absent. Tergal seta p 1.2 times as long as tergal branch t. The latter fusiform, 2.7 times as long as its greatest diameter and as long as sternal branch s; that branch 1.8 times as long as its greatest diameter; anterodistal corner of s truncate. Seta q cylindrical, annulate, somewhat tapering, as long as s. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=8; F_2=61, bs_2=8; F_3=86, bs_3=9. The F_2 thinnest; F_1 3.3 times as long as t, F_2 and F_3 2.0 and 2.8 times as long as s respectively. Distal calyces subhemispherical; distal part of flagella axes fusiform. Globulus g 1.4 times as long as wide; about nine bracts, capsule subspherical; width of g 0.7 of the greatest diameter of t. Antennae almost glabrous.

Trunk.-Setae of collum segment subcylindrical, annulate, blunt, furcate, but with rudimentary glabrous blunt secondary branches; sublateral ones twice as long as submedian ones; sternite process thin pointed; appendages subconical with rounded caps with collar; process and basal segment of appendages with distinct but short, erect pubescence.

Setae on tergites thin, cylindrical, annulate-striate insignificantly decreasing in length posteriorly; 4+4 setae on tergite I, 6+6 on II-IV, 6+4 on V, 4+2 on VI. Submedian



Figs. 72–81. *Decapauropus saltuariusr* sp.nov., holotype: 72, head, median and right part, tergal view; 73, temporal organ, posterior part, lateral view; 74, left antenna, sternal view; 75, collum segment, median and left part, sternal view; 76, tergite VI, posterior part; 77, T_3; 78, genital papillae and seta on coxa of 2nd pair of legs; 79, seta on trochanter of 9th pair of legs; 80, tarsus of 9th pair of legs; 81, pygidium, posterior and left part, sternal view: Scale line a for figures 77, 80; b for figures 72, 73, 75, 76, 78, 79; c for figures 74, 81.

posterior setae on VI 0.7 of their distance apart and 1.3 times as long as pygidial setae a_1. Tergites glabrous. Relative lengths of bothriotricha: T_1=100, T_2=104, T_3=108, T_4=129, T_5=166, axes thin, simple, straight, thickest in T_3. Pubescence hairs short oblique on proximal parts and on almost the whole T_5, more outwards longer erect, strongest on T_3.

Genital papillae oviform, glabrous, 1.7 times as long as their greatest diameter; seta about 0.5 of the length of organ.

Legs.-Setae on coxa and trochanter of leg 9 similar, furcate, branches subequal in length; main branch thick, blunt, with short pubescence in whorls; secondary branch similar but thinner, somewhat clavate, more anteriorly, with glabrous blunt rudiments of the secondary branches. Coxal seta on leg 2 in male not deviating. Tarsus of leg 9 somewhat curved, 3.6 times as long as its greatest diameter. Setae thin, proximal one tapering and pointed with short depressed pubescence, distal one cylindrical striate; proximal seta 0.4 of the length of tarsus and 2.5 times as long as distal seta. Cuticle of tarsus with short pubescence.

Pygidium. Tergum.-Posterior margin between *st* evenly rounded. Relative lengths of setae: $a_1=a_2$=100, a_3=222, *st*=67. These setae cylindrical, blunt, indistinctly striate; a_1 straight and somewhat pointing outwards, a_2 and a_3 curved inwards, the former also pointing inwards, *st* straight and pointing inwards. Distance a_1-a_1 1.2 times as long as a_1; distance a_1-a_2 1.2 times as long as distance a_2-a_3; distance *st*-*st* 3.5 times as long as *st* and 1.9 times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin between b_1 almost straight. Relative lengths of setae (a_1=100): b_1=455, b_2 about 130; setae cylindrical blunt striate. The b_1 1.4 times as long as their distance apart; b_2 about 0.5 of distance b_1-b_2. Anal plate 1.5 times as long as broad, with convex lateral margins and a V-shaped posterior incision separating two short, subcylindrical posterolateral lobes; from distal part of lobes, two straight, cylindrical, blunt, outwardly pointing appendages, 0.6 of the length of the plate; anterior part of plate glabrous, posterior part shortly pubescent, appendages distinctly striate, anterior of each base of appendage a small sternal knob.

Etymology.-From Latin *saltuarius* = of the forest.

Distribution in Tasmania. Found on two widely separated sites.

Decapauropus terrestris sp. nov.

(Figs. 82–93)

Material Examined. Holotype. Ad.9 (female), Savage River Pipeline Road, Loc. 1, (41°18.5'S, 145°16.3'E), soil core, 21.iv.1989 (JD).

Paratypes. Frodshams Pass, Loc. 9, (42°49.7'S, 146°22.9'E), soil core, 2 ad. 9 (female), 20.x.1989 (RC).

Other material. 2 specimens. Loc. 9, soil core, 1 juv. 3, 20.x.1989 (RC). Loc. 5, soil core, 1 ad. 9 (male), 22.xi.1989 (HM).

Diagnosis. The shape of the antennae and the anal plate indicate that the new species is related to *D. vicinus* Remy from Madagascar (Remy 1956c). They can be reliably distinguished as in *A. terrestris* there is a large semicircular lobe between the *st* (not in *vicinus*), the *st* are thin and cylindrical (not broad distally) and the anal plate narrows anteriorly (not the opposite).

Description. Length.-(0.59-)0.61 mm.

Head.-Tergal setae of short to medium length, subcylindrical, densely annulate, blunt. Relative lengths of setae, 1st row: a_1=10, a_2=(9-)11; 2nd row: a_1=(7-)8, a_2=(16-)20, a_3=(13-)17; 3rd row: a_1=14, a_2=(13-)18; 4th row: a_1=(7-)10, a_2=?(18), a_3=(15-)20, a_4=18(-19); lateral group setae: l_1=?, l_2=17, l_3=18. The ratio a_1/a_1-a_1 in 1st row 0.9(-1.0), 2nd row (0.4-)0.5, 3rd row 0.9 and 4th row 1.0(-1.3). Temporal organs oval in tergal view, their length 1.5 times as long as their shortest distance apart; an unusually large aperture inside posterior margin on a level with l_1. Head cuticle glabrous.

Antennae.-Segment 4 with 5 cylindrical annulate blunt setae; their relative lengths: *p*=100, *p*'=43(-50), *p*''=28(-29), *r*=(45-)46. The *p*''' rudimentary, *u* absent. Tergal seta *p* (1.5-)1.6 times as long as tergal branch *t*. The latter fusiform, 2.0(-2.2) times as long as its greatest diameter and as long as sternal branch ***s*;** that branch directed downwards and (1.7-)1.8 times as long as its greatest diameter; anterodistal corner of *s* only a little more truncate than posterior one. Seta *q* cylindrical annulate blunt, 1.2 times as long as *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=5(-6); F_2=35(-37), bs_2=4(-5); F_3=(83-)85, bs_3=5. The F_1 (5.3-)5.6 times as long as *t*, F_2 and F_3 1.8(-1.9) and 4.4 times as long as *s* respectively. Distal calyces subhemispherical; distal part of flagellar axes fusiform. Globulus *g* proportionately large, 1.4 times as long as wide; 15 bracts and capsule bottom flattened; width of *g* 1.1 times as long as the greatest diameter of *t*. Antennae glabrous.

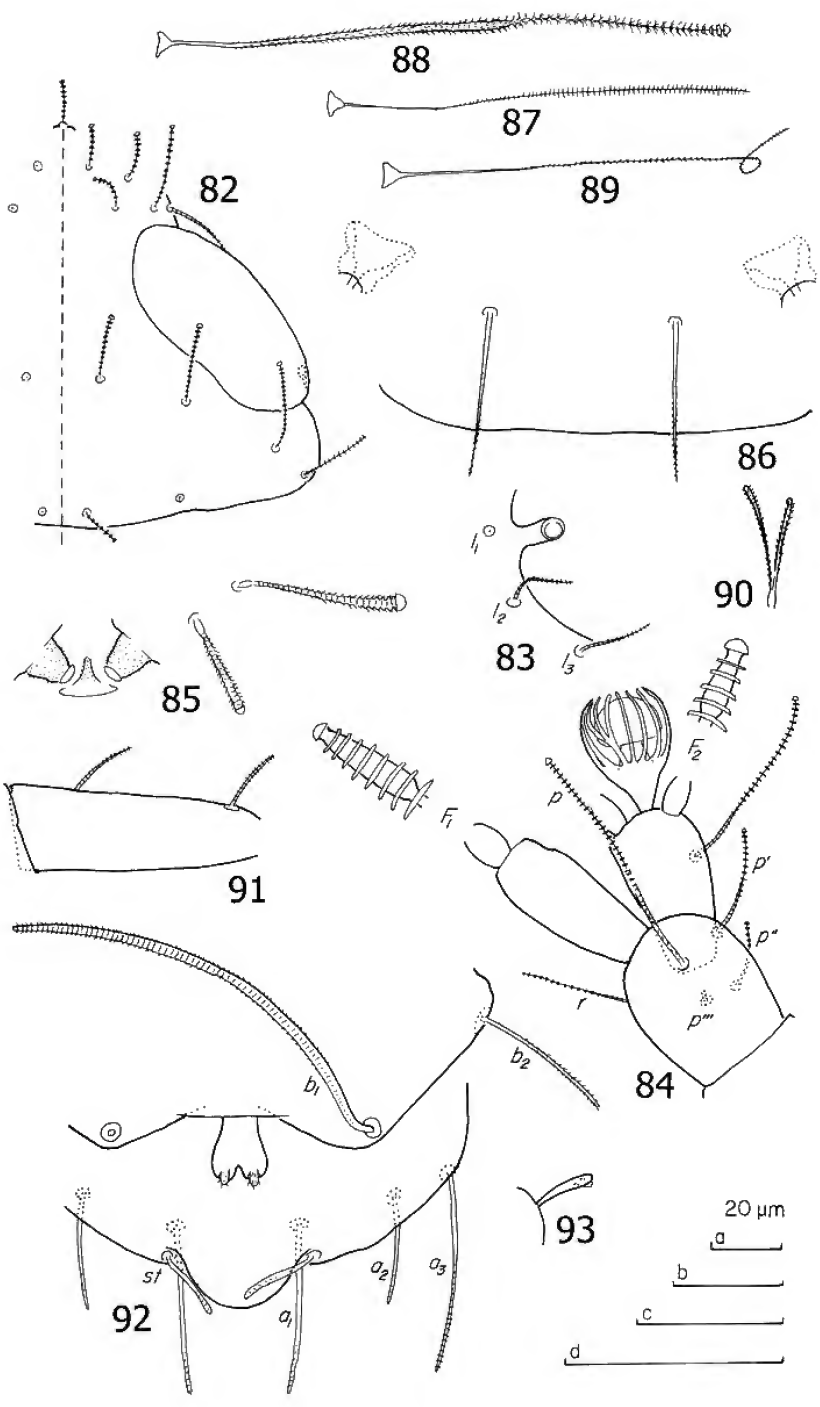
Trunk.-Setae of collum segment clavate, densely annulate-striate, distal segment large, hemispherical, rudiments of secondary branches probably absent. Sublateral setae 1.8 times as long as submedian ones; sternite process triangular, blunt; appendages narrowing distally and with flat caps; process and basal segment of appendages with distinct, almost erect, short pubescence.

Setae on tergites thin, cylindrical, on anterior tergites as on head, on posterior tergites tapering pointed with short pubescence distally; 4+4 setae on tergite I, 6+6 on II–IV, 6+4 on V, 4+2 on VI. Submedian posterior setae on VI (0.8-)0.9 of their distance apart and about as long as pygidial setae a_1. Tergites glabrous.

Relative lengths of bothriotricha: T_1=100, T_2=106(-113), T_3=(127-)135, T_4=(112-)140, T_5=166(-170), all with simple straight axes, very thin except in proximal 2/3 of T_3; T_3 with whip-like distal half; pubescence thin erect except on T_3, there oblique on thickened part, more distally erect and in distinct whorls, most distal part annulate with a subhemispherical distal segment. A specimen from Mount Victoria with T_3 thinner, without widened distal segment.

Legs.-Setae on coxa and trochanter of leg 9 similar, furcate with subcylindrical blunt branches. Tarsus of leg 9 short, somewhat tapering, 2.8 times as long as its greatest diameter. Setae subsimilar, thin, cylindrical, striate; their length 0.2 of the length of tarsus. Cuticle of tarsus with very delicate pubescence.

Pygidium. Tergum.-Posterior margin between *st* with large semicircular lobe. Relative lengths of setae: a_1=100, a_2=73(-80),



Figs. 82–93. *Decapauropus terrestris* sp.nov., holotype: 82, head, median and right part, tergal view; 83, temporal organ, posterolateral part, lateral view; 84, left antenna, tergal view; 85, collum segment, median and left part, sternal view; 86, tergite VI, posterior part; 87, T_1; 88, T_3; 89, T_5; 90, seta on trochanter of 9th pair of legs; 91, tarsus of 9th pair of legs; 92, pygidium, median and left part, sternal view; 93, anal plate, lateral view. Scale line a for figure 88; b for figures 86, 87; c for figures 82, 83, 85, 90, 91; d for figures: 84, 89, 92, 93.

a_3=127(-140), *st*=47(-60); setae almost straight, blunt; a_1, a_2 and a_3 directed posteriorly, *st* pointing inwards, almost glabrous except a_3 being striate in distal half. Distance a_1-a_1 1.4 times as long as a_1; distance a_1-a_2 (1.3-)1.4 times as long as distance a_2-a_3; distance *st-st* (1.5-)1.8 times as long as *st* and 1.2 times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin between b_1 with a broad indentation below anal plate. Relative lengths of setae (a_1=100): b_1=(253-)287, b_2=93(-107), setae cylindrical, b_1 densely striate, b_2 with short, oblique pubescence. The b_1 (1.6-)1.8 times as long as their distance apart; b_2 as long as distance b_1-b_2. Anal plate narrowest anteriorly and with somewhat concave lateral margins, being 1.2 times as long as broad and with two short, rounded, posterior lobes separated by a V-shaped incision; the plate glabrous and with two very short, cylindrical, blunt, shortly pubescent appendages on the sternal side of the posterior lobes.

Etymology.-From Latin *terra, terrestris* = of the earth (soil living).

Distribution in Tasmania. Seems to be a rare but very widely distributed species.

Genus *Nesopauropus* Scheller

Type species: *Nesopauropus ceylonicus* (Scheller, 1970): 63-65, fig. 29.

Nesopauropus tasmaniensis sp.nov.

(Figs. 94–104)

Material examined. *Holotype*. Ad.9 (female), Mount Michael, Loc. 6, (41°10.9'S,148°00.4'E), soil core, 11.xi.1989, (RC).

Diagnosis. *Nesopauropus tasmaniensis* is the sixth species in the genus. It is easily distinguished from the previously described species, three from Sri Lanka (Scheller 1970) and two from the Seychelles (Scheller 1982), by the shape of the anal plate: very short, blunt, parallel, posterior appendages and in between a distinct median incision. Disregarding the very dissimilar anal plate, the new species may have most in common with two species from Sri Lanka, *subtilis* Scheller and *unifibratus* Scheller (Scheller 1970).

Description. *Length*.-0.63 mm.

Head.-Tergal setae annulate, submedian ones rather short, somewhat clavate, sublateral and lateral ones at least of medium length, subclavate-cylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=14; 2nd row: a_1=10, a_2=25, a_3=22; 3rd row: a_1=10, a_2=17; 4th row: a_1=11, a_2=?, a_3=?, a_4=18; lateral group setae: l_1=30, l_2=28, l_3=25. The ratio a_1/a_1-a_1 in 1st row 0.9, 2nd row 0.5, 3rd row 0.8 and 4th row 1.3. Temporal organs oval in tergal view, 1.2 times as long as shortest distance apart; small aperture at posterior margin. Head cuticle glabrous.

Antennae.-Segment 4 with four subclavate-subcylindrical annulate blunt setae; their relative lengths: *p*=100, *p*'=34, *p*''=18, *r* about 16. Neither *p*''' nor *u*. Tergal seta *p* 1.8 times as long as tergal branch *t*. The latter fusiform, 2.3 times as long as its greatest diameter and 1.1 times as long as sternal branch *s* which is 1.6 times as long as its greatest diameter; anterodistal corner of *s* truncate. Seta *q* somewhat clavate, annulate, blunt, about 1.2 times as long as *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=8; F_2=35, bs_2=5; F_3=88, bs_3=7. The F_1 4.6 times as long as *t*, F_2 and F_3 1.8 and 4.4 times as long as *s* respectively. Distal calyces subhemispherical, on F_2 and F_3 very small; distal part of flagella axis fusiform. Globulus *g* 1.3 times as long as wide; 10 bracts and capsule subspherical; width of *g* 0.9 of the greatest diameter of *t*. Antennae glabrous.

Trunk.-Setae of collum segment simple, somewhat clavate, annulate, blunt. Sublateral ones 1.7 times as long as submedian ones; sternite process very small pointed; appendages proportionally large, almost cylindrical with subhemispherical caps; process and basal segment of appendages with distinct almost erect pubescence.

Tergites II and III weakly divided transversally, II between the groups of setae (two groups of setae, 6+6) and III more posteriorly (two groups of setae, 8+4). Setae on tergites thin, (sub)cylindrical, annulate, blunt, not decreasing in length posteriorly; 4+4 setae on tergite I, 6+6 on II–V, 4+2 on VI. Submedian posterior setae on VI 0.8 of their distance apart and 0.8 of the length of pygidial setae a_1. Tergites glabrous.

Relative lengths of bothriotricha: T_1=100, T_2=119, T_3=110, T_4=85, T_5=159; setae with thin, simple, straight axes, the proximal half of T_3 and T_5 thickest. Pubescence hairs on T_5 and on proximal 1/4 of the others short oblique, on distal 2/3 of T_1-T_4 much longer, branched and arranged in whorls.

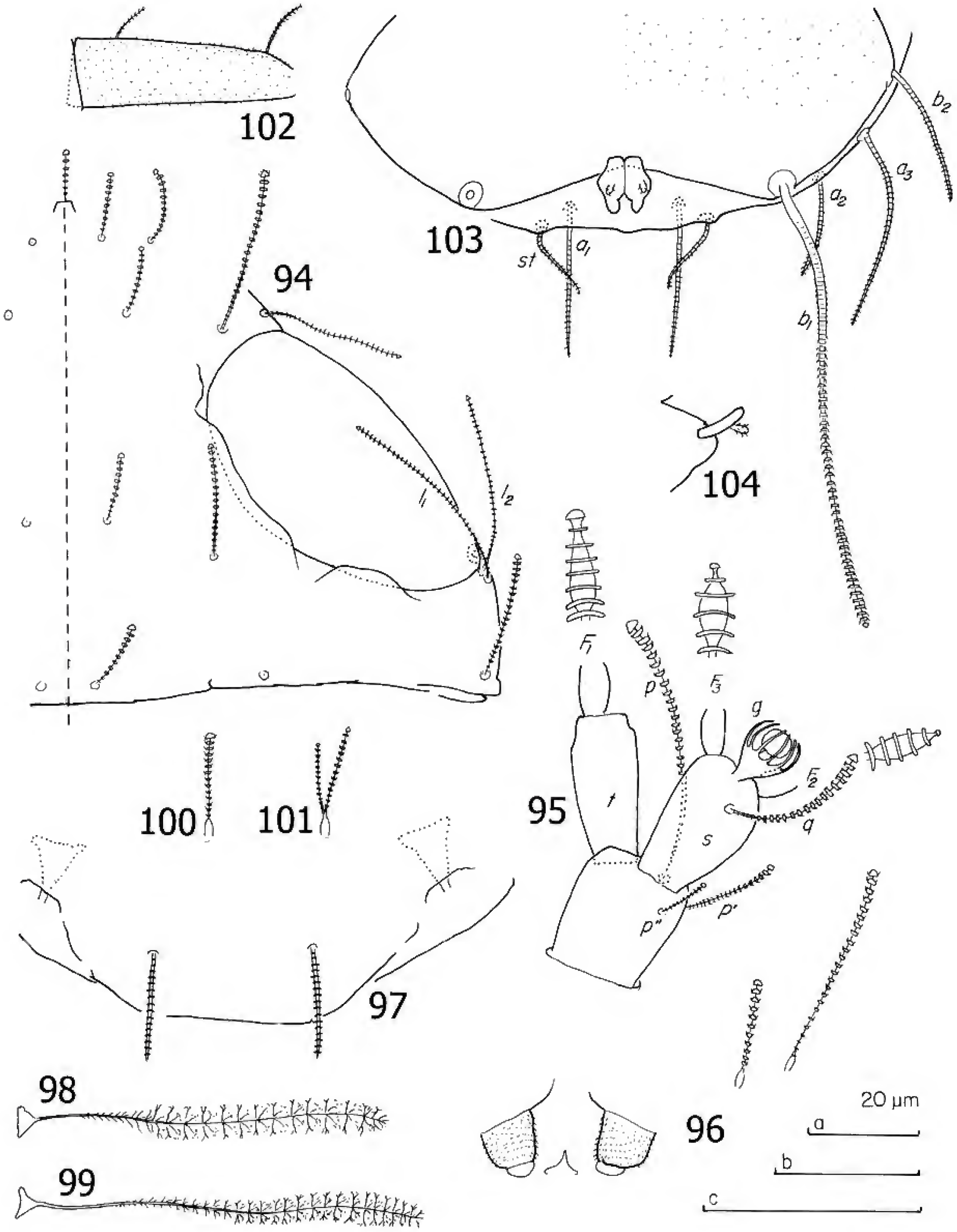
Legs.-Setae on coxa and trochanter of legs 1–8 and seta on coxa of leg 9 simple, somewhat clavate, annulate, blunt; seta on trochanter of leg 9 furcate, branches cylindrical, annulate, secondary branch somewhat thinner and shorter than primary branch. Tarsus of leg 9 tapering, 3.2 times as long as its greatest diameter. Setae subcylindrical, densely annulate, proximal seta 0.2 of the length of tarsus and 0.7 of the length of distal seta; the latter thicker than proximal seta. Cuticle of tarsus with minute pubescence.

Pygidium. *Tergum*.-Posterior margin between *st* almost straight. Relative lengths of setae: a_1=10, a_2=64, a_3=129, *st*=57; setae tapering, pointed, striate; a_1 almost straight, a_2 and a_3 curved inwards, *st* somewhat S-shaped and pointing inwards. Distance a_1-a_1 0.7 of the length of a_1; distance a_1-a_2 1.8 times as long as distance a_2-a_3; distance *st-st* 1.9 times as long as *st* and 1.5 times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin between b_1 with a broad indentation. Relative lengths of setae (a_1=100): b_1=293, b_2 about 98. The b_1 cylindrical, striate, distally annulate; b_2 tapering, striate, somewhat pointing outwards. The b_1 1.5 times as long as their distance apart; b_2 about 0.9 of distance b_1-b_2. Anal plate glabrous, as long as broad, narrowest anteriorly, with convex lateral margins and two distal and two sternal appendages; distal ones projecting backwards, short and thick, cylindrical, blunt, somewhat pointing inwards, length 1/4 of the length of the plate; sternal appendages of the same length but thinner and with short oblique pubescence.

Etymology.-A latinization of Tasmania.

Distribution in Tasmania. Known from a single locality on north-east Tasmania.



Figs. 94–104. *Nesopauropus tasmaniensisr* sp.nov., holotype: 94, head, median and right part, tergal view; 95, right antenna, sternal view; 96, collum segment, median and left part, sternal view; 97, tergite VI, posterior part; 98, T_1; 99, T_3; 100, seta on coxa of 9th pair of legs; 101, seta on trochanter of 9th pair of legs; 102, tarsus of 9th pair of legs; 103, pygidium, posterior part, sternal tergal view; 104, anal plate, lateral view. Scale line a for figures 98, 99; b for figures 100–102; c for figures 94–97, 103, 104.

Stylopauropoides Remy

Type species: *Stylopauropoides tiegsi* (Remy, 1949): 54–56, Fig. 1 a–e.

The genus has its main distribution in the Southern Hemisphere, has twenty-two species and two only have been reported to the north of the equator, in the Ivory Coast and Guinea. A provisional list of species with distributions is given below.

Species	Localities	References
1. S. *tiegsi* (Remy)	Australia (eastern)	Remy 1949
	New Zealand	Remy 1952b, 1956a, 1956b
2. *S. novaehollandiae*	Australia (eastern)	Harrison 1914
3. *S. bornemisszai* Remy	Australia (western)	Remy 1957, Postle *et al.* 1991
4. *S. ringueleti* Remy	Argentina	Remy 1962
	Chile	Scheller 1968
	Tasmania	New record
5. *S. rounsevelli* sp.nov.	Tasmania	New record
6. *S. lambda* Remy	New Zealand	Remy 1956b
7. *S. subantarcticus* Scheller	Crozet Islands	Scheller 1974
8. *S. infidus* (Remy)	New Zealand	Remy 1956a
9. *S. duplex* (Remy)	New Zealand	Remy 1956a
10. *S. erectus* sp.nov.	Tasmania	New record
11. *S. hetaeros* sp.nov.	Tasmania	New record
12. *S. scissus* sp.nov.	Tasmania	New record
13. *S. bilobatus* Scheller	New Caledonia	Scheller 1993
14. *S. hirtus* (Remy)	New Zealand	Remy 1952b, 1956a
15. *S. quadripartitus* sp.nov	Tasmania	New record
16. *S. delamarei* (Remy)	Ivory Coast	Remy 1948
	Guinea	Remy 1959a
17. *S. vadoni* (Remy)	Madagascar	Remy1956c, Remy & Bello 1960
18. *S. eximius* sp. nov.	Tasmania	New record
19. *S. incisus* Remy & Bello	Madagascar	Remy & Bello 1960
20. *S. furcillatus* (Remy)	New Zealand	Remy 1952b
	New Caledonia	Scheller 1993
21. *S. dytanekes* Scheller	Brazil	Scheller 2000
22. *S. salazarae* Scheller	Argentina	Scheller *et al.* 2004

Stylopauropoides ringueleti Remy, 1962

Material Examined. 38 specimens. Loc. 2, in moss on ground, 2 ad. 9 (female), 1 subad. 8 (female), 21.iv.1989 (HM). Loc. 14, leaf litter, 19 ad. 9 (9 male, 10 female), 2 subad. 8 (male, female), 1 juv. 6, 2 juv. 5, xii.1988 (MN). Loc. 15, litter, 10 ad. 9 (6 male, 4 female), 22.xii.1988 (MN). Loc. 19, leaf litter, 1 ad. 9 (female), 20.vi.1989 (PG).

Taxonomic remarks. The differences between the type material from southern Argentina and Chile and the Tasmanian populations are inconsiderable. In the latter the antennal globulus seems to be less spherical, the *st* less clavate and the T_3 have more erect pubescence and longer branches than has been reported by Remy, but in all important characters, they are alike.

Distribution in Tasmania. Known from the northern half of the State only.

General distribution. Previously known from southern Argentina (Remy 1962) and southern Chile (Scheller 1968).

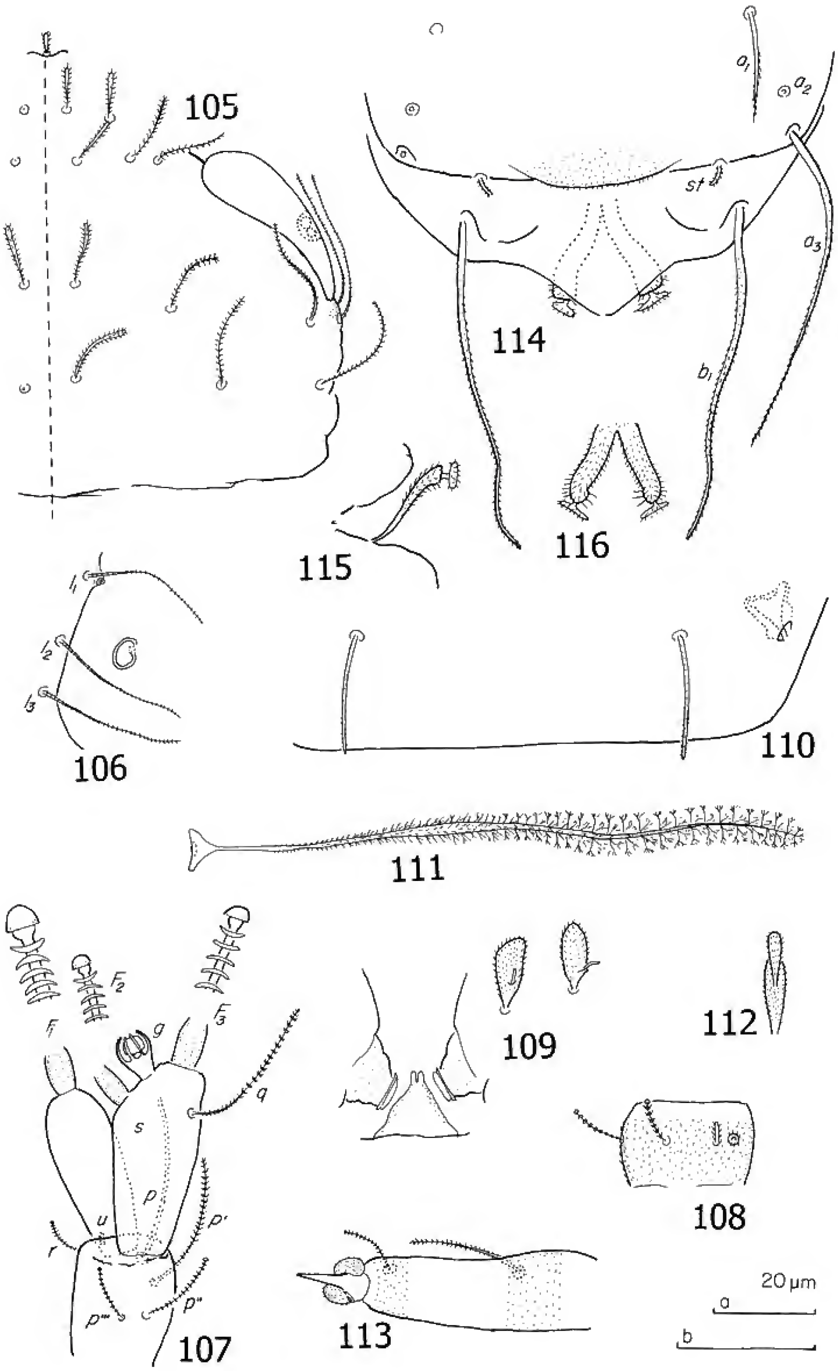
Stylopauropoides erectus sp.nov.

(Figs.105–116)

Material Examined. *Holotype*. Ad. 9 (female), Savage River Pipeline Road, Loc.1, (41°18.5'S, 145°16.3'E), litter, 21.iv.1989 (PG).

Paratypes. Same data as holotype, 5 ad. 9 (female), 2 juv. 5.

Other material. 160 specimens. Loc. 1, in moss on *Nothofagus*, 3 ad. 9 (female), 1 juv. 6, 1.iv.1989 (JD), and in moss on ground, 4 ad. 9 (female), 2 subad 8 (male, female), 21.iv.1989 (HM), and in litter 2 ad. 9 (female), 21.iv.1989 (JD,HM), and in moss on log, 1 ad. 9 (female),



Figs. 105–116. *Stylopauropoides erectus* sp.nov., holotype 105–115, paratype 116: 105, head, median and right part, tergal view; 106, temporal organ, posterior part with pistil, lateral view; 107, left antenna, tergal view; 108, 3rd antennal segment, tergal view; 109, collum segment, median and left part, sternal view; 110, tergite VI, posterior part; 111, T_3; 112, seta on coxa of 9th pair of legs; 113, tarsus of 9th pair of legs; 114, pygidium, tergal view; 115, anal plate, lateral view; 116, anal plate, sternal view. Scale line a for figures 105, 106, 110–113; b for figures 107–109, 114–116.

21.iv.1989 (JD,HM), and in moss on ground, 1 ad. 9 (female), 21.iv.1989 (JD). Loc. 2, in moss on ground, 1 ad. 9 (female), 1 juv. 6, and in leaf litter, 1 ad. 9 (female), 1 juv. 5, 21.iv.1989 (JD). Loc. 4, in moss on ground, 3 ad. 9 (2 male, 1 sex?), 1 subad. 8 (female), 1 juv. 6, 17.xi.1989 (RC,HM), and in moss on log, 23 ad. 9 (female), 16 subad. 8 (female), 8 juv. 6, 3 juv 5, 1 juv. 3, 18.xi.1989 (RC,HM), and in moss on myrtle, 1 ad. 9 (female), 1 juv. 6, 18.xi.1989 (HM), and in in moss on ground, 1 ad. 9 (female), 18.xi.1989 (HM). Loc. 5, in moss on log, 1 subad. 8 (female), 29.xi.1989 (RC), and PKD, 1 juv. 3, 25.xi.1989 (HM). Loc. 6, soil core, 5 ad. 9 (4 male,1 female), 1 subad. 8 (female), 1 juv. 6, 11.xi.1989 (RC). Loc. 7, in moss on log, 2 subad. 8 (female), 2 juv. 6, 17.v.1989 (HM), and in moss on ground, 1 ad. 9 (female), 12.v.1989 (PG), and without site description and date, 2 ad. 9 (female), 1 subad. 8 (female), 4 juv. 6, 1 juv. 5. Loc. 11, in leaf litter, 1 ad. 9 (female), and in moss on base of myrtle trunk, 2 ad. 9 (female), 2 juv. 6, and in moss on fallen logs, 15 ad. 9 (female), 6 subad. 8 (female), 5 juv. 6, 1 juv. 3, 21.iii.1989 (PG,JD). Loc. 17, in non-myrtle litter, 9 ad. 9 (female), 3 subad. 8 (female), 7 juv. 6, 5 juv. 5, 4 juv. 3, 8.iii.1989 (PG). Loc. 18, leaf litter, 1 ad. 9 (female), xii.1987 (MN).

Diagnosis. *Stylopauropoides erectus* belongs to a group of species in the genus having V-shaped anal plates with short-stalked appendages distally, among them *S. bornemisszai* Remy from west Australia (Remy 1957) but is well distinguished from it by the shape of the posterior setae of tergite VI and the distal appendages of the anal plate (cylindrical and similar to a drawing pin respectively in *S. erectus*, clavate and irregularly ovoid in *S. bornemisszai*). There are also distinct similarites with *S. ringueleti* from south Argentina and Chile (Remy 1962, Scheller 1968) diverging by the shape of the bothriotricha T_3 and the *st* (distal half of T_3 densely provided with branched pubescence hairs in *S. erectus*, sparsely provided with thin branches with short pubescence in *S. ringueleti*; *st* cylindrical, not clavate). A third similar species is *S. subantarcticus* Scheller from the Crozet Islands (Scheller 1974) but the shape of the antennal globulus is a good separating character (with short thick stalk, not long conical) as is also the shape of the T_3 (proximal half weakly thickened, not thick clavate). *S. erectus* has some characters not often met with in the genus. The F_2 are longer than the F_3, a character shared with *S. subantarcticus*, and the posterodistal corner of the sternal antennal branch is more truncate than the anterodistal one, also occurring in *S-infidus* Remy from New Zealand (Remy 1956a). The new species is distinguished from *S. infidus* by the shape of the posterior part of the pygidial tergum (with broad rounded bulge in *S. erectus*, with median indentation in *S. infidus*), by the proportion *st-st*/*st* (9–12, not about 4) and by the shape of the distal part of the pygidial setae b_1 (distal part undulated, not evenly curved). There are also similarities in direction *S. tiegsi* Remy from mainland Australia and New Zealand (Remy 1949, 1956a) but in that species the antennal flagella F_3 are as long as or longer than the F_2, the *st* proportionately longer and the distal part of the pygidial setae b_1 is straight, not undulated.

Description. *Length*.-(0.70-)0.73(-0.98) mm.

Head.-Submedian setae on the tergal side of median length, subclavate, with somewhat uneven pubescence, lateral setae fairly long, cylindrical, with short pubescence. Relative lengths of setae, 1st row: a_1=10, a_2=(8-)11(-12); 2nd row: a_1=(11-)12, a_2=(14-)15, a_3=(14-)16; 3rd row: a_1=(11-)14, a_2=(15-)18; 4th row: a_1=(13-)18, a_2=(19-)22, a_3=(20-)27, a_4=16(-22); lateral group setae: l_1=(24-)31, l_2=(26-)33, l_3=(27-32). The ratio a_1/a_1-a_1 in 1st row 1.0, 2nd row 0.8, 3rd row (1.1-)1.2(-1.3) and 4th row (1.2-)1.5. Length of temporal organs 0.7(-0.8) of their shortest distance apart; in a depression of the cuticle in posterior half of the organ anterior of $l_1$and l_2 a clavate curved vesicle almost 0.2 of the length of temporal organ. Head cuticle glabrous.

Antennae.-Segment 3 with three setae and rudiment of globular organ. Segment 4 with five cylindrical annulate blunt setae; their relative lengths: *p*=100, *p*'=(53-)64(-75), *p*''=(48-)52(-57), *p*'''=32(-40), *u*=(8-)9. Tergal seta *p* (0.8-)1.0(-1.1) times as long as tergal branch *t*. The latter fusiform, (2.4-)2.9(-3.1) times as long as its greatest diameter and (almost) as long as sternal branch *s*, that branch (1.9-)2.2(-2.3) times as long as its greatest diameter; posterodistal corner of *s* much more truncate than anterodistal one. Seta *q* cylindrical, annulate, blunt, (0.8-)0.9 of the length of *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=(8-)9(-10); F_2=(76-)87(-89), bs_2=8(-10); F_3=(47-)52(-53), bs_3=(7-)8(-9). The F_1 (2.9-)3.3(-3.6) times as long as *t*, F_2 and F_3 (2.4-)2.8 and (1.5-)1.7(-1.9) times as long as *s* respectively. Distal calyces hemispherical, largest on F_1; distal part of flagella axes not widened. Globulus *g* (1.4-)1.6 times as long as wide; at least 10 bracts, capsule bottom flattened; width of *g* 0.6(-0.7) of the greatest diameter of *t*. Antennae with faint pubescence.

Trunk.-Setae of collum segment furcate; primary branch folioform with distinct oblique pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae as long as (-somewhat longer than) submedian ones; sternite process triangular, anterior part narrow and with distinct incision; appendages subconical, caps flat with collar; process with faint lateral pubescence, appendages almost glabrous. Setae on anterior tergites thin, cylindrical, annulate, blunt, more posteriorly increasing in length and with short pubescence; 4+4 setae on tergite I, 6+6 on II-V, 4+2 on VI. Submedian posterior setae on VI 0.4 of their distance apart and (as long as-)1.2 times as long as pygidial setae a_1.

Relative lengths of bothriotricha: T_1=100, T_2=(101-)107 and 114(-120), T_3=106-114, T_4=(117-)122(-142), T_5=(132-)150(-187); axes thin, simple, straight, those in T_3 moderately thickened. Pubescence hairs on T_5 and on proximal 1/4 of the others short, oblique, on distal 2/3 of T_1-T_4 much longer, branched distally and arranged in whorls.

Legs.-Setae on coxa and trochanter of leg 9 furcate, clavate, with oblique short pubescence, secondary branch protruding from the middle of the primary one and reaching 0.5-0.7 of the length of primary branch, these setae more anteriorly with rudimentary glabrous secondary branches. Tarsus of leg 9 (2.6-) 2.9 times as long as its greatest diameter. Proximal seta tapering, in distal part annulate, pointed; distal seta cylindrical annnulate blunt. Proximal seta (0.4-)0.5 of the length of tarsus and (1.5-)1.9 times as long as distal seta. Cuticle of tarsus with minute pubescence.

Pygidium. *Tergum*.-Posterior margin between *st* with low rounded bulge. Relative lengths of setae: a_1=100, a_2=(200-)215(-242), a_3=(195-)235(-246), *st*=(12-)15(-18), setae curved inwards, thin, tapering; a_1, a_2 and a_3 pointed, *st* blunt and also pointing inwards; all setae with short, oblique pubescence. Distance a_1-a_1 (2.1-)2.3 times as long as a_1; distance a_1-a_2 2.0(-2.5) times as long as distance a_2-a_3; distance *st-st* (9.1-)11.3(-12.8) times as long as *st* and 0.7(-0.8) of distance a_1-a_1. Cuticle with distinct pubescence between *st*.

Sternum.-Posterior margin above and behind b_1 with a large and broad triangular lobe. Relative lengths of setae (a_1=100): b_1=(225-)245(-275); setae thin, shortly pubescent, tapering, undulated distally, (1.1-)1.2(-1.4) times as long as their distance apart. Anal plate almost upright, V-shaped, branches somewhat S-shaped, slender, somewhat increasing in width distally, each branch with a distal appendage in the shape of the head of a thread-nail; plate and appendages with very distinct almost erect pubescence, longest on distal part of the branches.

Stage juv. 5. Pygidial setae d_2 thin, their length somewhat more than 0.1 of their distance apart; d_1 absent.

Etymology.-From Latin *erectus* = steep, upright (anal plate).

Distribution in Tasmania. Like the preceding species the known range is restricted to northern Tasmania but its frequency in moss and litter samples may indicate a wider distribution.

Stylopauropoides rounsevelli sp.nov.

(Figs.117–127)

Material Examined. Holotype. Ad.9 (female), Bruny Island, Mount Mangana, Loc. 12, (43°22.1'S, 147°17.0'E), litter, 4.iv.1989 (PG).

Paratypes. Same data as holotype, 2 ad. 9 (male, female). Cradle Mountain Loc. 4, (41°35.4'S, 145°55.9'E), in moss on ground, 4 ad. 9 (female), 17.xi.1989 (RC).

Other material. 84 specimens. Loc. 1, *Fungi* sample,1 ad. 9 (female), 1 juv. 6, 21.iv.1989 (JD,HM). Loc. 5, soil core, 1 ad. 9 (female), 29.xi.1989 (PG). Loc. 6, in moss on log, 4 ad. 9 (female), 1 juv 6, 11.vi.1990 (ATW), and in litter, 3 ad. 9 (female), 1 subad. 8 (female), 29.xi.1989 (HM), and in pitfall trap, 2 ad. 9 (female), 24-29. xi.1989 (RC), and suction, 1 ad. 9 (female), 28.xi.1989 (RC). Loc. 7, soil cores, 1 ad. 9 (female), 1 juv. 5, 12.v.1989 (HM,JD). Loc. 9, soil core, 1 ad. 9 (male), 20.x.1989 (RC). Loc. 12, in litter, 2 ad. 9 (female), 4.iv.1989 (PG), and in leaf litter, 1 ad. 9 (female), 1 subad. 8 (male), 1 juv. 6, 4.iv.1989 (JD,PG), and in moss, 16 ad. 9 (4 male, 12 female), 6 subad. 8 (2 male, 4 female), 6 juv. 6, 6 juv. 5, 5 juv. 3 (JD). Loc. 13, in litter, 11 ad. 9 (4 male, 7 female), 7 subad. 8 (2 male, 5 female), 3 juv. 6, 27.ii.1989 (SS). Loc. 16, in litter, 2 ad. 9 (male, female), 20.xii.1988 (PG). Loc. 17, soil core, 1 juv. 6, 5.vi.1989 (PG).

Diagnosis. *S. rounsevelli* is a well defined species reason of the posterior vesicle of the temporal organs, the thin setae and the anal plate with distally thickened branches and appendages similar to nail-heads. It may be related to the preceding species, *S. erectus*, but is distinguished from that species by the following characters: antennal flagellae F_2 and F_3 subequal in length in *rounsevelli*, F_2 1.4–1.7 times as long as F_3 in *erectus*; the vesicle of the temporal organs straight and attached to the cuticle very near the posterior margin anterior of l_1 and l_2, not curved and situated near the middle of the temporal organ; the posterior margin of the pygidial sternum with low bulge between the b_1, not a large triangular one; the *st* thin and pointed, not cylindrical and blunt; the branches of the anal plate straight and with a short but marked distal swelling, not somewhat curved and subclavate. There is evidence to consider *S. rounsevelli* related to *S. bornemisszai* Remy from Western Australia (Remy 1957), but the differences are several, the shape of the tergal head setae, the shape of the *st* and the branches of the anal plate and their appendages.

Description. Length.-(0.50-)0.60(-0.84) mm.

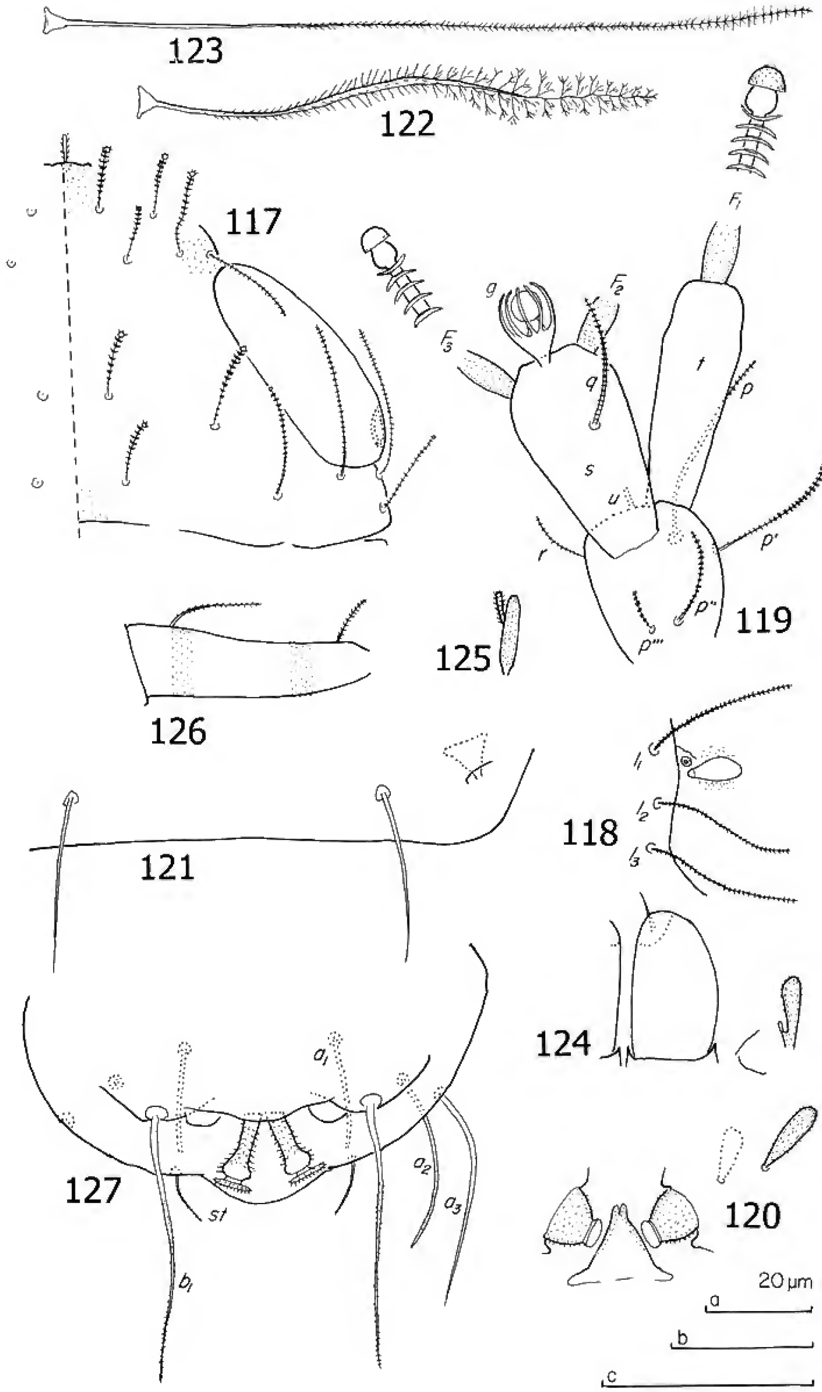
Head.-Tergal setae annulate, submedian ones of median length, subcylindrical, blunt, sublateral and lateral ones fairly long, cylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=(9-)10(-11); 2nd row: a_1=(9-)11(-12), a_2=13(-14), a_3=(13-)17; 3rd row: a_1=(9-)10, a_2=10(-13); 4th row: a_1=10(-12), a_2=17(-18), a_3=23(-27), a_4=11(-13); lateral group setae: l_1=24(-29), l_2=22(-27), l_3=24(-27). The ratio a_1/a_1-a_1 in 1st row 1.0(-1.1), 2nd row 0.5(-0.7), 3rd row 1.0(-1.2) and 4th row 0.8(-0.9). Length of temporal organs (0.8-)0.9 of their shortest distance apart; near posterior margin on a level with l_1 an aperture in the cuticle and in a depression anterior of l_1 and l_2 an exterior clavate straight vesicle; length of vesicle 0.2 of the length of temporal organ. Head cuticle and temporal organs faintly pubescent.

Antennae.-Segment 4 with six cylindrical annulate setae; their relative lengths: *p*=100, *p*'=(74-)85(-86), *p*''=(50-)51(-57), *p*'''=(18-)20(-29), *r*=(26-)31(-33), *u*=(6-)8. Tergal seta *p* (0.8-)0.9(-1.0) of the length of tergal branch *t*. The latter fusiform, (2.5-)2.8 times as long as its greatest diameter and about as long as sternal branch, that branch 1.8(-2.2) times as long as its greatest diameter; distal corners of *s* equally truncate. Seta *q* cylindrical, annulate, pointed, 0.6(-0.7) of the length of *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=(9-)10); F_2=(77-)79(-81), bs_2=9(-11); F_3=(78-)79(-82), bs_3=10(-12). The F_1 3.0(-3.5) times as long as *t*, F_2 and F_3 (2.2-)2.5 and (2.3-)2.5 times as long as *s* respectively. Distal calyces hemispherical with subglobular swelling of the flagellum axis between it and the most distal lamella, calyces largest on F_1; subdistal part of flagella axes not widened. Globulus *g* 1.4(-1.5) times as long as wide; about 10 bracts, capsule bottom convex; width of *g* 0.7 of the greatest diameter of *t*. Antennal branches glabrous, but the basal segments of flagella with delicate pubescence.

Trunk.-Setae of collum segment furcate; primary branch folioform with short almost erect pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae (1.2-)1.3 times as long as submedian ones; sternite process triangular, anterior part narrow and with distinct incision; appendages subconical, caps rather flat and thick; process and appendages with short pubescence.

Setae on tergites thin, cylindrical, annulate, blunt, more posteriorly increasing in length, tapering and with short pubescence; 4+4 setae on tergite I, 6+6 on II-V, 4+2 on VI. Submedian posterior setae on VI (0.5-)0.6 of their distance apart and 1.7(-1.8) times as long as pygidial setae a_1.

Relative lengths of bothriotricha: T_1=100, T_2=(82-)95(-97), T_3=(84-)98(-105), T_4=(85-)102(-114), T_5=(147-)175(-180), axes thin, simple, straight, those in proximal 2/3 of T_3 moderately thickened. Pubescence hairs on T_5 and on proximal 1/3 of T_1, T_2 and T_4 and on proximal half of T_3 simple, oblique-erect, increasing in length outwards, on distal 1/3 of T_1-T_4 much longer, branched distally and arranged in whorls.



Figs. 117–127. *Stylopauropoides rounsevelli* sp.nov., holotype: 117, head, median and right part, tergal view; 118, temporal organ, posterior part with pistil, lateral view; 119, right antenna, sternal view; 120, collum segment, median and left part, sternal view; 121, tergite VI, posterior part; 122, T_3; 123, T_5; 124, genital papillae and seta on coxa of 2nd pair of legs, anterior view; 125, seta on coxa of 9th pair of legs; 126, tarsus of 9th pair of legs; 127, pygidium, sternal view. Scale line a for figures 122–126; b for figures 117, 118, 120, 121, 127; c for figure 119.

Genital papillae subcylindrical with outer lateral part convex, 1.7(-1.8) times as long as their greatest diameter; distal seta 0.4 of the length of the organ.

Legs.-Setae on coxa and trochanter of leg 9 furcate, clavate, with oblique short pubescence, secondary branch protruding from the middle of the primary one and reaching 0.4–0.6 of the length of primary branch. These setae are more anteriorly with rudimentary glabrous secondary branches. Tarsus of leg 9 (3.3-)3.5(-3.7) times as long as its greatest diameter. Setae tapering, proximal one pointed and with very short oblique pubescence; distal seta subcylindrical and with longer pubescence. Proximal seta 0.4(-0.5) of the length of tarsus and 1.8(-2.5) times as long as distal seta. Cuticle of tarsus with minute pubescence.

Pygidium. Tergum.-Posterior margin between *st* with rounded bulge. Relative lengths of setae: a_1=100, a_2=(165-)167(-188), a_3=(193-)200(-223), *st*=(47-)53(-55); setae thin, tapering, pointed, curved inwards, *st* also pointing inwards. Distance a_1-a_1 1.4(-2.0) times as long as a_1; distance a_1-a_2 (1.7-)2.0 times as long as distance a_2-a_3; distance *st*-*st* 3.0(-3.5) times as long as *st* and (0.8-)1.1 times as long as distance a_1-a_1. Cuticle glabrous.

Sternum.-Posterior margin above b_1 with a rounded lobe. Relative lengths of setae (a_1=100): b_1=(164-)190(-198); setae very thin, tapering, with short pubescence only distally, 1.3(-1.4) times as long as their distance apart. Anal plate V-shaped, branches slender, cylindrical but with distal swelling, each branch with a distal appendage in the shape of the head of a thread-nail; plate and appendages with very distinct almost erect pubescence, longest on distal part of the branches, distal swelling glabrous on sternal side.

Etymology.-Dedicated to David Rounsevell who initiated the National Rainforest Conservation Program.

Distribution in Tasmania. Seems to be very widespread in Tasmanian rainforests.

Stylopauropoides quadripartitus sp.nov.

(Figs.128–141)

Material Examined. Holotype. Ad. 9 (female), Savage River Pipeline Road, Loc. 1, (41°18.5'S, 145°16.3'E), litter, 21.iv.1989 (PG).

Paratypes. Same data as holotype, 1 ad. 9 (female), 1 subad. 8 (female). Sandspit River, Loc. 8, (42°42.1'S, 147°51.5'E), in leaf litter, 3 ad. 9 (2 male, 1 female), 22.v.1989 (PG).

Other material. 60 specimens. Loc. 1, in moss on ground, 1 ad. 9 (female), 21.iv.1989 (HM). Loc. 3, soil core, 1 ad. 9 (female), 9.iii.1989 (PG). Loc. 4, in moss on ground, 1 ad. 9 (female), 17.xi.1989 (RC), and in litter, 1 juv. 5, 18.xi.1989 (HM), and in soil core, 2 ad. 9 (male), 2 subad. 8 (female), 3-8.xi.1989 (PG). Loc. 6, suction, 1 juv. 6, 28.xi.1989 (RC). Loc. 7, tree fern crown, 4 ad. 9 (female), 1 juv. 5, 17.v.1989 (HM), and in leaf litter, 1 ad. 9 (female), 12.v.1989 (PG). Loc. 8, in soil core, 1 ad. 9 (female), 22.v.1989 (PG). Loc. 9, in soil core, 1 ad. 9 (female), 20.x.1989 (RC), and in litter, 1 ad. 9 (female), 18.xi.1988 (PG). Loc. 11, in moss on fallen log, 2 ad. 9 (male, female), 1 subad. 8 (female), 1 juv. 6, 21.iii.1989 (JD). Loc. 12, litter, 12 ad. 9 (4 male, 8 female), 3 subad. 8 (1 male, 2 female), 9.iv.1989 (PG). Loc. 13, litter, 14 ad. 9 (6 male, 8 female), 4 subad. 8 (1 male, 3 female), 27.ii.1989 (SS). Loc. 17, in non-myrtle litter, 1 ad. 9 (male), 8.iii.1989 (PG). Loc. 19, leaf litter, 2 ad. 9 (female), 1 subad. 8 (male), 1 juv. 6, 20.vi.1989 (PG).

Diagnosis. Stylopauropoides quadripartitus is a long-legged species which is clearly distinguished from its congeners by the shape of its two-part anal plate: each half divided into two pointed branches, one lateral and the other posterior. It may be closest to *S. hirtus* (Remy) from New Zealand (Remy 1952b, 1956a) but, in that species, the posterior branches are cut squarely and have short cylindrical appendages and the pygidial setae a_1 do not reach more than 0.4–0.5 of the length of the a_2, not 0.7–0.9.

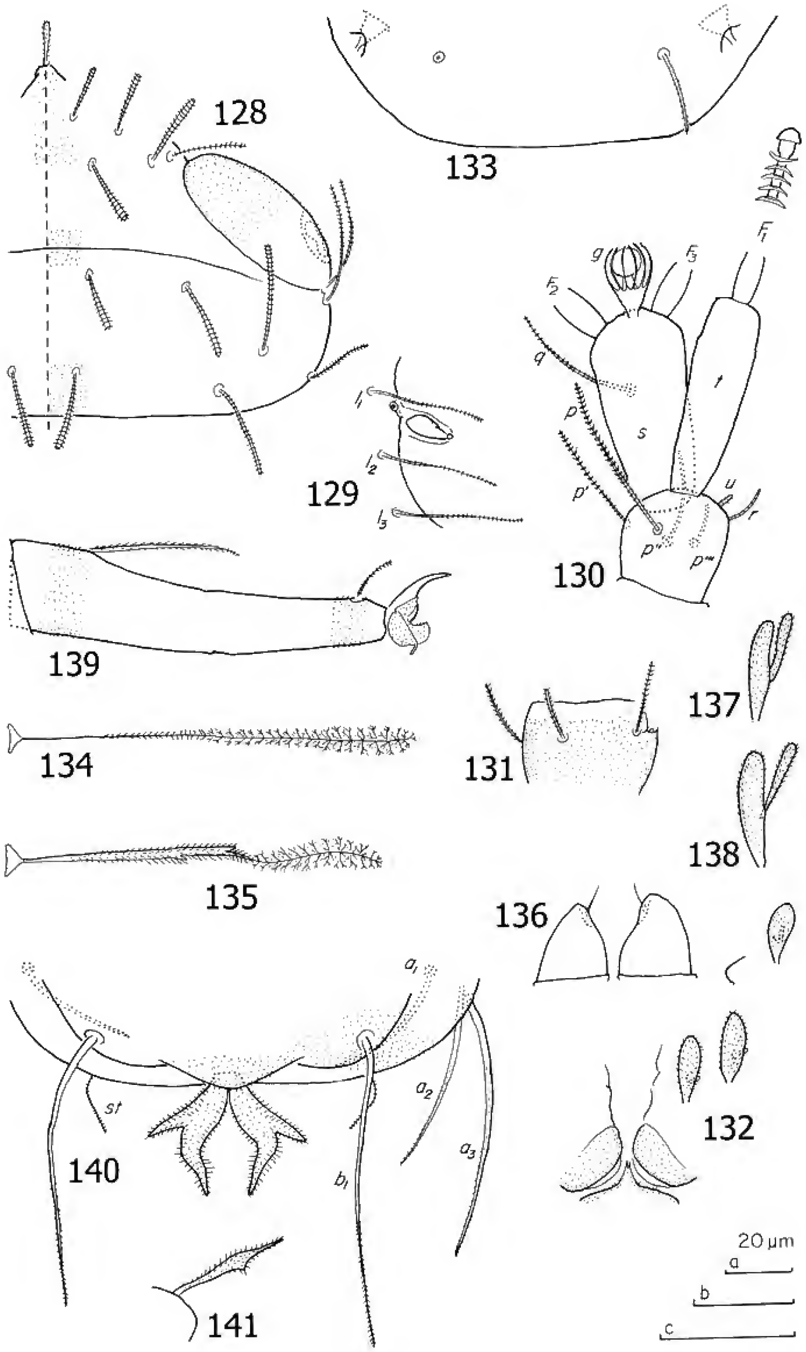
Description. Length.-(0.74-)1.25(-1.28) mm.

Head.-Submedian setae on the tergal side of medium length, somewhat clavate, striate; sublateral and lateral setae fairly long, cylindrical, densely striate. Relative lengths of setae, 1st row: a_1=10, a_2=(10-)11; 2nd row: a_1=12(-14), a_2=14(-15), a_3=15(-16); 3rd row: a_1=11(-13), a_2=(12-)14; 4th row: a_1=14(-15), a_2=a_3=(18-)19, a_4=13(-14); lateral group setae: l_1=26(-27), l_2=(19-)24, l_3=(26-)29. The ratio a_1/a_1-a_1 in 1st row 1.0(-1.2), 2nd row 0.6(-0.7), 3rd row 0.7(-1.0) and 4th row 1.1(-1.3). Temporal organs in tergal view ovoid, their length 0.7(-0.8) of their shortest distance apart. Just outside the posterior margin on a level with l_1, a small aperture in the cuticle and inside the posterior margin, in a depression, a clavate somewhat curved exterior vesicle. The latter almost 0.2 of the length of temporal organ and attached to it with its narrow anterior end. Head cuticle with indistinct transverse suture between 2nd and 3rd rows of setae; head cuticle with delicate granules, temporal organs with short erect pubescence.

Antennae.-Segment 4 with six subcylindrical annulate-striate setae; their relative lengths: *p*=100, *p*'=(67-)72(-79), *p*''=(44-)56, *p*'''=(21-)28, *r*=28(-35), *u*=(9-)10. Tergal seta *p* (0.8-)0.9(-1.1) times as long as tergal branch ***t***. The latter fusiform, (2.9-)3.2(-3.4) times as long as its greatest diameter and as long as (-1.1) times as long as sternal branch ***s***, that branch (2.1-)2.2(-2.3) times as long as its greatest diameter; posterodistal and anterodistal corners equally truncate. Seta *q* subcylindrical, tapering, annulate-striate, pointed, 0.7(-0.9) times the length of *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=(6-)8(-9); F_2=(71-)74(-83), bs_2=(9-)10(-11); F_3=79(-87), bs_3=(9-)10(-11). The F_1 (2.6-)3.0 times as long as *t*, F_2 and F_3 (1.9-)2.2(-2.5) and (2.2-)2.4(-2.7) times as long as *s* respectively. Distal calyces hemispherical; distal part of flagella axes widened only between calyx and the distal lamella. Globulus *g* (1.2-)1.5 times as long as wide; (12-)13(-14) bracts, capsule subspherical; width of *g* (0.7-)0.8 of the greatest diameter of *t*. Rudimentary globulus on posterotergal side of 3rd segment. Antennae glabrous.

Trunk.-Setae of collum segment furcate; primary branch folioform with short oblique pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae as long as (-1.2 times as long as) submedian ones; sternite process short and broad, anterior part narrow and with very small incision; appendages low and wide with flat caps; process with short lateral pubescence, appendages with delicate pubescence.

Setae on anterior tergites as lateral setae on the head, tapering posteriorly and with short, oblique pubescence; setae



Figs. 128–141. *Stylopauropoides quadripartitus* sp.nov., holotype 128–135, 137–141; paratype 136: 128, head, median and right part, tergal view; 129, temporal organ, posterior part with pistil, lateral view; 130, right antenna, tergal view; 131, 3rd antennal segment, tergal view; 132, collum segment, median and left part, sternal view; 133, tergite VI, posterior part; 134, T_1; 135, T_3; 136, genital papillae and seta on coxa of 2nd pair of legs, anterior view; 137, seta on coxa of 9th pair of legs; 138, seta on trochanter of 9th pair of legs; 139, tarsus of 9th pair of legs; 140, pygidium, median and left part, sternal view; 141, anal plate, lateral view. Scale line a for figures 133–136; b for figures 128, 129, 132, 137–139; c for figures 130, 131, 140, 141.

on posterior tergites not longer than those on anterior tergites; 4+4 setae on tergite I, 6+6 on II-V, 4+2 on VI. Submedian posterior setae on VI 0.4(-0.5) of their distance apart and (1.1-)1.2(-1.4) times as long as pygidial setae a_1.

Relative lengths of bothriotricha: T_1=100, T_2=(103-)?(-110), T_3=95(-108), T_4=116(-127), T_5=149 and 180(-196); axes simple, thin, straight except proximal half of T_3 being moderately thickened. Pubescence hairs on T_5 very short, on proximal halves of T_1-T_4 stronger, oblique, increasing in length outwards and on distal 1/3 long, ramose, whorled, most distally erect, for the rest directed obliquely downwards.

Genital papillae (paratype) short, conical, rounded distally, about as long as wide, glabrous; seta very thin, 0.4 of the length of the organ.

Legs.-Setae on coxa and trochanter of leg 9 furcate, densely pubescent, main branch leaf-shaped, broadest in the middle, secondary branch clavate, protruding from the middle of the primary one and reaching (0.6-)0.7 of the length of primary branch. These setae on more anterior legs with proportionately broader main branch and rudimentary glabrous secondary branch. Tarsus of leg 9 (4.4-)4.5(-4.7) times as long as its greatest diameter. Proximal seta tapering, pointed, with very short oblique pubescence; distal seta subcylindrical, annnulate, blunt. Proximal seta 0.4 of the length of tarsus and (2.9-)3.0 times as long as distal seta. Cuticle of tarsus with short pubescence.

Pygidium. Tergum.-Posterior margin between *st* straight. Relative lengths of setae: a_1=100, a_2=(112-)140(-148), a_3=181(-188), *st*=(38-)52; setae curved inwards, tapering, pointed, very shortly pubescent; a_1 and a_2 pointing inwards. Distance a_1-a_1 (2.3-)2.7 times as long as a_1; distance a_1-a_2 as long as (-1.4) times as long as distance a_2-a_3; distance *st-st* (3.6-)4.0 times as long as *st* and (0.6-)0.7 of distance a_1-a_1.

Sternum.-Posterior margin above b_1 with a broad triangular lobe. Relative lengths of setae (a_1=100): b_1=(204-)214 and 236; setae thin, shortly pubescent, tapering, 1.3 and 1.4(-1.5) times as long as their distance apart. Anal plate directed obliquely upwards, 1.3(-1.5) times as broad as long; divided longitudinally into two branches each in turn divided into two branches by a posterolateral incision; the secondary branches tapering, pointed, the posterior ones longest; lateral branches pointing outwards, posterior ones pointing inwards.

Stage subad. 8. Pygidial setae d_1 and d_2 thin pointed, the former 0.5 of their distance apart, d_2 0.6 of distance d_1-d_2.

Etymology.-From Latin *quadripartitus* = four-parted (anal plate).

Distribution in Tasmania. Probably one of the most widespread pauropods of the Tasmanian rainforests as it occurs in all major regions and has been collected at nine of the 12 main collecting sites and in three of the additional ones.

Stylopauropoides scissus sp.nov.

(Figs.142–154)

Material Examined. Holotype. Ad. 9 (male), Savage River Pipeline Road, Loc. 1, (41°18.5'S, 145°16.3'E), litter, 21.iv.1989 (PG).

Paratypes. Same data as holotype, 1 ad. 9 (male), 1 juv. 6. Mount Michael, Loc. 6, (41°10.9'S, 148°00.4'E), in moss on log, 1 ad. 9 (male), 1 subad. 8 (female), 11.vi.1990 (ATW). Projection Bluff, Loc. 3, (146°43.5'S, 41°43.1'E), in soil cores, 13 ad. 9 (8 male, 5 female), 2 subad. 8 (female), 2 juv. 6, 2 juv. 5 (PG).

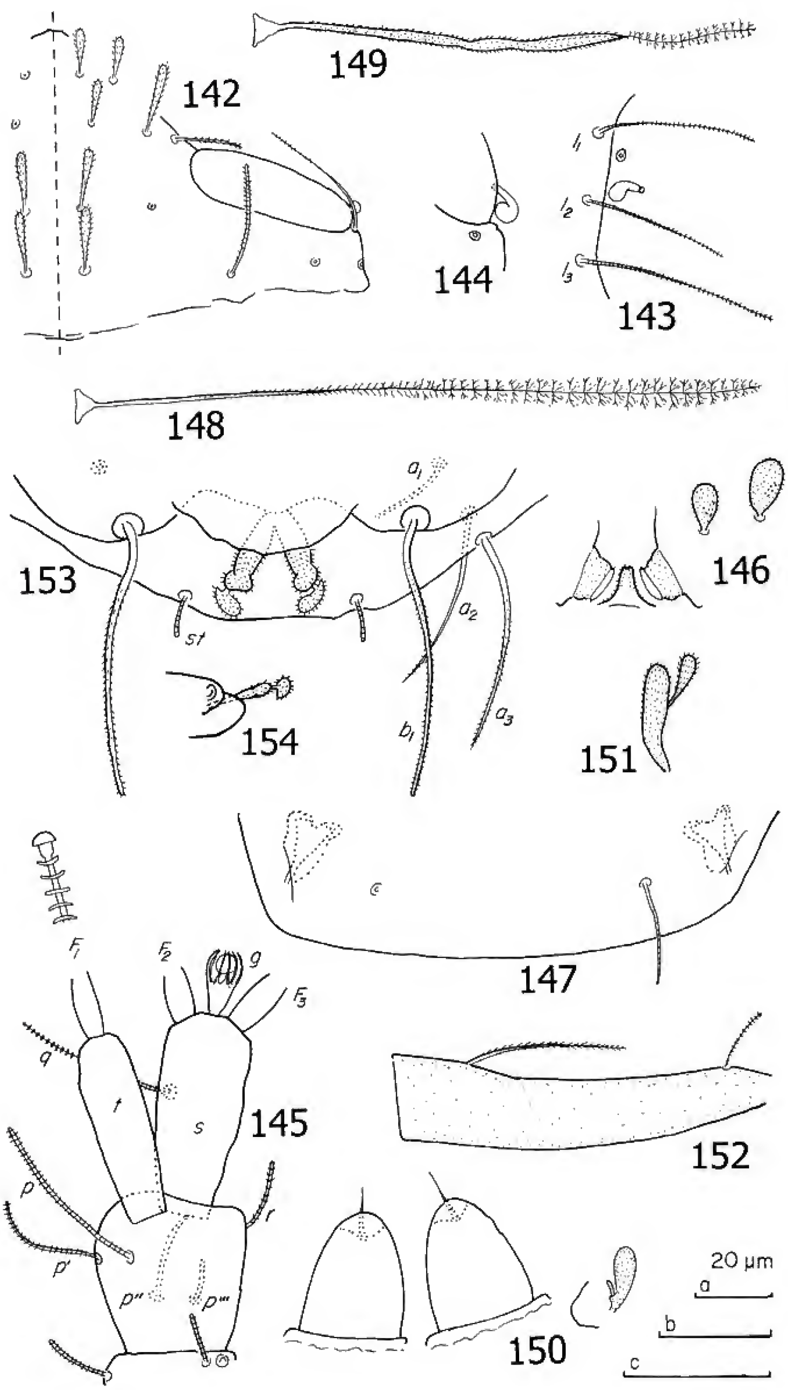
Other material. 172 specimens. Loc. 1, in moss on log, 1 ad. 9 (female), 1 juv. 6, 1 juv. 5, 21.iv.1989 (HM); ibid., *Fungi* sample, 2 ad. 9 (female), 1 subad. 8 (female), 21.iv.1989 (JD). Loc. 2, in moss on dead log, 1 ad. 9 (male), 1 juv. 6, 1 juv. 3, 21.iv.1989 (JD); in moss on ground, 2 subad. 8 (female), 1 juv. 6, 21.iv.1989 (HM); in moss on rocks, 2 ad. 9 (female), 1 subad. 8 (male), 1 juv. 5, 21.iv.1989 (PG). Loc. 4, in moss on logs, 8 ad. 9 (4 male, 4 female), 6 subad. 8 (3 male, 2 female, 1 sex?), 3 juv. 6, 7 juv. 5, 9.xi.1989 (PG), in moss, 7 ad. 9 (2 male, 5 female), 5 subad. 8 (1 male, 4 female), 3 juv. 6, 1 juv. 5, 18. xi.1989 (HM). Loc. 5, in moss on log, 1 juv. 5, 29.xi.1989 (RC); PKD, 1 juv. 3, 25.xi.1989 (RC); in soil core, 1 juv. 6, 29.xi.1989 (HM). Loc. 6, pitfall trap, 1 juv. 3, 24–29.xi.1989 (RC). Loc. 7, in leaf litter, 1 juv. 6, 12.v.1989 (PG); *Fungi* sample, 1 ad. 9 (male), 12.v.1989 (DR). Loc. 8, hand collection, 1 ad. 9 (female), 22.v.1989 (HM). Loc. 9, in leaf litter, 4 ad. 9 (2 male, 2 female), 3 subad. 8 (2 male, 1 female), 1 juv. 6, 2 juv. 3, 18.xi.1988 (PG); in soil cores, 2 ad. (male, female), 1 subad. 8 (female), 20.x.1989 (RC). Loc. 10, in moss on log, 7 ad. 9 (2 male, 5 female), 3 subad. 8 (1 male, 2 female), 3 juv. 6, 1 juv. 5, 25.viii.1989 (HM); in lichen on trees, 2 ad. 9 (male, female), 1 subad. 8 (male), 1 juv. 6, 3 juv. 5, 25.viii.1989 (HM); in moss on ground, 1 ad. 9 (female), 25.viii.1989 (RC). Loc. 12, in moss on dead log, 11 ad. 9 (7 male, 3 female, 1 sex?), 5 subad. 8 (3 male, 1 female, 1 sex?), 6 juv. 6, 5 juv. 5, 2 juv. 3, 4-9.iv.1989 (JD,PG); in moss on tree, 2 ad. 9 (female), 4. iv.1989 (JD,PG,HM); in leaf litter, 4 ad. 9 (1 male, 3 female), 3 subad. 8 (male), 4 juv. 6, 2 juv. 5, 4.iv.1989 (PG), and 6 ad. 9 (2 male, 4 female), 1 subad. 8 (female), 2 juv. 5, 2 stad.?, 9.iv.1989 (PG); in moss, 15 ad. 9 (5 male, 10 female), 1 juv. 5, 3 juv. 3, 9.iv.1989 (JD).

Diagnosis. *Stylopauropoides scissus* appears related to *S. duplex* (Remy) from New Zealand (Remy 1956a). It is distinguished from that species by the long-stalked antennal globulus *g* (short-stalked in *duplex*), the shape of the T_3 (in two parts, proximal 2/3 thickened and with dense oblique pubescence, distal 1/3 very thin with branched hairs arranged in whorls in *scissus*; axes thin, pubescence hairs short and thin in *duplex*) and the shape of the anal plate (branches subcylindrical with subapical constriction in *scissus*, thickest in distal half, rounded and without constriction in *duplex*; and the distal appendages of the anal plate (with subcentral stalk in *scissus*, anteroproximal in *duplex*).

Description. Length.-(0.76-)0.82(-1.03) mm.

Head.-The a_2 and a_3 of 4th row fairly long, other tergal setae of medium length, submedian and anterior setae clavate, a_3 of 2nd row and posterolateral setae subcylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=(10-)11(-12); 2nd row: a_1=9(-11), a_2=a_3=(14-)16(-17); 3rd row: a_1=12(-14), a_2=?(13-16); 4th row: a_1=(13-)14(-17), a_2=(24-)25(-31), a_3=(18-)25(-28), a_4=?(15-18); lateral group setae: l_1=(26-)27(-30), l_2=(24-)25(-31), l_3=(28-)34. The ratio a_1/a_1-a_1 in 1st row 0.8(-0.9), 2nd row 0.5(-0.7), 3rd row 0.8(-1.0) and 4th row 1.0(-1.3). Temporal organs in tergal view narrowly ovoid, their length 0.7(-0.8) of their shortest distance apart, posterolateral part with exterior, clavate, somewhat curved vesicle, length = 0.1 of the length of temporal organ. Head and temporal organs almost glabrous.

Antennae.-Segment 4 with six subcylindrical annulate-striate setae; their relative lengths: *p*=100, *p*'=67(-84), *p*''=(42-)43(-48), *p*'''=(20-)25(-27), *r*=20(-22), *u*=(6-)7. Tergal seta *p* (0.8-)0.9(-1.1) times as long as tergal branch *t*. The latter



Figs. 142–154. *Stylopauropoides scissus* sp.nov., holotype: 142, head, median and right part, tergal view; 143, temporal organ, posterior part with pistil, lateral view; 144, temporal organ, posterior part with pistil, tergal view; 145, right antenna, tergal view; 146, collum segment, submedian and left part, sternal view; 147, tergite VI, posterior part; 148, T_1; 149, T_3; 150, genital papillae and seta on coxa of 2nd pair of legs, anterior view; 151, seta on coxa of 9th pair of legs; 152, tarsus of 9th pair of legs; 153, pygidium, posterior part, sternal view; 154, anal plate, lateral view. Scale line a for figure 149; b for figures 145–148, 150–152; c for figures 142–144, 153, 154.

fusiform, (3.1-)3.4(-3.7) times as long as its greatest diameter and (0.9-)1.1 times as long as sternal branch *s*, that branch (2.1-)2.3(-2.5) times as long as its greatest diameter; posterodistal and anterodistal corners equally truncate. Seta *q* subcylindrical, annulate-striate, tapering distally, (0.7-)0.8 of the length of *s*. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=(9-)11(-12); F_2=(71-)87, bs_2=(7-)9(-11); F_3=(76-)84(-85), bs_3=(10-)12. The F_1 (2.3-)2.4(-2.7) times as long as *t*, F_2 and F_3 (2.0-)2.2(-3.0) and (2.0-)2.2(-2.9) times as long as *s* respectively. Distal calyces subhemispherical; distal part of flagella axes widened only between calyx and the distal lamella. Globulus *g* (1.7-)1.9 times as long as wide; 9 (-10) bracts, capsule spherical; width of *g* 0.6 of the greatest diameter of *t*. Rudimentary globulus on posterotergal side of 3rd segment. Antennae glabrous.

Trunk.-Setae of collum segment furcate; primary branch folioform with short almost erect pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae 1.1(-1.3) times as long as submedian ones; sternite process rounded but with a small anteromedian incision; appendages low and wide with flat divided caps with collar; process and appendages with delicate pubescence.

Setae on most anterior and posterior tergites cylindrical, medial ones clavate; 4+4 setae on tergite I, 6+6 on II-V, 4+2 on VI. Submedian posterior setae on VI 0.4 of their distance apart and (1.3-)1.4(-1.7) times as long as pygidial setae a_1.

Relative lengths of bothriotricha: T_1=100, T_2=(98-)110(-112), T_3=?(114-136), T_4=(140-)144(-155), T_5=(160-)168(-210), axes thin, simple, straight except T_3 being moderately thickened in proximal 2/3. Pubescence hairs on T_5 and on thickened part of T_3 very short, on proximal halves of T_1, T_2 and T_4 thicker, oblique, increasing in length outwards and on distal 1/3 of T_1-T_4 long, erect, ramose, whorled.

Genital papillae short, subcylindrical, rounded distally, 1.2(-1.3) times as long as wide, glabrous; seta very thin and short, 0.4 of the length of the organ.

Legs.-Setae on coxa and trochanter of leg 9 furcate, densely pubescent, main branch leaf-shaped, broadest in the middle, secondary branch clavate, protruding from the middle of the primary one and reaching 0.6(-0.7) of the length of primary branch; these setae more anteriorly with proportionately broader main branch and the secondary branch rudimentary and glabrous. Tarsus of leg 9 (3.7-)4.2(-4.4) times as long as its greatest diameter. Proximal seta tapering, pointed, with very short oblique pubescence; distal seta subcylindrical annnulate blunt. Proximal seta 0.4(-0.5) of the length of tarsus and (2.1-)2.3(-2.5) times as long as distal seta. Cuticle of tarsus with minute pubescence.

Pygidium. Tergum.-Posterior margin between *st* straight. Relative lengths of setae: a_1=100, a_2=(171-)200(-231), a_3=(247-)250(-308), *st*=(48-)50(-64). All but *st* curved inwards, tapering, pointed, very shortly pubescent; a_1 and a_2 pointing inwards; *st* cylindrical, blunt with short pubescence. Distance a_1-a_1 3.2(-3.7) times as long as a_1; distance a_1-a_2 1.1(-1.4) times as long as distance a_2-a_3; distance *st-st* (2.7-)3.8(-3.9) times as long as *st* and 0.5 of distance a_1-a_1.

Sternum.-Posterior margin between b_1 with deep indentation and large posteromedian rounded lobe. Relative lengths of setae (a_1=100): b_1=(277-)317(-320); setae thin, somewhat tapering, shortly pubescent in proximal half, striate distally, (as long as-)1.1 times as long as their distance apart. Anal plate directed somewhat upwards, somewhat broader than long and divided longitudinally into two branches separated by a V-shaped posteromedian incision; branches with subapical constriction; each branch with a distal stalked subhemispherical appendage; plate and appendages with very distinct almost erect pubescence.

Etymology.-From Latin *scissus* = forked, cloven (anal plate).

Distribution in Tasmania. This species is the most widely distributed of all the Tasmanian species. It was collected at 11 of the 12 main collecting sites.

Stylopauropoides hetaeros sp.nov.

(Figs.155–168)

Material Examined. Holotype. Ad. 9 (female), Big Sassy Creek, Loc. 7, (42°08.5'S, 147°54.3'E), soil core, 12.v.1989 (PG,DR).

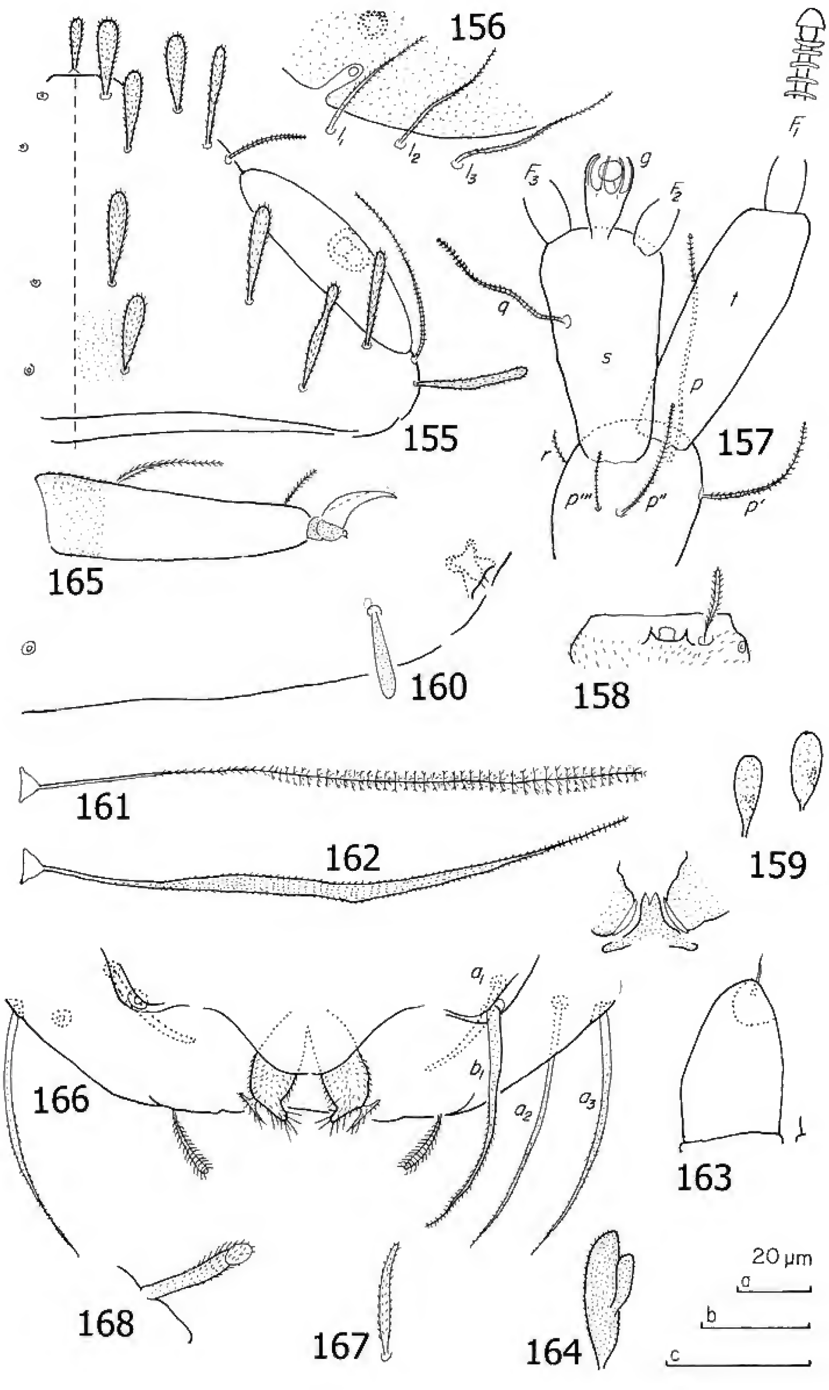
Paratypes. Mount Michael (41°10.9'S, 148°00.4'E), litter, 1 ad. 9 (male), 1 subad. 8 (female), 2 juv. 5, 4 juv. 3, 1 stad. ?, 29.xi.1989 (HM). Mount Victoria, Loc. 5, (41°20.4'S, 147°49.9'E), litter, 2 ad. 9 (female), 1 subad. 8 (male), 1 juv. 5, 29.xi.1989, (RC). Simons Road, Loc. 17, (41°21.5',147°31.3'), non-myrtle litter, 1 ad. 9 (female), 8.iii.1989 (PG).

Other material. 30 specimens. Loc. 1, in moss on dead trunk, 2 ad. 9 (female), 31.iv.1989 (PG), and in moss on ground, 6 ad. 9 (3 male, 3 female), 2 subad. 8 (male, female), 21.iv.1989 (HM). Loc. 4, litter, 1 juv. 5, 18.xi.1989 (RC). Loc. 5, PKD, tree, 1 juv. 5, 25.xi.1989 (RC). Loc. 6, in moss on ground, 6 ad. 9 (2 male, 4 female), 11.vi.1990 (ATW), and in pitfall trap, 1 subad. 8 (female), 24–29.xi.1989 (RC), and in litter, 2 juv. 5, 4 juv. 3, 1 juv. stad.?, 29.xi.1989 (HM). Loc. 7, soil core, 1 juv. 6, 1 juv. 3, 8.iii.1989 (PG). Loc. 17, Vilt area, soil core, 1 juv. 5, 5.vi.1989 (PG).

Diagnosis. There are many similarities between *S. hetaeros* and *S. duplex* (Remy) from New Zealand (Remy 1956a) particularly in the shape of the setae of the tergal side of the head, the antennal branches, the setae of the pygidial tergum and the general shape of the anal plate. Good distinguishing characters are: the distal part of the branches of the anal plate (with distinct inner process in *haeteros*, evenly rounded in *duplex*); the appendages of the anal plate (in the shape of a nail-head, not clavate); the shape of the setae in the posterior row of tergite VI (clavate, not subcylindrical).

Description. Length.-(0.82-)1.03(-1.27) mm.

Head.-All tergal setae except for a_3 of 2nd row clavate and densely pubescent with short oblique hairs, submedian setae distinctly clavate and sublateral ones weakly, a_3 of 2nd row cylindrical striate; lateral group setae thin cylindrical striate. Relative lengths of setae, 1st row: a_1=10, a_2=11(-13); 2nd row: a_1=11(-12), a_2=11(-13), a_3=10(-12); 3rd row: a_1=11(-12), a_2=(11-)13(-14); 4th row: a_1=11(-13), a_2=(12-)14(-15), a_3=(13-)14(-15), a_4=(12-)14(-16); lateral group setae: l_1=(22-)26, l_2=18(-22), l_3=23(-25). The ratio a_1/a_1-a_1 in 1st row (1.1-)1.2(-1.4), 2nd row (0.7-)0.8, 3rd row 1.1(-1.2) and 4th row 0.8. Temporal organs in tergal view ovoid, their length (0.6-)0.7 of their shortest distance apart; in the middle, a probable interior



Figs. 155–168. *Stylopauropoides hetaeros*r sp.nov., holotype, 155–161, 164–168, paratype 162, 163: 155, head, median and right part, tergal view; 156, temporal organ, posterior part with pistil, lateral view; 157, left antenna, sternal view; 158, distal part of 3rd antennal segment, tergal view; 159, collum segment, median and left part, sternal view; 160, tergite VI, posterior part; 161, T_1; 162, T_3; 163, left genital papilla, anterior view; 164, seta on coxa of 9th pair of legs; 165, tarsus of 9th pair of legs; 166, pygidium, posterior part, sternal view; 167, pygidial seta a_1; 168, anal plate, lateral view. Scale line a for figures 160–163, 165; b for figures 155, 156, 159, 164; c for figures 157, 158, 166–168.

vesicle opening outwards with a very small pore in the cuticula; length of vesicle almost 0.2 of the length of the temporal organ. Head cuticle with very dense and short pubescence.

Antennae.-Segment 4 with six cylindrical striate-annulate setae; their relative lengths: p=100, p'=(64-)67(-72), p''=(44-)57(-59), p'''=(21-)30, r=17(-19), u=? (5-6). Tergal seta p (0.7-)0.8(-0.9) of the length of tergal branch t. The latter fusiform, obliquely truncate distally, branch 2.7(-3.4) times as long as its greatest diameter and 0.9(-1.0) of the length of sternal branch s, that branch (1.5-)1.6(-1.7) times as long as its greatest diameter; posterodistal and anterodistal corners equally truncate. Seta q cylindrical, annulate-striate, tapering, pointed, (0.6-)0.7 of the length of s. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=(8-)9; F_2=(87-)94, bs_2=(8-)9; F_3=(77-)92, bs_3=8. The F_1 (2.3-)2.6(-2.7) times as long as t, F_2 and F_3 (1.8-)2.6 and (1.9-)2.5 times as long as s respectively. Distal calyces hemispherical; distal part of flagella axes widened only between calyx and the distal lamella. Globulus g with thick stalk, (1.7-)2.2 times as long as wide; about nine bracts, capsule spherical; width of g (0.5-)0.6 of the greatest diameter of t. Rudimentary globulus on posterotergal side of 3rd segment. Antennae with short pubescence.

Trunk.-Setae of collum segment furcate; primary branch folioform with almost erect short pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae as long as (-1.1) times as long as submedian ones; sternite process with distinct anterior incision; appendages with flat caps; process and appendages with minute pubescence.

Setae on tergites as submedian setae on tergal side of head and of about the same length on all tergites; 4+4 setae on tergite I, 6+6 on II-V, 4+2 on VI. Submedian posterior setae on VI (0.2-)0.3 of their distance apart and (1.2-)1.6 times as long as pygidial setae a_1.

Relative lengths of bothriotricha: T_1=100, T_2=(101-)102(-105), T_3=?(81-138), T_4=(105-)107(-135), T_5=(118-)120(-172); all setae with simple straight axes, very thin in all but T_3, the latter distinctly thickened in the middle. Pubescence short and oblique on proximal 1/3 of T_1 and T_2, proximal 4/5 of T_3 and 9/10 of T_4 and T_5; pubescence long erect whorled and partly branched in distal 2/3 of T_1 and T_2, short and erect in most distal part of T_4 and T_5.

Genital papillae (paratype) short, subcylindrical, rounded distally, 1.5 times as wide as long, glabrous; seta thin, 0.2 of the length of the organ.

Legs.-Setae on coxa and trochanter of leg 9 furcate, densely pubescent, main branch leaf-shaped, broadest in the middle, secondary branch clavate, protruding from a point just below the middle of the primary one and reaching 0.5 of the length of primary branch; these setae more anteriorly, with rudimentary cylindrical glabrous secondary branch. Tarsus of leg 9 almost straight, tapering, (3.0-)3.3(-3.7) times as long as its greatest diameter. Setae with oblique pubescence, proximal one tapering, pointed, distal seta subcylindrical annulate blunt. Proximal seta 0.4 of the length of tarsus and (2.1-)2.2(-2.4) times as long as distal seta. Cuticle of tarsus with very short dense pubescence.

Pygidium. Tergum.-Posterior margin between st almost straight. Relative lengths of setae: a_1=100, a_2=(233-)237(-309), a_3=231(-292), st=65(-81); setae curved inwards; a_1 tapering blunt, a_2 and a_3 tapering pointed, st subcylindrical blunt; pubescence very short in all but st, on the latter longer and whorled; all setae pointing inwards, a_1 and st distinctly, a_2 and a_3 only a little, st thin, somewhat clavate, blunt. Distance a_1-a_1 (3.1-)3.3(-3.7) times as long as a_1; distance a_1-a_2 about twice as long as than distance a_2-a_3; distance st-st (3.0-)3.7 times as long as s and 0.7 of distance a_1-a_1.

Sternum.-Posterior margin with large median semicircular lobe below anal plate. Relative lengths of setae (a_1=100): b_1=212(-357); similar to a_3 of pygidial tergum, but thicker at base and with stronger pubescence, 0.7(-0.9) of their distance apart. Anal plate directed obliquely upwards, about as broad as long, divided longitudinally by a V-shaped incision into two broad fusiform branches, the latter cut squarely and a with distal short inner process directed obliquely inwards; each branch with a short-stalked distal appendage in the shape of a nail-head; pubescence short oblique, most distally and on the appendages longer, longest on the inner processes.

Stage subad. 8. Genital papillae rather well developed, ovoid, seta absent.

Etymology.-From Greek *hetaeros* = companion (to *S. duplex*).

Distribution in Tasmania. As are *S. ringueleti* and *S. erectus*, this species may be confined to the northern half of the State.

Stylopauropoides eximius sp.nov.

(Figs.169–179)

Material Examined. Holotype. Ad. 9 (female), Savage River Pipeline Road, Loc. 1, (41°18.5'S, 145°16.3'E), in moss on log, 21.iv.1989 (JD,HM).

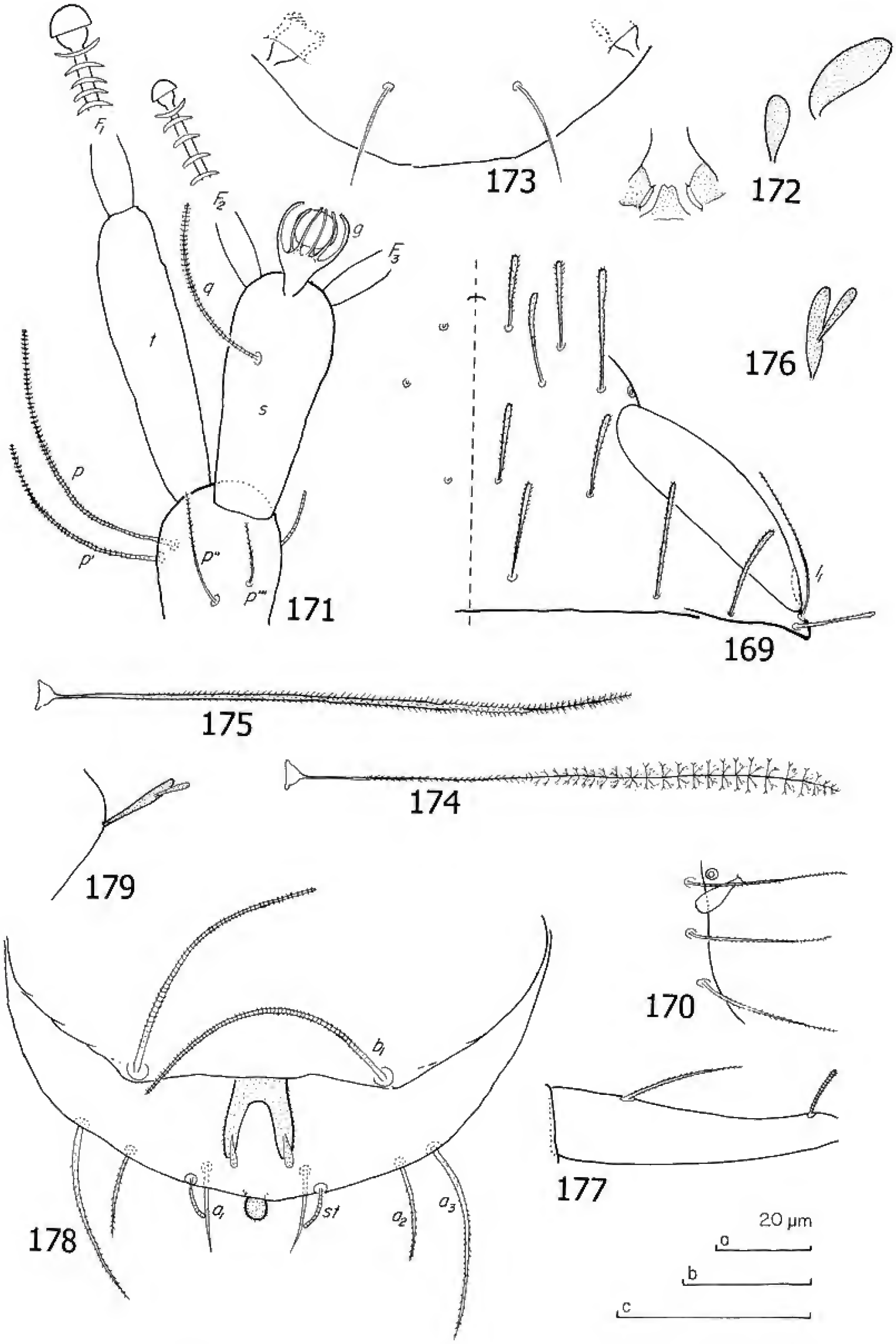
Paratypes. Hibbs Lagoon Loc. 13, (42°34'S, 145°19.5'E), litter, 4 ad. 9 (1 male, 3 female), 1 subad. 8 (female), 27.ii.1989 (SS).

Other material. 1 specimen. Loc. 1, in moss on ground, 1 ad. 9 (female), 21.iv.1989 (HM).

Diagnosis. *Stylopauropoides eximius* is a close relative of *S. vadoni* Remy from Madagascar (Remy 1956c; Remy & Bello 1960). They have great similarities in the antennae, the tergites and the pygidium, but can be distinguished by differences in the T_5 (dense minute pubescence in *eximius*, sparse thorny in *vadoni*), the shape of the posteromedian lobe of the pygidial tergum (linguiform and longer than broad, not subrectangular and broader than long), the length of the pygidial setae a_1, a_2 and a_3 (a_1 and a_2 about half of the length of a_3, not all subequal) and by the shape of the anal plate (branches broad and blunt, not narrow, tapering, pointed; appendages clavate, not lanceolate-subcylindrical).

Description. Length.-(0.60-)0.82 mm.

Head.-Tergal setae of medium length or fairly long with dense short oblique pubescence, submedian ones somewhat clavate, sublateral and lateral ones cylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=(10-)13; 2nd row: a_1=(12-)14, a_2=(15-)18, a_3=?(17); 3rd row: a_1=(9-)11, a_2=(9-)12; 4th row: a_1=(12-)14, a_2=(15-)16, a_3=15(-19), a_4=(10-)12; lateral group setae: l_1=(20-)23, l_2=(18-)20, l_3=(17-)20. The ratio a_1/a_1-a_1 in 1st row 1.1(-1.3), 2nd row (0.6-)0.7, 3rd row (1.0-)1.5 and 4th



Figs. 169–179. *Stylopauropoides eximiusr* sp.nov., holotype: 169, head, median and right part, tergal view; 170, temporal organ, posterior part with pistil, lateral view; 171, left antenna, sternal view; 172, collum segment, median and left part, sternal view; 173, tergite VI, posterior part; 174, T_1; 175, T_3; 176, seta on trochanter of 9th pair of legs; 177, tarsus of 9th pair of legs; 178, pygidium, sternal view; 179, anal plate, lateral view. Scale line a for figures 174–177; b for figures 169, 170, 172, 173, 178, 179; c for figure 171.

row (1.1-)1.3. Temporal organs (0.9-) as long as their shortest distance apart. A small, exterior, clavate, straight, vesicle directed posteriorly and 0.2 of the length of temporal organ just inside the posterior margin on a level with l_1. Head cuticle with minute pubescence, temporal organs glabrous.

Antennae.-Segment 4 with five cylindrical striate-annulate setae; their relative lengths: p=100, p'=69(-71), p''=37(-43), p'''=20(-23), r=22(-23). Tergal seta p 1.1 times as long as tergal branch t. The latter fusiform, (3.3-)4.0 times as long as its greatest diameter and (1.1-)1.2 times as long as sternal branch s, that branch being somewhat clavate, (2.1-)2.3 times as long as its greatest diameter; posterodistal and anterodistal corners equally truncate. Seta q cylindrical, annulate-striate, 1.1(-1.2) times as long as s. Relative lengths of flagella (basal segments included) and basal segments (one paratype only): F_1=100, bs_1=11; F_2=F_3=73, bs_2=bs_3=12. The F_1 2.9 times as long as t, F_2 and F_3 2.4 times as long as s. Distal calyces subhemispherical; distal part of flagella axes widened only just below calyx. Globulus g 1.3(-1.4) times as long as wide; (11-)about 13 bracts, capsule subspherical; width of g (0.9-) as long as greatest diameter of t. Antennae glabrous.

Trunk.-Setae of collum segment furcate; primary branch folioform with almost erect pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae 1.5 times as long as submedian ones; sternite process blunt with small anterior incision; appendages with flat caps with distinct collar; process and appendages with short pubescence.

Setae on anterior tergites as submedian setae on the tergal side of head, on posterior tergites subcylindrical, tapering, pointed and with very short pubescence; posterior setae 1.5-2 times longer than anterior ones; 4+4 setae on tergite I, 6+6 on II-IV, 6+? on V, 4+2 on VI. Submedian posterior setae on VI (holotype only) 0.9 of their distance apart and 1.2(-1.3) times as long as pygidial setae a_1.

Relative lengths of bothriotricha (most of them broken or lost): T_1=100, T_2=96(-99), T_3=(130), T_4=(130), T_5=(186); axes simple, thin, straight except in proximal 3/4 of T_3. Pubescent hairs simple oblique on T_4 and T_5, the main part of T_3 and on proximal halves of T_1 and T_2, very short on T_4 and T_5; hairs long, erect, branched distally and whorled on distal halves of T_1 and T_2, short erect and whorled on most distal part of T_3.

Legs.-Setae on coxa and trochanter of leg 9 furcate, densely but very shortly pubescent, main branch leaf-shaped, secondary branch clavate, protruding from the middle of the primary one and reaching (0.6-)0.7 of the length of primary branch; these setae on more anterior legs with rudimentary, cylindrical, glabrous, secondary branch. Tarsus of leg 9 slender, (3.8-)4.1 times as long as its greatest diameter. Proximal seta tapering, pointed, with short oblique pubescence; distal seta subcylindrical striate blunt. Proximal seta 0.4(-0.5) of the length of tarsus and 2.3(-2.9) times as long as distal seta. Cuticle of tarsus almost glabrous.

Pygidium. Tergum.-Posterior margin evenly rounded. Very small but distinct semicircular posterior lobe above st. Relative lengths of setae: a_1=100, a_2=107-115, a_3=(185-)207-223, st=(46-)54(-58); setae all curved inwards; a_1, a_2 and a_3 also tapering pointed and with short pubescence distally; a_2 and a_3 pointing outwards, st pointing inwards, cylindrical, blunt, striate. Distance a_1-a_1 (1.0-)1.1 and 1.2 times as long as a_1; distance a_1-a_2 (1.6-)1.9 times as long as distance a_2-a_3; distance st-st (2.6-)2.7(-2.9) times as long as st and 1.3(-1.4) times as long as distance a_1-a_1.

Sternum.-Posterior margin between b_1 almost straight. Relative lengths of setae (a_1=100): b_1=(286-)321-346; setae thin, tapering, striate, (1.1-)1.2 times as long as their distance apart. Anal plate directed obliquely upwards, somewhat longer than broad, consisting of two subcylindrical somewhat pointing outwards blunt branches separated by a deep U-shaped incision, length of branches 3/4 of the length of plate; from the sternal side of each branch, a clavate, posteriorly directed appendage 0.5 of the length of branch; plate and appendages with very short oblique pubescence.

Etymology.-From Latin *eximius* = exceptional (among the Tasmanian representatives of the genus).

Distribution in Tasmania. The small number of localities makes it impossible to determine the range accurately.

Genus *Pauropus* Lubbock

Type species: *Pauropus huxleyi* Lubbock, 1867:182–185, pl. 10, figs.1–19.

Pauropus dolosus Remy, 1956a

Material Examined. 44 specimens. Loc. 8, upstream site, soil core, 1 ad. 9 (female), 22.v.1989 (PG). Loc. 11, south track, suction, 1 ad. 9 (sex **?**), 1 subad. 8 (female), 16.iii.1989 (PG), and in leaf litter, 3 ad. 9 (1 male, 2 female), 4 subad. 8 (1 male, 3 female), 2 juv. 6, 2 juv. 5, 21.iii.1989 (PG,JD), and in moss, base myrtle trunk, 1 ad. 9 (male), 2 subad. 8 (male, female), 21.iii.1989 (JD), and in moss on fallen log, 3 ad. 9 (1 male, 2 female), 5 subad. 8 (2 male, 3 female), 3 juv. 6, 1 juv. 5, 21.iii.1989 (JD), and PKD, 1 ad. 9 (female), 16.iv.1989 (PG,JD), and north track, in moss on dead log, 8 ad. 9 (4 male, 3 female, 1 (sex**?**), 2 juv. 6, 3 juv. 3, 21.iii.1989 (JD). Loc. 12, litter, 1 ad. 9 (female), 9. iv.1989(PG).

Distribution in Tasmania. Pauropus dolosus has been collected at three sites only, all in south-eastern Tasmania.

General distribution. Known previously only from the holotype from New Zealand (Remy 1956a).

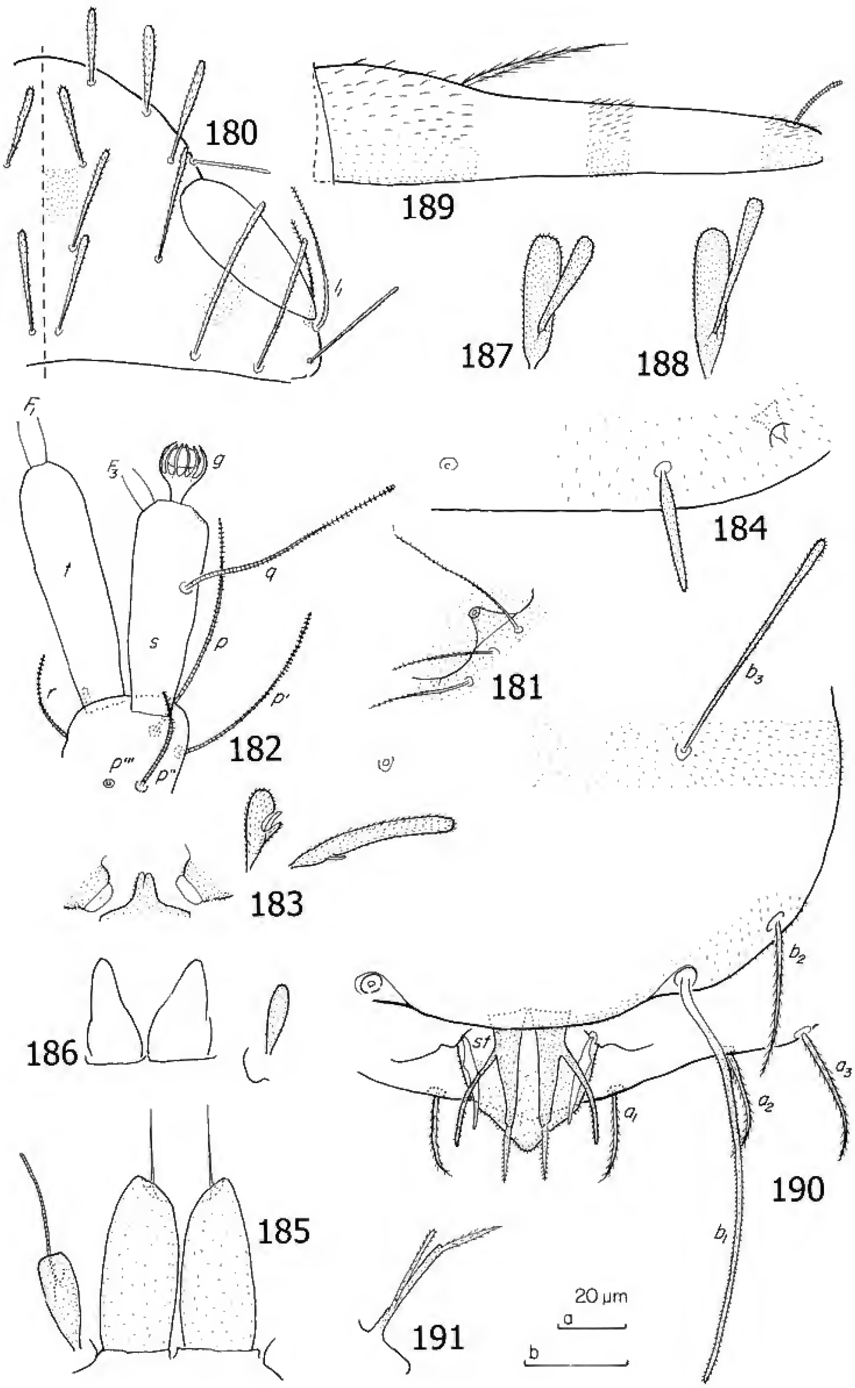
Pauropus vandiemeni sp.nov.

(Figs.180–191)

Material Examined. Holotype. Ad. 9 (male), Bradshaw's Road, Mount Murchison, Loc 2, (41°49.9'S, 145°37.0'E), leaf litter, 21.iv.1989 (JD).

Paratypes. Same data as holotype, 1 ad. 9 (male). Bruny Island, Mount Mangana, Loc. 12, (43°22.1'S, 147°17.0'E), leaf litter, 5 ad. 9 (female), 1 subad. 8 (female), 2 juv. 6, 1 juv. 3, 4.iv.1989 (JD,PG).

Other material. 53 specimens. Loc. 1, in moss on ground, 1 ad. 9 (female), 1 juv. 3, 21.iv.1989 (HM), and in leaf litter, 2 ad. 9 (female), 21.iv.1989 (JD,HM), and suction sample from moss on ground, site 1, 1 ad. 9 (female) and site 2, 1 ad. 9 (female), 21.iv.1989 (PG). Loc. 6, hand collection, 2 ad. 9 (female), 28.xi.1989 (RC). Loc. 8, leaf litter, 1 ad. 9 (male), 2 juv. 3, 22.v.1989 (PG), and bridge site, soil core, 1 subad. 8 (male), 22.v.1989 (JD), and PKD from *Sassafras*, 1 ad. 9 (sex?), 2. vi.1989 (JD,PG). Loc. 9, leaf litter, 2 ad. 9 (male, female), 1 subad. 8 (female), 2 juv. 6, 3 juv. 5, 18.xi.1988 (PG). Loc. 10, in moss on ground/



Figs. 180–191. *Pauropus vandiemeni* sp.nov., holotype 180–185, 187–191, paratype 186: 180, head, median and right part, tergal view; 181, temporal organ, posterior part, lateral view; 182, right antenna, sternal view; 183, collum segment, median and left part, sternal view; 184, tergite VI, posteromedian part; 185, genital papillae and seta on coxa of 2nd pair of legs, anterior view; 186, genital papillae and seta of coxa of 2nd pair of legs in subad. 8; 187, seta on coxa of 9th pair of legs; 188, seta on trochanter of 9th pair of legs; 189, tarsus of 9th pair of legs; 190, pygidium, sternal view; 191, anal plate, lateral view. Scale line a for figures 180, 181, 183–191; b for figure 182.

rock, 6 ad. 9 (1 male, 5 female), 2 subad. 8 (female), 25.viii.1989 (RC). Loc. 12, in moss on dead log on ground, 4 ad. 9 (female), 4.iv.1989 (JD), and in litter, 4 ad. 9 (female), 1 subad. 8 (male), 4.iv.1989 (PG) and, 2 ad. 9 (male), 4.iv.1989 (PG), and suction, 4 ad. 9 (female), 9.iv.1989 (PG), and in moss, 2 ad. 9 (female), 9.iv.1989 (JD). Loc. 13, litter, 2 ad. 9 (male, female), 27.ii.1989 (SS). Loc. 17, non-myrtle litter, 1 ad. 9 (female), 2 subad. 8 (male, female), 1 juv. 6, 1 juv. 5, 8.iii.1989 (PG).

Diagnosis. *Pauropus vandiemeni* forms a group with *P. montanus* Scheller from New Caledonia (Scheller 1993), *P. wieheorum* Remy from Mauritius (Remy 1959b) and *P. difficilis* Remy from Pondichéry (Remy 1961) on the basis of the similar anal plates but they differ considerably in other features. The new species is distinguished from *P. montanus* by anteriorly-incised collum process (blunt in *montanus*), 6+4 setae on tergite V (not 6+6), lanceolate pubescent setae in the posterior row on tergite VI (not cylindrical glabrous), the tarsus of leg 9 with strong pubescence on the tergal side (not delicate), the pygidial tergum with large triangular posterior lobe (not a small one with posteromedian incision) and distinctly pubescent pygidial setae a_1 and a_2 (not glabrous). From *P. wieheorum* it is distinguished by the shape of the posterior lobe of the pygidial tergum (large and subtriangular in *vandiemeni*, low with posteromedian incision in *wieheorum*), the pygidial setae a_1 (thin and pointed, not thick and blunt) and the *st* (inner margin evenly curved and outer with bulge, not inner margin with bulge and outer evenly curved). There are reliable characters to distinguish this species from *P. difficilis*: the length of the posterior setae on tergite VI in relation to their distance apart (0.6-0.7 in *vandiemeni*, 1.1 in *difficilis*), the pubescence on setae a_1, a_2 and a_3 of the pygidial tergum (distinct from base to apex, compared to somewhat indistinct and present only distally) and the shape of the *st* (similar to a knife-blade compared to not clavate).

Description. *Length*.-(0.84-)0.93(-1.27) mm.

Head.-Tergal setae long, with dense short oblique pubescence, anterior and submedian ones somewhat clavate, sublateral and lateral ones cylindrical. Relative lengths of setae, 1st row: a_1=10, a_2=(10-)13; 2nd row: a_1=(10-)13, a_2=(12-)15, a_3=(9)11; 3rd row: a_1=(12-)14(-15), a_2=(15-)18; 4th row: a_1=(12-)13(-14), a_2=(19-)22(-23), a_3=(17-)20(-24), a_4=(15-)16(-18); lateral group setae: l_1=(16-)19(-20), l_2=(12-)14, l_3=about 13(-18). The ratio a_1/a_1-a_1 in 1st row (0.8-)0.9, 2nd row (0.8-)1.0, 3rd row 2.0(-2.2) and 4th row (2.2-)3.8. Temporal organs (0.7-)0.8 of their shortest distance apart. Just inside the posterior margin on a level with l_1 a small exterior pore. Head cuticle with minute pubescence, temporal organs almost glabrous.

Antennae.–Segment 4 with 5 cylindrical striate-annulate setae; their relative lengths: *p*=100, *p*'=(83-)89(-95), *p*''=30(-44), *r*=(30-)42(-44), *u*=(6-)7; *p*''' as a rudimentary knob. Tergal seta *p* (0.7-)0.9 of the length of tergal branch *t*. The latter subcylindrical, 3.9(-7.2) times as long as its greatest diameter and 1.2(-1.4) times as long as sternal branch *s*, that branch slightly clavate, (3.2-)3.8 times as long as its greatest diameter; anterodistal corner somewhat more truncate than posterodistal one. Seta *q* cylindrical, striate-annulate, (as long as-)1.1 times as long as *s*. Relative lengths of flagella (basal segments included) and basal segments (paratypes only): F_1=100, bs_1=(6-7); F_2=(63-82), bs_2=(6); F_3=(68-86), bs_3=(6-7). The F_1 2.1-3.0 times as long as *t*, F_2 1.8-1.9 and F_3 1.8-2.7 times as long as *s* respectively. Globulus *g* (1.3-)1.4(-1.5) times as long as wide, stalk thin; (11-)13 bracts, capsule with flattened bottom, subhemispherical; width of *g* (0.7-)0.8 of greatest diameter of *t*. Antennae very faintly pubescent.

Trunk.-Setae of collum segment furcate; primary branch folioform with oblique pubescence, secondary branch rudimentary, cylindrical, glabrous. Sublateral setae (1.8-)1.9(-2.0) times as long as submedian ones; sternite process blunt with small anterior incision; appendages low with flat caps; process and appendages with distinct pubescence.

Setae on tergite I as submedian setae on the tergal side of head, on II subcylindrical blunt, on III-V subcylindrical tapering, on VI even somewhat lanceolate, but blunt. Posterior setae about 1.5 times as long as anterior ones; 4+4 setae on tergite I, 6+6 on II-IV, 6+4 on V, 4+2 on VI. Submedian posterior setae on VI 0.6(-0.7) of their distance apart and 2.0-(2.3) times as long as pygidial setae a_1.

Relative lengths of bothriotricha (most broken or lost): T_1=100, T_2=96(-99), the following paratypes only, T_3=(121-136), T_4=(113-172), T_5=(184-261), setae with simple, straight axes increasing in thickness posteriorly, T_1 very thin, T_5 thickest. Pubescence delicate, distally mostly erect.

Genital papillae subcylindrical with somewhat granular cuticle, 2.5 times as long as their greatest width; distal seta straight thin and 0.5 of the length of papilla.

Legs.-Posterior legs very long, anterior ones proportionationally shorter. Setae on coxa and trochanter of leg 9 with dense oblique pubescence, furcate, main branch leaf-shaped, secondary branch clavate and protruding from a point 1/4 from the base of the seta; secondary branch 0.8 of the length of the primary branch in coxal seta, 0.9 in the seta on trochanter; these setae more anteriorly with rudimentary, cylindrical, glabrous secondary branch. Coxal setae in leg 2 in males spatulate and very shortly pubescent and with a long thin cylindrical secondary branch (as long as-)1.3 times as long as primary branch. Tarsus of leg 9 strongly tapering, slender, 4.3(-5.3) times as long as its greatest diameter. Proximal seta tapering, pointed, with distinct oblique pubescence; distal seta cylindrical striate blunt. Proximal seta 0.3(-0.4) of the length of tarsus and 2.5(-3.0) times as long as distal seta. Cuticle of tarsus with oblique pubescence, strong and sparse on tergal side, short and denser on ventral side.

Pygidium. *Tergum*.-Posterior margin with low bulge between a_1 and a large subtriangular densely pubescent lobe projecting backwards above *st*. Relative lengths of setae: a_1=100, a_2=(111-)122(-165), a_3=(144-)150(-197), *st*=100(-111); setae all pointed, a_1, a_2 and a_3 curved inwards, subcylindrical, tapering, with distinct oblique pubescence; a_2 and a_3 divergent, *st* knife-like, somewhat curved inwards, convergent, glabrous. Distance a_1-a_1 (1.7-)1.9 times as long as a_1; distance a_1-a_2 (1.5-)1.6(-2.0) times as long as distance a_2-a_3; distance *st*-*st* (1.1-)1.4 times as long as *st* and 0.7(-0.8) of distance a_1-a_1.

Sternum.-Posterior margin between b_1 with low, very broad, rounded bulge. Relative lengths of setae (a_1=100): b_1=(410-)417(-511), b_2=(162-)178(-183), b_3=(250-)277(-289).

The b_1 subcylindrical, blunt, very shortly pubescent; b_2 subcylindrical, somewhat curved inwards, tapering, pointed, with distinct oblique pubescence; b_3 somewhat clavate, straight, with short oblique pubescence. The b_1 1.3(-1.5) times as long as their distance apart; b_2 (1.4-)1.5(-1.7) times as long as distance b_1-b_2; b_3 0.7(-0.8) of distance b_3-b_3.

Anal plate broadest anteriorly, directed steeply upwards, 1.7(-2.2) times as long as broad; with two lateral and two submedian branches; the former thin, cylindrical, blunt, pointing outwards, curved inwards; the latter thicker, straight, tapering, distally cut obliquely, separated by a V-shaped incision dividing the plate into two almost unconnected halves; submedian branches with distal, straight, thin pointed appendages the length being 0.5 of the length of plate. Plate and appendages with short oblique pubescence, strongest on distal halves of appendages.

Stage subad. 8. Genital papillae conical with blunt tip; seta absent; seta on coxa of leg 2 leaf-shaped, secondary branch rudimentary, cylindrical, blunt and glabrous.

Etymology.–Named after the original name for Tasmania, Van Diemen´s land.

Distribution in Tasmania. Pauropus vandiemeni belongs to the group of widely distributed species. It occurs in all main regions of the State except Central Tasmania.

Family Brachypauropodidae

Genus *Borneopauropus* Scheller

Type species: *Borneopauropus penanorum* (Scheller, 1994), in: Scheller *et al.* 1994: 8-11, figs 31-42.

Borneopauropus dignus sp. nov.

(Figs. 192–206)

Material Examined. Holotype. Ad. 9 (male), Savage River Pipeline Road, site 2, Loc. 1, (41°18.5'S, 145°16.3'E), in litter, 21.iv.1989 (PG).

Paratypes. Sandspit River, Loc. 8, (42°42.1'S, 147°51.5'E), PKD from *Sassafras*, 1 ad. 9 (female), 2.vi.1989 (JD,PG). Bradshaw's Road, Mount Murchison, Loc. 2, (41°49.9'S, 145°37.0'E), site 2, in leaf litter, 3 ad. 9 (2 male, 1 female), 1 subad. 8 (female), 21.iv.1989 (JD).

Other material. 55 specimens. Loc. 1, site 1, in moss on ground, 1 ad. 9 (female), 21.iv.1989 (HM), and in leaf litter, 2 ad.9 (male), 21. iv.1989 (JD,HM), and site 2, in moss on log, 4 ad. 9 (female), 1 subad. 8 (female), 21.iv.1989 (JD,HM), and in moss on *Nothofagus*, 6 ad. 9 (2 male, 4 female), 1 juv. 5, 21.iv.1989 (JD), and on moss on ground, 1 ad. 9 (female), 21.iv.1989 (PG). Loc. 2, site 1, in moss on ground, 1 juv. 5, 21.iv.1989 (HM), and in leaf litter, 4 ad. (2 male, 2 female), 1 subad. 8 (male), 21.iv.1989 (PG). Loc. 6, in moss on log, 1 juv. 5, and in moss on tree trunk, 3 ad. 9 (1 male, 2 female), 1 subad. 8 (female), 4 juv. 5, 11.vi.1990 (ATW). Loc.7, site 2, in leaf litter, 6 ad. 9 (female), 10 juv. 5, 12.v.1989 (PG). Loc. 8, in leaf litter, 1 ad. 9 (male), 1 subad. 8 (male), 22.v.1989 (PG) and suction sample, 1 ad. 9 (female), 2.vi.1989 (JD). Loc. 13, litter, 2 ad. 9 (male, female), 1 subad. 8 (female), 1 juv. 5, 27. ii.1989 (SS). Loc. 17, soil core, 1 ad. 9 (male), 5.vi.1989 (PG).

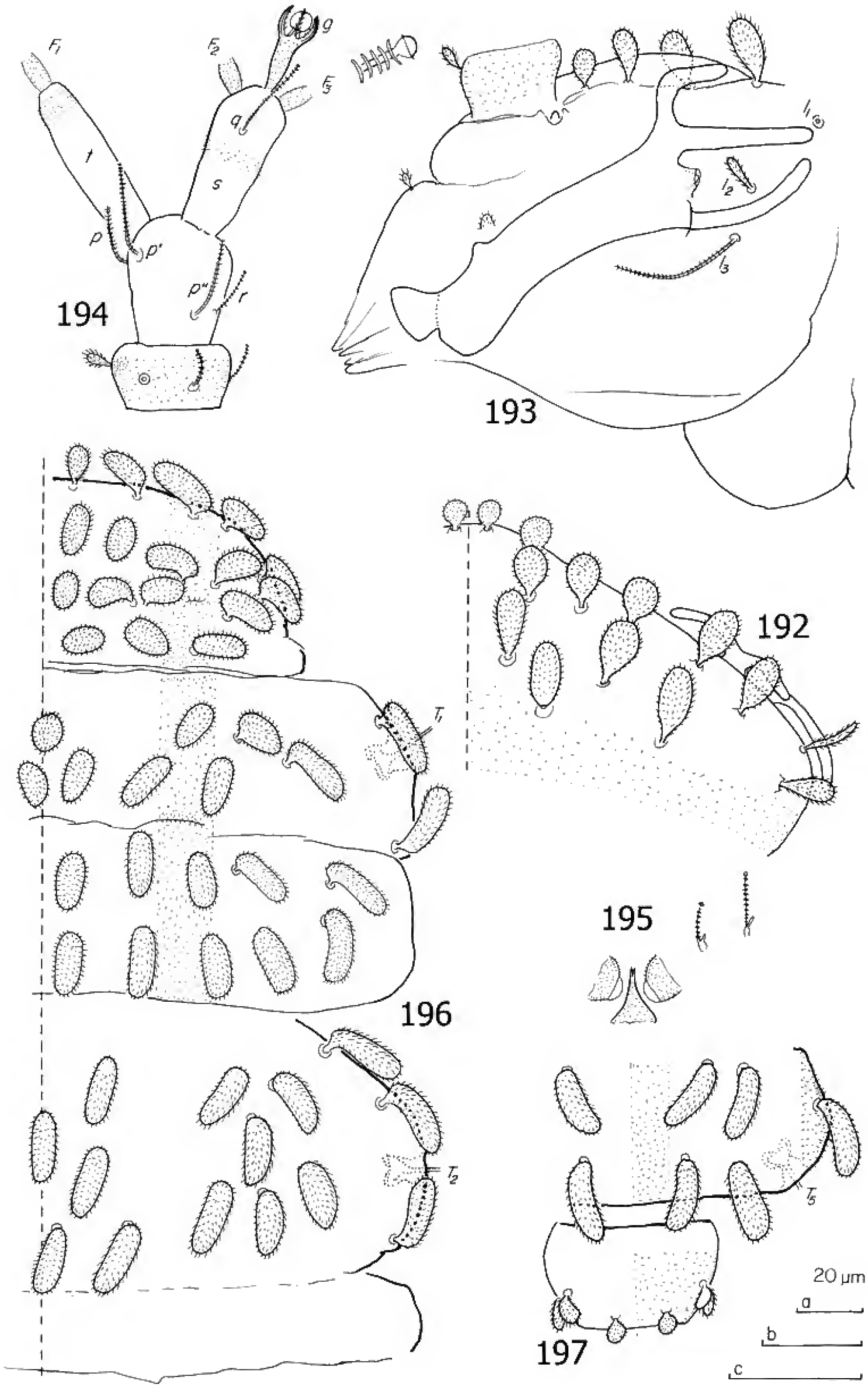
Diagnosis. The genus has three species, *B. penanorum* (Scheller) and *B. prolatus* (Scheller), both from Sabah (in Scheller *et al.* 1994 and Scheller, 2001 respectively), and *B. curtipes* Scheller from Indonesia (Scheller 2009). The Tasmanian species is well delineated from them all in having the tergites II-IV transversely divided (II, IV, V in *penanorum*, II, IV in *prolatus*, II-V in *curtipes*). It can also be distinguished from them by other good characters. There are three long uplifted posterior extensions of the temporal organs (in *penanorum* and *prolatus* two, one large and one very small), the process of the collum segment is very narrow (broader and rounded in *penanorum* and *prolatus*, broad and with distinct anterior incision in *curtipes*), the posterior end of the anal plate is cut squarely (triangular in *penanorum* and *curtipes*, cylindrical and blunt in *prolatus*), and the appendages of the anal plate have distinct distal swelling (distally cylindrical in the other species).

Description. Length. (0.58-)0.68(-0.85) mm.

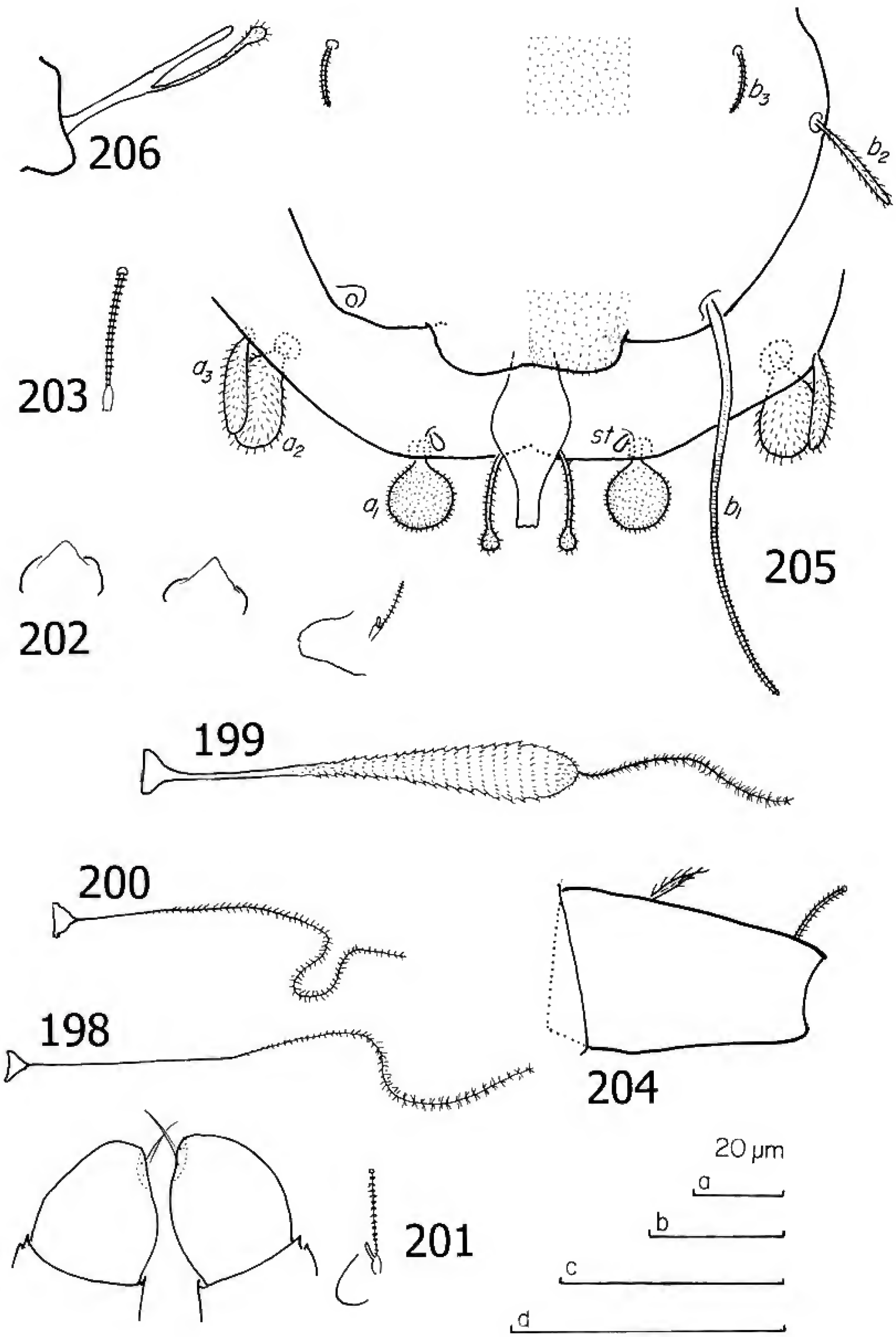
Head. Tergal and lateral sides with 28 setae arranged as in Figs. 192. and 193; transversal rows difficult to interpret. Relative lengths of the five submedian setae: 10, 13, 16, 20, 21; lateral group: l_1 large bladder-shaped, relative length = 18; l_2 subclavate = (12-)18, l_3 subcylindrical striate-annulate tapering pointed = 52. All tergal and lateral setae except l_2 and l_3 bladder-shaped with distinct and proportionally sparse oblique pubescence. Temporal organs complicated (fig. 193), longish, running along from mouth to posterior part of head; anterior end with short uplifted lobe close to the mouth; posterior part twice furcate ending in three narrow tubes with subcircular diameter, the upper tube shortest and curved posteriorly, the median one straight, the sternal one curved upwards; between the latter two a low cupulate organ with a short inner conical structure; on the tergal side of the longish median part a small protuberance from which a wart-like pubescent process protrudes from the head cuticle. Tergal side of head sparsely granular, temporal organs glabrous.

Antennae. Segment 3 with a rudimentary globulus and four setae, one clavate, distinctly pubescent and 3 subcylindrical annulate setae. Segment 4 with 5 setae, all thin cylindrical annulate; relative lengths of them: p=100, p'=(118-)150(-168), p''=(100-)130, p'''=(37-)69, r=50. Tergal seta p 0.4(-0.5) of the length of tergal branch t. The latter subcylindrical, (3.1-)3.6 times as long as wide, (as long as-)1.1 times as long as sternal branch s. The latter thickest in distal third and with anterodistal corner somewhat more truncated than posterodistal one; (1.8-)2.3 times as long as its greatest diameter and its seta q cylindrical annulate, 0.6(-0.7) of the length of s. Relative lengths of flagella (basal segments included) and basal segments: F_1=100, bs_1=7(-8); F_2=81(-92), bs_2=(6-)7(-8); F_3=79(-88), bs_3=6(-8). The F_1 (3.3-)3.4(-3.6) times as long as t, F_2 and F_3 (2.6-)3.0(-3.2) and (2.6-)2.9(-3.0) times as long as s respectively. Distal calyces low, helmet-shaped, glabrous. Globulus g with slender stalk, (2.1-)2.2(-2.4) times as long as its greatest diameter, the latter (0.8-)0.9(-1.0) of the greatest diameter of t. Antennae with g and bs_1-bs_3 with short pubescence.

Trunk. Setae of collum segment furcate, primary branch cylindrical, blunt, annulate; secondary branch rudimentarily glabrous; sublateral seta 1.1(-1.3) times as long as submedian one. Sternite process very narrow in anterior half and with apical incision; appendages with low caps; process and appendages shortly pubescent.



Figs. 192–197. *Borneopauropus dignus* sp.nov., holotype 192, 194–197, paratype 193: 192, head, median and right part, tergal view; 193, head with temporal organ, lateral view; 194, left antenna, sternal view; 195, collum segment, median and left part, sternal view; 196, tergites I–III; 197, tergite VI, median and right part, and pygidium, tergal view. Scale line a for figures 196, 197; b for figure 195; c for figures 192–194.



Figs. 198–206. *Borneopauropus dignus*, Scheller sp.nov., holotype 198–200, 203–206, paratypes 201, 202: 198, T_1; 199, T_3; 200, T_5; 201, genital papillae and seta on coxa of 2nd pair of legs, anterior view; 202, genital papillae and seta on coxa of 2nd pair of legs in subad. 8, anterior view; 203, seta on coxa of 9th pair of legs; 204, tarsus of 9th pair of legs; 205, pygidium, sternal view; 206, anal plate, lateral view. Scale line a for figures 198, 200, 202; b for figures 199, 201; c for figures 203, 204; d: for figures 205, 206.

Tergites I, V, VI entire, II, III, IV transversely divided weakly in two. Number of setae on tergites (if two groups of values, they are anterior and posterior groups respectively: I (29-)31(-37), II 17(-24)+20, III (23-)26(-27)+(18-)24, IV (21-)28+(14-)17(-28), V 34(-40), VI 6+4. Setae bladder-shaped with distinct oblique-erect pubescence, stalk inserted unsymmetrically. Cuticle of tergites pubescent.

Relative lengths of bothriotricha: T_1=100, T_2=98(-105), T_3=(78-)81(-82), T_4=(99-)110, T_5=(88-)89(-92), axes simple, most proximally glabrous; proximal half of T_3 strongly clavate, distal half very thin; other bothriotricha with thin and curved axes; pubescence short oblique on proximal halves, erect distally; clavate part of T_3 with pubescence arranged in sparse whorls.

Genital papillae, 1.2 times as long as their greatest diameter, widest near the middle, glabrous; seta almost 0.5 of the length of papilla.

Legs. All legs 5-segmented. Setae on coxa and trochanter of leg 9 similar, simple, cylindrical, densely annulate, blunt, without traces of secondary branches. More anteriorly these setae of the same shape, but with short cylindrical glabrous rudiments of secondary branches. Tarsus of leg 9 short, tapering, 1.8(-2.7) times as long as its greatest diameter. Proximal seta tapering, pointed, with a few oblique pubescence hairs on tergal side; distal seta cylindrical, striate, blunt; the former 0.2(-0.3) of the length of tarsus and (0.9-) as long as the latter. Cuticle of tarsus with delicate pubescence.

Pygidium. Tergum. Hind margin with a shallow incision between a_1. Relative lengths of setae: a_1=10, a_2=12(-15), a_3=13(-18), *st*=2(-4). All but *st* bladder-shaped, *st* very short, (cylindrical-)clavate, straight, pointing inwards; a_1 straight, subspherical, in tergal view broadly spatulate, with very dense short erect pubescence; a_2 and a_3 somewhat curved inwards, ovoid, with sparse but distinct oblique pubescence, these setae very similar to those on the tergites. Distance a_1-a_1 (2.0-)2.7 times as long as a_1, distance a_1-a_2 considerably longer than distance a_2-a_3; distance *st-st* (7.2-)9.3 times as long as *st* and 0.9(-1.0) times as long as distance a_1-a_1.

Sternum. Posterior margin between b_1 rounded and with broad lobe below anal plate; lobe with rounded posterolateral corners and shallow median indentation. Relative lengths of setae (pygidial a_1=10): b_1=(43-)50(-62), b_2=13(-15), b_3=9(-10). The b_1 subcylindrical, tapering, striate, blunt, b_2 and b_3 cylindrical, the former tapering distally and with distinct oblique pubescence, the latter striate blunt. The b_1 1.1(-1.2) times as long as distance b_1-b_1, b_2 0.5(-0.7) of distance b_1-b_2 and b_3 0.2 of distance b_3-b_3. Anal plate twice as long as its greatest width, widening from its base, lateral margins convex, broadest about at the middle; distal part narrow with parallel lateral margins and cut squarely at the end; two thin cylindrical appendages with globular distal enlargements protrude backwards from the middle of the sternal side, length of appendages 0.6(-0.7) of the length of plate.

Stage subad. 8. Genital papillae weakly developed and in the shape of small blunt cones from a low rounded base.

Stage juv. 5. The number of setae on the tergites I 13-14, II 20, III 20, IV 8(6+2) or 16(8+8) indicating an additional moult in this stage.

Etymology. From Latin *dignus* = worth.

Distribution in Tasmania. The species is widely distributed along both the western and eastern regions of the island.

Notes on collecting methods and sites

Pauropods depend upon sustained conditions of moisture and humidity in their living space and are normally true soil dwellers adapted to a uniform type of environment. However, in humid climates, they sometimes, at least temporarily, inhabit lower litter layers and can be found under moss and under bark of rotting wood. By using different collecting techniques in Tasmanian rainforest and by careful handling of the material, it has appeared that pauropods are unexpectedly abundant in moss and are probably living in the contact zone between the moss and underlying soil or log. They were also found in habitats not previously considered to be inhabited by pauropods such as on tree trunks (Greenslade, 2008). The record of both adults and juveniles of *Stylopauropoides quadripartitus* sp. nov. in the crown of a tree fern indicates that reproduction was occurring in this habitat.

Acknowledgements

Special thanks are directed to the collectors and to Penelope Greenslade who offered the material to me. Thanks are also due to the Parks and Wildlife Service, Forestry Commission and the Department of the Arts, Sport, the Environment and Territories for financially supporting the National Rainforest Conservation Programme.

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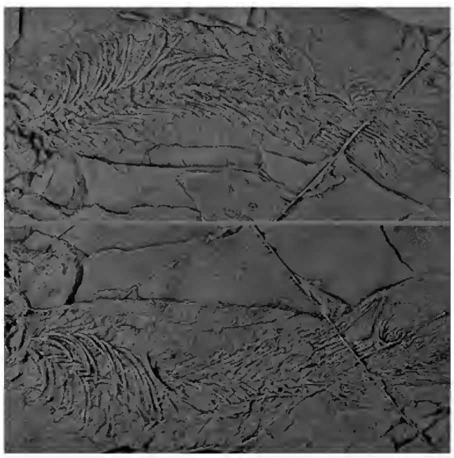

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