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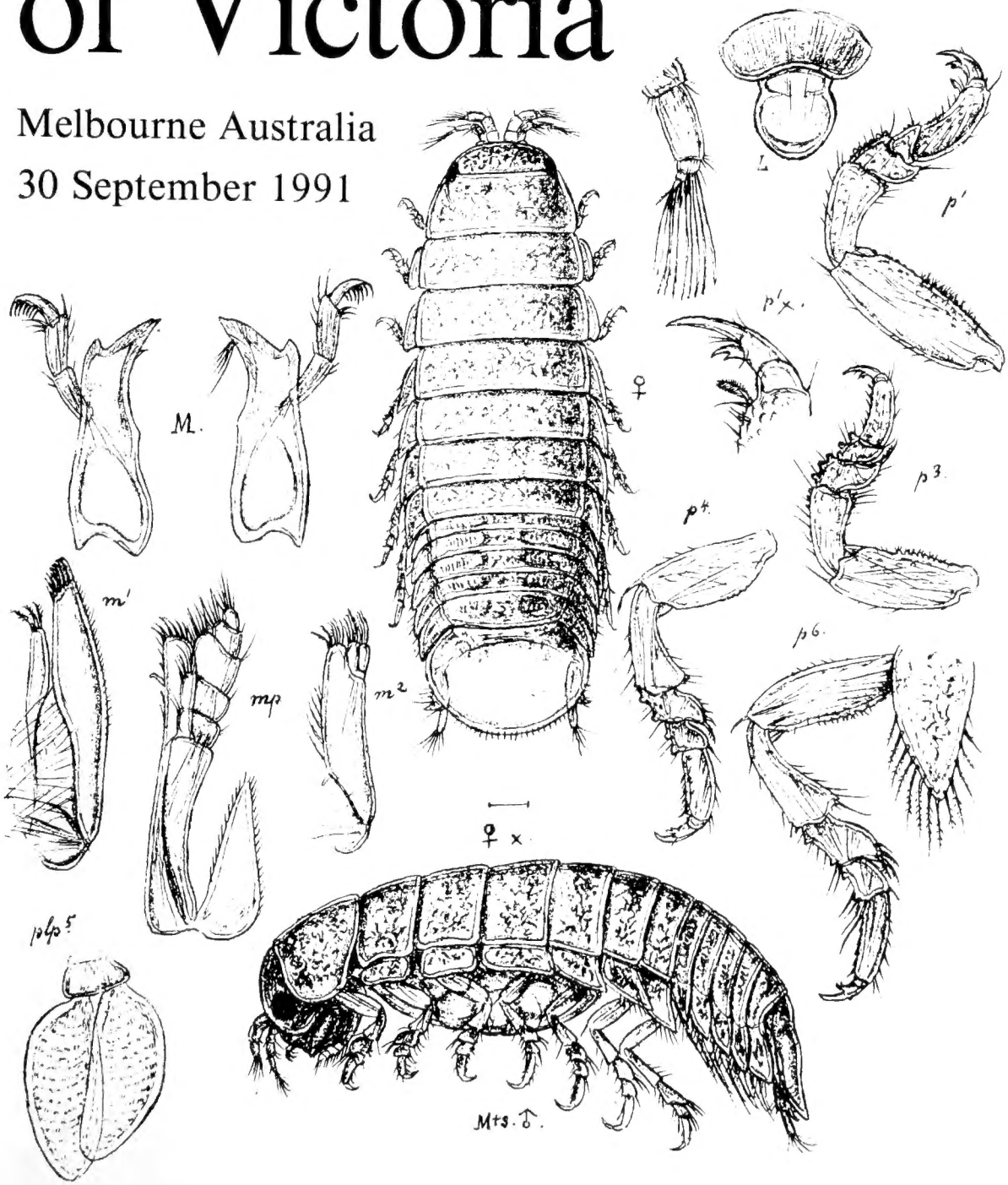

Cover. G. O. Sars' *An Account of the Crustacea of Norway* Vol. 2 (1896–1898) contained some of the best early illustrations of Crustacea. *Limnoria lignorum*, a wood-boring marine gribble figured by him, is type species of its genus. This important family of crustaceans is reviewed by Laurie Cookson in this issue. Many new species from Australia are reported.

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In taxonomic papers synonymies should be of the short form: taxon, author, year, pages, figures. A period and dash must separate taxon and author except in the case of reference to the original description.

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Memoirs of the Museum of Victoria 52(2): 137–262 (1990) ISSN 0814-1827

AUSTRALASIAN SPECIES OF LIMNORIIDAE (CRUSTACEA: ISOPODA)

By Laurie J. Cookson

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Abstract

Cookson, L.J., 1991. Australasian species of Limnoriidae (Crustacea: Isopoda). *Memoirs of the Museum of Victoria* 52: 137–262.

Some members of the Limnoriidae are important marine wood-borers. The taxonomy of the family was studied with emphasis on species from the Australasian region. The Limnoriidae are reduced to two genera: *Limnoria* Leach and *Paralimnoria* Menzies. The genus *Phycolimnoria* is synonymised with *Limnoria*.

Species from Australia are redescribed: *Limnoria indica* Becker and Kampf, *L. insulae* Menzies, *L. multipunctata* Menzies, *L. nonsegnis* Menzies, *L. pfefferi* Stebbing, *L. platycauda* Menzies, *L. quadripunctata* Holthuis, *L. rugosissima* Menzies, *L. sublittorale* Menzies, *L. tripunctata* Menzies and *L. unicornis* Menzies.

New species from Australia are: *L. agrostisa*, *L. echidna*, *L. gibbera*, *L. glaucinosa*, *L. orbellum*, *L. poorei*, *L. raruslima*, *L. torquisa* and *L. uncapedis*. The new species *L. loricata* and *L. convexa* are also described from The Snares, New Zealand.

Species from Papua New Guinea are: *Paralimnoria andrewsi* (Calman), *P. asterosa* Cookson and Cragg, *L. andamanensis* Rao and Ganapati, *L. indica*, *L. insulae*, *L. kautensis* Cookson and Cragg, *L. multipunctata*, *L. pfefferi*, *L. tripunctata* and *L. unicornis*.

L. antarctica Pfeffer and *L. stephenseni* Menzies from Macquarie Island are redescribed.

Although not found near Australia, *L. tuberculata* Sowinsky is also redescribed to distinguish it from *L. tripunctata*.

Of the above species, 15 are wood-borers, 12 algal-borers or dwellers, and 2 seagrass-borers. Commensal crustaceans found with limnoriids, such as harpacticoid copepods, ostracods, and amphipods of the family Cheluridae are noted. *Tropichelura insulae* (Calman) (Amphipoda) is recorded from Australia for the first time.

Contents

Introduction

Isopod crustacean marine borers in the family Limnoriidae, commonly called "gribble", have received a great deal of attention from wood preservationists because of the damage they can cause to marine timber structures. They are one of four main groups of marine borers which can substantially damage timber in the sea. The three other groups are isopods of the genus *Sphaeroma*, and molluscs of the families Pholadidae (piddocks) and Teredinidae (shipworms). Studies on Limnoriidae have increased dramatically since Menzies (1951a) correlated the premature failure of creosote-treated softwoods in the USA due to the presence of *Limnoria tripunctata* Menzies. This species, *and L. quadripunctata* Holthuis and *L. lignorum* (Rathke), are the three most studied species.

Algal- and seagrass-boring species of Limnoriidae have received much less attention. The algal-borers can cause seaweeds to come adrift by boring into holdfasts (Jones, 1971). The importance of seagrass-borers to the erosion of seagrass meadows is not known.

Ecology

Habitats in which limnoriids have been found include dead wood (e.g., Menzies, 1957); preservative treated wood (e.g., Menzies, 1951a; Cookson and Barnacle, 1987a); bamboo (Richardson, 1909), dead and decaying wood from live mangroves (Kensley and Schotte, 1987); live soft uncorticated mangrove roots (Ellison and Farnsworth, 1990); holdfasts of brown algal kelps from the order Laminariales, such as *Macrocystis* (Pfeffer, 1887; Chilton, 1914a; Hale, 1937; Menzies, 1957; Paternoster and Elías, 1980; present study), *Egregia*, *Eisenia*, *Laminaria*, *Postelsia*, *Nereocystis* (Menzies, 1957), *Pelagophycus* (Jones, 1971), *Lessonia* (Stephensen, 1927; present study), *Ecklonia* (present study); kelps from the order Fucales, such as *Sargassum* (Pillai, 1957; Jones, 1971), *Durvillaea*, *Cystophora*, possibly *Acrocarpia* (present study); on the Fucales brown alga *Hormosira* (present study); *Corallina* (Menzies, 1957) and other red algae (present study); possibly green algae (present study); on *Galeolaria* tube-worm colonies (present study); under algal covered stones (Pfeffer, 1887; present study); algal epifauna in rock pools (present study); under encrusting and coralline algae (present study); and in the seagrasses *Phyllospadix* (Kussakin, 1979), *Thalassia* (Müller, 1988), *Posidonia*, *Heterozostera*, *Zostera* and *Amphibolis* (present study). *Limnoria* has also been found in gutta-percha (insulating latex) from old submarine cables (Chilton, 1916), and can produce shallow pits in materials made from a com-

bination of certain plastics and ground wood (Griffin and Turner, 1980).

In Australia, the greatest depth where algae are likely to be found growing is 75 m (Rochford, 1980), while seagrasses are mostly within 35 m, although some have been found at 68 m (Lanyon, 1986). The deepest algal-borers are *L. rugosissima* Menzies and *L. nonsegnis* Menzies at 30 m, and *L. uncapedis* sp. nov. at 21 m (present study). The deepest seagrass-borer is *L. raruslima* sp. nov. at 12 m (present study). *L. torquisa* sp. nov. appears to be largely restricted to the tidal zone. Most known species of wood-boring *Limnoria* are found in comparatively shallow water. However, some species appear to be restricted to deeper water. These species are: *L. japonica* Richardson at 300 m (Richardson, 1909), *L. septima* Barnard (probably a wood-borer) at 340-460 m (Barnard, 1936), *L. sublittorale* Menzies at 110 m (Menzies, 1957), *L. reniculus* Schotte at 520 m (Schotte, 1989), *L. foveolata* Menzies (may be a wood-borer) at 52 m (Menzies, 1957), *L. borealis* Kussakin at 18–230 m (Kussakin, 1963), *L. emarginata* Kussakin and Malyutina at 1050 m (Kussakin and Malyutina, 1989) and *L. hicksi* Schotte at 1100 m (Schotte, 1989). *Paralimnoria asterosa* Cookson and Cragg and *L. kautensis* Cookson and Cragg have so far been found only at 8–9 m depths, despite collections from several more shallow locations in Papua New Guinea (Cookson and Cragg, 1988). The deepest occurring limnoriid species appears to be those boring into wood at 1514 m (Hicks, 1988).

Commensals

A large variety of commensals has been found on the Limnoriidae and in their burrows. These include various microorganisms such as bacteria (Boyle and Mitchell, 1981), protozoans (Mohr, 1959; Sleeter and Coull, 1973) and diatoms (Sleeter and Coull, 1973). On several occasions numerous strands of filamentous algae were found on the antennae, mouthparts and body of certain algal feeding *Limnoria* such as *L. stephenseni, L. antarctica* and *L. rugosissima.* Nematodes and polychaetes may also be found in limnoriid burrows (Sleeter and Coull, 1973).

Many crustaceans have been found in association with the Limnoriidae. *Donsiella limnoriae* Stephensen (Copepoda: Harpacticoida: Thalestridae) was found on *L. lignorum* (Stephensen, 1936; Holmes and Jeal, 1987), *L. tripunctata* and *L. quadripunctata* (Krishnaswamy and Jones, 1958, 1962). Seven more donseilline species have been found recently, including three collected from the Australian limnoriid material (Hicks, 1988, 1990).

Other harpacticoid copepods associated with *Limnoria* include *Harrietella simulans* (Scott) (Laophontidae) (Coull and Lindgren, 1969; Boer, 1971). This species was also associated with some wood-boring *Limnoria* from Australia (Hicks, 1988). The Australian specimens of *H. simulans* were mostly associated with burrows of *Limnoria*, but were also collected when they became caught on setae of collected *Limnoria*. However, most of the donsielline specimens were found in the brood pouch and on the sternum of *Limnoria*. The specimens found in the brood pouches did not appear to have damaged the limnoriid eggs, as broken eggs or egg pieces were very rarely found.

Aspidoconcha limnoriae De Vos (Ostracoda: Podocopida: Paradoxostomatidae) was found on the dorsal surface of the pleotelson of *L. lignorum* (De Vos, 1953). At least four species of ostracods were collected from the brood pouch, pleotelson and sternum of *Limnoria* from Australia.

Caecijaera borealis Kussakin (Isopoda: Asellota: Janiridae) was found in association with *L. borealis* (Kussakin, 1962; Svavarsson, 1982), while *C. horvathi* Menzies was found with *L. tripunctata* (Cooke, 1977). Asellotans were also found in the current study with *L. stephenseni* from Macquarie Island, and *L. pfefferi* and *L. indica* from Green Island, Queensland.

Species of *Corophium* (Amphipoda: Corophiidae) and Tanaidacea were often found in old *Limnoria* burrows which were overgrown with a film of algae.

The amphipod family Cheluridae appears to be found only in association with Limnoriidae. It contains three species: *Chelura terebrans* Phillippi, *Tropichelura insulae* (Calman) and *Nippochelura brevicauda* (Shiino) (Barnard, 1959). *Chelura terebrans* is unable to produce tunnels of its own (Johnson and McNeill, 1941), although it is able to produce furrows in softwood and widen the exterior ends of *Limnoria* burrows (Barnard, 1955). It may also feed on the faecal pellets of *Limnoria* (Kühne and Becker, 1964). *Chelura terebrans* has been previously reported from Melbourne and Sydney (Barnard, 1959). *C. terebrans* was found, in association with one or both species of *L. tripunctata* and *L. quadripunctata*, at Albany, Bunbury and Geraldton in WA; at Goat Island, Cabarita, Watsons Bay and Ulladulla in NSW;

at Williamstown, Sandringham and St Kilda in Victoria; and at Burnie, Tasmania. *Tropichelura insulae* was found with *L. pfefferi* and *L. indica* at Green Island, Queensland, and is the first record of this species from Australia.

Taxonomy

Menzies (1957) divided the Limnoriidae into two genera: *Paralimnoria* Menzies, 1957 and *Limnoria* Leach, 1814. The most important feature separating the genera was the shape of the uropods. In *Paralimnoria* both rami are long and have an apical claw. In *Limnoria* only the reduced exopod has an apical claw. Menzies (1957) also erected the subgenus *Phycolimnoria* of *Limnoria* to accommodate the seven algal-borers then known. This separation was based on the absence in *Phycolimnoria* of rasp (Plate 1a) and file (Cookson and Cragg, 1988: Fig. 3e) incisors on the mandibles. *Phycolimnoria* was raised to generic status by Kussakin (1963), which was accepted by Kensley and Schotte (1987). However, the rasp and file no longer clearly separates the species known today.

Hadromastax merga Bruce, 1988, which was originally placed in the Limnoriidae, has been moved to a new family (Bruce and Müller, 1990). Other families closely related to the Limnoriidae are the Keuphyliidae Bruce, 1980 and the Lynseiidae Poore, 1987.

Prior to papers by Menzies (1951b, and comprehensive review in 1957), only eight species and one poorly known variety of Limnoriidae were known (Holthuis, 1949, Sowinsky, 1884). The species then thought to be most responsible for the destruction of timber structures was *Limnoria lignorum*. In Australia limnoriid attack of timber was usually attributed to *L. lignorum* (Hale, 1929; Iredale et al., 1932; Watson et al., 1936; Iredale, 1939; Dakin, 1987), an arctic-boreal species now known not to be present in Australia. Including the new species described herein, there are 51 species of Limnoriidae world-wide (Tables 1, 2), of which 28 are wood-borers, 17 algal-borers and feeders, 4 seagrass-borers, while the substrates for *L. septima* and *L. foveolata* are as yet unknown.

This study is concerned primarily with species from Australasia, and includes material from Australia, Macquarie Island, The Snares in New Zealand, Papua New Guinea and Cocos Islands.

Table 1. Check-list of the species of Limnoriidae.
*Species described here.
**Species examined but descriptions not published here.

Paralimnoria andrewsi (Calman, 1910)*
P. asterosa Cookson and Cragg, 1988*
Limnoria lignorum (Rathke, 1799)**
L. segnis Chilton, 1883
L. tuberculata Sowinsky, 1884*
L. antarctica Pfeffer, 1887*
L. pfefferi Stebbing, 1904*
L. japonica Richardson, 1909
L. septima Barnard, 1936
L. quadripunctata Holthuis, 1949*
L. tripunctata Menzies, 1951*
L. platycauda Menzies, 1957*
L. saseboensis Menzies, 1957**
L. simulata Menzies, 1957**
L. algarum Menzies, 1957**
L. multipunctata Menzies, 1957*
L. unicornis Menzies, 1957*
L. foveolata Menzies, 1957
L. sublittorale Menzies, 1957*
L. insulae Menzies, 1957*
L. segnoides Menzies, 1957
L. nonsegnis Menzies, 1957*
L. rugosissima Menzies, 1957*
L. stephenseni Menzies, 1957*
L. carinata Menzies and Becker, 1957
L. bituberculata Pillai, 1957
L. indica Becker and Kampf, 1958*
L. bombayensis Pillai, 1961
L. magadanensis Jesakova, 1961
L. chilensis Menzies, 1962
L. borealis Kussakin, 1963**
L. zinovae (Kussakin, 1963)
L. andamanensis Rao and Ganapati, 1969*
L. sexcarinata Kühne, 1975**
L. clarkae (Kensley and Schotte, 1987)**
L. kautensis Cookson and Cragg, 1988*
L. emarginata Kussakin and Malyutina, 1989
L. hicksi Schotte, 1989
L. reniculus Schotte, 1989
L. cristata Cookson and Cragg, 1991
L. agrostisa sp. nov.*
L. convexa sp. nov.*
L. echidna sp. nov.*
L. gibbera sp. nov.*
L. glaucinosa sp. nov.*
L. loricata sp. nov.*
L. orbellum sp. nov.*
L. poorei sp. nov.*
L. raruslima sp. nov.*
L. torquisa sp. nov.*
L. uncapedis sp. nov.*

Table 2. Annotated check-list of the species of Limnoriidae not described in text.

L. algarum Menzies, 1957.
Distribution: Oregon to southern California (Menzies, 1957).
Depths: 0–15 m (Ghelardi, 1971).
Substrates: Holdfasts of *Macrocystis*, *Egregia*, *Eisenia*, *Laminaria*, *Postelsia*, *Nereocystis*, *Sargassum* (Menzies, 1957) and *Pelagophycus* (Jones, 1971).

L. bituberculata Pillai, 1957.
Distribution: Kerala, India.
Depths: Littoral (tidal) zone.
Substrate: *Sargassum* (Pillai, 1957, 1961).
Remarks: In several important respects the descriptions given by Pillai in 1957 and 1961 differ, such as the presence or absence on pleonite 5 of a dorsomedial pair of longitudinal grooves, the exact position of the two pleotelsonal puncta, the number of flagellar articles on antenna 1, and the structure of the pereopods. This species seems most similar to *L. uncapedis*.

L. bombayensis Pillai, 1961.
Distribution: Bombay, India (Pillai, 1961).
Depths: Tidal zone and shallow water.
Substrates: Light woods (Palakar and Bal, 1957); various untreated and some CCA- and creosote-treated test timbers (Santhakumaran, 1969b).
Remarks: Pillai (1961) considered *L. bombayensis* most similar to *L. tripunctata*.

L. borealis Kussakin, 1963.
Distribution: Kandalaksha Gulf in the White Sea, Barents Sea, Okhotsk Sea, Japan Sea, USSR (Kussakin, 1963); probably Newfoundland, Canada (called *L. japonica* by Brunel, 1963); Iceland (Svavarsson, 1982).
Depths: 18–260 m (Kussakin, 1963).
Substrate: Wood (Kussakin, 1963).
Remarks: *L. borealis* seems most similar to *L. lignorum* and *L. japonica*.

L. carinata Menzies and Becker, 1957.
Distribution: Italy.
Depths: Precise depths unknown, shallow water.
Substrates: Softwood (Menzies and Becker, 1957).
Remarks: The taxonomic position of this species requires further examination, as Kühne (1971) suggested synonymy with *L. quadripunctata*. The foveolate surface found on *L. carinata* (Menzies and Becker, 1957) can also be found on some specimens of *L. quadripunctata*. The presence of only four flagellar articles on antenna 2 of *L. carinata* appears to be the most important character distinguishing the species; however, the reliability of this character in *L. carinata* needs to be checked.

L. chilensis Menzies, 1962.
Distribution: Chile (Menzies, 1962); Argentina (Paternoster and Elías, 1980).
Depths: Tidal zone, and probably shallow water.
Substrates: Algae (Menzies, 1962); *M. pyrifera* (Paternoster and Elías, 1980).
Remarks: The ornamentation on pleonite 5 differ in figures given by Menzies (1962) and Paternoster and Elías (1980) (V-shaped versus longitudinal). Paternoster and Elías (1980) may have been incorrect in describing five flagellar articles on antenna 1, a condition found normally in *Paralimnoria* not *Limnoria*. *L. chilensis* is most similar to *L. nonsegnis* (Menzies, 1962).

L. clarkae (Kensley and Schotte, 1987).

Distribution: San Salvador, Bahamas (Kensley and Schotte, 1987); Belize (unpublished).

Depths: Precise depths not published, but probably tidal (mangrove) zone.

Substrates: Dead and decaying red mangrove wood (Kensley and Schotte, 1987), soft uncorticated mangrove roots (Ellison and Farnsworth, 1990).

Remarks: Antenna 1 does not have three flagellar articles (Kensley and Schotte, 1987), but two.

L. cristata Cookson and Cragg, 1991.
Distribution: Singapore.
Depth: Tidal zone.
Substrate: Driftwood plank.

L. emarginata Kussakin and Malyutina, 1989.
Distribution: Okhotsk Sea, USSR.
Depths: 1040–1050 m.
Substrate: Piece of wood (Kussakin and Malyutina, 1989).

L. foveolata Menzies, 1957.
Distribution: Near the Kai Islands, Indonesia.
Depth: 52 m.
Substrate: Unknown. The presence of rasp and file incisors on the mandibles suggests that this species is a wood- or seagrass-borer.
Remarks: This species requires further examination to show that it is clearly distinguishable from *L. saseboensis*. *L. foveolata* appears to have a longer maxillipedal epipod, more pitted pleotelson, and more apical teeth on the right mandible lacinia mobilis than *L. saseboensis*. However, these characters are not always reliable. The most useful distinguishing character may be the lack of a tuberculate pleotelsonal perimeter on *L. foveolata*.

L. hicksi Schotte, 1989
Distribution: Off New Zealand.
Depths: 1075–1100 m.
Substrate: Rotting wood (Schotte, 1989).

L. japonica Richardson, 1909.
Distribution: Near Hondo, Japan.
Depth: 300 m.
Substrate: Bamboo (Richardson, 1909).
Remarks: The specimens identified as *L. japonica* by Brunel (1963) from the Gulf of St Lawrence were probably *L. borealis* (Kussakin, 1963; Kühne, 1976).

L. lignorum (Rathke, 1799).
Distribution: Temperate and boreal northern hemisphere distribution; Norway (Rathke, 1799; Sars, 1899; Menzies, 1957); The Netherlands (Holthuis, 1949); USSR (Jesakova, 1961; Kussakin, 1963); northern USA (Menzies, 1957); Alaska (Richards and Belmore, 1976); Canada (Menzies, 1957; Brunel, 1963; Bohn and Walden, 1970); UK (Jones, 1963); Ireland (Holmes and Jeal, 1987); Iceland (Svavarsson, 1982); Hokkaido, Japan; Chinhae, Korea (Kühne, 1976); Germany (Jones et al., 1972).
Depths: 0–20 m (Kussakin, 1963).
Substrates: Mainly untreated timbers; wood and piling (Jones, 1963; Kussakin, 1963; Bohn and Walden, 1970); sawn *Pinus sylvestris* (Jones et al., 1972); unpreserved piles and regions of piles (Richards and Belmore, 1976); lightly creosoted piling (Vind and Hochman, 1961); water-logged stalks of the plant *Rumex* (Somme, 1940); untreated *Alstonia scholaris* (Eaton et al., 1989); light attack on creosote- and ammoniacal copper arsenate-treated pine (Baechler et al., 1970); in Scotland where only *L. lignorum* appears to be present (Jones, 1963), creosoted timbers (Stevenson, 1862), and greenheart (Stevenson, 1874).

L. magadanensis Jesakova, 1961.
Distribution: Sea of Okhotsk (Jesakova, 1961; Kussakin, 1963), Sea of Japan (Kussakin, 1963), USSR; Hokkaido, Japan (Kühne, 1976).
Depths: 4–112 m (Jesakova, 1961; Kussakin, 1963).
Substrates: Piling (Jesakova, 1961); wood (Kussakin, 1963).
Remarks: Contrary to the original description, *L. magadanensis* does have a dorsal row of scale spikes on the pleotelson posterior margin, and the pleotelsonal puncta are shorter than suggested in Jesakova's figure (Kussakin, 1963). Also contrary to Jesakova (1961), both *L. japonica* and *L. magadanensis* have setae on the maxilliped (Kühne, 1976), and probably pappose setae along a ventral median line on the uropod peduncle, a character not shown in Menzies' (1957) figure of the uropod of *L. japonica* where it appears in dorsal view.

L. reniculus Schotte, 1989
Distribution: New Zealand.

Depths: 44–520 m.
Substrates: Rotting wood, timber, log (Schotte, 1989).

L. saseboensis Menzies, 1957.
Distribution: Sasebo, Japan; Florida (Menzies, 1957); Japan (Kühne, 1976).
Depths: Precise depths unknown, shallow water.
Substrates: From a causeway, presumably in wood (Menzies, 1957).
Remarks: This species requires redescription to separate it more clearly from *L. indica*. The length of the maxillipedal epipod is more variable in *L. saseboensis* than suggested by Menzies (1957).

L. segnis Chilton, 1883.
Distribution: New Zealand (Chilton, 1883).
Depths: Precise depths unknown, shallow water.
Substrate: *Macrocystis* holdfasts (Chilton, 1883).

L. segnoides Menzies, 1957.
Distribution: Misaki, Japan.
Depth: Low tide zone.
Substrate: Washed from the red alga *Corallina* (Menzies, 1957).
Remarks: *L. segnoides* seems most similar to *L. bituberculata* and *L. uncapedis*.

L. septima Barnard, 1936.
Distribution: Andaman Islands.
Depths: 340–460 m.
Substrate: Unknown, but at this depth the substrate is probably wood.

L. sexcarinata Kühne, 1975.
Distribution: Satta Hip, Thailand; Takeshiki, Koniya, Japan.
Depth: Precise depths not known, but shallow water.
Substrates: Wood (Kühne, 1975).
Remarks: Instead of having only three flagellar articles on antenna 1 (Kühne, 1975), there are four. *L. sexcarinata* seems most similar to *L. pfefferi*.

L. simulata Menzies, 1957.
Distribution: Virgin Islands, West Indies (Menzies, 1957); Caribbean Sea of north Colombia (Müller, 1988); Tarpon Springs, Florida (Cookson, unpublished).
Depth: 0–4 m (Müller, 1988).
Substrate: Washed from the seagrass *Thalassia testudinum* (Müller, 1988); leaves of the seagrass *Thalassia* (Cookson, unpublished).
Remarks: Specimens of *L. simulata* which I examined from Tarpon Springs, Florida, were collected from leaves of the seagrass *Thalassia*. The identification from Kenya of *L. simulata* in wood by McKoy-Hill (1964) was probably incorrect. *L. indica* may not be a synonym of *L. simulata* (see discussion for *L. indica*).

L. zinovae (Kussakin, 1963).
Distribution: Ascold Island, Sea of Japan (Kussakin, 1963); Posvet Bay; Lake Ascold; Lake Kunashir, Sea of Okhotsk (Kussakin, 1979).
Depth: 20 m (Kussakin, 1963).
Substrate: Rhizomes of the seagrass *Phyllospadix iwatensis* (Kussakin, 1979).
Remarks: The original diagnosis (Kussakin, 1963) stated that the median tubercle was on pleonite 5, which was obviously incorrect, and the position was later corrected to the pleotelson (Kussakin, 1979). The maxillipedal epipod is still to be described for this species. *L. zinovae* seems most similar to *L. unicornis*, as both have a similar and sexually dimorphic sculpturing on the pleotelson.

Specimen sources

Material was obtained from the Museum of Victoria, Melbourne (NMV); Australian Museum, Sydney (AM); South Australian Museum, Adelaide (SAM); Western Australian Museum, Perth (WAM); Tasmanian Museum and Art Gallery, Hobart (TM); National Museum of New Zealand, Wellington (NMNZ); Canterbury Museum, Christchurch, New Zealand; British Museum (Natural History), London; United States National Museum of Natural History, Washington D.C. (USNM); and Zoologisk Museum, Copenhagen.

Most wood-borers from the Australian Museum were collected from bait blocks and other timbers during an Australia-wide teredinid survey organised by CSIRO and the University of New South Wales (Anonymous, 1972). This work was followed up at the university by J.V. Marshall (now J.V. Ibrahim) with a baiting programme using blocks of *Pinus taeda* L. Another source of wood-boring *Limnoria*, now all housed with the Museum of Victoria, was from a Masters thesis project in Western Australia on teredinids by Mr R. Howlett in 1960–1961 using baits of *Pinus pinaster* Ait. Wood-boring limnoriids from Papua New Guinea (PNG) were also made available by Dr S.M. Cragg who at the time of collection was with the PNG Department of Primary Industry, Forest Products Research Centre, Boroko.

This material was supplemented by personal collections, and collections made by Mr J.E. Barnacle also of CSIRO, during inspections of various timber structures and CSIRO timber preservative tests, or through baiting. These specimens are now with the Museum of Victoria. The baits used were mostly blocks of *Pinus radiata* D. Don which were sent to various harbour authorities for submersion. Limnoriids in bait blocks were usually still alive when returned by courier within 1–4 days after removal from the sea. Limnoriids were mostly collected directly from their burrows with forceps. Occasionally they were collected from riddled wood by placing the block in a bucket containing seawater (not aerated), and laying a piece of paper towelling over the block. Over the next few days limnoriids could be collected directly from the paper towelling. Hochman et al. (1956) used a similar method for removing *Limnoria* directly from the wood surface. The method was also useful for collecting *L. nonsegnis* from a *Macrocystis* holdfast which at first appeared not to contain *Limnoria*. Bubbling seawater with carbon dioxide gas and then sealing the wood and water in a jar speeded the exit of limnoriids from the substrate.

Examination of specimens

Most whole specimens were examined in glycerine placed on a cavity slide. Best illumination of sculpturing on the posterior somites was obtained by positioning the light source almost horizontally to the specimen, and reflecting light at the edge of the glycerine onto a black stage. The pleotelson and pleonite 5 were drawn with the aid of a drawing tube fitted to a Wild Leitz Dialux 20 EB transmission microscope. The wedge-shaped pleotelson was raised posteriorly, usually by the thickness of one glass coverslip, so that the dorsal surface was flat. Specimens were dissected in glycerine and mounted in Aquamount containing a little Rose Bengal dye. Dissected parts were examined and drawn using a Carl Zeiss Photomicroscope III fitted with a projection attachment screen. Parts could then be traced from the screen onto transparent plastic (AGFA copyproof positive film matt CPFm) under full illumination.

Scales. In the line drawings of the various species, single scale bars represent 50 μm, double scale bars 10 μm, and triple scale bars 200 μm. Unless otherwise indicated by different scales, all pereopods within a figure were drawn to similar scale. Other groups of appendages each drawn with similar scales were the antennae, pleopods and penes, mandibles, and maxillae.

Terminology

The following terms have been used in the description of species, and are defined here. The bracketed numbers refer to structures found in Figs 1 and 2.

Posterior margin of the ventral pleopodal cavity. This line, although ventral, can usually be easily seen when examining the dorsal structure of the pleotelson with transmitted light. Pleopods do not extend beyond this line (1).

True setae. These have a hollow axial cavity which usually contain a nerve fibre and invariably protoplasm (Menzies, 1956).

False setae. These are entirely skeletal and lack a hollow axial cavity (Menzies, 1956).

Simple setae. True setae which lack projections or setules (2).

Sheathed setae. Found on the posterior margin of the pleotelson. The sheath surrounds the proximal end of the setal stalk and has a fluted appearance. The sheath may be long and wide or short and narrow. (3, see also Plate 1b, c).

Stout setae. These are only found on the posterior margin of the pleotelson, and appear to have the mechanical function of bracing the pleotelson (4, see also Plate 1c). Stout setae probably evolved from sheathed setae. An intermediate form between the two types of setae is a flexible unsheathed seta.

Scale spikes (spike-like bristles). False setae often found covering the body, including the pleotelson and its posterior margin (5, see also Plate 1c).

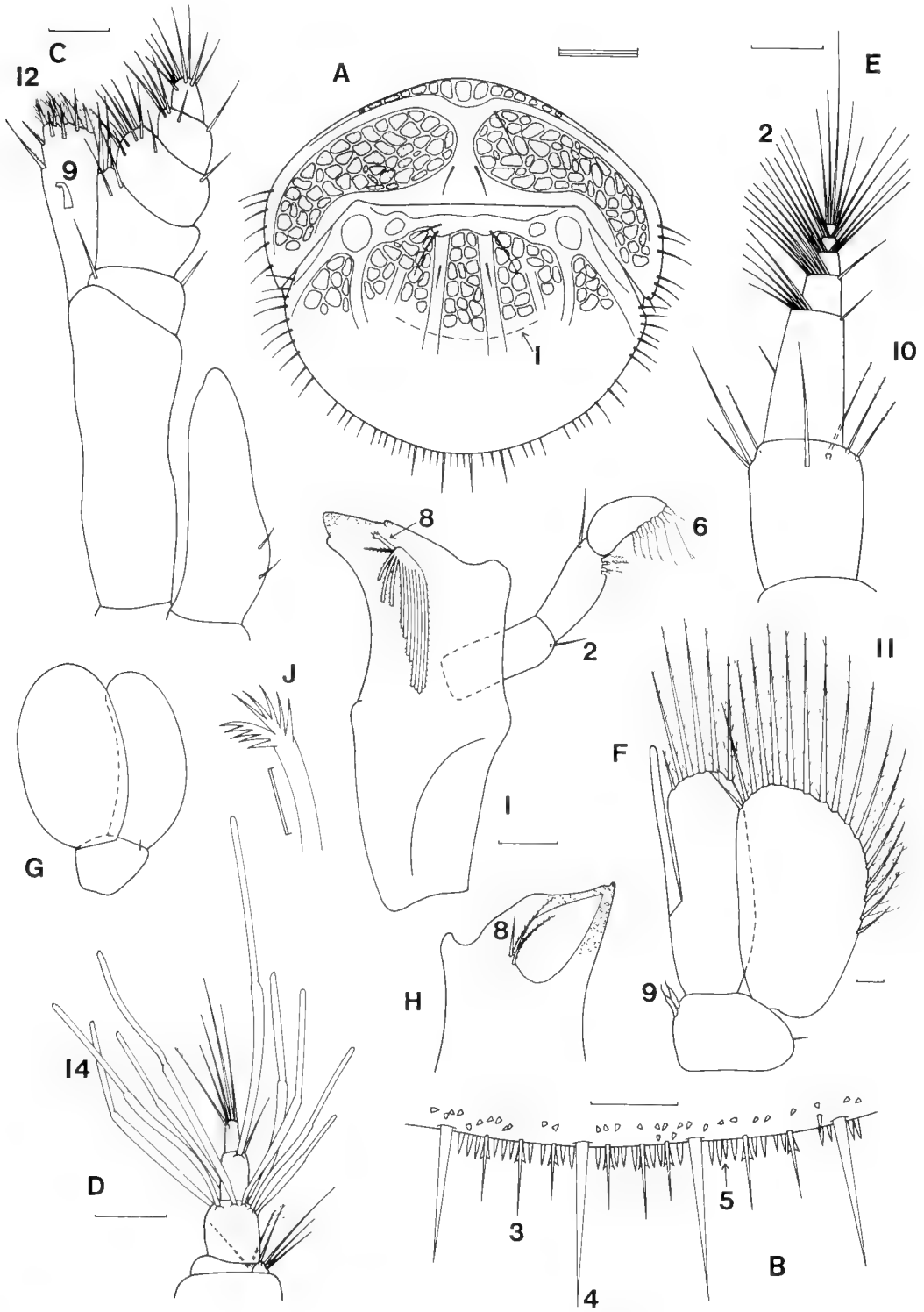

Figure 1. *Limnoria loricata* sp. nov. A–J, male, NMNZ Cr. 6456, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2; F, pleopod 2; G, pleopod 5; H, incisor of left mandible; I, right mandible; J, lacinia mobilis of right mandible.

1, posterior margin of ventral pleopodal cavity; 2, simple seta; 3, sheathed seta; 4, stout seta; 5, scale spike; 6, comb seta; 8, lacinia mobilis; 9, coupling hook; 10, brush seta; 11, plumose seta; 12, pappose setae; 14, aesthetasc.

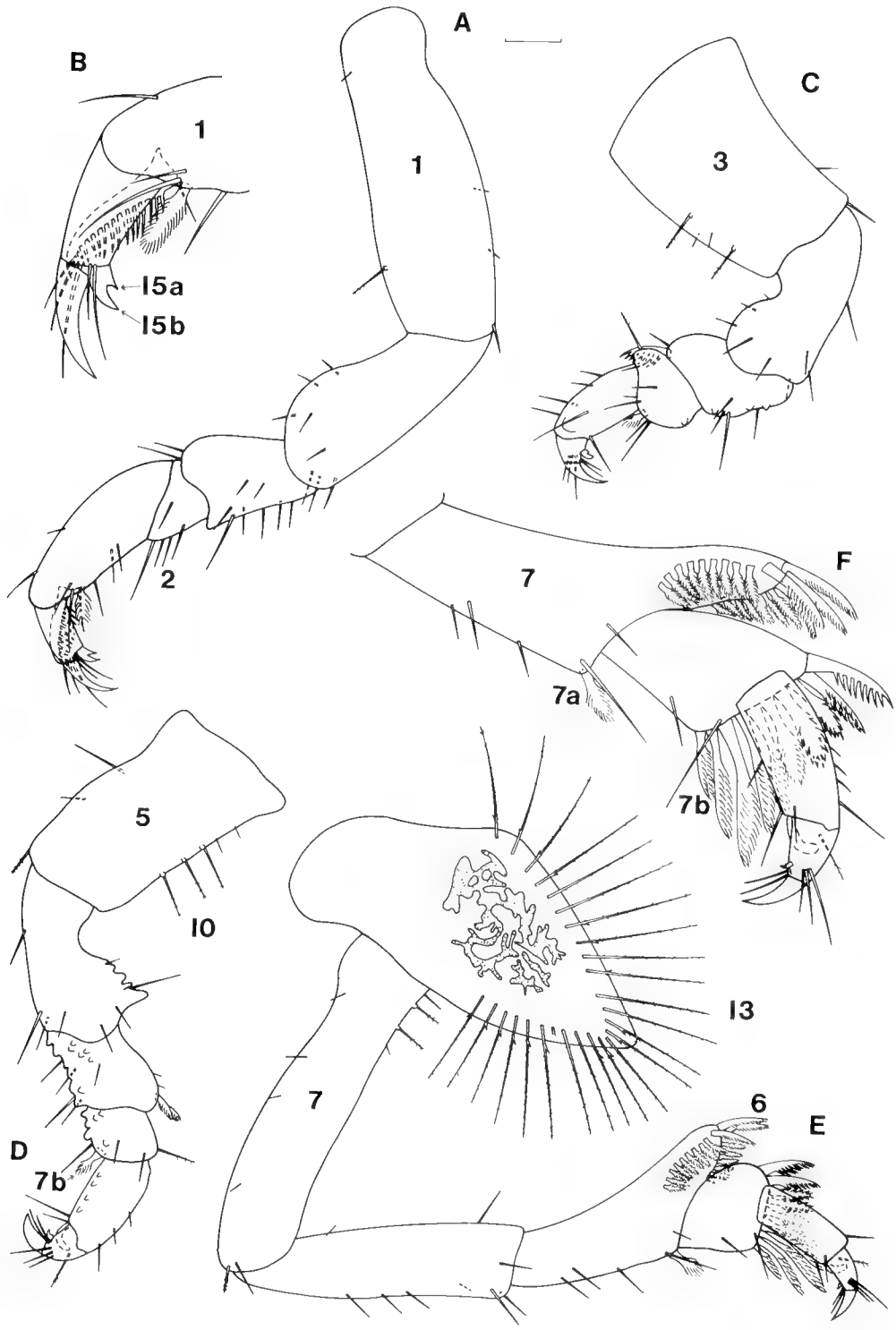

Figure 2. *Limnoria kautensis* Cookson and Cragg. A–F, male, NMV J14773, holotype: A, pereopod 1; B, dactylus of pereopod 1; C, pereopod 3; D, pereopod 5; E, pereopod 7 with coxa; F, distal articles of pereopod 7; all lateral views.

2, simple seta; 6, comb seta; 7a, ventral comb seta on merus; 7b, ventral comb seta on carpus; 10, brush seta; 13, proximally bifurcate pappose seta; 15a, vental branch of secondary unguis; 15b, dorsal branch of secondary unguis.

Spines. Large blunt setae found distally on maxilla 1.

Comb setae (pectinate setae). Setae with two rows of thin projections or teeth which are both directed away from the same side of the shaft (6).

Ventral comb setae. Found on the merus (7a) and carpus (7b) of pereopods.

Lacinia mobilis. Located on the right and left mandibles (8).

Coupling hooks. Specialized setae found on the maxilliped and pleopods (9).

Brush setae (palmate setae). Setae with apical setules (10).

Setules. Thin false setae (epicuticular projections) found on some true setae.

Plumose setae. Setae with two opposing rows of setules along the setal shaft, arranged so that setae have the appearance of feathers (Oshel and Steele, 1988). Found on pleopods (11).

Pappose setae. Setae with setules which arise all around the setal shaft (Oshel and Steele, 1988) (12).

Proximally bifurcate pappose setae. Pappose setae which have a short branch near the proximal end. Setules are usually level and distal to this branch (13).

Aesthetascs. Found on antenna 1. Highly modified hollow setae with an apical pore (14).

Secondary unguis, ventral branch (15a) *and dorsal branch* (15b).

Tubercles. Swellings and globular projections from the exoskeleton.

Puncta. Large tubercles (Plate 1d).

Nodes and bosses. Large raised areas, usually involving a larger area than for puncta; also with gradual sloping sides, sides less abrupt than for puncta (Plate 1e).

Crests. Dorsolateral ridges found on pleotelson, pleonite 5, and sometimes other pleonites, which help to produce a flat or scalloped dorsal appearance to these segments.

The relative length to width of the maxillipedal epipod was determined by measuring the length from the epipod tip to the centre (not the often more posterior lateral edge) of its articulation, while width was taken as the widest point anywhere along its length.

The relative length of plumose setae on the exopod of pleopod 2 was derived from the length of the longest plumose seta, and the length of the exopod from the centre of its point of articulation (not its often produced anterolateral lobe) to its distal tip (not including plumose setae).

The relative length of the uropodal endopod was derived from the length of the endopod (excluding apical claw in *Paralimnoria*), and the length of the peduncle from its most proximal end to the centre of where it articulates with the endopod (not the more posterior tip of the peduncular ventral process which extends between the rami).

Useful systematic characters

Figs 5–9 (*P. asterosa*) and Figs 23–26 (*L. indica*) show examples of most of the characters discussed below. The relative position of antennae and mouthparts are shown in Fig. 24.

Uropod. The uropod is the most important character separating *Limnoria* from *Paralimnoria*. *Paralimnoria* has an apical claw on the endopod; a long claw on the exopod; the exopod claw directed dorsolaterally rather than laterally; the articulation of the exopod ventrolateral to the endopod rather than lateral; and trifid pappose setae on the peduncle. In *Limnoria* the exopod claw may be very small (*L. kautensis*, *L. pfefferi*, *L. clarkae* and *L. torquisa*, or more developed and laterally recurved (most other *Limnoria*). In *P. andrewsi* and *P. asterosa* there are about ten simple setae on the exopod, while in *L. kautensis* there are about eight. Most other species of *Limnoria* have less than six simple setae on the exopod, exceptions are *L. pfefferi*, *L. echidna* and the large species *L. sublittorale* and *L. stephenseni*. Also, on the endopod of *Paralimnoria* the row of simple setae are placed apically and distolaterally. In most *Limnoria* the row is only apical, but in *L. kautensis*, *L. andamanensis*, *L. sexcarinata*, and (slightly) *L. pfefferi* the row also has a lateral component which extends well beyond the bases of the most posterior set of brush setae.

Some *Limnoria*, such as *L. tripunctata*, *L. insulae* and *L. lignorum*, have large lateral tubercles on the uropod peduncle (Plate 2a). In these species tubercles are then usually also present laterally on the exopod, and also on the ventral projection on the peduncle between the rami. In some other *Limnoria* only small tubercles are present. Other species (e.g., *L. quadripunctata*, *L. stephenseni*) may have many short simple lateral setae instead of tubercles. *P. andrewsi* also has a few tubercles on the peduncle, but these are ventrally placed. Due to the tubular nature of uropods, dissected uropods may roll slightly from an exact ventral view when mounted on a slide. In the figures of the uropods, an estimate of the degree of rolling can be gained from the fact that all setae near the lateral margin of the peduncle should be seen from ventral

view, and not dorsally as is sometimes suggested in the figures (by dashed lines). If rolling has occurred, small lateral tubercles may no longer be in view. For this reason the structure of the uropods of *Limnoria* should also be examined *in situ*.

In some species, the ventral row of proximally bifurcate pappose setae on the peduncle is situated on a crest (e.g. *L. pfefferi*), while in others the peduncle is more flattened in this region (e.g. *L. stephenseni*, *L. lignorum*). Small tubercles may also be found between the pappose setae (e.g. *L. indica*, *L. sexcarinata*, and *L. pfefferi*).

The relative length of the endopod and peduncle can also vary between species. Pillai (1961) in particular used this character in his species diagnoses. Although there can be small variations in length between specimens, this character is still useful to a certain degree.

The endopod of *L. torquisa* and *L. glaucinosa* have well developed proximally bifurcate pappose setae ventrally, similar to those found on the peduncle. Other *Limnoria*, and *Paralimnoria*, lack these setae on the endopod.

Antenna 1. *Limnoria* and *Paralimnoria* are unusual amongst isopods in that they have a scale which articulates distally on peduncular article 3. The scale was possibly derived from the lost ramus of the plesiomorphic biramous antenna 1 (Calman, 1910). A scale is also found in the cirolanid *Bathynomus* and cryptoniscan larvae of some Epicaridea (Calman, 1910). All limnoriid species examined in the current study had a scale, which was largest in *P. andrewsi* and *P. asterosa* and smallest in *L. cristata*.

Paralimnoria have five flagellar articles on antenna 1 while *Limnoria* have three or four articles. In his diagnosis of *Limnoria*, Menzies (1957) stated that the flagellum has four articles, even though in some species he examined there were three (*L. multipunctata*, *L. platycauda* and *L. insulae*). However, Menzies (1957) figured the number of flagella on antenna 1 correctly for *L. platycauda* and *L. multipunctata*.

In all species examined there was only one aesthetasc on the third segment of the flagellum. The number of aesthetascs on the second segment can vary greatly between species, and ranged from one in *L. orbellum* to about 13 in *L. indica*. *L. indica* and *L. saseboensis* are unusual in that the aesthetascs on segment 2 arise from two definite groups or tufts, one of which is closer to the mid-length of the segment than usual. For species which only have about two to five aesthetascs, the number of aesthetascs found appears to be fairly constant between specimens. For those species with many aesthetascs there is often more variation between specimens, and some of the variation may depend on geographical location and specimen size.

The first segment on the flagellum of antenna 1 is usually very short. For this reason it has often been overlooked in species descriptions. Pillai (1957) stated in his original description of *L. bituberculata* that there were three segments on the flagellum, but later corrected this to four (Pillai, 1961). Kühne (1975) figured only three flagellar articles on antenna 1 for *L. sexcarinata*, but there are four segments. Similarly for *L. clarkae*, only two flagellar articles were described (Kensley and Schotte, 1987), although there are three.

Antenna 2. The number of flagellar articles varies between species. *Limnoria* have three to five articles, while *Paralimnoria* have five to six. In most species the number of segments is constant, although the number can vary in some species to a certain degree: *P. andrewsi* (5–6), *L. sexcarinata* (4–5), *L. poorei* (3–4) and *L. simulata* (4–5). When describing *L. sexcarinata*, Kühne (1976) generalised that this character was not particularly reliable, however I found it to be very useful for the remaining species examined.

Mandibles. Mandibles of the Limnoriidae lack a molar, although they do have an inner bump or projection which may be a vestigial molar (Pillai, 1957). This projection is present on all *Limnoria* and *Paralimnoria*, although it is further reduced in *L. torquisa*.

The incisor surfaces in some species may be modified so that the left incisor has numerous pointed projections resembling a rasp (Plate 1a), and the right incisor has several parallel ridges resembling a file (Fig. 50c; Cookson and Cragg, 1988: Fig. 3e). The presence or absence of a rasp and file is constant within each species, although in *L. echidna* the rasp may be absent or greatly reduced. I have examined mainly the rasp of the left mandible, as the file of the right mandible was not fully visible in the orientation used to view the lacinia mobilis on prepared slides. The number of grooves in a file can also vary between species. *L. tripunctata* has about three to five grooves while *L. quadripunctata* has about five to eight. However, such overlap in variation probably means that this would not be a useful taxonomic character.

The lacinia mobilis of the left mandible is a short simple spine-like seta. Accompanying the lacinia mobilis is usually two long serrated setae in *Limnoria*, or three in *Paralimnoria*. In some species of *Limnoria* there is only one seta (e.g. *L.*

uncapedis), while in others the seta may be greatly reduced (e.g. *L. rugosissima*).

The lacinia mobilis of the right mandible is a useful diagnostic feature which varies only slightly within a species. In *L. indica* it varies in the degree of compactness of the apical teeth. In *L. agrostisa* the apical teeth may be pointed or rounded (possibly from becoming blunt). The number of setae in the spine row tends to be fewer in some species (about four in *L. uncapedis*) than in others, but varies too much to be useful.

The number and size of articles in the mandibular palp is very useful. For most species there are three segments. In other species there may be a slight reduction of article 3 (*L. nonsegnis*, *L. cristata*, *L. chilensis*, *L. poorei*, *L. convexa*), loss of article 3 (*L. segnis*), loss of articles 2 and 3 (*L. unicornis*), or loss of all articles (*L. bituberculata*, *L. uncapedis*, *L. segnoides*, *L. zinovae*). *L. indica* has article 3 elongated and apically pointed. Most *Limnoria* and *Paralimnoria* have one simple true apical seta on articles 1 and 2, but in some species there are several simple setae on article 2 (*L. stephenseni*, *L. antarctica*, *L. glaucinosa*).

Maxilla 1. There is little variation between species in the form of maxilla 1. In *Paralimnoria* one of the outer smooth spines is shorter than the other spines, while in *Limnoria* the same spine is smaller again or absent. Of the five barbed inner spines on the outer lobe, two usually have more pointed barbs than the other three. The most inner of the bluntly barbed spines can vary slightly in shape. The inner lobe of maxilla 1 also varies little between species, although in *L. uncapedis* the normally long innermost pappose seta is similar in length to the two adjacent pappose setae.

Maxilla 2. In most species there are two long comb setae on the outer lobe, three on the middle lobe, and a more variable number on the inner lobe. On the inner lobe all species also have a large mesial inwardly directed comb seta. This inner seta is strongly recurved in *L. uncapedis*, and in some other species it is slightly sinuous (*L. nonsegnis*, *L. convexa*, *L. poorei*).

Maxilliped. The palp has five articles. In *L. torquisa* the joint between the basis and first article of the palp appears to be partly fused and is difficult to find in some specimens. In all species examined, the endite has two stout subapical setae which may bear a few setules proximally; another stout seta which is short, mesial and without setules; and two distomedial pappose setae which have numerous setules. Lateral to these are five (in *Paralimnoria*) or three (in *Limnoria*) apical curved pappose setae. Depending on how the endite settled when mounted on a slide, a few other sub-apical ventromesial setae may be visible. Each endite has one coupling hook.

The shape of the epipod is very useful taxonomically. Although the shape is mostly constant within a species, the length can sometimes vary between specimens of certain species (e.g., *L. indica*, *L. raruslima*, *L. saseboensis*, *L. rugosissima*). Simple true setae are found on the epipods of *Paralimnoria* and many *Limnoria*, however they are absent on some species such as *L. kautensis* and *L. lignorum*.

Clypeus, labrum, labium. There are only minor variations between species in the form of the clypeus, labrum and labium.

Pereopods. The pereopods have been drawn in lateral view, and because pereopods 1–3 are anteriorly directed and pereopods 4–7 posteriorly directed (as in many isopods), this reversal is reflected in the figures. From pereopods 1–4 there is a gradual decrease in size, followed by an increase thereafter. There is also an increase in the number of comb setae found dorsally on the merus of pereopods 4–7. For *Limnoria*, the presence or absence of a comb seta ventrally on the merus and carpus of the pereopods is remarkably variable between species and consistent within a species (Table 3).

The secondary unguis on the first pereopod (and often other pereopods) can be very useful in helping to distinguish certain species. In *Paralimnoria* the unguis is trifid (although in some specimens of *P. andrewsi* the unguis is bifid), in most *Limnoria* it is bifid, while in other species of *Limnoria* there are a variety of modifications (*L. uncapedis*, *L. poorei*, *L. bituberculata*, *L. segnoides*, *L. stephenseni*, *L. torquisa*).

The form of the secondary unguis on the seventh pereopod can also vary between species. In *L. kautensis* it is tiny, in *L. orbellum* absent, and in *L. cristata* it is absent on pereopods 2–7.

The number and size of tubercles on the pereopods can vary between species, but these characters appear to vary too greatly between specimens to be useful.

In some species the basis of pereopod 4 may have proximally bifurcate pappose setae. A few short proximally bifurcate pappose setae occur on pereopod 4 in *Paralimnoria*. On *L. sexcarinata* there are many long proximally bifurcate pappose setae which have lost setules. In *L. torquisa* the setae are abundant.

Pereopod 7 is often not directionally aligned with pereopods 4–6, but directed anteromedially. In some species (especially wood-borers)

Table 3. Pereopods on which ventral comb seta was present on carpus or merus of species of Limnoriidae.
*Vestigial comb seta.
L, R, left and right.
[1]From Pillai, 1961.

Species	Collection location	Specimens examined	Carpus	Merus
P. andrewsi	Port Moresby, PNG	3	765432	0
”	Madang, PNG	5	765 32	6*5*4*
”	Christmas Island	3	765 32	5*4*
”	Cocos Islands	5	765 32	0
”	Lorengau, PNG	1	765 32	6*5*
P. asterosa	Kaut, PNG	3	765 32	6*5*
L. kautensis	Kaut, PNG	3	765432	76
L. sexcarinata	Satta Hip, Thailand	3	76 32	76
L. pfefferi	Port Moresby, PNG	3	76 32	76
L. andamanensis	Buka Passage, PNG	2	765 32	76
”	Madang, PNG	3	765 32	76
”	Belize	3	765 32	76
L. platycauda	Curaçao, West Indies	2	765432	7
”	Nelly Bay, Qld	3	765432	7
”	Red Wallis Is, Qld	3	765432	7
L. multipunctata	Kai Is, Banda Sea	2	765432	7
”	Cocos Islands	3	765432	7
”	Green Island, Qld	3	765432	7
L. insulae	Arcadia, Qld	3	7654	7
”	Barrow Island, WA	3	7654	7
”	Tahira, PNG	2	7654	7
L. saseboensis	Sasebo, Japan	3	765432	7
L. indica	Bowen, Qld	5	765432	7
”	Lady Musgrave Is, Qld	2	765432	7
”	Lorengau, PNG	2	765432	7
”	India[1]	1	765432	7
L. simulata	Florida	3	765432	7
L. sublittorale	New South Wales	2	765432	7
L. raruslima	West Island, SA	3	765	7
”	Crib Point, Vic.	3	765	7
”	Geelong, Vic.	2	765	7
”	Geelong, Vic.	1	7654*	7
L. unicornis	Port Douglas, Qld	3	765432	0
L. tripunctata	Ulladulla, NSW	3	76 32	7
”	Ulladulla, NSW	1	76 32	76
”	Goat Island, NSW	3	76 32	7
”	California	2	76 32	7
”	England	2	76 32	7
”	England	1	76 32	0
L. tuberculata	“Germany” in aquaria	3	76 32	7
L. orbellum	Cape Don, NT	3	76	0
L. cristata	Singapore	3	76	0
L. lignorum	Canada	2	765432	7
”	Bramley, England	3	765432	7
L. borealis	White Sea	2	765 32	7
L. gibbera	Thistle Cove, WA	2	76	0

L. poorei	West Island, SA	1	76	0
"	Topgallant Is., SA	1	76	0
L. uncapedis	Flinders Island, SA	2	76	0
"	McCluer Island, NT	2	76	0
L. clarkae	Belize	3	765432	0
L. quadripunctata	Brighton, Vic.	3	765432	0
"	Portobello, NZ	2	765432	0
"	Bramley, England	2	765432	0
"	The Snares, NZ	4	7654	0
L. agrostisa	Cliff Head, WA	1L	765	0
		1R	765	7
"	Tiparra Bay, SA	1	765	7
L. echidna	Coles Bay, Tas	1	76	7
"	Ninepin Point, Tas	1	76	7
L. algarum	California	3	765	7
L. rugosissima	Sydney	2	765	7
"	West Island, SA	3	765	7
"	The Snares, NZ	2	765	7
L. loricata	The Snares, NZ	2	76	7
L. glaucinosa	Flinders Island, SA	3	76	7
"	Flinders Island, SA	1	765	7
"	Marengo, Vic.	4	765	7
L. antarctica	Macquarie Island	3	765	7
L. stephenseni	Macquarie Island	3	765	7
L. nonsegnis	Variety Bay, Tas.	3	76	0
"	Aireys Inlet, Vic.	2	76	0
"	Port Arthur, Tas.	3	76	0
L. convexa	The Snares, NZ	5	765	0
L. torquisa	Aireys Inlet, Vic.	3	765	0

the merus of pereopod 7 has a marked dorsal projection fringed with a semicircle of comb setae. The carpus also has long distal comb setae, which in some species have thicker comb teeth on the more dorsal comb setae. Both sexes have these comb structures. Possibly they are used for cleaning other appendages, including mouthparts. The relative length of the propodus varies between species.

The dorsal coxal plates, fused on pereonite 1, become progressively pointed posteriorly. There are only slight variations between species in shapes, although coxa 7 in *P. andrewsi*, *P. asterosa* and *L. torquisa* is more rounded posteriorly than in other species.

Penes. There is little variation in shape between species, although relative length varies slightly.

Pleopods. The pleopods provide many useful characteristics, including: presence (*Paralimnoria*) or absence (*Limnoria*) of plumose setae on pleopod 5, and the length of plumose setae on pleopod 2 (and other pleopods).

The position of the articulation of the appendix masculina is mostly constant for each species. Length is also often constant, although it cannot always be relied upon in some species such as *L. tripunctata*, *L. insulae* and *L. raruslima*. In all specimens of *L. tripunctata* examined from Australia, the length was fairly constant so that the appendix masculina reached near the tip of the endopod, however those from England were slightly longer.

In *P. andrewsi*, *P. asterosa*, *L. kautensis*, *L. pfefferi*, *L. andamanensis*, and *L. sexcarinata* the endopod articulation of pleopods 1–5 is posterior to the exopod; but for other species of *Limnoria* the endopod of pleopod 5 is anterior to the exopod.

In *Paralimnoria* and most *Limnoria* the number of coupling hooks on the pleopod peduncles follow the sequence of 32220, but in *L. orbellum* it is 22220, and in *L. sublittorale* it is 33330. *L. reniculus* has 3 coupling hooks on pleopod 2 (Schotte, 1989). In only two specimens of *Limnoria* examined (one *L. multipunctata* and one *L. gibbera*), the peduncle of pleopod 5 was unusually large medially and had 1 or 2 vestigial coupling hooks.

Relative length, and shape especially, of the

endopod of pleopod 5 is useful taxonomically. Laterally on the peduncle of pleopod 5 there may be a comb seta in some species, while in other species the seta may be simple or absent. The lateral seta on *Paralimnoria* appears to be a reduced comb seta which lacks setules, rather than a simple seta. The presence or absence on the endopod of pleopod 5 of small simple setae is also a useful character (found in *L. nonsegnis*, *L. rugosissima* and *L. torquisa*).

Colour. Most species are pale yellow or white in colour, and many specimens of certain species (usually wood-borers) also have a faint dark reticulate pattern. *L. glaucinosa* is unusual for its blue-grey colouration.

Body shape. Most species are similarly narrow and elongated in shape. Some species such as *L. torquisa*, *L. stephenseni*, and *L. nonsegnis* are slightly wider than usual. On the head, the Limnoriidae lack a dorsal occipital groove, which is contrary to the finding of Menzies (1957: Table 1).

Pleonite 5 and pleotelson. The relative length of pleonite 5 and the pleotelson is a useful taxonomic character.

The sculpturing of the pleotelson and pleonite 5 presents the most useful specific features. The sculpturing mainly takes shape from the various puncta and carinae. The prominence of the sculpturing can vary between specimens, so that in some specimens the complete pattern may be difficult to detect.

In some species there is a sexual dimorphism in the pleotelson. Males of *L. unicornis* and *L. zinovae* have a much larger median punctum than females. *L. platycauda* males have a longer pleotelson than females (longer posterior to the pleopodal cavity). Some specimens of *L. insulae* have a much deeper cup-shaped pleotelson than females. *L. indica* shows the greatest degree of sexual dimorphism in the arrangement of puncta and carinae on the pleotelson.

Structure of pleonite 5 and pleotelson dorsal surface. The microscopic structure of the surface of pleonite 5 and the pleotelson (and probably other segments) is useful taxonomically. However, to see this structure the somites must be brushed clean of most debris. The scanning electron microscope is particularly useful for studying this character. The structures include a smooth surface constructed from scales which bear several fine scale spikes on the posterior fringes (Plate 1e) (e.g., *L. tripunctata*, *L. kautensis* and *L. nonsegnis*). In *Paralimnoria* the fine scale spikes are thickened into stout scale spikes, while in other species of *Limnoria* the scale spikes remain thin but are greatly elongated (*L. gibbera*). In some species the scales have a single large spike centrally rather than a posterior fringe of small spikes (*L. lignorum*, *L. andamanensis*, *L. pfefferi*). In many species with the large central spike, the scales are apparently fused and cannot be detected as separate entities (e.g., *L. indica*, *L. quadripunctata*, *L. echidna*, *L. rugosissima*).

Many species have pits on the surface, especially on pleonite 5 and the anterior portion of the pleotelson (e.g., *L. rugosissima*, *L. loricata*, *L. unicornis*, *L. indica*, *L. nonsegnis*). This situation occurs mainly in species with fused scales (Plates 2d, 2e).

The dorsal surface structure near the perimeter of the pleotelson varies between species. Some species have a dorsal row of tubercles or scale spikes, or both (as in *L. orbellum*), while in other species these rows may be absent. Few algal-borers have tubercles, although *L. gibbera* and *L. poorei* have on the lateral crests small tubercles with dorsal scale spikes, which are swellings which seem different to the tubercles found on some wood-borers. Tubercles are usually larger on lateral crests of the pleotelson than on the hind margin, and in some species (and specimens of *P. andrewsi*) tubercles are present on crests but absent on the hind margin. The size and number of scale spikes also varies between species. In *L. uncapedis* the spikes are small and numerous. In *L. quadripunctata* they are large. On the lateral crests the scale spikes are larger than on the posterior margin.

On the posterior margin of the pleotelson there are three main types of setae (including false setae). The shortest are the scale spikes which may be thin and in groups of about three to seven (*L. poorei* and *L. orbellum*) (Plate 1c), or thick and often fewer (*L. quadripunctata*, *L. glaucinosa*). In some species the scale spikes are lost (Plate 1b). The second type of setae are long, flexible, basally sheathed setae (Plate 1b). The sheathing can be fairly difficult to see in some species and specimens (Plate 1c). The third type of setae are posteromedial stout unsheathed setae (Plate 1c). Many species have four of these (e.g., *L. tripunctata*, *L. quadripunctata*, *L. indica*, *L. rugosissima*, *L. lignorum*) (Plate 2c), a few may have six (*L. nonsegnis*, *L. convexa*, *L. chilensis*, *L. torquisa*), while *L. stephenseni* has a continuous row of stout setae extending from the posterior margin to the lateral crests, and so for this species the number may reach over twenty. *L. platycauda* and *L. insulae* have an intermediate form of unsheathed flexible seta of sim-

ilar size to adjacent sheathed setae. Some species have the sheathed setae between stout setae greatly reduced, and the sheaths on these appear to be lost (*L. orbellum*, *L. stephenseni*, *L. nonsegnis*).

Systematics

Limnoriidae White

Limnoriadae White, 1850: 68.—White, 1857: 226.

Limnorinae.—Dana, 1853: 716.

Limnoriidae.—Harger, 1879: 161.—Harger, 1880: 371–373.—Pfeffer, 1887: 60.—Stebbing, 1893: 367.—Sars, 1899: 74–75.—Richardson, 1904: 8.—Richardson, 1905: 268.—Stebbing, 1904: 713.—Zirwas, 1910: 86.—Vanhöffen, 1914: 508.—Dahl, 1916: 28.—Shiino, 1950: 334.—Menzies, 1957: 115–121.—Menzies, 1962: 112–113.—Bastida and Torti, 1972: 144.—Kussakin, 1979: 309–310.—Bruce, 1988: 346–353.—Kensley and Schotte, 1989: 193.

Limnorina group.—Gerstaecker, 1881–1883: 220.

Limnoriinae.—Hansen, 1905: 98.—Hansen, 1916: 177.—Omer-Cooper and Rawson, 1934: 28–30.

Limnoridae.—Schultz, 1969: 138.—Brusca, 1980: 233.

Type genus. Limnoria Leach, 1814: 433.

Diagnosis. Head ovoid in cross section, freely articulating, pereonite 1 overlaps cephalon posteriorly. Coxal plates free and articulating on pereonites 2–7. Pleonite 5 longer than each preceding 4 pleonites, pleonite 1 not extending ventrally as far as other pleonites. Pleotelson posteriorly semi-circular, pleonite 5 and pleotelson in combination circular or oval; pleonite 5 (or pleonite 4) and pleotelson with lateral crests.

Clypeus transversely elongated, with oval labrum inserted ventromedially; without frontal lamina. Labium consisting of 2 anterior lobes and 2 more posterior dissimilar plates. Antennae not contiguous at bases; neither base markedly more anterior than other. Peduncle of antenna 1 with 3 articles, peduncle of antenna 2 with 5 articles. Scale inserted into peduncular article 3 of antenna 1. Mandibles lacking molar process, lacinia mobilis reduced to small seta. Maxilla 1 with 2 lobes; maxilla 2 with 3 nonarticulating apical lobes. Maxilliped with epipod, 5-articled palp, and coupling hook on each endite. Pereopod 1 with carpus reduced and nearly concealed dorsally by merus and propodus, with 2 comb setae distally on propodus, dactylus with 2 ungui. Penes articulating and separate. Testes each with one lobe. Gut with 4 digestive caeca. Pleopod 5 with none or fewer plumose setae than on pleopods 1–4. Uropod ventral to pleotelson; rami tubular, not markedly expanded or flattened.

Key to genera of Limnoriidae

1. Both uropod rami elongate, with apical claw (Fig. 5f). Antenna 1 with 5 flagellar articles (Fig. 6e). Pereopod 1 secondary unguis trifid (Fig. 7b) ..... *Paralimnoria*
— Uropod exopod much shorter than endopod, endopod without apical claw (Fig. 24d). Antenna 1 with 4 or fewer flagellar articles (Fig. 25g). Pereopod 1 secondary unguis bifid (Fig. 26a), or undivided and sometimes with accessory spinules (Fig. 62b) ..... *Limnoria*

Key to species of *Paralimnoria*

1. Pleonite 5 with anterior transverse carina bearing part of ring of radiating setae which continues around pleonite 4 and pleotelson (Fig. 5b) ..... *P. asterosa*
— Pleonite 5 dorsomedially without anterior transverse carina (Fig. 3a) ..... *P. andrewsi*

Key to species of *Limnoria*

This key contains several triplets. Examples of structures found in figures and plates are not necessarily from the species being referred to in the key.

1. Pleonite 5 dorsomedially with opposing horseshoe-shaped carinae, structure of mandibular incisors unknown. Substrate unknown ..... *L. septima*

— Pleonite 5 dorsomedially without opposing horseshoe-shaped carinae, left mandible with well developed rasp (more than 20 teeth) (Fig. 46f). Substrate wood or seagrass 2

— Pleonite 5 dorsomedially without opposing horseshoe-shaped carinae, left mandible without rasp (Fig. 16e), or only few small teeth (Fig. 17h). Substrate mainly algae, sometimes wood or seagrass 25

2. Antenna 1 with 3 flagellar articles 3

— Antenna 1 with 4 flagellar articles 7

3. Pleonite 5 with an anterior row of 4 puncta and a posterior row of 2 puncta. Posterior perimeter of pleotelson uneven, with pair of shallow symmetrical notches. Substrate wood ..... *L. hicksi*

— Pleonite 5 without puncta or with 3 puncta. Posterior perimeter of pleotelson evenly rounded 4

4. Pereopods 2–7 with secondary unguis (Figs 26b–g). Maxillipedal epipod broad (Fig. 33c). Peduncle of pleopod 5 with comb seta laterally (Figs 34c, d) 5

— Pereopods 2–7 without secondary unguis (Fig. 39b). Maxillipedal epipod narrowed distally to finger-like projection. Peduncle of pleopod 5 without seta laterally (Fig. 65c). Substrate wood ..... *L. cristata*

5. Lacinia mobilis of right mandible well developed (Figs 28h, 43c). Pleotelson may have sexual dimorphism 6

— Lacinia mobilis of right mandible reduced (Fig. 33g). Pleotelson without sexual dimorphism. Usually with at least longitudinal tuberculate carina posteromedially. Substrate wood ..... *L. multipunctata*

6. Uropod peduncle laterally compressed and broadened (Figs 28f,g). Pleotelson of males may be deeply cup-shaped (Plate 2b). Substrate wood ..... *L. insulae*

— Uropod peduncle tubular, not laterally compressed (Fig. 42e). Pleotelson longer in males than females (Figs 42a,f). Substrate wood ..... *L. platycauda*

7. Articulation of pleopod 5 endopod posterior to exopod, endopod triangular (Fig. 11f). Maxillipedal epipod broad and oval 8

— Articulation of pleopod 5 endopod anterior to exopod, endopod oval (Fig. 65c), elongated (Fig. 34c) or circular (Fig. 37h). Maxillipedal epipod broad and oval (Fig. 40f), triangular (Fig. 46c), or strap-like (Fig. 10c) 10

8. Pleotelson dorsally with 1 pair of carinae. Uropodal exopod claw greatly reduced to small knob (Figs 30h, 41d). Basis of pereopod 4 without long setae 9

— Pleotelson dorsally with 3 pairs of carinae. Uropodal exopod claw reduced. Basis of pereopod 4 with many long flexible setae (Fig. 57d). Substrate wood ..... *L. sexcarinata*

— Pleotelson dorsally with 2 pairs of puncta. Uropodal exopod claw well developed (Fig. 11g). Basis of pereopod 4 without long setae. Substrate wood ..... *L. andamanensis*

9. Pleonite 5 dorsomedially with Y-shaped carina (Fig. 40a). Pereopods 4 and 5 without ventral comb seta on carpus. Secondary unguis on pereopod 7 not reduced. Substrate wood ..... *L. pfefferi*

— Pleonite 5 dorsomedially without carinae. Pereopods 4 and 5 with ventral comb seta on carpus (Fig. 2d). Uropodal exopod long, half as long as endopod. Secondary unguis on pereopod 7 tiny (Fig. 2f). Substrate wood ..... *L. kautensis*

10. Pleotelson dorsomedially with pair of anterior puncta not associated with carinae, may also have more lateral pair of small puncta. Rasp reduced and confined to distal half of right mandibular incisor. Substrate seagrass ..... *L. simulata*

— Pleotelson dorsomedially without pair of anterior puncta, or with pair of anterior puncta associated with longitudinal carinae. Rasp well developed and not confined to distal half of right incisor (except in *L. ruralima*, Fig. 50f). Substrate wood or seagrass 11

11. Antenna 2 with 3 or 4 flagellar articles 12

— Antenna 2 with 5 flagellar articles 17

12. Dorsomedial sculpture on pleotelson with 1 central anterior punctum or carina, which may or may not be followed posteriorly by additional sculpturing (Fig. 64a) 13

— Dorsomedial sculpture on pleotelson with pair of puncta anteriorly, followed posteriorly by carinae bearing another 1 or 2 pairs of puncta (Fig. 46a). Substrate wood ..... *L. carinata*

13. Mandibular palp with 3 articles 14

— Mandibular palp with 1 article (Fig. 64f). Substrate wood *L. unicornis*

14. Maxillipedal epipod triangular 15

— Maxillipedal epipod broad and apically rounded. Substrate wood ... . *L. magadanensis*

15. Pleotelson dorsomedially with anterior punctum and pair of more posterior puncta (Fig. 58a) 16

— Pleotelson dorsomedially with anterior punctum followed posteriorly by another medial punctum. Substrate wood ..... *L. emarginata*

— Pleotelson dorsomedially without puncta, with carina shaped as a short-stemmed inverted Y. Substrate wood ..... *L. lignorum*

16. Posterior margin of pleotelson with dorsal row of scale spikes. Substrate wood ..... *L. borealis*

— Posterior margin of pleotelson without dorsal row of scale spikes. Substrate wood (bamboo) ..... *L. japonica*

17. Dorsomedial sculpture on pleotelson with anterior central punctum (Fig. 36a). Dorsal structure of pleotelson composed of scales (Fig. 36c), lacking pits 18

— Dorsomedial sculpture of pleotelson with pair of anterior puncta or carinae (Figs 23b, i). Dorsal structure of pleotelson with scales fused, often with pits (Plate 2d) 19

— Pleotelson without dorsomedial sculpture. Dorsal structure of pleotelson unknown, but without pits. Substrate wood ..... *L. bombayensis*

18. Dorsomedial puncta on pleotelson not followed by carinae (Fig. 36a). Pleopod 1 with only 2 coupling hooks (Fig. 37c). Pereopod 7 without secondary unguis (Fig. 39b). Endopod of pleopod 5 circular (Fig. 37h). Substrate wood ..... *L. orbellum*

— Dorsomedial puncta on pleotelson each followed by short carina of similar length (Fig. 58a). Pleopod 1 with 3 coupling hooks (Fig. 58h). Pereopod 7 with secondary unguis. Endopod of pleopod 5 circular but produced proxomedially (Fig. 58g). Substrate wood ... *L. tripunctata*

— Dorsomedial puncta on pleotelson with posterior pair of puncta followed by carinae (bearing tubercles) much longer than carina following anterior punctum (Fig. 59a). Pleopod 1 with 3 coupling hooks. Pereopod 7 with secondary unguis. Endopod of pleopod 5 oval (Fig. 59b). Substrate wood ..... *L. tuberculata*

19. Posterior margin and lateral crests of pleotelson with tubercles (Figs 23b, 25i) 20

— Posterior margin and lateral crests of pleotelson without tubercles (Figs 50a, 54b) 21

20. Dorsomedial parallel carinae on pleotelson long, with small anterior pair of puncta, carinae rugose when adjacent pits well developed; also with 2 short pairs of more lateral carinae. Substrate wood .... *L. saseboensis*

— Pleotelson with sexual dimorphism; males dorsomedially with 2 pairs of

well developed puncta, not followed posteriorly by carinae (Fig. 23b); female dorsomedially with parallel carinae each with anterior punctum (Fig. 23i); sexes without lateral carinae and well developed pits. Substrate wood ..... *L. indica*

21. Pleonite 5 with parallel dorsomedial carinae extending full length of pleonite (Fig. 54a) 22

— Pleonite 5 with parallel dorsomedial carinae not extending to anterior margin, U-shaped. Substrate wood ..... *L. reniculus*

— Pleonite 5 with Y- or X-shaped dorsomedial carinae (Figs 10a, 46a) 24

22. Pleonite 5 not markedly foveolate 23

— Pleonite 5 markedly foveolate. Substrate unknown ..... *L. foveolata*

23. Pleopods 2–4 with 3 coupling hooks (Fig. 54d). Pleotelson with only 1 pair of carinae dorsomedially (Fig. 54a). Substrate wood ..... *L. sublittorale*

— Pleopods 2–4 with 2 coupling hooks (Fig. 49f). Pleotelson with dorsomedial pair of carinae and 2 more lateral pairs of carinae (Fig. 49a). Substrate seagrass ..... *L. raruslima*

24. Maxillipedal epipod triangular (Fig. 46c). Dorsomedial sculpture on pleotelson includes 2 pairs of puncta (Fig. 46a). Lacinia mobilis of right mandible apically curved, fringed with many small teeth (Fig. 46h). Substrate wood ..... *L. quadripunctata*

— Maxillipedal epipod strap-like (Fig. 10c). Dorsomedial sculpture on pleotelson includes only 1 pair of anterior puncta (Fig. 10a). Lacinia mobilis of right mandible small, straight, with 2–3 apical teeth (Figs 10 h, i). Substrate seagrass ..... *L. agrostisa*

25. Mandibular palp lacking 26

— Mandibular palp with 3 articles (Fig. 55g), third article may be small (Fig. 44d) 29

— Mandibular palp with 2 articles. Substrate algae ..... *L. segnis*

26. Pleonite 5 dorsomedially with Y- or V-shaped carina. Secondary unguis of pereopod 1 bifid (Fig. 26a) or undivided, without spinules 27

— Pleonite 5 dorsomedially without carinae. Secondary unguis of pereopod 1 with several spinules (Fig. 62b) 28

27. Secondary unguis of pereopod 1 bifid. Pleotelson with dorsomedial anterior punctum. Lacinia mobilis of right mandible undivided other than for apical teeth. Substrate seagrass ..... *L. zinovae*

— Secondary unguis of pereopod 1 undivided. Pleotelson with dorsomedial wide elevated anterior region. Lacinia mobilis of right mandible bifid (Fig. 60h). Substrate algae ..... *L. segnoides*

28. Pleotelson dorsomedially without puncta (Fig. 60b). Substrate algae ..... *L. uncapedis*

— Pleotelson dorsomedially with 2 puncta joined by transverse carina. Substrate algae ..... *L. bituberculata*

29. Antenna 1 with 3 flagellar articles. Uropodal exopod claw reduced (Fig. 57h) 30

— Antenna 1 with 4 flagellar articles. Uropodal exopod claw well developed 31

30. Pleotelson dorsomedially with pair of parallel carinae. Antenna 2 with 5 flagellar articles. Basis of pereopod 4, and uropodal endopod, without large pappose setae. Secondary unguis of pereopods without accessory spinules. Substrate wood. ..... *L. clarkae*

— Pleotelson dorsomedially without carinae or puncta (Fig. 55a). Antenna 2 with 4 flagellar articles. Basis of pereopod 4 (Fig. 57d) and uropodal endopod (Fig. 57h) with several large pappose setae. Secondary unguis of pereopods with accessory spinules (Figs 57b,g). Substrate algae ..... *L. torquisa*

31. Antenna 2 with 3 or 4 flagellar articles 32
— Antenna 2 with 5 flagellar articles 37
32. Posterior margin of pleotelson without large stout setae (Fig. 45d). Endopod of pleopod 5 narrowly elongated and oval (Fig. 45c) 33
— Posterior margin of pleotelson with at least 4 large stout setae (Figs 13b, 32b). Endopod of pleopod 5 short and oval (Fig. 13i) 34
33. Third article of mandibular palp well developed, with comb setae (Fig. 19j). Secondary unguis of pereopod 1 bifid. Lacinia mobilis of right mandible with apical expansion bearing small teeth (Figs 19k, l). Substrate algae ..... *L. gibbera*
— Third article of mandibular palp reduced, without comb setae (Fig. 44d). Secondary unguis of pereopod 1 undivided but with 2 spiky protuberances sub-proximally (Fig. 45f). Lacinia mobilis of right mandible thin and serrated (Fig. 44e). Substrate algae. ..... *L. poorei*
34. Third article of mandibular palp well developed, second article with several simple true setae (Fig. 53f) 35
— Third article of mandibular palp reduced, second article with 1 apical simple true seta (Fig. 35d) 36
35. Pleotelson and pleonite 5 with carinae dorsomedially (Fig. 13a). Secondary unguis of pereopod 1 bifid. Posterior margin of pleotelson with 4 or 6 stout setae. Substrate algae ..... *L. antarctica*
— Pleotelson and pleonite 5 without carinae dorsomedially (Fig. 53a). Secondary unguis of pereopod 1 bifid, but ventral branch tiny (Fig. 53j). Pleotelson margin with stout setae both posteriorly and laterally. Substrate algae ..... *L. stephenseni*
36. Pleonite 5 dorsomedially with V-shaped carina. Substrate algae ..... *L. chilensis*
— Pleonite 5 dorsomedially with longitudinal carina, or at least a raised longitudinal area (Fig. 35a). Substrate algae ..... *L. nonsegnis*
— Pleonite 5 dorsomedially smoothly convex, without carinae (Fig. 14a). Substrate algae ..... *L. convexa*
37. Pleonite 5 pale yellow or white in colour, with carinae. Second article of mandibular palp with 1 simple seta 38
— Pleonite 5 blue-grey in colour, without carinae (Fig. 20a). Second article of mandibular palp with several simple setae (Fig. 21f). Substrate algae ..... *L. glaucinosa*
38. Pleonite 5 dorsomedially with Y- or X-shaped carina. Lacinia mobilis of right mandible serrated apically only, may also be divided or expanded apically 39
— Pleonite 5 dorsomedially with pair of longitudinal carinae which converge posteriorly. Lacinia mobilis of right mandible serrated apically and laterally, undivided (Fig. 44e). Substrate algae ..... *L. algarum*
39. Mandibular incisor of right mandible without deep cleft apically (Fig. 32i). Pleopod 5 without simple seta on endopod (Fig. 32g) 40
— Mandibular incisor of right mandible with deep cleft apically (Fig. 51g). Pleopod 5 with simple seta on endopod (Fig. 52b). Substrate algae ..... *L. rugosissima*
40. Pleonite 5 dorsally markedly foveolate, with X-shaped carina with axes joined near mid-length of pleonite (Fig. 32a). Lacinia mobilis of right mandible with long apical serrations (Fig. 32j). Substrate algae. ..... *L. loricata*
— Pleonite 5 dorsally not markedly foveolate, with X-shaped carina with axes joined near posterior margin of pleonite (Figs 17a, 18a). Lacinia mobilis of right mandible with apical expansion fringed by short teeth (Fig. 17g). Substrate algae ..... *L. echidna*

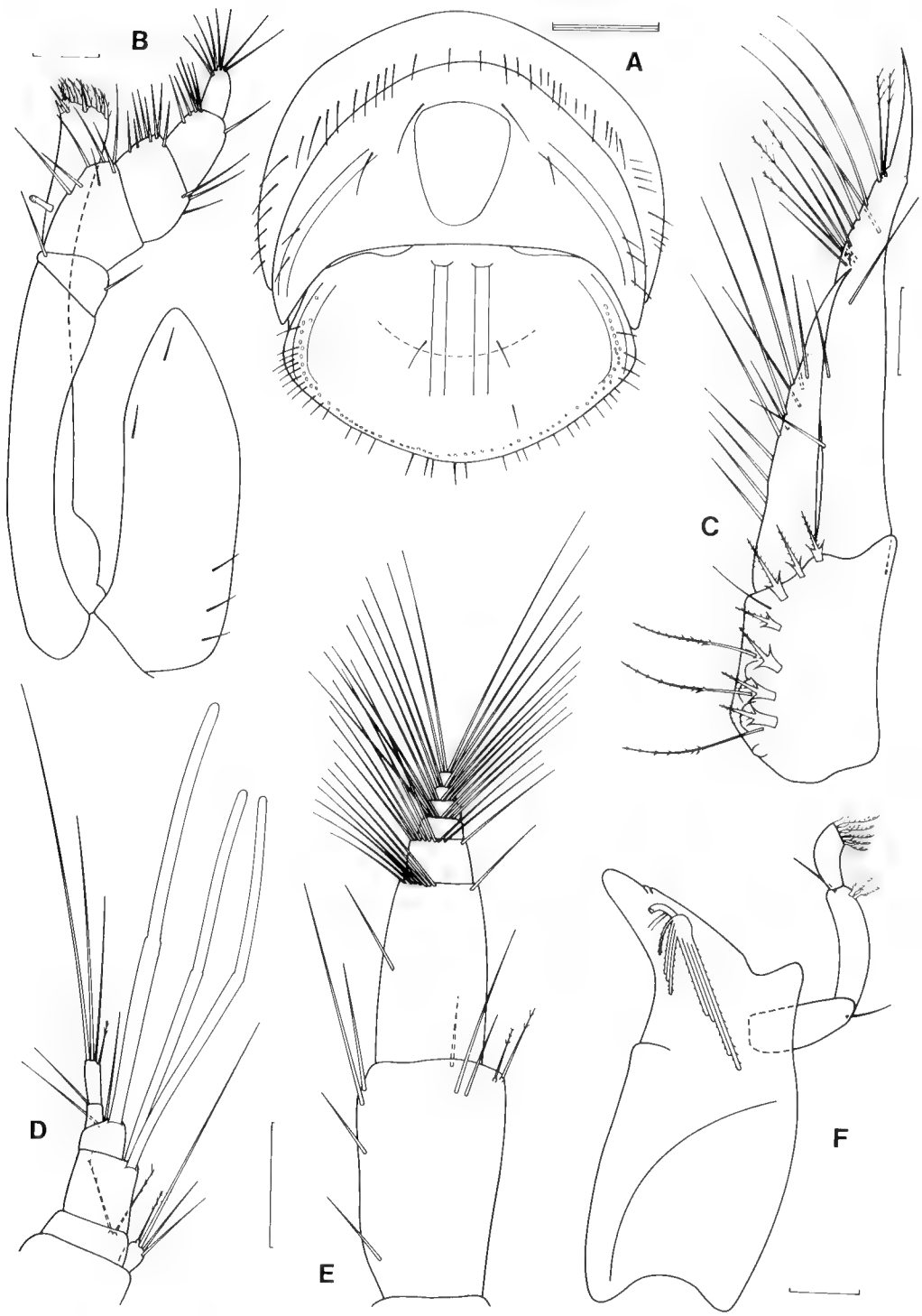

Figure 3. *Paralimnoria andrewsi* (Calman). A–E, male, AM P38919: A, pleonite 4, 5 and pleotelson, dorsal view; B, maxilliped; C, uropod, ventral view; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2. F, male, NMV J15473, right mandible.

Paralimnoria Menzies

Paralimnoria Menzies, 1957: 147–148.—Kensley and Schotte, 1989: 199.

Type species. Limnoria andrewsi Calman, 1910 (original designation).

Diagnosis. Flagellum of antenna 1 with 5 articles. Flagellum of antenna 2 with 5–6 articles. Left mandible with "rasp" and right mandible with "file" incisor surface. Spine row of left mandible of 3 serrated setae. Exopod of uropod long, more than half as long as endopod, both rami with long apical claws; exopod ventrolateral to endopod; peduncle with trifurcate pappose setae ventrally. Peduncles of pleopods 1–4 with medial lobe; appendix masculina articulating proximally; both rami of pleopod 5 with few plumose setae; pleopod 5 nearly as large as other pleopods. Pleonite 5 and pleotelson similar in length. Outer lobe of maxilla 1 with 5 smooth outer spines of which 4 are similar length and 1 is more than half this length. Maxillipedal endites with 5 apical curved pappose setae of similar form. Secondary unguis of pereopod 1 usually trifid, occasionally bifid.

Paralimnoria andrewsi (Calman)

Figures 3, 4

Limnoria andrewsi Calman, 1910: 184–186, pl. V figs 7–14.—Chilton, 1914a: 382–387.—Miller, 1924: 159–164, figs 3–5.—Atwood et al., 1924: 24–25, pl. I figs 3–5.—Shiino, 1944: 1–19.—Holthuis, 1949: 170.—Shiino, 1950: 341–358, figs 4–6.

Paralimnoria andrewsi.—Menzies, 1957: 148–151, figs 7, 22–24.—Menzies, 1959: 14.—Mohr, 1959: 88.—Menzies and Robinson, 1960: 132–137.—Menzies and Glynn, 1968: 50, figs 21A–B.—Schultz, 1969: 139, fig. 204.—Kühne, 1971: 67, 70.—Jones et al., 1972: 105, 109.—Kühne, 1975: 452.—Barnacle and Ampong, 1975: 289–310.—Kühne, 1976: 550, fig. 11.—Barnacle, 1976: 59.—Ampong and Asare-Nuadu, 1985: 2.—Eaton et al., 1989: 63.—Kensley and Schotte, 1989: 199–201, fig. 88C–D.

Material examined. Syntypes: Flying Fish Cove, Christmas Islands (10°30′S, 105°44′E), timber piles, C.W. Andrews, 1908, British Museum (Natural History) 1909.5.19: 335–339 (3 males, 1.6–1.7 mm, 3 juvs., 1.15–1.6 mm).

Other material: PNG. Madang, low tide, pine bait block no. 27 after 2 months, R.D. Turner, J.V. Marshall and J. Beesley, 30 Aug 1970, AM P38919 (male, 2.6 mm, 0.7 mm wide pleotelson, with 1 slide),

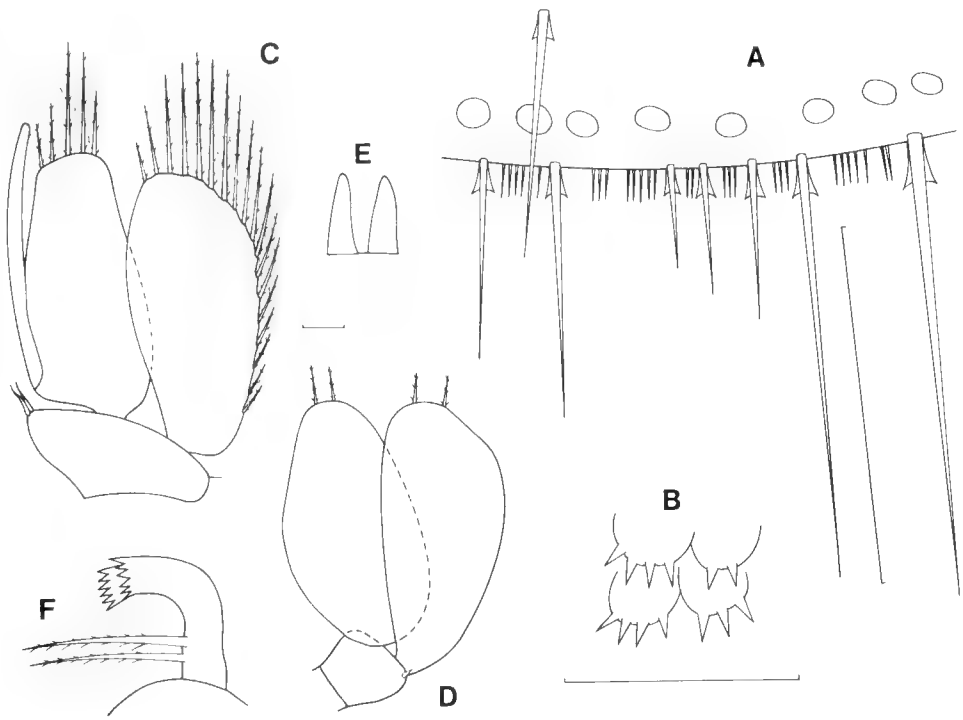

Figure 4. *Paralimnoria andrewsi* (Calman). A–E, male, AM P38919: A, posterior margin of pleotelson, dorsal view; B, dorsal structure of pleotelson; C, pleopod 2; D, pleopod 5; E, penes. F, male NMV J15473, lacinia mobilis of right mandible.

AM P38918 (3 non-ovig. females, 2.7, 2.8, 2.9 mm, 2 juvs., 2.2, 2.5 mm). Port Moresby, Harbour, S.M. Rayner, Oct 1972, NMV J15473 (male, 2.5 mm, with 1 slide), NMV J15474 (non-ovig. female, 2.9 mm, with 2 slides), NMV J15472 (5 males, 2.3–2.5 mm, 3 non-ovig. females, 2.7, 3.0, 3.1 mm, 2 ovig. females, 2.5, 2.7 mm, juv. 1.8 mm). Lorengau, Admiralty Islands, S.M. Rayner, 10 Oct 1970, NMV J15489 (2 males, 1.8, 2.0 mm).

Cocos Islands, pine bait block no. 242 after 5 months, J.D. Turner, J.V. Marshall and J. Beesley, Nov 1970, AM P38920 (5 males, 6 females).

Types. All types held by the British Museum (Natural History).

Diagnosis (based on Madang specimens). Pleonite 5 dorsomedially with depressed triangular area, with lateral crests. Pleotelson with dorsomedial pair of long longitudinal parallel carinae slightly raised anteriorly as puncta. Pleonite 5 0.85 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with several thick scale spikes. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson; posterior margin fringed with thin scale spikes and short-sheathed setae, lacking stout setae.

Antenna 1 with 5 flagellar articles; second article with 2 aesthetascs. Flagellum of antenna 2 with 5–6 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible tubular, recurved, with apical perimeter of teeth. Epipod of maxilliped broad, apically pointed, 3 times as long as wide, reaching beyond palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 trifid. Ventral comb seta on merus of pereopods 4,5 and 6 vestigial (none present in Port Moresby specimens), present on carpus of pereopods 2, 3, 5, 6 and 7 (and pereopod 4 in Port Moresby specimens). Uropod peduncle without tubercles on lateral margin, with ventrolateral tubercles; endopod 1.6 times as long as (claw not included) peduncle.

Pleopod 2 with short plumose setae, up to 0.5 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximally. Endopod of pleopod 5 posterior to exopod, oval-slightly triangular, 0.9 times shorter than endopod of pleopod 2; peduncle of pleopod 5 with vestigial comb seta laterally.

Additional characters. Body length up to 3.1 mm. Colour in alcohol white to pale yellow with dark reticulate pigment.

Distribution. Flying Fish Cove, Christmas Islands (type locality) (Calman, 1910); Samoa; Hawaii (Miller, 1924); Japan (Shiino, 1950; Kühne, 1976); Florida; Caribbean; Philippines (Menzies, 1957); Puerto Rico (Menzies and Glynn, 1968); Ghana (Barnacle and Ampong, 1975); Papua New Guinea (Kühne, 1976; current study); Cocos Islands (current study). 0–4 m depths (Barnacle and Ampong, 1975).

Substrates. Timber piles (Calman, 1910), *Chlorophora excelsa* (Welw.) Benth. piles (Barnacle and Ampong, 1975), pine blocks (current study).

Remarks. Menzies (1957) described three forms of *P. andrewsi*, which were not subspecies but only morphological variations that could be found together within certain populations, and in others were so mixed that a precise assignment was not possible (Menzies, 1957). Some of the morphological variations found in *P. andrewsi* are: the depressed triangular area on pleonite 5 may be absent, although the dorsomedial area is still flat; the longitudinal carinae on the pleotelson may be shorter than indicated in Fig. 3, or even absent (Menzies and Glynn, 1968); the degree of tuberculation on the lateral crests and posterior margin of the pleotelson can vary; and the occurrence of ventral comb seta on the various pereopods of *P. andrewsi*, unlike *Limnoria* species, is variable.

Normally the secondary unguis on pereopod 1 is trifid, however one of the male syntypes examined had a bifid secondary unguis as is typically found in *Limnoria*. One male from the Cocos Islands had a trifid unguis on the left pereopod, but a bifid unguis on the right.

Of the dissected specimens examined, all had five flagellar articles on antenna 2. However, some specimens may have six articles (Menzies, 1957). It cannot be certain that the *Paralimnoria* examined by Shiino (1950) were *P. andrewsi*, as he noted only four flagellar articles on antenna 2. Also, the maxillipedal epipodite was triangular (Shiino, 1950), which is different from the broad shape found in the syntypes of *P. andrewsi*.

Paralimnoria asterosa Cookson and Cragg

Figures 5–9

Paralimnoria asterosa Cookson and Cragg, 1988: 1512–1515, figs 4, 5.

Material examined. Holotype: PNG, Kaut, New Ireland Province (2°46′03″S, 150°54′28″E), 8 m, dense rainforest log, SCUBA, S.M. Cragg, 10 Oct

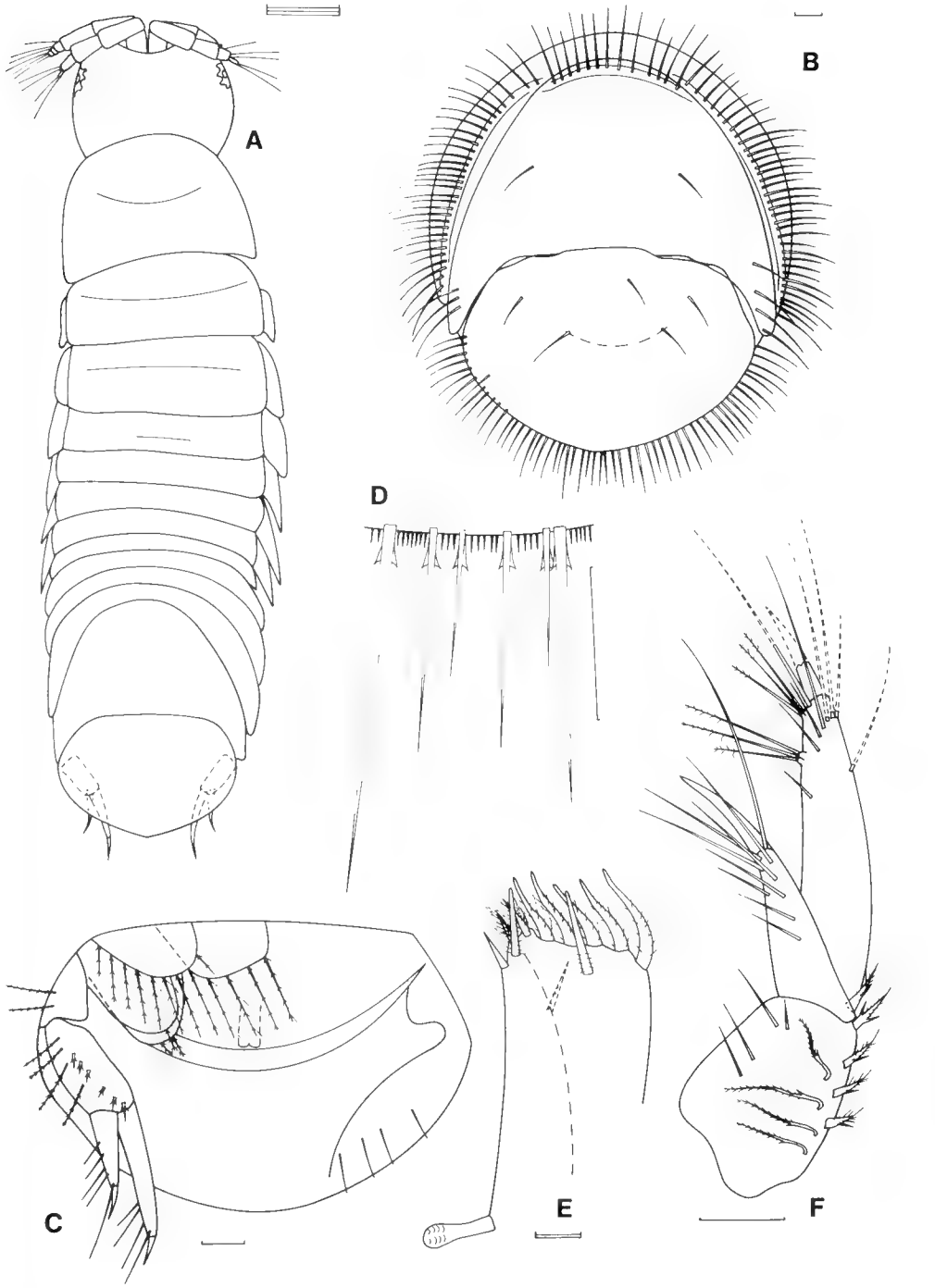

Figure 5. *Paralimnoria asterosa* Cookson and Cragg. A–F, juvenile, NMV J14779, holotype: A, dorsal view, most setae omitted; B, pleonites 4, 5 and pleotelson, dorsal view; C, pleotelson, left uropod and pleopods removed, ventral view; D, posterior margin of pleotelson, dorsal view; E, endite of maxilliped; F, uropod, lateral view.

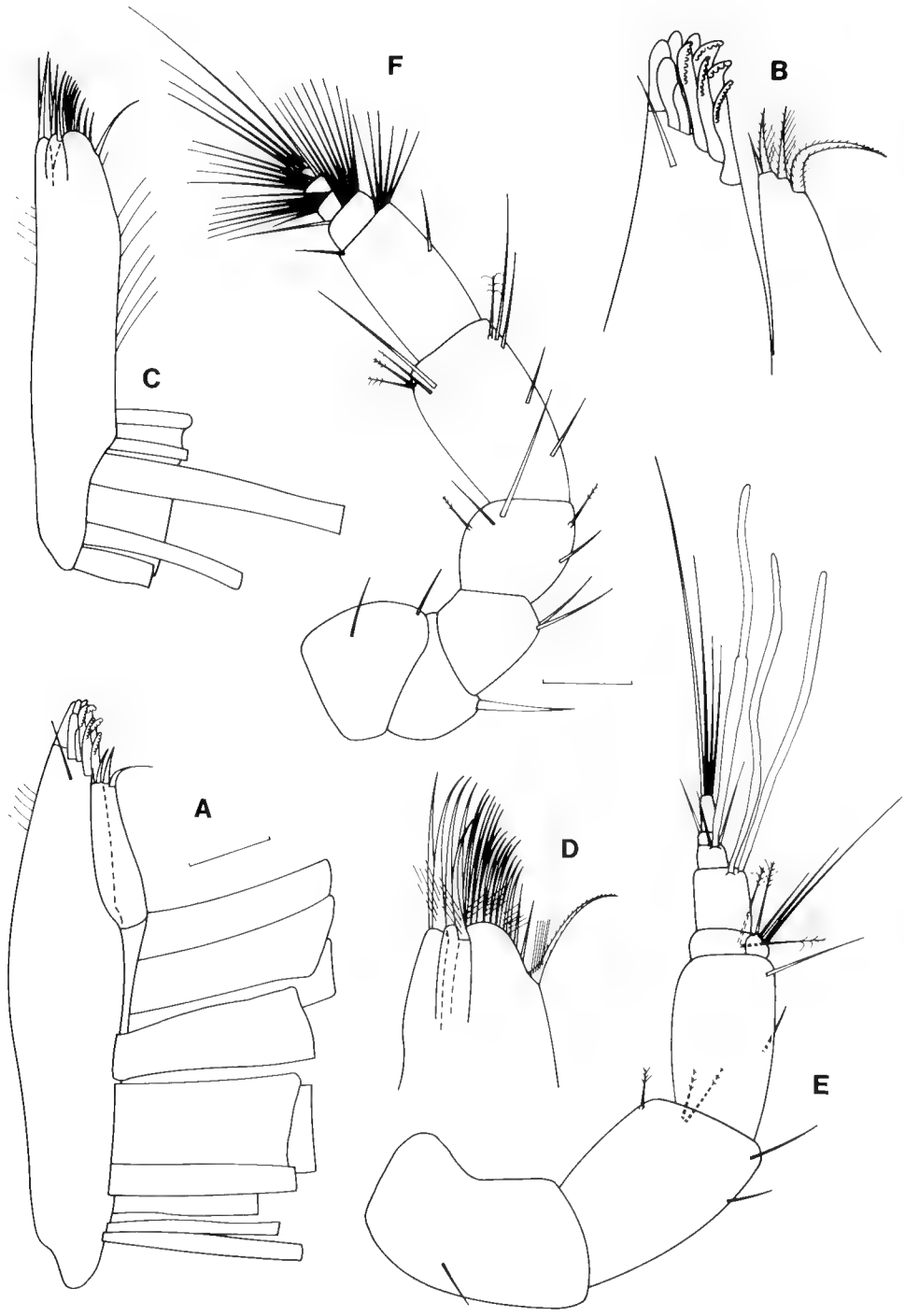

Figure 6. *Paralimnoria asterosa* Cookson and Cragg. A–F, juvenile, NMV J14779, holotype: A, maxilla 1 with associated muscle; B, distal portion of maxilla 1; C, maxilla 2 with associated muscle; D, distal portion of maxilla 2; E, antenna 1; F, antenna 2.

1985, NMV J14779 (juv., 2.2 mm, 0.5 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J14780 (ovig. female damaged at pereonite 1–cephalon juncture, 2.7 mm, with 3 slides), NMV J14781 (juv., 1.9 mm).

Diagnosis. Pleonite 5 dorsomedially with anterior transverse carina; with very short lateral crests as pleonite dorsolaterally mostly surrounded by lateral crests of pleonite 4; without central depressed area, but central area flattened. Pleotelson without dorsomedial carinae and puncta. Pleonite 5 0.9 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with several thick scale spikes. With continuous ring of radially directed, short-sheathed setae on lateral carinae of pleonite 4, anterior transverse carina of pleonite 5, and lateral crests and posterior margin of pleotelson. Posterior margin of pleotelson also fringed with thin scale spikes, without stout setae; posterior margin and lateral crests without dorsal row of tubercles or scale spikes.

Antenna 1 with 5 flagellar articles; second article with 2 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible tubular, recurved, with perimeter of apical teeth. Epipod of maxilliped broad, apically pointed, 3 times as long as wide, reaching beyond palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 trifid. Ventral comb seta on merus of pereopods 5 and 6 vestigial, seta present on carpus of pereopods 2, 3, 5, 6 and 7. Uropod peduncle without tubercles laterally or ventrally; endopod 1.6 times as long as (not including claw) peduncle.

Pleopod 2 with plumose setae up to 0.6 times as long as exopod. Characteristics of appendix masculina unknown. Endopod of pleopod 5 posterior to exopod, oval-slightly triangular, same length as endopod of pleopod 2; peduncle of pleopod 5 with vestigial comb seta laterally.

Additional characters. Body length up to 2.7 mm. Colour in alcohol white, with faint dark reticulate pigment.

Distribution. Kaut, Papua New Guinea (type locality). 8 m depth.

Substrate. Dense log.

Remarks. The species is re-illustrated here in more detail than in the original description. *P. asterosa* differs from *P. andrewsi* in having a transverse anteromedial carina on pleonite 5. *P. asterosa* also lacks the central depressed area on pleonite 5 often found in *P. andrewsi*. Unlike *P. andrewsi*, the lateral crests on pleonite 4 of *P. asterosa* surround most of the lateral margin of pleonite 5, so that pleonite 5 is mostly without lateral crests. Its pleotelson lacks the two parallel medial carinae found on *P. andrewsi*. Though *P. andrewsi*, like *P. asterosa*, has sheathed setae, these are shorter, less numerous, are not situated on carinae on pleonites 4 and 5, and do not cross medially as a row from pleonite 4 to 5. Also they are not so distinctly radially orientated. *P. andrewsi* has tubercles on the lateral crests and posterior margin of the pleotelson and on the uropod peduncle while *P. asterosa* does not.

Limnoria Leach

Limnoria Leach, 1814: 433.—Coldstream, 1836: 316–334.—Bate and Westwood, 1868: 351.—Harger, 1880: 373.—Hoek, 1893: 1–97.—Sars, 1899: 75.—Richardson, 1905: 269–270.—Nierstrasz and Schuurmans Stekhoven, 1930: 79.—Kussakin, 1979: 315.—Kensley and Schotte, 1989: 194.

Limnoria (*Limnoria*).—Menzies, 1957: 121–122.—Menzies, 1959: 12–14.—Pillai, 1961: 20.—Rao and Ganapati, 1969: 225–226.

Limnoria (*Phycolimnoria*) Menzies, 1957: 144, 146.—Pillai, 1957: 149–150.—Menzies, 1959: 13–14.

Phycolimnoria.—Kussakin, 1963: 281.—Kussakin, 1979: 310.—Kensley and Schotte, 1987: 226.—Kensley and Schotte, 1989: 201.

Lemnoria.—Humphreys, 1845: 22 (lapsus).

Lunovia.—Fox and Boulton, 1877: 189-194 (lapsus).

Type species. Limnoria terebrans Leach, 1814: 433 (= *Cymothoa lignorum* Rathke, 1799) (monotypy).

Diagnosis. Flagellum of antenna 1 with 3–4 articles. Flagellum of antenna 2 with 3–5 articles. Mandibular incisors with or without "rasp" and "file"; mandibular palp with 0–3 articles; spine row of left mandible of 2 or fewer serrated setae. Exopod of uropod much shorter than endopod, provided with apical claw or knob; apex of endopod blunt, without claw; exopod lateral to endopod. Pleopod 5 lacking plumose setae; rami nearly as long, or smaller than on other pleopods; peduncle of pleopods 1–4 without inner lobe; appendix masculina articulating sub-proximally to sub-apically. Outer lobe of maxilla 1 with 5 smooth outer spines of which 4 are similar length and 1 is less than half this length or absent. Maxilliped endite with 3 apical curved pappose setae of similar form. Pleotelson often much longer than pleonite 5. Secondary unguis of pereopod 1 bifid or variable.

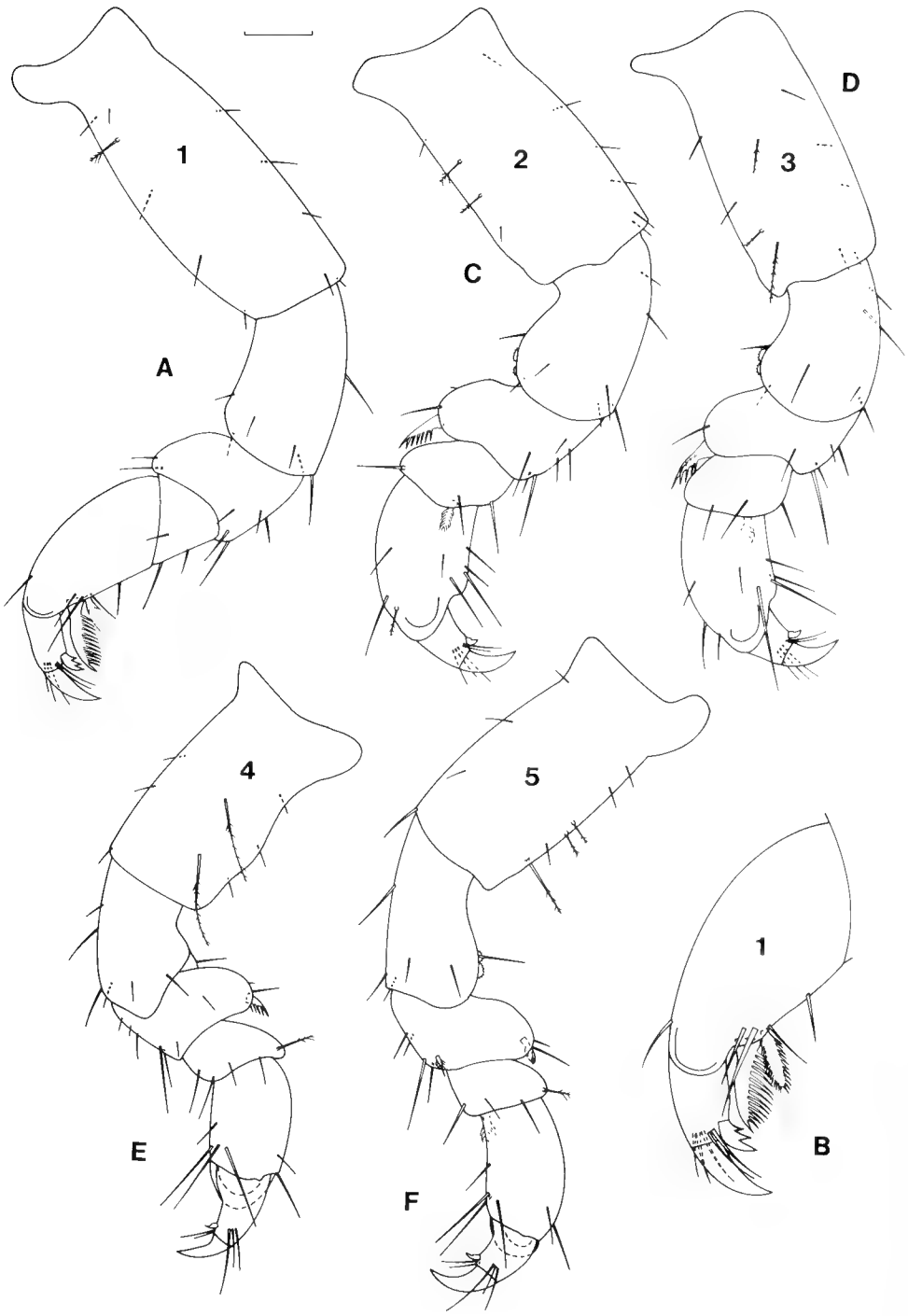

Figure 7. *Paralimnoria asterosa* Cookson and Cragg. A–F, juvenile, NMV J14779, holotype: A, pereopod 1, lateral view; B, propodus and dactylus of pereopod 1, lateral view; C–F, pereopods 2–5, lateral views.

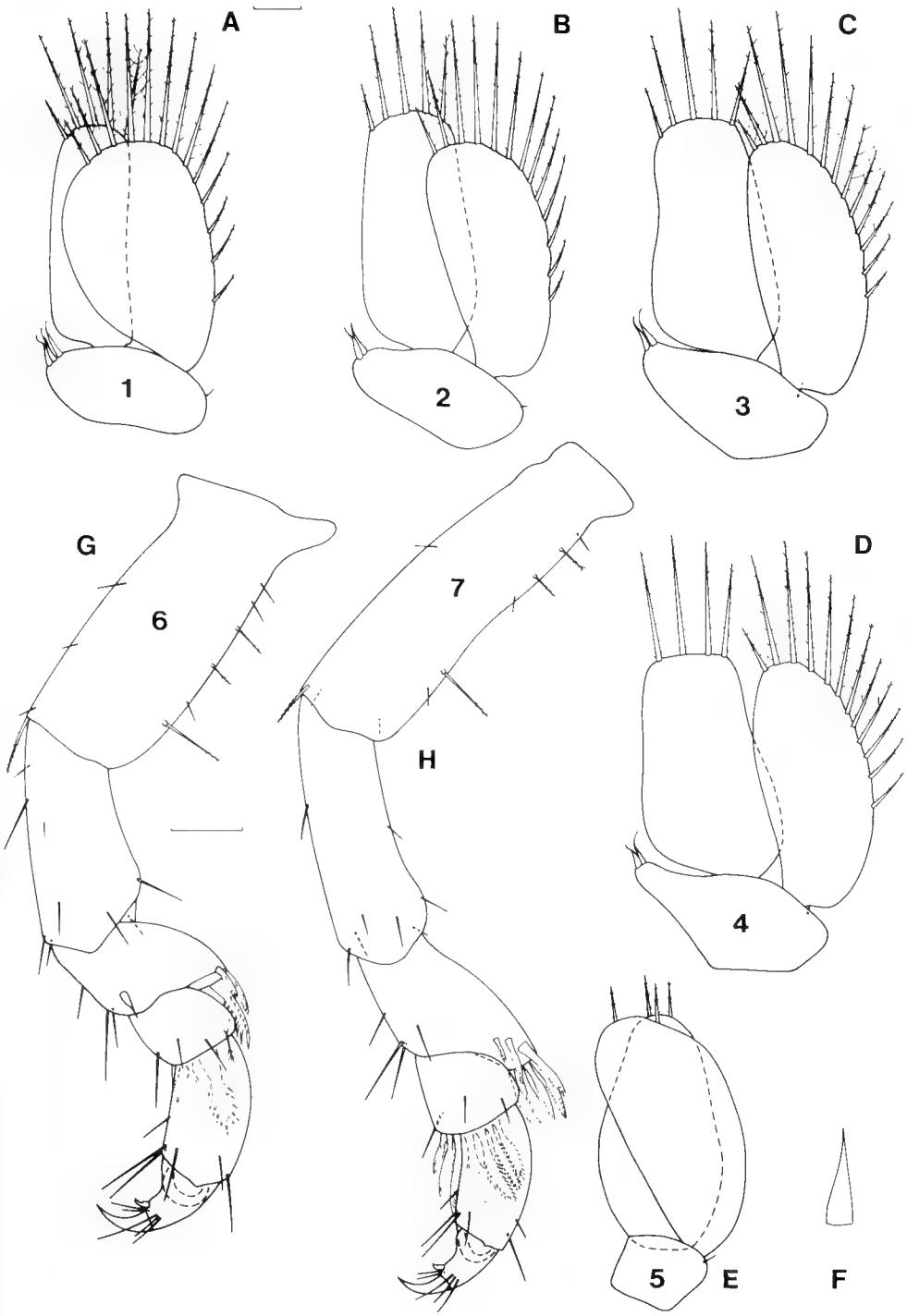

Figure 8. *Paralimnoria asterosa* Cookson and Cragg. A–H, juvenile, NMV J14779, holotype: A–E, pleopods 1–5; F, vestigial comb seta on peduncle of pleopod 5; G, pereopod 6, lateral view; H, pereopod 7, lateral view.

Remarks. For the full description of a species of *Limnoria*, see *L. indica*.

Although specimens of *L. lignorum* from England were examined, this species has not been described here because it is not an Australasian species. Also, type material for the species is not known to exist, although new specimens collected from the type locality in Norway would suffice in such a description.

Menzies (1957) erected the subgenus *Limnoria* (*Phycolimnoria*). Kussakin (1963) later raised *Phycolimnoria* to generic status, using the characters determined by Menzies (1957) of the lack of mandibular rasp and file, and an algal habitat. It is now known that these two characters are not always correlated. Two species which lack a rasp and file are not algal dwellers. *L. zinovae* is a seagrass-borer, and *L. clarkae* bores into soft mangrove wood. These may be examples of habitat induced convergence.

The rasp and file can no longer be used to clearly separate species. Intermediate states, where the rasp is reduced, can be found in *L. raruslima, L. simulata* and *L. echidna*. For the two known specimens of *L. echidna*, one lacks a rasp and the other has about 11 small teeth. *L. echidna* is most similar to the wood-borer *L. quadripunctata*. Also, no additional character was found that supported the division of species according to rasp and file. For these reasons, *Phycolimnoria* is synonymised with *Limnoria*.

Limnoria agrostisa sp. nov.

Figure 10

Material examined. Holotype: WA, 300 m offshore near Cliff Head, 30 km south of Dongara (29°32′S, 114°59′E), 2 m, in rhizomes at edge of *Posidonia* bed, SCUBA, G.C.B. Poore and H.M. Lew Ton, 22 Apr 1986 (stn SWA 85), NMV J14972 (juv., 2.8 mm, 0.6 mm wide pleotelson, with 1 slide).

Paratype: SA, Coal Reef, Tiparra Reef, Tiparra Bay (34°4′S, 137°23′E), 5 m, dead seagrass in sand and grit, SCUBA, G.C.B. Poore and H.M. Lew Ton, 15 Mar 1985 (stn SA 13), NMV J14973 (male, 2.1 mm, 0.5 mm wide pleotelson, with 1 slide).

Diagnosis. Pleonite 5 dorsomedially with X-shaped carina, anterior axes longer than posterior axes, posterior axes without depression between them. Pleotelson with 2 dorsomedial parallel carinae slightly raised anteriorly as puncta; carinae followed laterally by another short pair of carinae and long pair of carinae, as well as lateral crests. Pleonite 5 0.6 times as long

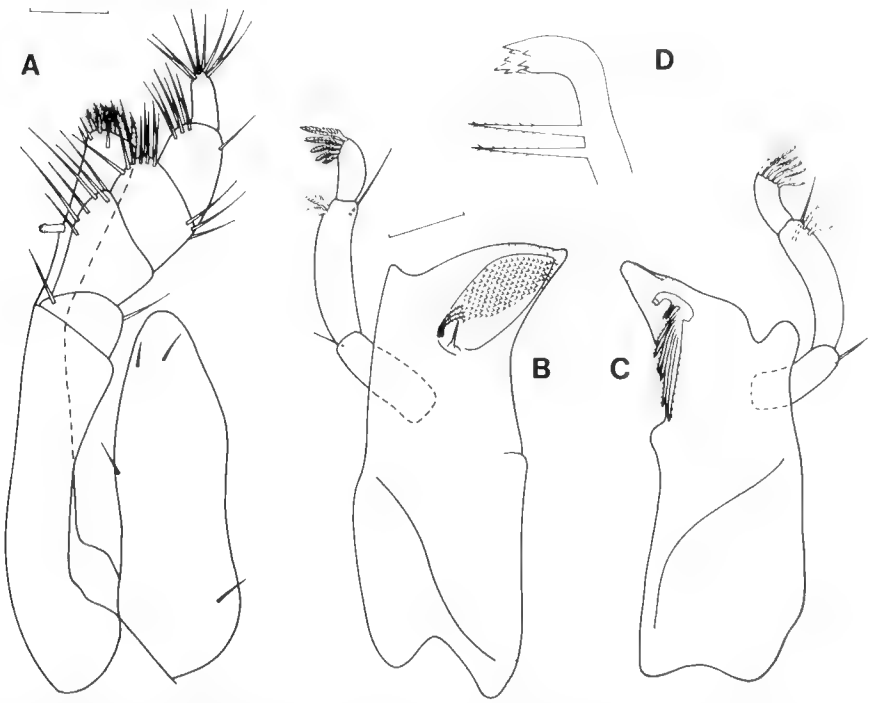

Figure 9. *Paralimnoria asterosa* Cookson and Cragg. A–D, juvenile, NMV J14779, holotype: A, maxilliped; B, left mandible; C, right mandible; D, lacinia mobilis of right mandible.

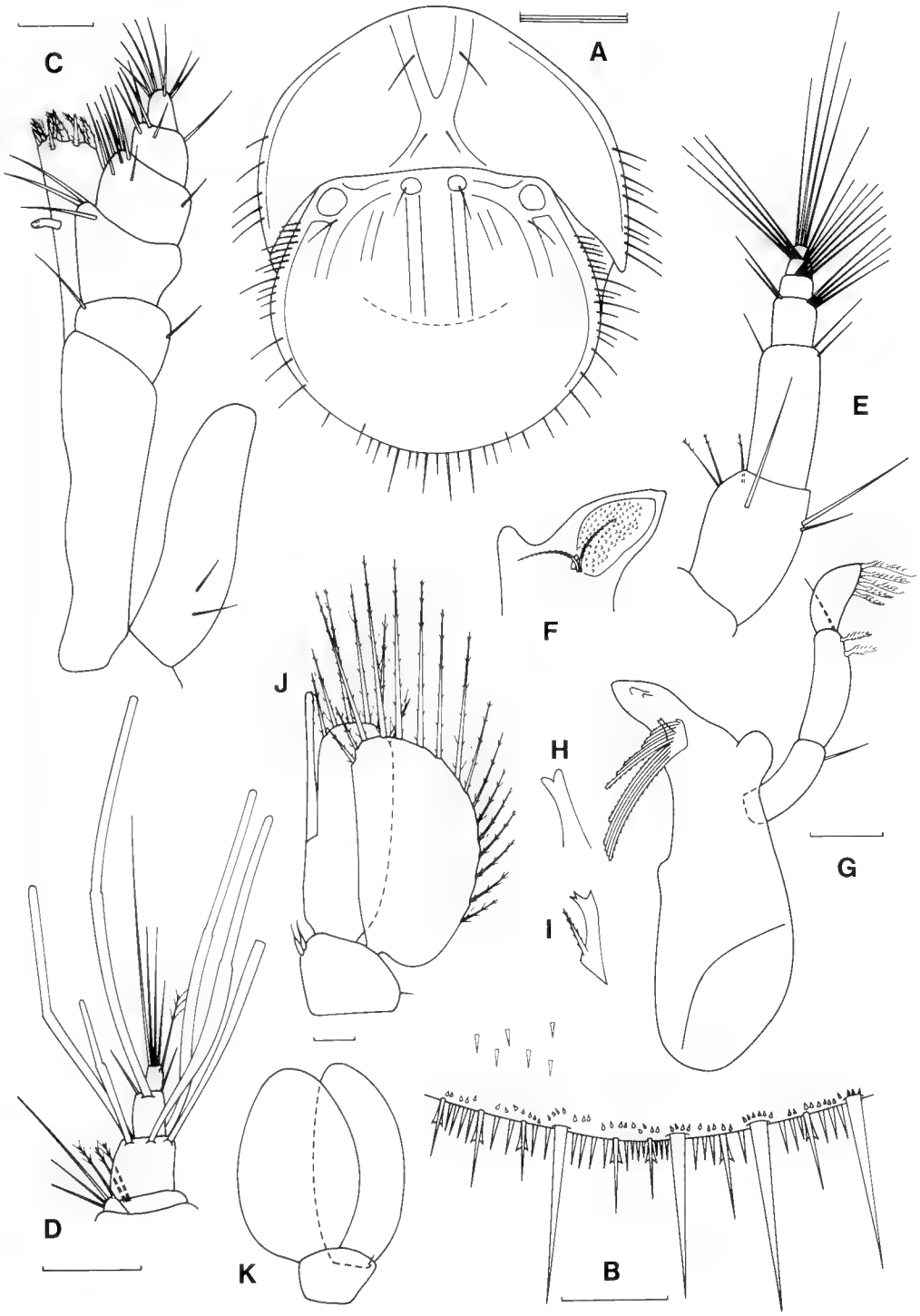

Figure 10. *Limnoria agrostisa* sp. nov. A–H, juvenile, NMV J14972, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2; F, incisor of left mandible; G, right mandible; H, lacinia mobilis of right mandible. I–K, male, NMV J14973, paratype: I, lacinia mobilis of right mandible; J, pleopod 2; K, pleopod 5.

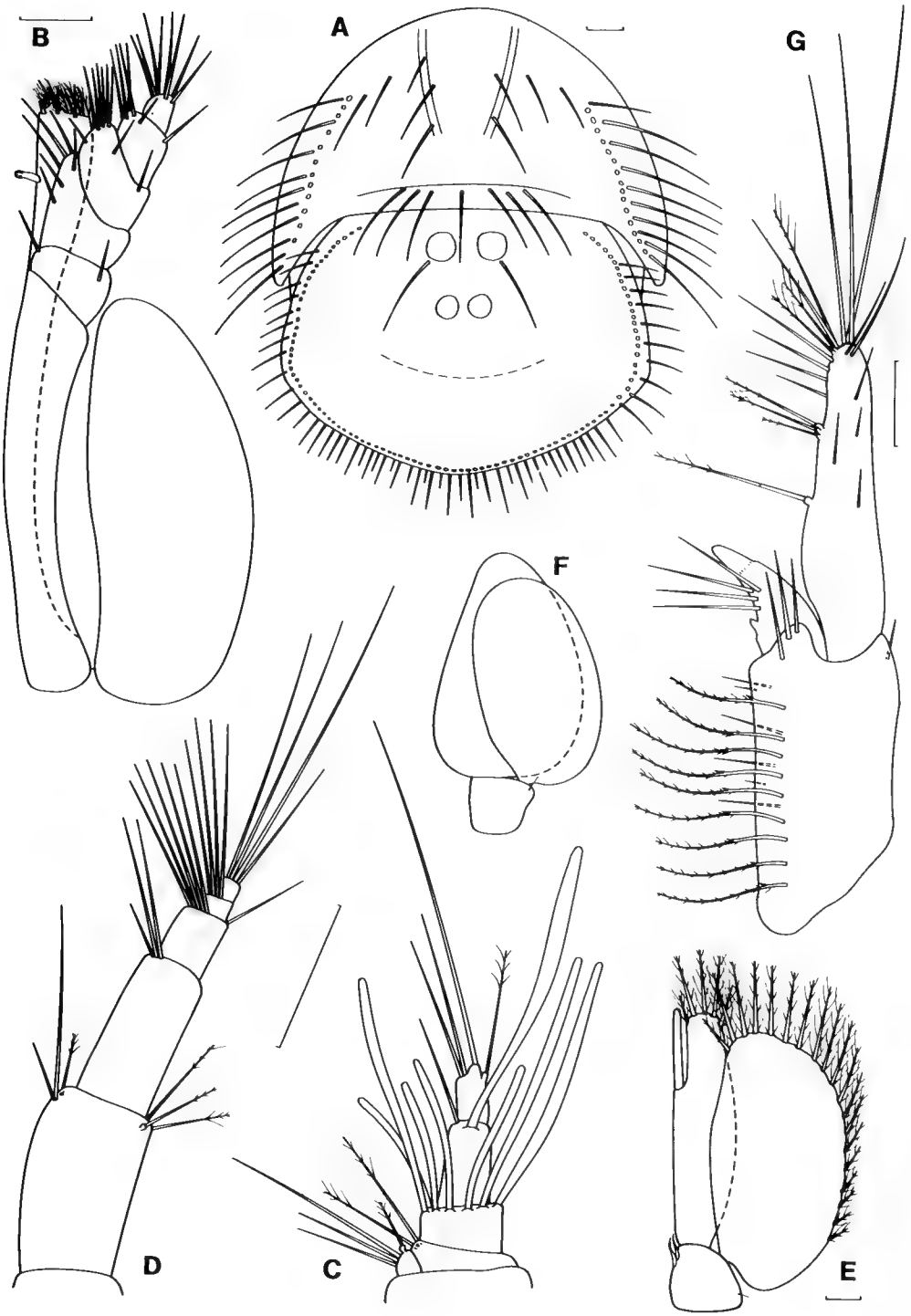

Figure 11. *Limnoria andamanensis* Rao and Ganapati. A, E, F, male, NMV J15468: A, pleonite 5 and pleotelson, dorsal view; E, pleopod 2; F, pleopod 5. B–D, G, male, NMV J15469: B, maxilliped; C, flagellum of antenna 1; D, peduncle article 5 and flagellum of antenna 2; G, uropod, ventral view.

as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, surface pitted. Posterior margin of pleotelson with dorsal row of small scale spikes clustered into groups of 2–6; posterior margin with 4 stout setae between which are short-sheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 4–5 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible short, straight, with 2–3 sharp or blunt apical teeth. Epipod of maxilliped strap-like, 3.7 times as long as wide, just reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 5, 6 and 7. Uropod peduncle with small lateral tubercles; endopod 0.8 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.8 times length of exopod. Appendix masculina reaching beyond endopod tip, articulating just proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.9 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Body length up to 2.8 mm. Colour in alcohol pale yellow.

Etymology. From *agrostis*, Latin for couch-grass.

Distribution. South Australia and southern Western Australia. 2–5 m depths.

Substrates. Seagrass rhizomes such as those from *Posidonia.*

Remarks. The rasp on the left mandible is not absent or reduced as it is in the other seagrass borers *L. zinovae*, *L. simulata* and *L. raruslima.*

L. agrostisa is most similar to *L. quadripunctata* in the ornamentation on pleonite 5 and the pleotelson, possession of a rasp and file, possession of a dorsal row of scale spikes on the posterior margin of the pleotelson, and the shape of the pleopods. *L. agrostisa* may be distinguished from *L. quadripunctata* by the shapes of the maxillipedal epipod, lacinia mobilis of the right mandible, and carina on pleonite 5. Further, *L. agrostisa* lacks a posterior pair of puncta on the pleotelson, and has scale spikes dorsally on the posterior margin of the pleotelson which are small and divided into groups of 2–6.

Limnoria andamanensis Rao and Ganapati

Figures 11, 12, Plate 1f

Limnoria (*Limnoria*) *andamanensis* Rao and Ganapati, 1969: 225–230, figs 1–21.—Nair, 1984: 208.

Material examined. PNG. Buka Passage, Bougainville, S.M. Rayner, NMV J15468 (male, 2.3 mm, 0.53 mm wide pleotelson, with 1 slide), NMV J15469 (male, 2.6 mm, with 1 slide), NMV J15470 (3 males, 2.2, 2.4, 2.4 mm, 3 ovig. females, 2.2, 2.3, 2.5 mm). Rabaul, timber piles from main wharf, S.M. Cragg, 15 Nov 1982, NMV J15482 (male, ovig. female). Alotau, Milne Bay Province, S.M. Rayner, Aug 1971, NMV J15476 (2 males, 2 ovig. females). Madang, low tide, pine bait block no. 27 after 2 months, R.D. Turner, J.V. Marshall and J. Beesley, 30 Aug 1970, AM P38917 (2 males, non-ovig. female).
Belize, Twin Cays, 1 m, rotting wood, B. Kensley, 12 Dec 1986, NMV J15440 (11 specimens).

Types. Zoology Museum, Andhra University, Waltair, India. Attempts to obtain the types have been unsuccessful.

Diagnosis. Pleonite 5 dorsomedially with 2 longitudinal carinae of very low elevation which converge posteriorly; with prominent posterotransverse ridge bearing 7–10 long setae. Pleotelson with 2 pairs of anteromedial puncta, posterior pair closer together than anterior pair. Pleonite 5 0.75 times as long as pleotelson. Dorsal surface of pleotelson composed of scales bearing central spike. Dorsal row of laterally compressed tubercles extend from lateral crests to posterior margin of pleotelson; some tubercles with row of tiny spikes at apex. Posterior margin of pleotelson fringed with long-sheathed setae, without stout setae or scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 7 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible short, curved, with row of small teeth. Epipod of maxilliped broad, oval, 2.5 times as long as wide, reaching past palp articulation; epipod lacking simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopods 6 and 7, and carpus of pereopods 2,3,5,6 and 7. Uropod peduncle with small lateral tubercles; endopod 1.1 times as long as peduncle; endopod with apical row of simple setae extending laterally.

Pleopod 2 with short plumose setae, up to 0.3 times length of exopod. Appendix masculina short, reaching endopod tip, articulating distal to midlength of endopod. Endopod of pleopod 5 posterior to exopod, triangular, similar length to

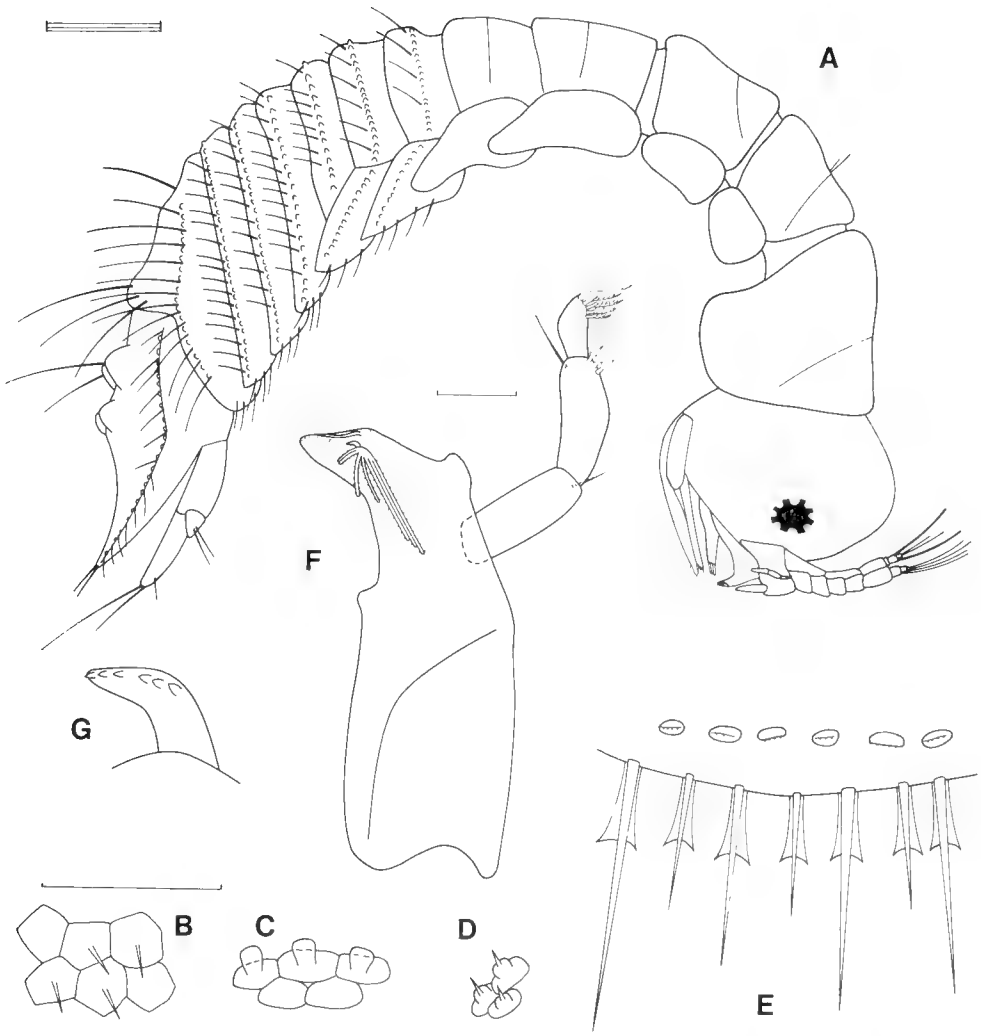

Figure 12. *Limnoria andamanensis* Rao and Ganapati. A–E, male, NMV J15468: A, lateral view; B, dorsal structure of pleotelson; C, dorsal tubercles on pleonite 2; D, dorsal tubercles on lateral crests of pleotelson; E, posterior margin of pleotelson, dorsal view. F,G, male, NMV J15469: F, right mandible; G, lacinia mobilis of right mandible.

endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Somites pereonite 6 to pleonite 4 with transverse row of dorsal tubercles, most prominent on pleonites 1 and 2; pleonites 3 and 4 with tuberculate row near posterior margins, row becomes more centrally located on more anterior somites. Exopod of uropod with two lateral tubercles. Body length up to 2.6 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Distribution. Andaman Islands, Indian Ocean (type locality) (Rao and Ganapati, 1969); Papua New Guinea; Belize. 1 m depth (current study).

Substrates. Log (Rao and Ganapati, 1969), rotting wood, pine bait blocks (current study).

Remarks. The subparallel longitudinal carinae on pleonite 5 are indistinct, and on most specimens not detectable. When present, these carinae have a similar position to two sides of the depressed triangular area found on *P. andrewsi*. The hind pair of puncta on the pleotelson vary in the degree with which they are separated – in some specimens they are joined together (although still distinct puncta). The apical teeth on the lacinia mobilis of the right mandible (Plate 1f) are difficult to detect with the light microscope, and so may have been over-

looked in the specimens examined by Rao and Ganapati (1969), where the lacinia mobilis was described as pointed, smooth and curved.

The specimens from Papua New Guinea and Belize differ slightly from the original description (Rao and Ganapati, 1969), in that they have a row of modified tubercles on the posterior margin of the pleotelson. In the original description it was stated that the distal border was without tubercles. However, due to the possibility that these were overlooked, the specimens from Papua New Guinea and Belize cannot be separated as a different species (or subspecies) without examining the types. The rather prominent tubercles on pereonites 6 to pleonite 5 were also not noted by Rao and Ganapati (1969).

L. andamanensis is most similar to *L. pfefferi*, for the reasons listed with that species.

Limnoria antarctica Pfeffer

Figure 13

Limnoria antarctica Pfeffer, 1887: 96–102, pl. 2 figs 12–13, pl. 5 figs 2–22.—Pfeffer, 1890: 504.—Vanhöffen, 1914: 509–510.—Chilton, 1914a: 382–388, pl. 17 fig. 8.—Holthuis, 1949: 170.

Limnoria (*Phycolimnoria*) *antarctica*.—Menzies, 1957: 180–182, fig. 36.—Pillai, 1957: 150.—Menzies, 1959: 29.

Phycolimnoria antarctica.—Edgar, 1987: 607.

Not *Limnoria antarctica*.—Richardson, 1913: 8.—Chilton, 1914b: 448 (possible).—Hale, 1937: 21–23, fig. 6 (= *Limnoria stephenseni*).

Material examined. Macquarie Island. Large rock on SW side of Caroline Cove, 8 m, *Macrocystis pyrifera* holdfasts, SCUBA, J.K. Lowry, 15 Jan 1978 (stn MA 298), NMV J15399 (male, 3.3 mm, 0.9 mm wide pleotelson, with 1 slide), NMV J15398 (male, 2.7 mm, with 1 slide), NMV J15397 (13 males, 2.1–3.4 mm, 2 non-ovig. females, 2.6, 2.9 mm, 4 ovig. females, 3.3–4.2 mm, 11 juvs., 1.2–2.0 mm). 3 rocks at mouth of Caroline Cove, 13–18 m, red algae from dense *Macrocystis* bed, SCUBA, J.K. Lowry, 16 Jan 1978 (stn MA 307), NMV J15393 (4 males); 13 m, *M. pyrifera* holdfasts (stn MA 306), NMV J15394 (6 males, 2 non-ovig. females, 2 ovig. females, 6 juvs.). Green Gorge, 18 m, *M. pyrifera* holdfasts on platform with rocky gravel bottom and boulders, SCUBA, J.K. Lowry, 8 Jan 1978 (stn MA 250), NMV J15391 (male, ovig. female, 10 juvs.); 15 m, *M. pyrifera* holdfasts on rocks on sandy gravel bottom, SCUBA, D.S. Horning, 13 Jan 1978 (stn MA 294), NMV J15392 (12 males, 2 non-ovig. females, 6 juvs.). Garden Bay, 8 m, *M. pyrifera* holdfasts, SCUBA, D.S. Horning, 7 Dec 1977 (stn MA 91), NMV J15396 (ovig. female, 4.7 mm).

South Orkney Islands, "Scotia" Expedition, 1903, determined C. Chilton, Canterbury Museum (ovig. female, 4.2 mm, pleotelson).

Types. Hamburg Museum, not examined.

Diagnosis. Pleonite 5 dorsomedially with 2 transverse carinae. Pleotelson with 2 dorsomedial puncta joined by transverse carina, followed posteriorly by 2 parallel carinae; laterally with 2 more pairs of short carinae and lateral crests. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of indistinct partly fused scales with single scale spike, surface anteriorly with small pits. Posterior margin of pleotelson with dorsal row of scale spikes; margin fringed with 4 or 6 stout setae between which are short unsheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 6 aesthetases. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible unbranched, apically serrated. Epipod of maxilliped strap-like, 4.4 times as long as wide, reaching articulation of articles 1 and 2 of palp; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 5,6 and 7. Uropod peduncle with short lateral spike setae, some setae on small elevations, without prominent tubercles; endopod 0.55 times as long as peduncle.

Pleopod 2 with long plumose setae up to length equal to exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.7 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Article 2 of mandibular palp with more than 1 simple seta. Mandibular incisor of right mandible with 3 cusps. Body length up to 4.7 mm. Colour in alcohol pale yellow.

Distribution. South Georgia Island (type locality) (Pfeffer, 1887); South Orkney Islands (Chilton, 1914a); Kerguelen (Menzies, 1957); Macquarie Island. 8–18 m depths (current study).

Substrates. Macrocystis, and algae under stones (Pfeffer, 1887); *M. pyrifera* holdfasts, red algae amongst a dense *Macrocystis* bed (present study).

Remarks. L. antarctica is most similar to *L. stephenseni* for the reasons listed with that species. *L. antarctica* may have arisen from an

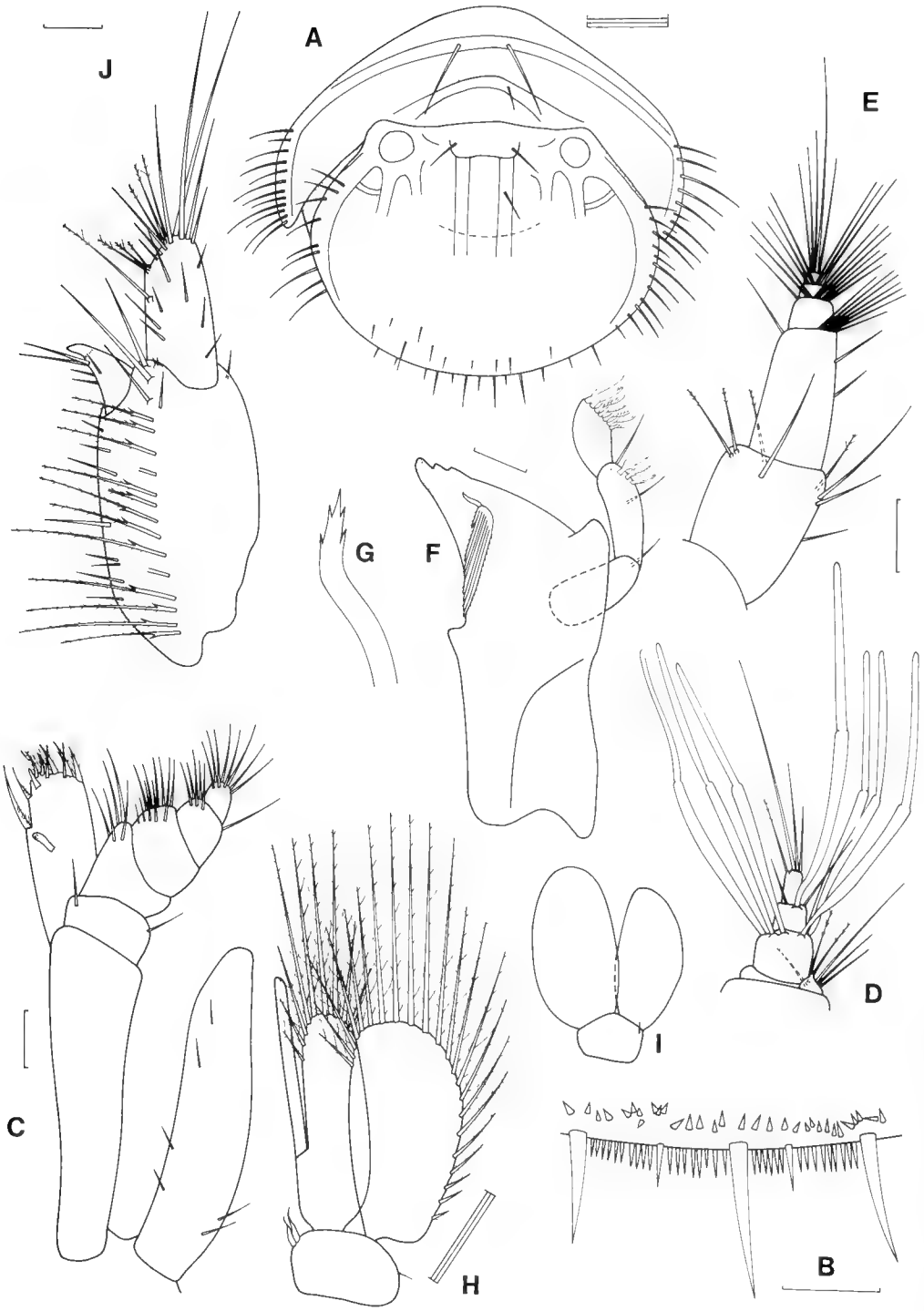

Figure 13. *Limnoria antarctica* Pfeffer. A–I, male, NMV J15399: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2; F, right mandible; G, lacinia mobilis of right mandible; H, pleopod 2; I, pleopod 5. J, male, NMV J15398, uropod, ventral view.

ancestor similar to *L. glaucinosa* and *L. loricata*. All are large cold-water algal-borers with strap-like maxillipedal epipods, and similar pleopods with long appendix masculina and long plumose setae. *L. glaucinosa* also has more than one simple seta on article 2 of the mandibular palp. The carinae on the pleotelson of *L. loricata* and *L. antarctica* are of similar form, while the transverse carinae on pleonite 5 of *L. antarctica* could have arisen from the broad X-shaped carina on *L. loricata*. Also, some specimens of *L. antarctica* have fine carinae around the surface pits on pleonite 5 as in *L. loricata*. A male *L. antarctica* specimen from lot NMV J15397 had a discernible anterior and posterior pair of puncta on the dorsomedial carinae; therefore, a sculpture pattern approaching *L. quadripunctata* and *L. echidna* was apparent.

Menzies (1957) thought the specimens from South Orkney Islands might be *L. stephenseni*, based on the proportions of the uropod figured by Chilton (1914a). However, examination of the remaining intact specimen showed it to be *L. antarctica*.

Limnoria convexa sp. nov.

Figures 14–16

Material examined. Holotype: New Zealand, The Snares islands, Station Point (48°07′S, 166°38′E), low intertidal zone, *Durvillaea* holdfast, K.J. Sainsbury, 3 Feb 1972, NMNZ Cr.6467 (male, 1.6 mm, 0.5 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J15449 (ovig. female, 2.2 mm, with 1 slide), NMV J15450 (2 males, 1.3, 1.5 mm). The Snares, NW corner of Ho Ho Bay, 14 m, among clumps of concentric crustose coralline algae, G.D. Fenwick, 19 Dec 1976 (stn SA 3459), NMV J15447 (ovig. female, 2.1 mm, with 1 slide); Cod Cavern, Gutway, 12–15 m, red algae, D.S. Horning, 24 Jan 1975 (stn SA 902), AM P38915 (male, 1.4 mm), AM P30750 (non-ovig. female, 2.0 mm, with 1 slide); south side of Ho Ho Bay, 5 m, algae on vertical rock face, D.S. Horning, 23 Dec 1974 (stn SA 795), NMNZ Cr. 6458 (male, 1.5 mm, non-ovig. female, 1.4 mm).

Other material: NZ, The Snares, north side of Boat Harbour, from *D. antarctica* holdfast in upper *Durvillaea* zone, G.D. Fenwick, 13 Nov 1976 (stn SA 3386), NMNZ Cr. 6460 (ovig. female, 2.6 mm, pleonite 5 damaged, left uropod and antennae missing).

Diagnosis. Pleonite 5 dorsomedially smoothly convex, without sublateral depressions; pleonite 5 with posterolateral extensions reaching as far as widest part of lateral margins of pleotelson. Pleotelson with 2 short dorsomedial longitudinal carinae. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine scale spikes. Posterior margin of pleotelson with dorsal row of scale spikes; margin fringed with 6 long stout setae between which are short unsheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 3 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles, article 3 reduced, with 1 or 2 apical comb setae. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible unbranched, curved near midlength and serrated. Epipod of maxilliped strap-like, apically round, 4.5 times as long as wide, reaching beyond palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta absent on merus of pereopods, present on carpus of pereopods 5, 6 and 7. Uropod peduncle with few small lateral tubercles bearing short spikes; endopod 0.75 times as long as peduncle.

Pleopod 2 with long plumose setae up to 0.9 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.6 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Large medial seta on maxilla 2 sinuous. Lacinia mobilis of left mandible accompanied by only 1 serrated seta in spine row. Body length up to 2.2 mm. Colour in alcohol white.

Etymology. From the Latin *convexa*, relating to the convex nature of pleonite 5 which is the main feature distinguishing it from *L. nonsegnis*.

Distribution. The Snares, New Zealand. 0–15 m depths.

Substrates. Durvillaea holdfasts, among coralline algae, red algae.

Remarks. This species is very similar to *L. nonsegnis*, but differs slightly in that for *L. convexa*: the epipod of the maxilliped is not club-shaped; pleonite 5 is convex and lacks depressions on either side of the median region; body size is smaller; the food substrate is different; the lacinia mobilis of the right mandible is undivided; the endopod on pleopod 5 lacks a simple seta; the lateral margin on pleonite 5 is longer posteriorly giving a more circular appearance to pleonite 5 and the pleotelson; the lacinia mobilis of the left mandible is accompanied by one not

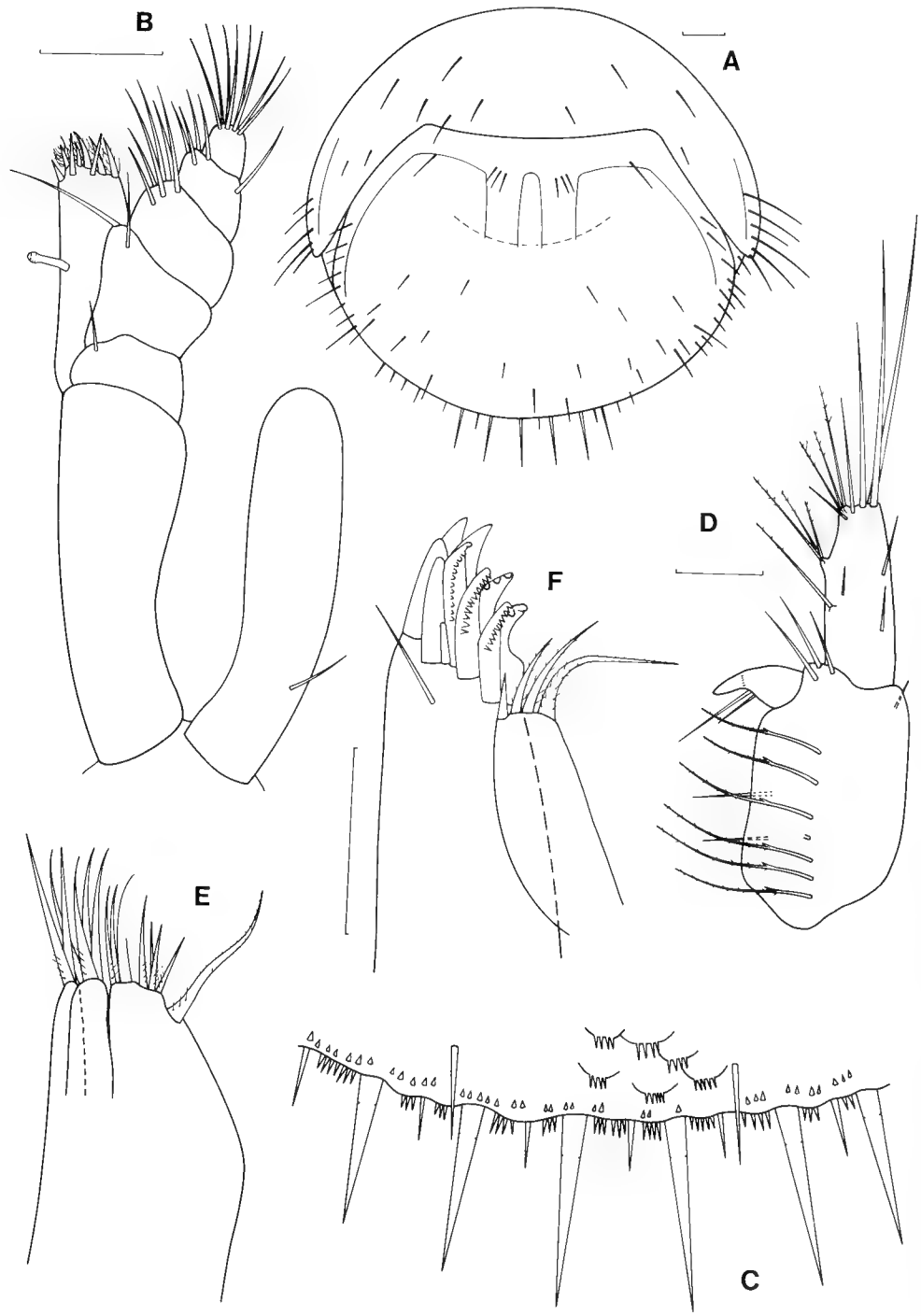

Figure 14. *Limnoria convexa* sp. nov. A–F, male, NMNZ Cr.6467, holotype: A, pleonite 5 and pleotelson, dorsal view; B, maxilliped; C, posterior margin of pleotelson, dorsal view; D, uropod, ventral view; E, maxilla 2; F, maxilla 1.

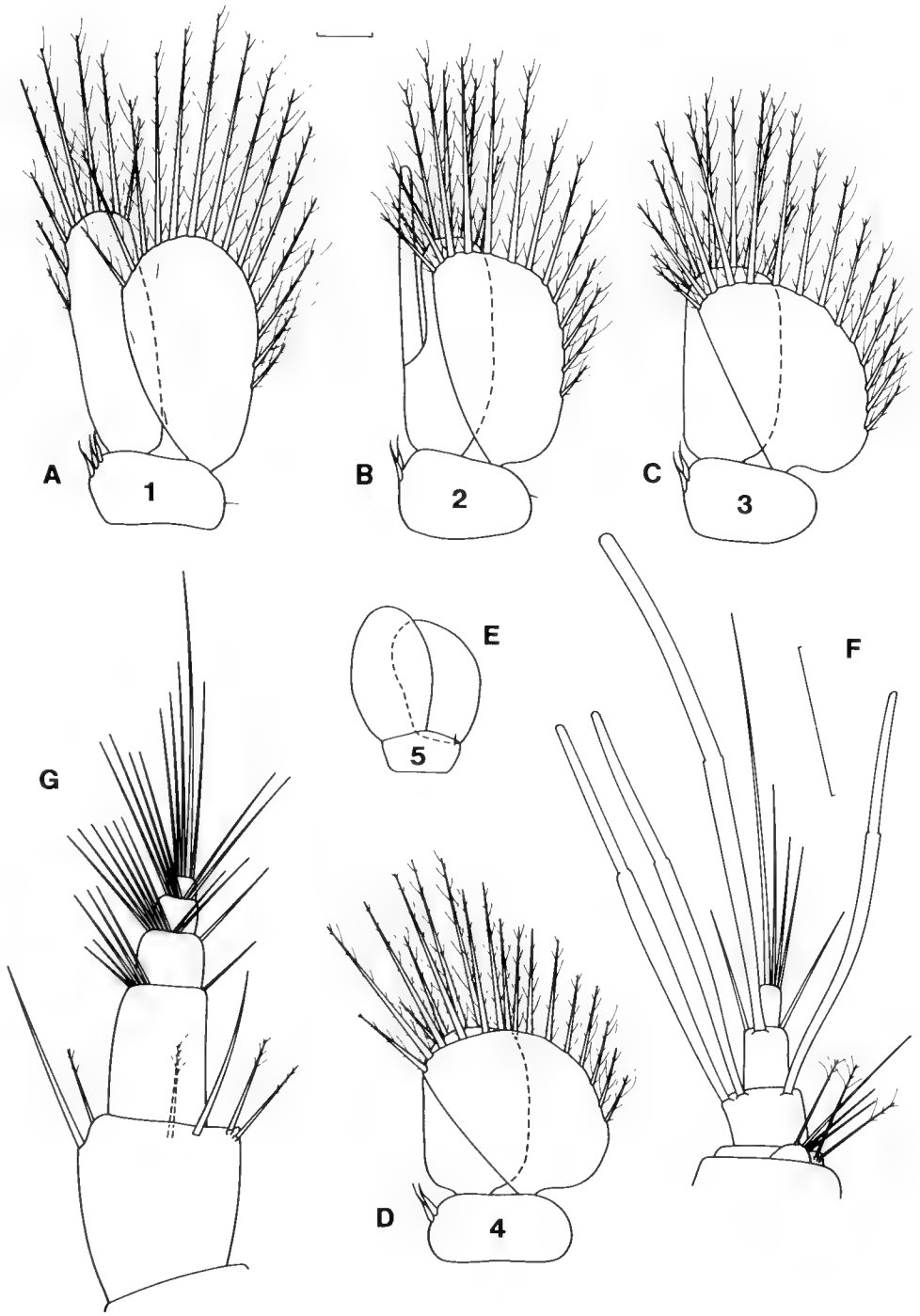

Figure 15. *Limnoria convexa* sp. nov. A–G, male, NMNZ Cr.6467, holotype: A–E, pleopods 1–5; F, flagellum of antenna 1; G, peduncle article 5 and flagellum of antenna 2.

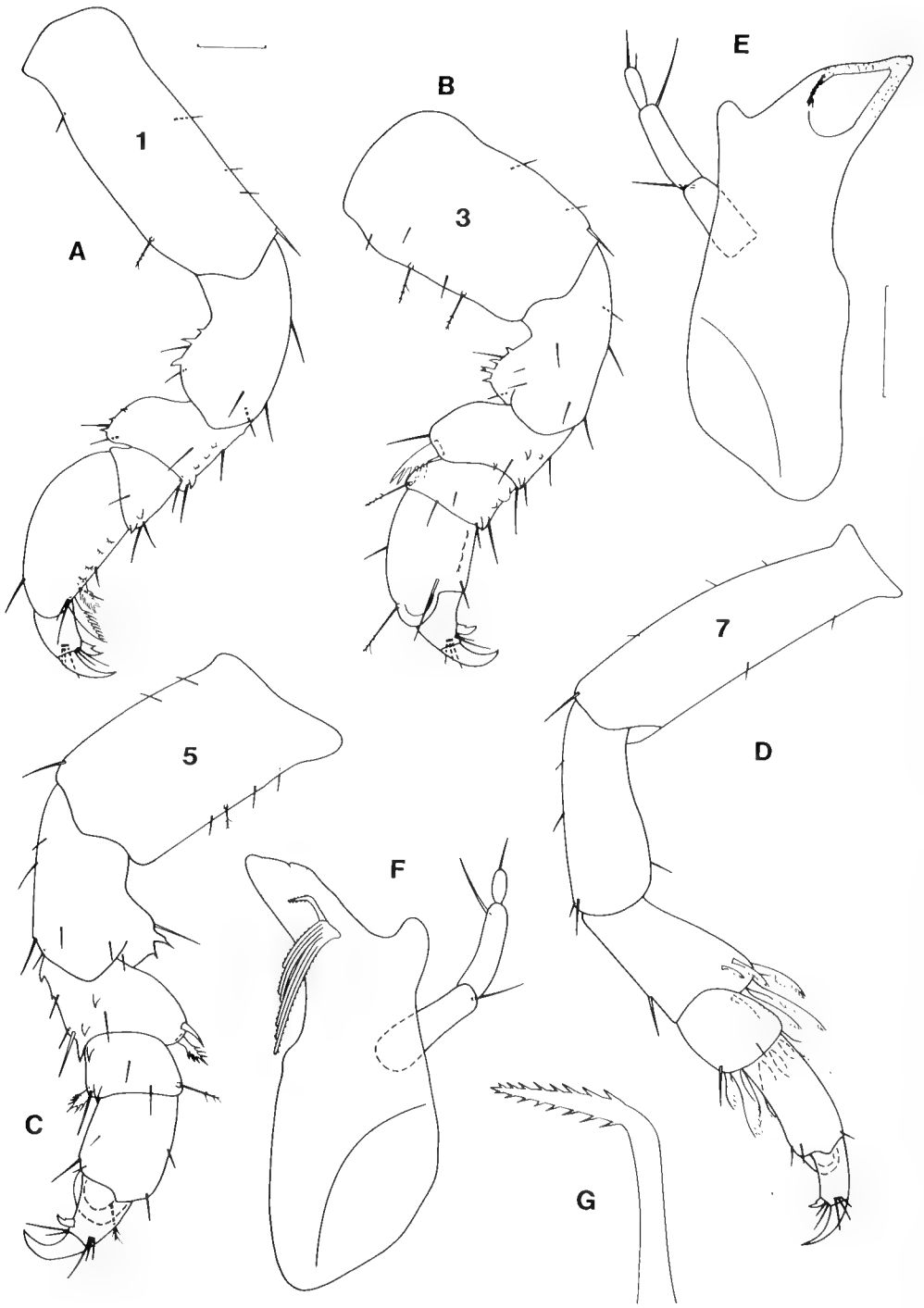

Figure 16. *Limnoria convexa* sp. nov. A–G, male, NMNZ Cr.6467, holotype: A–D, pereopods 1, 3, 5 and 7, lateral views; E, left mandible; F, right mandible; G, lacinia mobilis of right mandible.

two serrated setae; and a ventral comb seta is present on the carpus of pereopod 5.

Edgar (1987) suggested that floating seaweed would rarely be able to cross the Tasman Sea, as it would not maintain buoyancy or growth due to low dissolved nitrate levels in seawater. Therefore there would be little gene flow between The Snares and Tasmanian populations, allowing speciation of *L. nonsegnis* and *L. convexa*.

Limnoria echidna sp. nov.

Figures 17, 18

Material examined. Holotype: Tas. Coles Bay, near boat ramp (42°7′S, 148°17′E), 1 m, red algae and invertebrates on vertical rock wall, airlift, R.S. Wilson, 21 Apr 1985 (stn TAS 17), NMV J14782 (male, 2.1 mm, 0.55 mm wide pleotelson, with 1 slide).

Paratype: Tas. Ninepin Point (43°17′S, 147°15′E), 1–2 m, washings from red, green, and some brown algae, some freshwater input to site apparent, G.C.B. Poore and H.M. Lew Ton, 20 Mar 1988 (stn TAS 69), NMV J15467 (male, 2.6 mm, with 1 slide).

Diagnosis. Pleonite 5 dorsomedially with X-shaped carina, anterior axes diverging laterally near pleonite margins. Pleotelson with 2 long parallel dorsomedial carinae, carinae with 2 pairs of tiny or large anterior and subanterior puncta; carinae followed laterally by pair of short less distinct or even absent carinae, and further pair of lateral carinae as long as medial pair. Pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, anterior surface slightly pitted. Posterior margin of pleotelson without dorsal row of scale spikes or tubercles; posterior margin fringed with 4 stout setae between which are short-sheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 5–8 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisor of left mandible with rasp vestigial or absent. Lacinia mobilis of right mandible enlarged apically, fringed by row of small teeth. Epipod of maxilliped subtriangular, 3.1 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 6 and 7. Uropod peduncle with small lateral tubercles; epipod 0.9 times as long as peduncle.

Pleopod 2 with long plumose setae up to 1.1 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.7 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Body length up to 2.6 mm. Colour in alcohol pale yellow.

Etymology. Named after the Australian monotreme, the echidna, alluding to the covering of the body with spikes.

Distribution. Tasmania. 1–2 m depths.

Substrate. Possibly red algae.

Remarks. When the holotype was first examined it was white, and the small puncta on the pleotelson were not detected. The specimen has since become more transparent, possibly due to examinations in glycerine, and the tiny puncta became noticeable. On the paratype the puncta on the pleotelson are prominent, to the degree found in *L. quadripunctata*. Like the holotype, the paratype lacks a dorsal row of scale spikes on the posterior margin of the pleotelson. Although the dorsal surface of the pleotelson was generally covered by more scale spikes than the holotype, and although some of these scale spikes were near the hind perimeter of the pleotelson, they did not form a regular row. The left mandible on the holotype was slightly distorted after mounting and placement of the coverslip, which is why the incisor was drawn as being partially concealed. The paratype had no small teeth or vestigial rasp on the incisor of the left mandible.

L. echidna has a similar pleotelsonal ornamentation to *L. quadripunctata*, *L. agrostisa* and *L. rugosissima*. It seems most similar to *L. quadripunctata* as both species have four dorsomedial puncta on the pleotelson, and similar lacinia mobilis of the right mandible (also similar to the lacinia mobilis on *L. raruslima*).

L. echidna may be distinguished from *L. quadripunctata* by: longer carinae (especially the lateral carinae) on the pleotelson, slightly different carinae on pleonite 5, more tuberculate lateral margin on the uropod peduncle, greatly reduced or absent rasp, slightly larger right mandibular lacinia mobilis, more apically rounded maxillipedal epipod, absence of a dorsal row of scale spikes on the posterior margin of the pleotelson, and different ventral comb setal sequence on the pereopods.

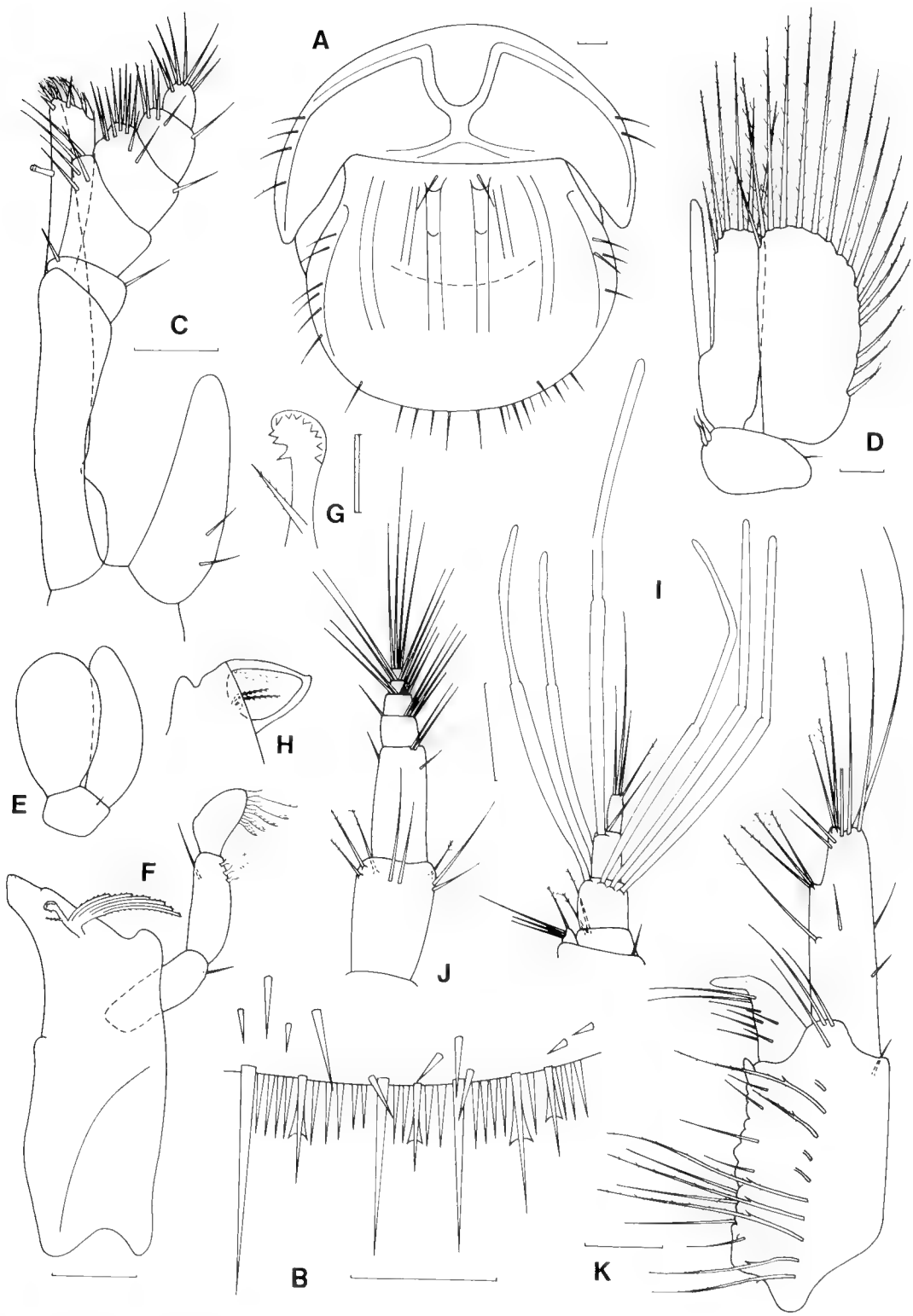

Figure 17. *Limnoria echidna* sp. nov. A–K, male, NMV J14782, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, pleopod 2; E, pleopod 5; F, right mandible; G, lacinia mobilis of right mandible; H, incisor of left mandible; I, flagellum of antenna 1; J, peduncle article 5 and flagellum of antenna 2; K, uropod, ventral view.

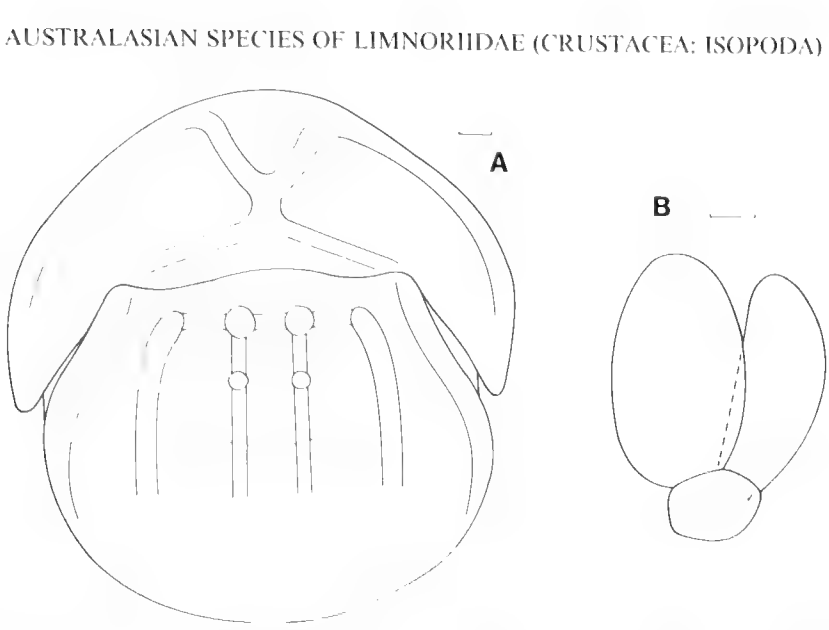

Figure 18. *Limnoria echidna* sp. nov. A, B, Male, NMV J15467, paratype: A, pleonite 5 and pleotelson, dorsal view, setae omitted; B, pleopod 5.

Limnoria gibbera sp. nov.

Figure 19

Material examined. Holotype: WA, eastern end of Thistle Cove (34°0′S, 122°12′E), 7 m, red algae, SCUBA, G.C.B. Poore and H.M. Lew Ton, 11 Apr 1984 (stn SWA 27), NMV J15339 (male, 2.0 mm, 0.55 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J15340 (non-ovig. female, 2.2 mm, with 1 slide). WA, NE end of Vancouver Peninsula (35°3.4′S, 117°56.2′E), 10 m, red algae, SCUBA, G.C.B. Poore and H.M. Lew Ton, 8 Apr 1984 (stn SWA 24), NMV J15341 (non-ovig. female, 1.9 mm).

SA, north side of West Island (35°37′S, 138°36′E), 5 m, sandy sediment, SCUBA, G.C.B. Poore and H.M. Lew Ton, 21 Mar 1985 (stn SA 46), NMV J15342 (male, 1.6 mm).

Diagnosis. Pleonite 5 dorsomedially lacking carinae and puncta, with many long setae. Pleotelson with broad raised dorsomedial area, with pair of lateral carinae. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson with scales bearing fine spikes posteriorly, spikes long on anterior scales. Posterior margin of pleotelson with dorsal row of scale spikes, lateral crests with tubercles each bearing dorsal row of scale spikes; posterior margin fringed with scale spikes and short-sheathed setae, lacking stout setae.

Antenna 1 with 4 flagellar articles; second article with about 4 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors lacking rasp and file. Lacinia mobilis of right mandible with apical expansion with regular or irregular row of small teeth. Epipod of maxilliped almost strap-like, but broad at midlength, 2.7 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta absent on merus, present on carpus of pereopods 6 and 7. Uropod peduncle with few small proximolateral tubercles; endopod as long as peduncle.

Pleopod 2 with long plumose setae up to 0.9 times length of exopod. Appendix masculina reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, elongated, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Secondary unguis on all pereopods clearly bifid. Endopod of uropod with 2 small vestigial proximally bifurcate pappose setae similar to those found on peduncle. Lacinia mobilis of left mandible accompanied by only 1 long serrated seta. Body length up to 2.2 mm. Colour in alcohol red-brown due to colour of gut and surface debris; NMV J15342 specimen pale yellow.

Etymology. From the Latin for hump, *gibber*. Relates to the pleotelsonal shape.

Distribution. Southern Western Australia and South Australia. 5–10 m depths.

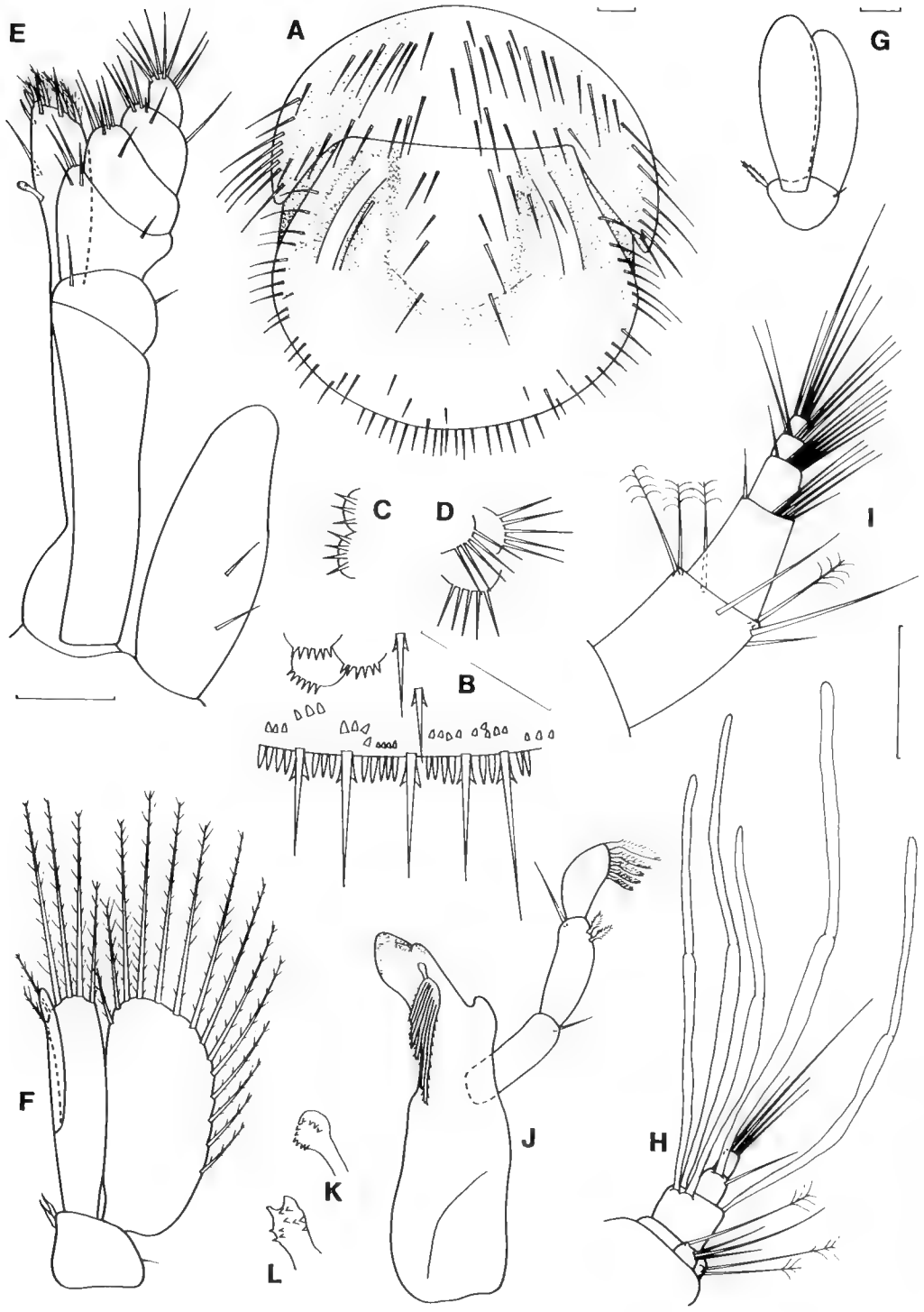

Figure 19. *Limnoria gibbera* sp. nov. A -G, J, L, male, NMV J15339, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, tubercles on lateral crests of pleotelson; D, dorsal structure of anterior region of pleotelson; E, maxilliped; F, pleopod 2; G, pleopod 5; J, right mandible; L, lacinia mobilis of right mandible. H,I,K, female, NMV J15340, paratype: H, flagellum of antenna 1; I, peduncle article 5 and flagellum of antenna 2; K, lacinia mobilis of right mandible.

Substrate. Red algae.

Remarks. The peduncle on pleopod 5 in the holotype is broader than in the paratypes, and has what may be a vestigial coupling hook which also is not found in the paratypes.

The carinae on the pleotelson of *L. gibbera* have similarities to those found on *L. echidna*. The central humped area may have arisen from a merging of the area between two parallel medial carinae. The lacinia mobilis of the right mandible has similarities to that found on *L. echidna*, *L. raruslima* and *L. quadripunctata*.

L. gibbera may be most similar to *L. poorei*. Both species have been collected from red algae, have broad maxillipedal epipods (only slightly broad in *L. gibbera*), four flagellar articles on antenna 2, elongated rami on pleopod 5, similar pleopod 2 shapes, lack stout setae on the posterior margin of the pleotelson, and lack carinae on pleonite 5. *L. gibbera* does not have the reduction in the mandibular palp or modification of the secondary unguis found in *L. poorei* or the related species: *L. uncapedis*, *L. bituberculata* and *L. segnoides*. *L. gibbera* appears to have evolved before the ancestor to the latter species.

Limnoria glaucinosa sp. nov.

Figures 20–22

Phycolimnoria spp. Edgar, 1987: 599–610.

Material examined. Holotype: SA, "Hotspot" reef, 5 nautical miles W of north end of Flinders Island (33°40.5′S, 134°22′E), 17 m, assorted large brown, green and red algae, SCUBA, S.A. Shepherd, 19 Apr 1985 (stn SA 65), NMV J14974 (male, 3.9 mm, 1.05 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J14975 (ovig. female, 4.0 mm, with 1 slide), NMV J14976 (male, 3.3 mm, non-ovig. female, 3.1 mm). Vic. Marengo, near Apollo Bay (38°46′S, 143°44′E), W.F. Seed, 28 Dec 1970, NMV J15376 (male, 5.6 mm, with 1 slide), NMV J15375 (65 males, 2.7–6.8 mm, 32 non-ovig. females, 3.3–7.5 mm, 15 ovig. females, 3.6–6.2 mm, 60 juvs., 1.9–3.3 mm).

Other material: SA. NE side of Topgallant Island (33°43′S, 134°36.6′E), 16 m, *Cystophora*, SCUBA, S.A. Shepherd and G.C.B. Poore, 21 Apr 1985 (stn SA 84), NMV J14977 (male); 7 m, *Acrocarpia aniculata* and red algae, 22 Apr 1985 (stn SA 83), NMV J14978 (male, intersex, non-ovig. female, juv.).

Vic. NE shore of Cape Wellington, Wilsons Promontory (39°3.5′S, 146°28.7′E), 0–15 m, various substrates, SCUBA, G. Smith and L. Rubelman, 2 Sep 1982 (stn WPNP 36), NMV J15368 (male, 4 juvs.). Southwestern Bass Strait (39°32.8′S, 144°16′E), 18 m, fine sand, epibenthic sled, G.C.B. Poore on FV "Sarda", 1 Nov 1980 (stn BSS 107), NMV J15369 (non-ovig. female). 1 km E of Harmers Haven, 300 m offshore (38°34′S, 145°40′E), 6 m, algal turf on rocks, SCUBA, R. Wilson and C. Larsen, 6 Mar 1982 (stn CPA 15), NMV J12881 (2 juvs.); 500 m offshore, 11 m, algal turf on rocks, C. Larsen and G. Barber (stn CPA 14), NMV J12882 (2 males, non-ovig. female). Shack Bay, Venus Bay (38°40′S, 145°40′E), 12 m, rocky habitat, SCUBA, C. Larsen, G. Barber, M. MacDonald et al., 4 Mar 1982 (stn CPA 4), NMV J12889 (juv.). The Oaks, Bunurong Coast (38°40′S, 145°38′E), algae in LWM rock pools, G.C.B. Poore, 5 Mar 1982 (stn CPA 21), NMV J12891 (intersex). Apollo Bay, rock pools, W.F. Seed, 22 Dec 1970, NMV J13894 (4 males, 2 juvs.). Shoreham, Western Port Bay, W.F. Seed, 28 Feb 1959, NMV J13896 (2 males, 2 non-ovig. females, 2 juvs., blue-grey colour, now white).

Tas. Variety Bay (43°12′S, 147°24′E), 6.8 m, *Macrocystis* holdfast, G. Edgar, 1984, NMV J15370 (2 males, non-ovig. female, ovig. female).

Diagnosis. Pleonite 5 without sculpturing dorsomedially, slightly convex, not concave laterally. Pleotelson flat, not concave, semicircular as lateral margins begin to converge posteriorly from proximal end; with 4 small and short dorsomedial anterior carinae, 2 longitudinal and 2 oblique; with pair of oblique grooves. Pleonite 5 0.4 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, without pits. Posterior margin of pleotelson with dorsal row of scale spikes; fringed with 4 large stout setae between which are many short-sheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 7 aesthetases. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible long, with several blunt apical teeth. Epipod of maxilliped strap-like, 4.2 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 5 (sometimes), 6 and 7. Uropod peduncle with small tubercles on lateral margin; endopod 1.3 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.7 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.7 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Second article of mandibular palp with more than 1 simple seta. Lacinia

mobilis of left mandible without accompanying pair of serrated setae in spine row. Body length up to 7.5 mm. Colour in alcohol, blue-grey with irregular patches of pale yellow, on cephalon, pereonites 1–3 and 7, pleonites 1–5 and pleotelson; pereonites 4–6 mostly pale yellow. Blue-grey colour is closest to colour given in plate 30, square a6, by Maerz and Paul (1950).

Etymology. From the Greek for bluish-grey, *glaucinos.*

Distribution. Victoria, Tasmania and South Australia. 0–18 m depths, and rock pools.

Substrates. Macrocystis holdfasts (Edgar, 1987), *Cystophora*, assorted red brown and green algae, algal turf, and *Acrocarpia aniculata* or red algae (present study).

Remarks. The range of substrates for this borer seems quite large, it bores into holdfasts of kelps, and may also live under or on algal turf in rock-pools. *L. glaucinosa* is the only brightly coloured limnoriid species known. It may be relevant that some *Macrocystis* haptera have a purple appearance due to an iron-tannin complex (Jones, 1971).

Many specimens had pleopods 1–4 pointing anteriorly. Possibly this was due to, or allowed, the presence of commensals, mainly ostracods, between pleopods 4 and 5.

The dissected specimen from Marengo had 14–15 aesthetascs on flagellar article 2 on antenna 1. Although there was only one simple seta on article 2 on the right mandibular palp of the holotype, there were two on the left mandible. Other specimens collected with the holotype also had the two simple setae on article 2 on both the left and right mandibular palps. Four paratypes examined from Marengo had a ventral comb seta on the carpus of pereopods 5, 6 and 7, as did a male paratype from near Flinders Island; however, the holotype and two other paratypes from near Flinders Island had the comb seta present on pereopods 6 and 7 only.

The shape of the maxillipedal epipod and presence of several simple setae on article 2 of the mandibular palp suggest a similarity of *L. glaucinosa* to *L. antarctica* and *L. stephenseni.* However, the later two species have only four flagellar articles on antenna 2, and very short uropodal endopods. Both *L. torquisa* and *L. glaucinosa* have pappose setae on the uropodal endopod, but the two species have few other similarities.

L. glaucinosa may be most similar to *L. loricata* and *L. rugosissima* as all have five flagellar articles on antenna 2, similar setal structure on the posterior margin of the pleotelson, similar pleopod 2 shapes, and similar ventral comb setal arrangement on the pereopods. The faint pleotelsonal carinae found on *L. glaucinosa* may be derived from well developed carinae similar to those found on *L. loricata* and *L. rugosissima.* Both the maxillipedal epipod, and the setal arrangement adjacent to the lacinia mobilis of the left mandible, are also similar to those found in *L. rugosissima.* The lacinia mobilis of the right mandible has some similarities to that found in *L. loricata.*

L. glaucinosa is most readily distinguished by its large patches of blue-grey colouration. Also useful are the setal arrangements on both the left and right mandibular palps, and the shapes of the pleotelson (perimeter outline) and lacinia mobilis of the right mandible.

Limnoria indica Becker and Kampf

Figures 23–26

Limnoria (*Limnoria*) *indica* Becker and Kampf, 1958: 1–9, figs 2–4.—Becker and Kampf, 1959: 12–17, figs 2–4.—Ganapati and Rao, 1960: 275–276.—Pillai, 1961: 23, 25, pl. II figs 4–5, text-figs 11–12.—Rao and Ganapati, 1969: 226.—Kühne, 1975: 453.—Kühne, 1976: 546, figs 3–4.—Santhakumaran, 1976: 238.—Krishnan et al., 1980: 20.—Kensley and Schotte, 1987: 222, fig. 4.

Limnoria indica.—Jones et al., 1972: 105, 109–110.—Karande, 1978: 41, 43.—Nair, 1984: 208–209.—Barnacle et al., 1986: 10–11.—Cookson, 1987a: 1–14.—Cookson, 1987b: 85–89, figs 1–8.—Cookson and Barnacle, 1987b: 287–293.—Cookson et al., 1989: 1–8.—Kensley and Schotte, 1989: 194, fig. 86A–B.

Limnoria simulata.—McCoy-Hill, 1964: 46 (possible).—Müller, 1988: 397–403 (*L. indica* material only).

Material examined. Holotype: India, Mandapam Camp (9°18′N, 78°8′E), palm log in shallow water, G. Becker, 30 Oct 1956, Bundesanstalt für Materialprüfung, Berlin (male).

Allotype: Type locality, Bundesanstalt für Materialprüfung, Berlin (female).

Other material. Qld. Bowen, 1 m, untreated turpentine pile C20 heartwood, L.J. Cookson, 4 Jul 1985, NMV J15495 (male, 3.0 mm, 0.8 mm wide pleotelson, with 1 slide), NMV J15301 (male, 3.0 mm), NMV J15299 (intersex, 3.1 mm, with 1 slide), NMV J15300 (non-ovig. female, 2.9 mm, with 1 slide), NMV J15298 (35 males, 1.9–3.1 mm, 16 non-ovig. females, 2.0–2.8 mm, 18 ovig. females, 2.6–3.0 mm, 12 juvs., 1.5–2.1 mm); 0–4 m, turpentine heartwoods, NMV J15297 (51), NMV J14994 (23), NMV J15289 (94), NMV J15291 (240); 4 m, turpentine bark at mud-line, NMV

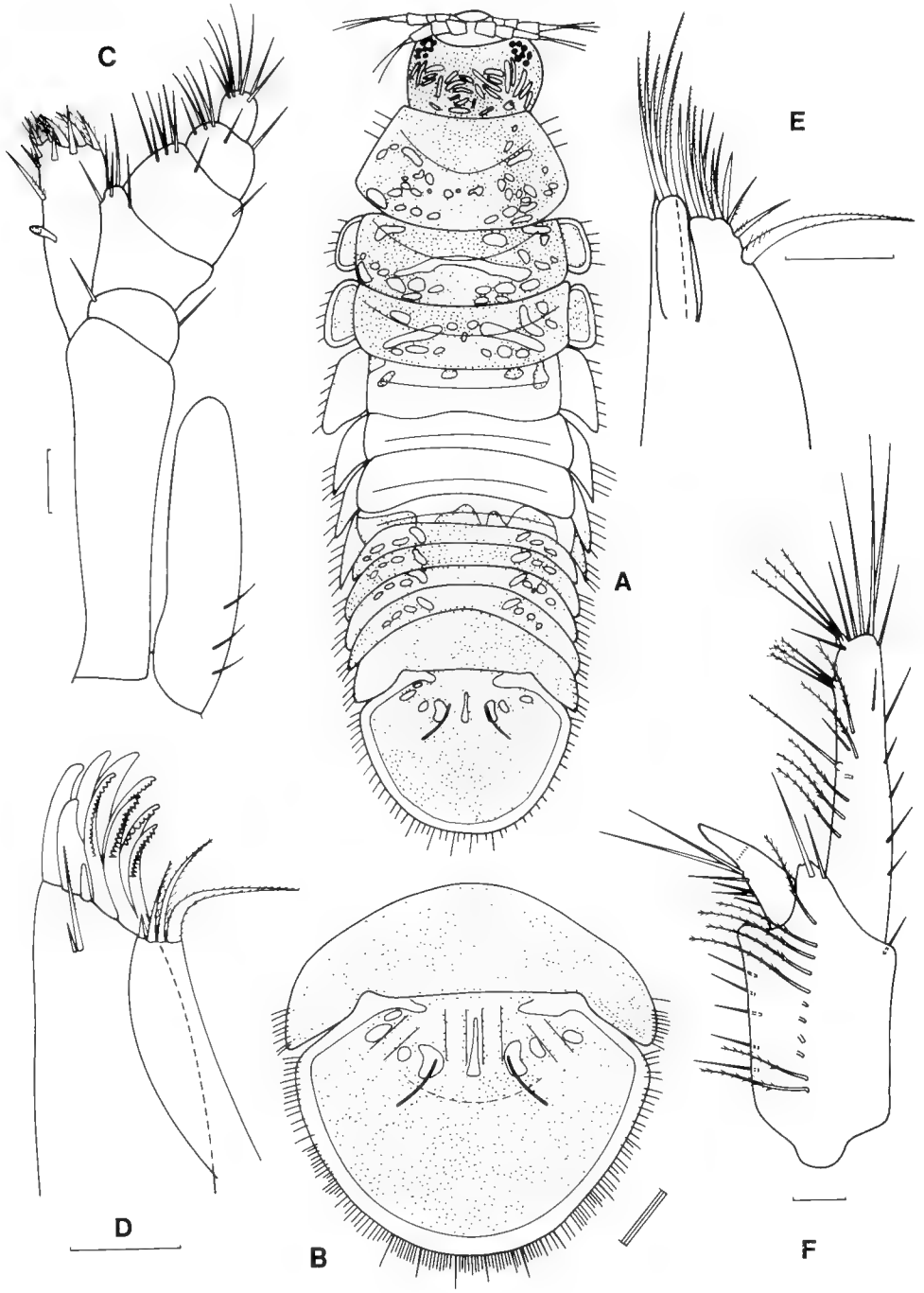

Figure 20. *Limnoria glaucinosa* sp. nov. A–F, male, NMV J14974, holotype: A, dorsal view; B, pleonite 5 and pleotelson, dorsal view; C, maxilliped; D, maxilla 1; E, maxilla 2; F, uropod, ventral view.

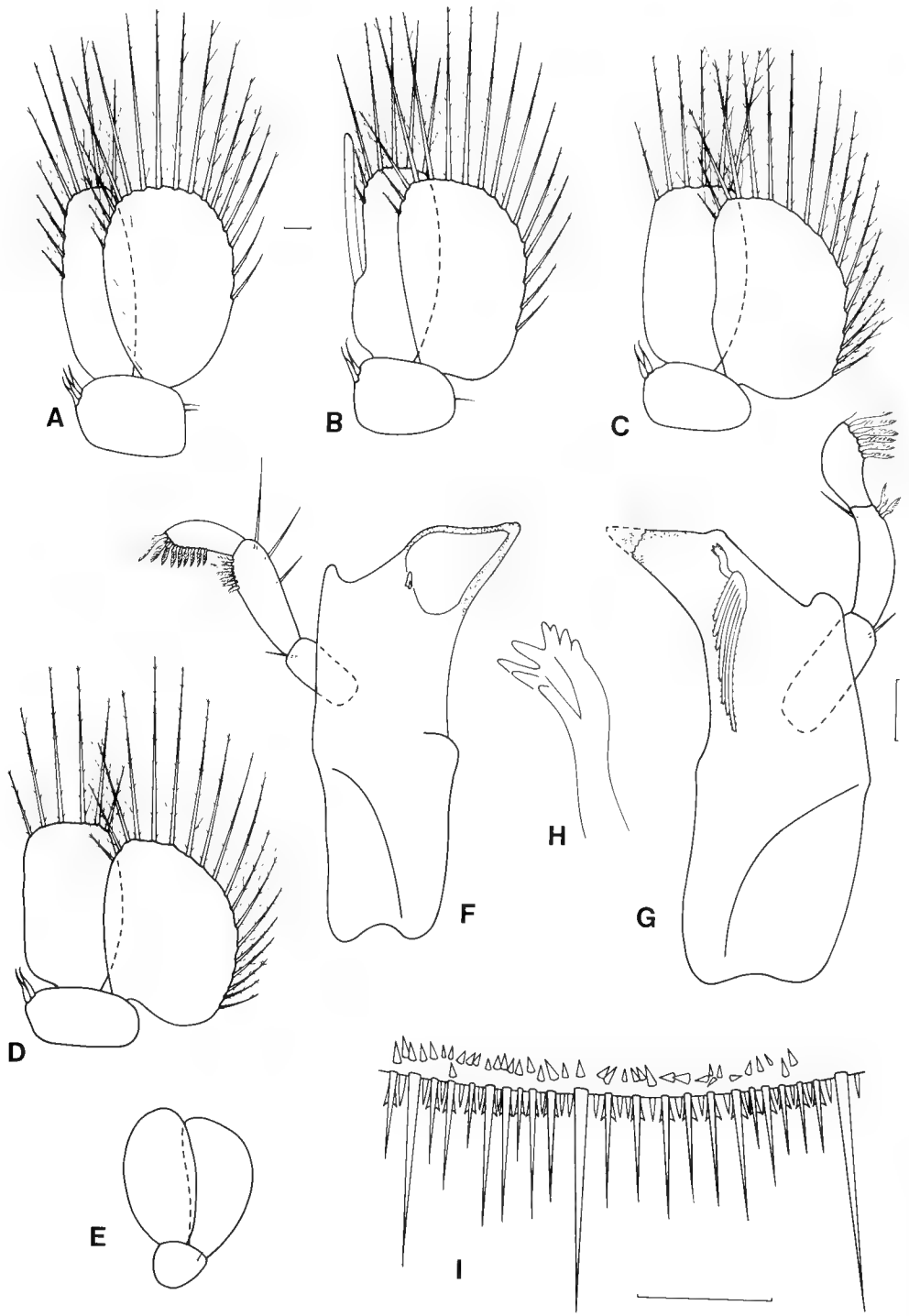

Figure 21. *Limnoria glaucinosa* sp. nov. A–E, G–I, male, NMV J14974, holotype: A–E, pleopods 1–5; G, right mandible; H, lacinia mobilis of right mandible; I, posterior margin of pleotelson. F, male, NMV J15376, left mandible.

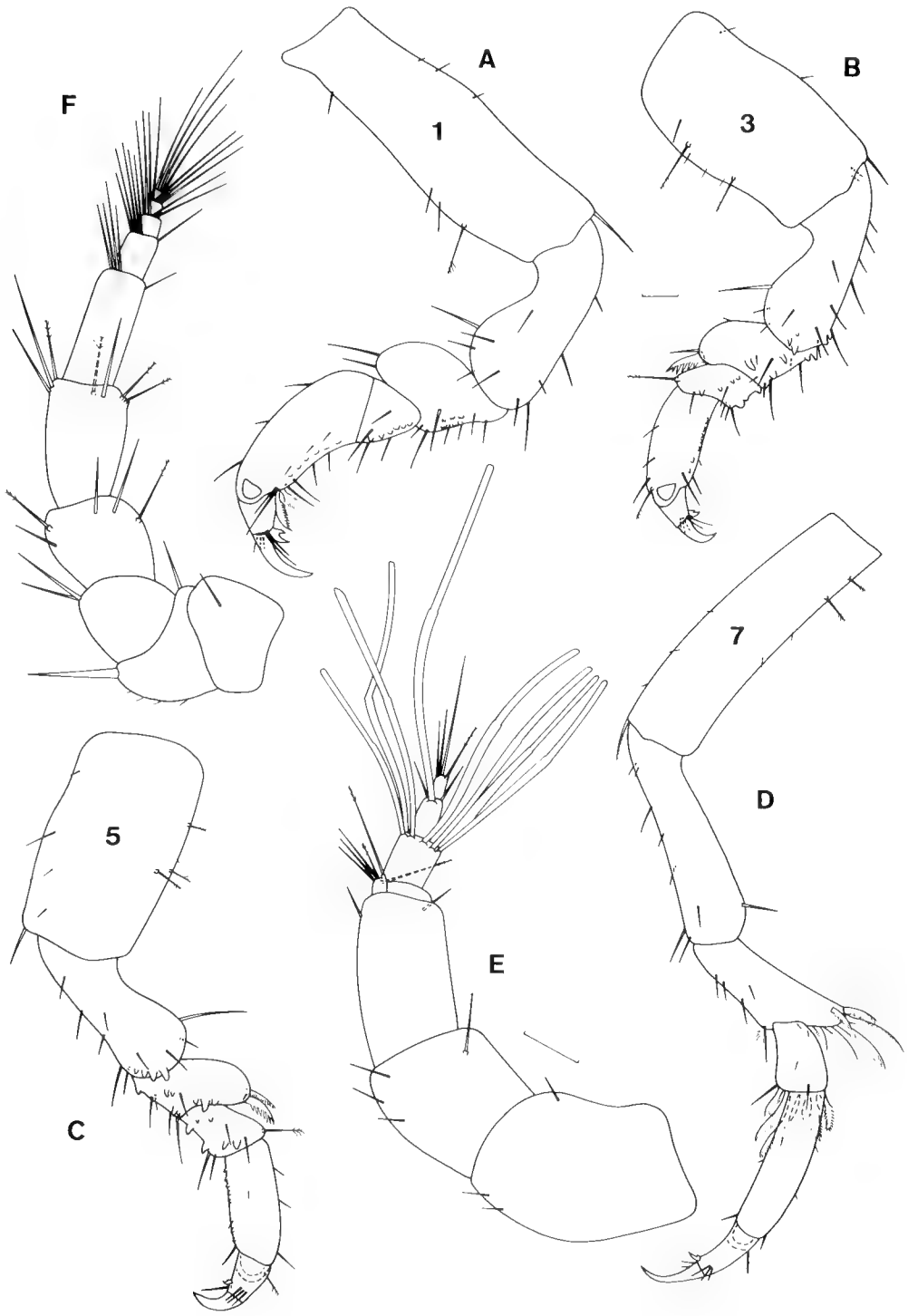

Figure 22. *Limnoria glaucinosa* sp. nov. A–F, male, NMV J14974, holotype: A–D, pereopods 1, 3, 5 and 7, lateral views; E, antenna 1; F, antenna 2.

J15288 (6); 0–3 m, sapwood of CCA-treated turpentine pile C18, NMV J15290 (85); 0.5 m, pine bait block no. 154 after 5.5 months, R.D. Turner, J.V. Marshall and J. Beesley, 29 Sep 1970, AM P37043 (1). Lady Musgrave Island, Capricorn-Bunker group, 3 m, *Melaleuca* block from shipwreck, L.J. Cookson and P. Gestner, 25 May 1986, NMV J15231 (3). Mackay, 1 m, *P. radiata* bait block after 4 months, L.J. Cookson, 21 Apr 1987, NMV J15208 (11). Townsville, Port, 4 m, dry turpentine pile heartwood on jetty, L.J. Cookson, 17 Dec 1987, NMV J15207 (8); berth 8, 0.3 m, *P. radiata* bait blocks after 8 months, L.J. Cookson, 21 Sep 1988, NMV J15455 (3). Cairns, 1 m, arsenical creosoted *Eucalyptus pilularis* Sm. stake 1685, J.E. Barnacle, 19 May 1986, NMV J14982 (1); 2 m, sapwood of double-treated *E. maculata* Hook stake 8544, L.J. Cookson, 16 Dec 1987, NMV J15204 (4); sapwood of arsenical creosoted *E. maculata* stake 1981, NMV J15205 (1); sapwood-heartwood boundary of double-treated *E. pilularis* stake 8542, NMV J15206 (18). Green Island, 10 m from jetty, 2 m, hardwood plank on sand, L.J. Cookson, 19 Sep 1988, NMV J15454 (76). Port Douglas, 0.5–1 m, untreated turpentine pile 6, J.E. Barnacle, 29 May 1984, NMV J15235 (71); 0 m, 19 May 1986, NMV J14979 (3); 4 m, sapwood at mud-line of turpentine pile 6, L.J. Cookson, 15 Dec 1987, NMV J15212 (33); 1.5 m, sapwood and heartwood of turpentine pile 5, NMV J15213 (68); 2 m, sapwood and heartwood of CCA-treated turpentine pile 1, 16 Dec 1987, NMV J15214 (41); 3.5 m, NMV J15215 (26).

PNG. Lorengau, Admiralty Islands, S.M. Rayner, 10 Oct 1970, NMV J15491 (male, 3.1 mm, with 1 slide), NMV J15490 (4 males, 1.9-2.8 mm, 2 non-ovig. females, 2.1 2.4 mm).

Diagnosis (male). Pleonite 5 dorsomedially with 2 subparallel longitudinal carinae which converge slightly posteriorly. Pleotelson with 2 pairs of anteromedial puncta, one pair directly behind other, without carinae behind posterior pair of puncta, with another anterolateral pair of puncta or long setae. Pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with many solitary scale spikes, slightly pitted anteriorly. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson; posterior margin fringed with 4 large stout setae between which are scale spikes and short-sheathed setae.

Antenna 1 with 4 flagellar articles; second article with about 13 aesthetascs arising from 2 tufts. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles, article 3 elongated apically, with large terminal comb seta anterior to row of other comb setae. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible straight, apex with several compact or separate teeth. Epipod of maxilliped triangular, 3.5 times as long as wide, not reaching palp articulation; epipod with true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta present on merus of pereopod 7 and carpus of pereopods 2, 3, 4, 5, 6 and 7. Uropod peduncle laterally with many short simple setae, few on small tubercles; with small tubercles between plumose setae; endopod 0.8 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.6 times length of exopod. Appendix masculina reaching or nearly reaching apex of endopod of pleopod 2, articulating just proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, broadly oval, 0.7 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. With sexual dimorphism of pleotelson sculpturing; female with pair of anteromedial puncta followed posteriorly by long carinae, pleotelson without other puncta, posterior margin of ventral pleopodal cavity more posterior than in males. Body length up to 3.3 mm. Colour in alcohol pale yellow.

Full description of male (NMV J15495). Body 3.8 times as long as wide; pale yellow colour. Cephalon oval, partly covered dorsoposteriorly by pereonite 1; without dorsal occipital groove. Pereonites 2–7 and pleonites 1–4 all similar width, pleonite 5 and pleotelson slightly narrower. Pereonite 1 2.4 times as long as other pereonites, coxal plates fused, centrally slightly depressed transversely. Pereonites 2–5 anteriorly slightly depressed transversely, longer than pereonites 6 and 7. Pereonites 2–7 coxal plates all overlap bases of pereopods; coxa 2 rectangular, not overlapping coxa 3; coxa 3 rectangular but more rounded posteriorly and just overlapping coxa 4; remaining coxae increasingly pointed distoposteriorly, overlapping following coxae posteriorly; coxae 5–7 with row of small tubercles. Pleonites 1–4 similar in length; pleonite 1 shorter ventrolaterally than other segments. Pleonites 5 about 7 times as long as other pleonites, pleotelson 1.7 times as long as pleonite 5.

Pleonite 5 and pleotelson with lateral crests. Pleonite 5 with pair of longitudinal subparallel dorsomedial carinae, reaching from anterior to posterior margins, converging slightly posteriorly; dorsal surface between carinae and lateral crests slightly concave. Pleotelson with 2 pairs of proximal puncta dorsomedially, one pair directly behind other, with long seta near base of each anterior puncta; with another pair of long

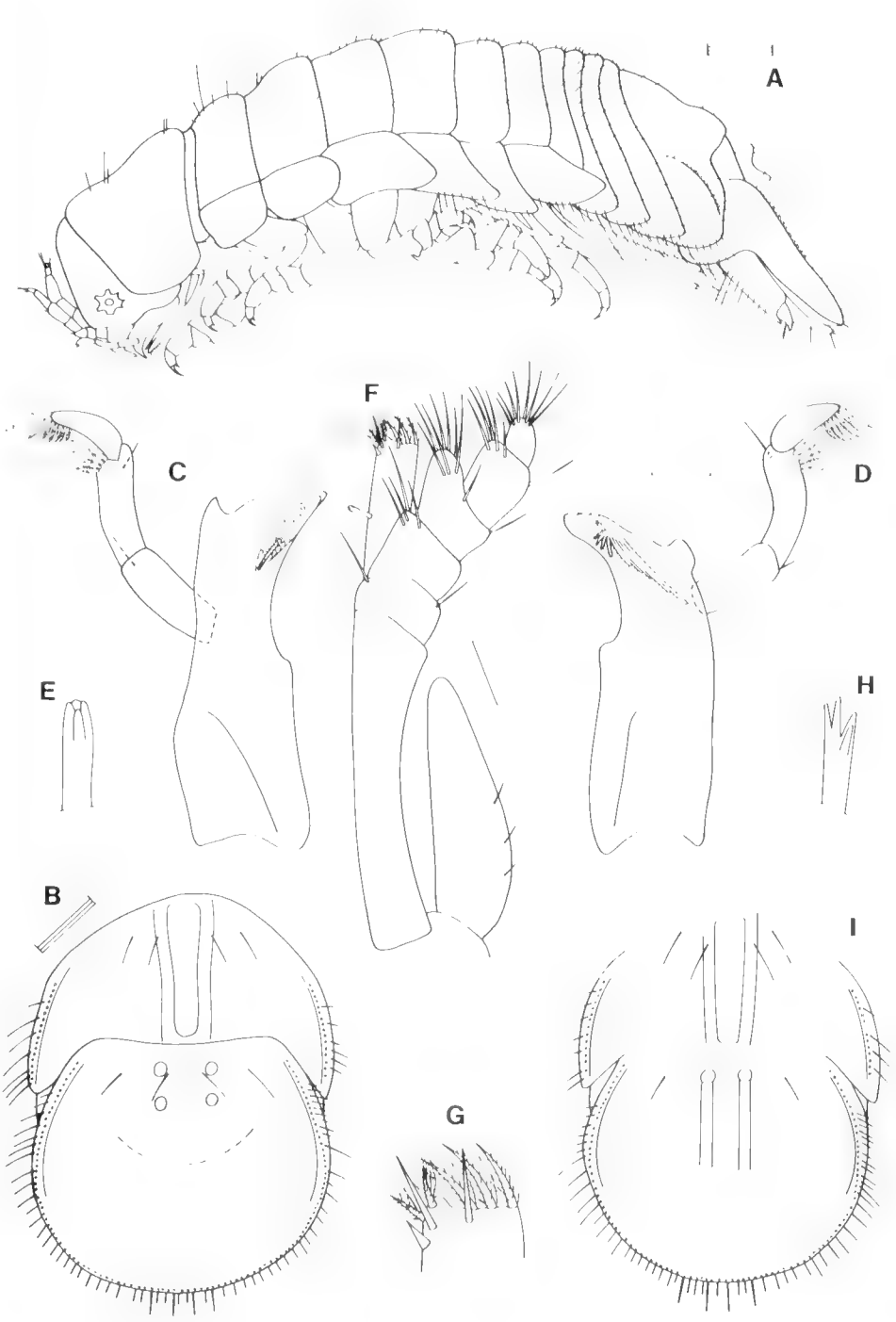

Figure 23. *Limnoria indica* Becker and Kampf. A–G, male, NMV J15495: A, lateral view; B, pleonite 5 and pleotelson, dorsal view; C, left mandible; D, right mandible; E, lacinia mobilis of right mandible; F, maxilliped; G, distal portion of maxillipedal endite. H, male, NMV J15299, lacinia mobilis of right mandible. I, female, NMV J15300, pleonite 5 and pleotelson, dorsal view.

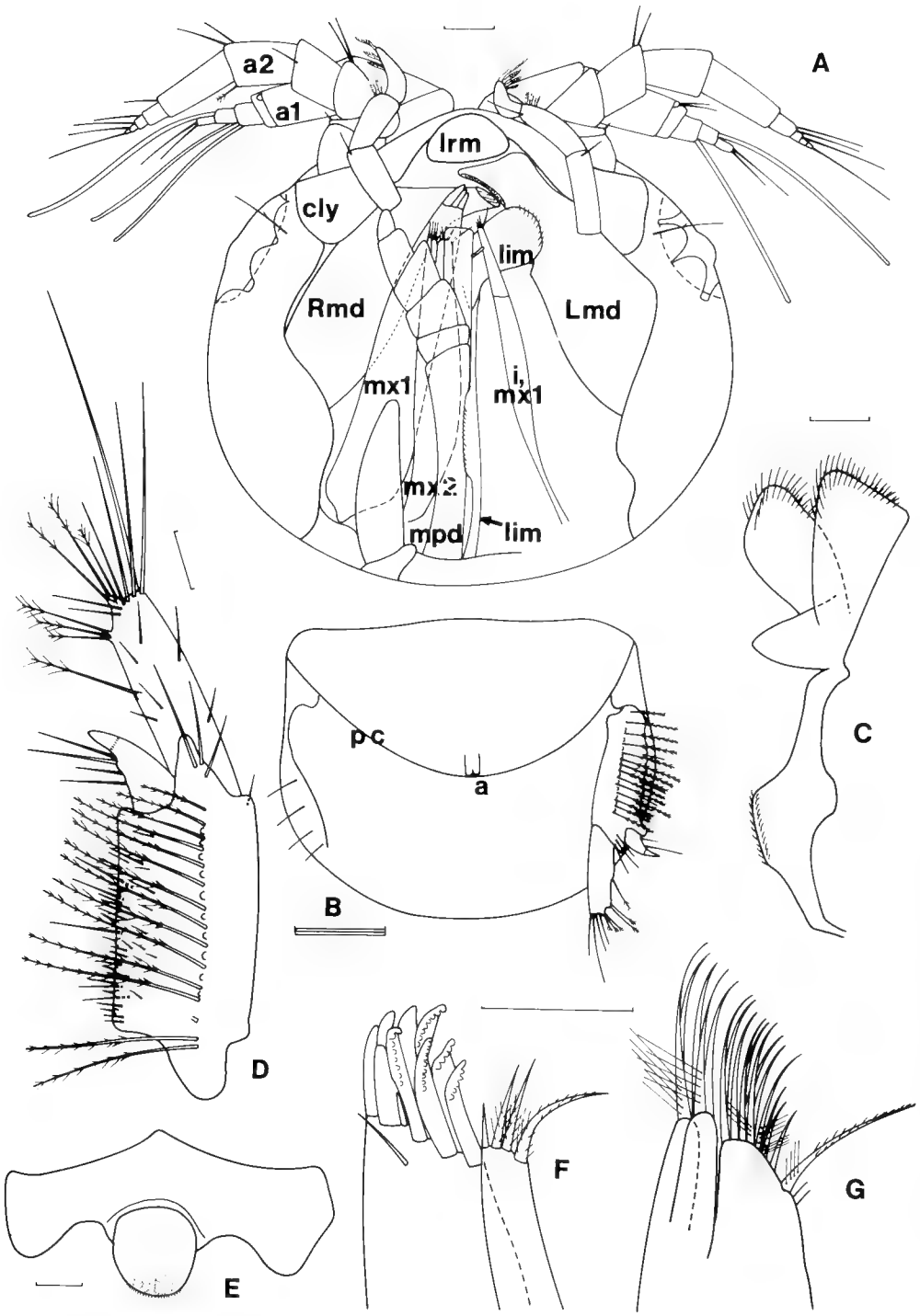

Figure 24. *Limnoria indica* Becker and Kampf. A, male, NMV J15301, cephalon, ventral view: a1 = antenna 1; a2 = antenna 2; lrm = labrum; cly = clypeus; Rmd = right mandible; Lmd = left mandible; lim = labium; mx1 = maxilla 1; i,mx1 = inner lobe and muscle of maxilla 1; mx2 = maxilla 2; mpd = maxilliped. B, male, NMV J15299, pleotelson, ventral view: pc = posterior margin of pleopodal cavity; a = anus. C, labium, lateral view. D–G, male, NMV J15495: D, uropod, ventral view; E, clypeus and labrum, anterior view; F, maxilla 1; G, maxilla 2.

setae (position of lateral puncta in some specimens) lateral to anterior puncta. Area between medial puncta and lateral crests concave. Posterior margin of ventral pleopodal cavity extends to midlength of pleotelson.

Dorsal surface of pleotelson without scale structure, scales fused, with slight pitting anteriorly, surface covered with solitary scale spikes, abundant on lateral crests and bases of puncta. Pleotelson with row of tubercles extending from lateral crests to posterior margin. Posterior margin of pleotelson with 4 stout setae between which are 2–3 short-sheathed setae and many scale spikes.

Antennae similar length. Peduncle article 2 on antenna 1 with several distal simple setae and brush setae; both small scale and article 1 of flagellum inserted into peduncle; scale small, with 3 simple setae and 1 brush seta apically. Flagellum of antenna 1 with 4 articles; article 1 short, with 2 brush setae ventral and opposite to scale; article 2 with 2 groups of aesthetases totalling 13 aesthetases; article 3 narrow, with 1 long aesthetase and 2 simple setae; article 4 small, with 3 simple setae and 1 brush seta apically. Peduncle article 2 on antenna 2 with large stout seta directed anteriorly and smaller seta opposite; article 3 with 2 inner simple setae directed anteriorly; articles 4 and 5 with simple and brush setae. Flagellum of antenna 2 with 5 articles; article 1 of flagellum and article 5 of peduncle similar in length; articles 2–5 of flagellum each with 4–6 long simple setae.

Clypeus expanded laterally; labrum circular plate articulating ventromesially with clypeus. Labium bilobed anteriorly, posteriorly with single plate positioned between inner lobes of maxilla 1, larger more posterior plate positioned to partly protrude between bases of maxillipedal endopods.

Left mandible with rasp, right mandible with file incisor surfaces. Left mandible with short pointed distolateral projection; with small lacinia mobilis flanked by 2 longer serrated setae in spine row. Palp with 3 articles, articles 1 and 2 similar length, with outer distal simple seta, article 2 with 4 distolateral comb setae; article 3 shorter than articles 1 and 2, narrowed apically, with about 7 distolateral comb setae, of which largest at apex is anterior (outer) to row of 6 comb setae. Right mandible with lacinia mobilis bearing 4 apical teeth closed together; spine row with 9 serrated setae; mandible with squarish distolateral projection; palp similar to palp of left mandible.

Inner lobe of maxilla 1 with long curved mesial pappose seta, 2 straighter pappose setae and shorter non-pappose seta; outer lobe with 5 outer smooth spines, with one only 0.4 times length of others; outer lobe also with 5 inner serrated spines. Inner lobe of maxilla 2 large, with about 13 setae, medial seta largest; medial lobe with 3 and outer lobe with 2 distal setae.

Articles 2–4 of maxillipedal palp with 4–7 distomesial setae, article 5 with 8 apical setae; endite with 8 distal setae of 4 different types: 3 apicolateral curved pappose setae, 2 straighter apicomedial pappose setae with many setules, 1 medial short stout simple seta subapically, and 2 subapical simple setae; epipod triangular, 3.5 times as long as wide, not reaching palp articulation, with 2–3 short lateral simple setae.

Pereopod 4 overlaps pereopods 3 and 5 basally; pereopod 4 smallest, pereopods increasing length from pereopods 4–1 and 4–7; pereopod 1 about 1.5 times as long, and pereopod 7 about 2.9 times as long, as pereopod 4. Dactylus of pereopod 1 with claw-like primary unguis and shorter bifid secondary unguis; lacking comb setae on merus and carpus. Pereopods 2–7 without comb setae on propodus; pereopods 2 and 3 with 1 comb seta dorsally on merus and ventrally on carpus; pereopods 4 and 5 with 2 comb setae dorsally on merus and 1 ventrally on carpus; merus of pereopods 6 and 7 increasingly enlarged dorsally, with 4 comb setae dorsally on pereopod 6 and 8 on pereopod 7, both pereopods with ventral comb seta; carpus of pereopod 6 with 4 inner comb setae of various length, more dorsal comb with comb teeth broader than other combs; carpus of pereopod 7 with 6 inner comb setae of various length, more dorsal combs with comb teeth increasingly broad. Secondary unguis of pereopods 2–6 undivided, slightly bifid on pereopod 7.

Endopods of pleopods 1–4 anterior to exopods, reversed for pleopod 5. Pleopods 1–4 with plumose setae up to 0.6 times length of rami; exopods increasingly lobate lateroproximally; endopods longer, from point of articulation, than exopods. Peduncles without inner lobes, coupling hook sequence 32220. Pleopod 1 with several thin true setae on exopod. Appendix masculina slightly medially curved, articulating just proximal to midlength of endopod, nearly reaching apex of endopod. Pleopod 5 without plumose setae, endopod shorter than exopod, 0.7 times as long as endopod of pleopod 2; endopod oval; peduncle small, with simple seta laterally.

Uropod tubular, not flattened or compressed, covered dorsally by pleotelson, inserted laterally just anterior to midlength of pleotelson. Exopod inserted laterally to endopod, points of articu-

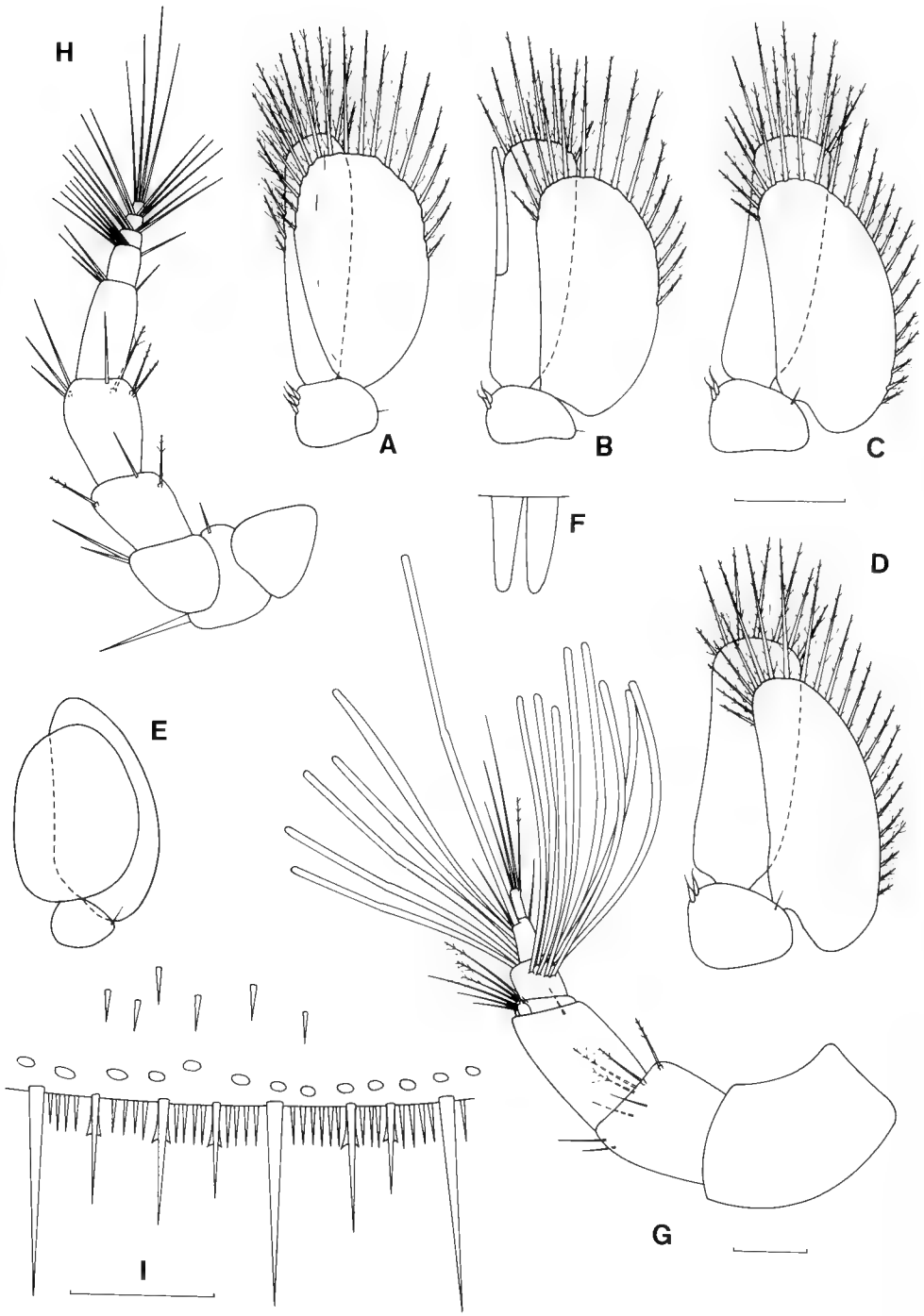

Figure 25. *Limnoria indica* Becker and Kampf. A–F, I, male, NMV J15495: A–E, pleopods 1–5; F, penes; I, posterior margin of pleotelson, dorsal view. G, H, female, NMV J15300: G, antenna 1; H, antenna 2.

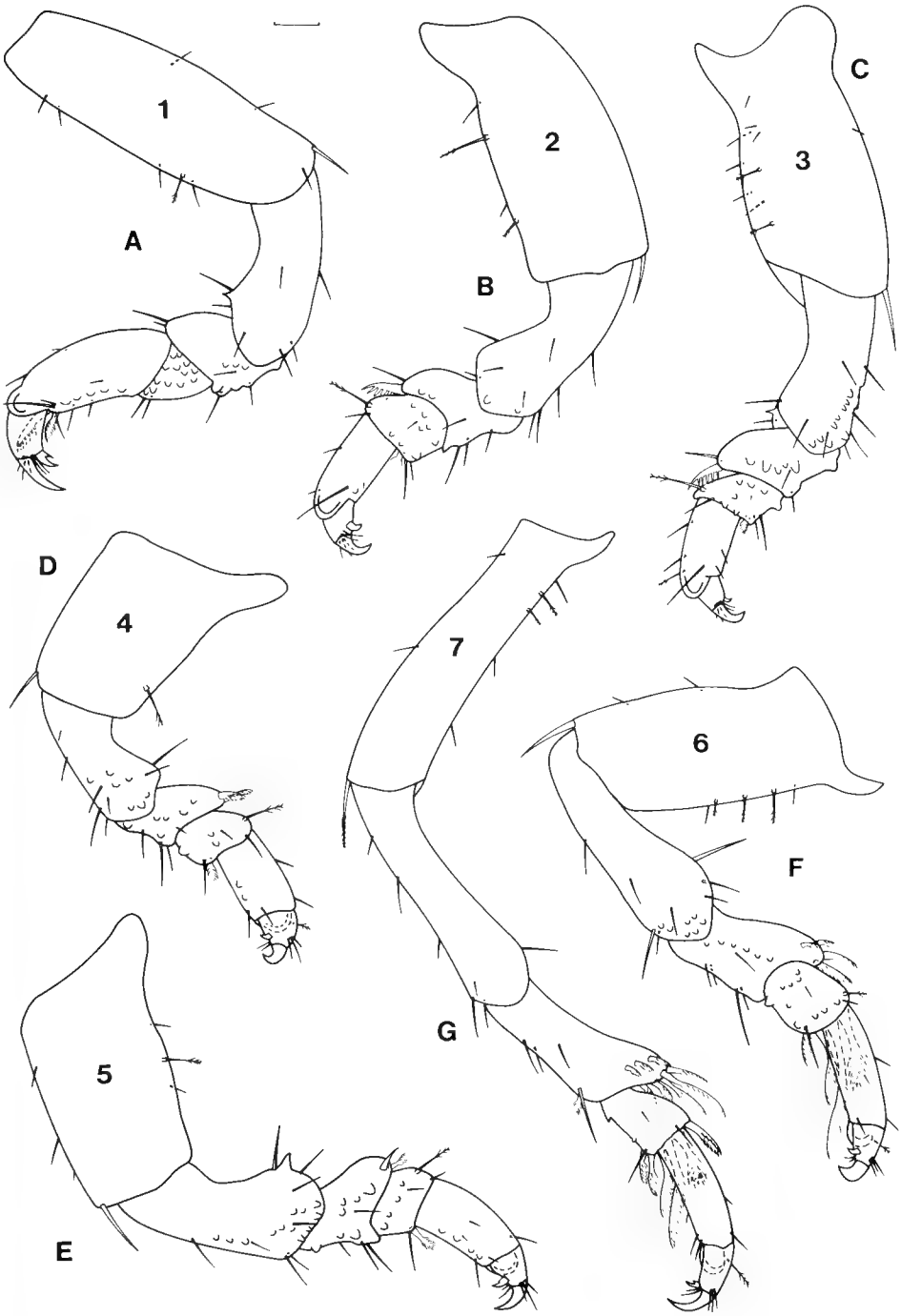

Figure 26. *Limnoria indica* Becker and Kampf. A–G, male, NMV J15495, pereopods 1–7, lateral views.

lation at similar level on peduncle; endopod 0.6 times as long as peduncle, exopod 0.3 times as long as peduncle. Exopod with laterally curved apical claw, with 4 lateral simple setae. Endopod apically truncate, without claw, with row of 6 ventral simple setae and long dorsal simple seta; endopod with 3 groups of brush setae. Peduncle with mesial projection between rami, projection with 3 simple setae; peduncle with ventral row of about 15 proximally bifurcate pappose setae, with small tubercles between pappose setae; with many short lateral simple setae, some raised on small tubercles.

Distribution. Mandapam Camp, India (type locality) (Becker and Kampf, 1958); Andaman Islands (Ganapati and Rao, 1960); Hong Kong; Manila, Philippines (Kühne, 1976); Koniya, Japan (Kühne, 1975); Penang, Malaysia (Jones et al., 1972); Belize (Kensley and Schotte, 1987); Admiralty Islands; Queensland; 0–4 m depths (current study).

Substrates. Red mangrove roots (Kensley and Schotte, 1987); various untreated timbers, especially turpentine (*Syncarpia glomulifera* (Sm.) Niedenzu) (Cookson and Barnacle, 1987b); and preservative-treated timbers (current study).

Remarks. The sculpturing on the male pleotelson is variable. In most males examined, the lateral pair of puncta are either small, or absent and represented by only a long simple seta. Also, in most males, and the holotype, the posterior pair of puncta are directly behind the anterior pair. However, some specimens do have one or both hind puncta slightly more lateral than the anterior pair of puncta, although not to the degree shown by Becker and Kampf (1958). Juveniles have the same pleotelsonal sculpture found in females. Some small males also have the pleotelsonal carinae and puncta found in females, but with an extra pair of small more posterior puncta on the carinae. In fully developed males the two medial pair of puncta are larger and the posterior carinae lost.

Pillai (1961) drew pereopods 1–7 of a specimen of *L. indica* from India. The ventral comb setal sequence drawn matches the sequence found in Australian specimens. Pillai did not find a dorsal row of tubercles on the posterior margin of the pleotelson in a male specimen he examined, although it was present in a female specimen. This row of tubercles was present in ten males and ten females examined from the Australian material.

L. indica appears to be similar to *L. simulata* and most similar to *L. saseboensis*. Both *L. indica* and *L. saseboensis* have similarly shaped carinae on pleonite 5, a maxillipedal epipod which tapers apically, five flagellar articles on antenna 2, aesthetascs which arise from two tufts on antenna 1, similar pleopod 2 shapes, rounded endopods on pleopod 5, similar setal and tuberculate structure on the posterior margin of the pleotelson, and similar ventral comb setal sequence on the pereopods. The species differ in that *L. saseboensis*: has prominent pits on pleonite 5 which are bordered by fine carinae, lacks a tapered third article on the mandibular palp, has a much rounder endopod on pleopod 5, and lacks sexual dimorphism in the sculpturing on the pleotelson in that both sexes have equally long dorsomedial carinae. The sculpturing on the pleotelson of the female *L. indica* specimen is closer to *L. saseboensis* than the male; however, *L. indica* lacks the short lateral carinae found on the pleotelson of *L. saseboensis*.

Müller (1988) suggested that *L. indica* was a junior synonym of *L. simulata*, based on the observation that the sexual dimorphism found in *L. indica* also occurs in the types of *L. simulata* and in *L. simulata* collected from the seagrass *Thalassia testudinum* in Colombia. However, three specimens of *L. simulata* (identified originally by Menzies) collected from the leaves of *Thalassia* at Tarpon Springs, Florida (USNM 103005) and both Menzies' (1957) and Müller's (1988) drawings show several differences. Unlike *L. indica*, *L. simulata*: lacks a dorsal row of tubercles on the posterior margin of the pleotelson (although sometimes present on the lateral crests); lacks the covering of solitary scale spikes on a fused dorsal surface of the pleotelson, but has groups of smaller scale spikes on partially fused scales; has much weaker or even absent longitudinal carinae on pleonite 5; does not always have the posterior pair of dorsomedial puncta on the pleotelson (the presence of the lateral pair of puncta is variable in both species); has longer and more numerous setae dorsomedially on pleonite 5; does not have the aesthetascs on flagellar article 2 of antenna 1 arising from two separate tufts; has the right mandibular rasp confined to the distal half of the incisor; has much longer plumose setae on pleopod 2 (up to 0.9 times as long as exopod); and has the appendix masculina extending beyond the endopod tip. Also, the substrate is seagrass not wood. In the Limnoriidae such variability in habitat is uncommon, although *L. quadripunctata* occurs both in wood and occasionally among algae under rocks.

Unlike the type specimens of *L. simulata* described by Menzies (1957), both the Colombia

(Müller, 1988) and Florida specimens had five not four flagellar articles on antenna 2. The Florida male specimen only had a pair of anterior dorsomedial puncta on the pleotelson. Another species which appears to sometimes have a sexual dimorphism similar to *L. indica* is *L. saseboensis* (unpublished). I have yet to examine the types of *L. simulata*, but would caution against synonymy with *L. indica*.

Limnoria insulae Menzies

Figures 27, 28, Plates 2a, b

Limnoria (*Limnoria*) *insulae* Menzies, 1957: 178–180, fig. 35.—Menzies, 1959: 19.—Ganapati and Rao, 1960: 275—276.–Rao and Ganapati, 1969: 226.

Limnoria insulae.—McCoy-Hill, 1964: 46.—Nair, 1984: 208.—Cookson, 1987a: 3, 7.—Cookson et al., 1989: 1–8.—Kensley and Schotte, 1989: 195, fig. 86C.

Material examined. Qld. Magnetic Island, Arcadia, low tide, turpentine pile stump, J.E. Barnacle and L.J. Cookson, 12 Jul 1985, NMV J15222 (male, 2.7 mm, 0.65 mm wide pleotelson, with 1 slide), NMV J15223 (male, 2.7 mm, with 1 slide), NMV J15224 (male, 2.7 mm, with 1 slide), NMV J15225 (male, 2.7 mm, with 3 slides), NMV J15226 (non-ovig. female, 3.3 mm, with 2 slides); NMV J15221 (11 males, 2.3–2.8 mm, 11 non-ovig. females, 2.4–2.8 mm, 5 ovig. females, 2.6–3.0 mm, 3 juvs., 1.6–2.1 mm); dry pulled turpentine pile on beach, J.E. Barnacle, NMV J15228 (9); Geoffrey Bay, tidal zone, turpentine pile in jetty, L.J. Cookson and J.E. Barnacle, NMV J15227 (7 males, 2.0–2.8 mm, 12 non-ovig. females, 2.5–3.2 mm, ovig. female, 3.2 mm, 7 juvs., 1.7–2.2 mm). Port Douglas, low tide, turpentine pile, J.E. Barnacle, 29 May 1986, NMV J14980 (3 pleotelsons).

WA. Barrow Island, sawn jarrah piles after 4 years, L.J. Cookson and S. Gorjy, Mar 1986, NMV J14956 (male, 3.4 mm, with 1 slide), NMV J14957 (130).

NT. Cape Don, Cobourg Peninsula (11°18′S, 131°46′E), R.D. Turner and J.V. Marshall, 26 Oct 1970, AM P35426 (male, 3.3 mm, 4 intersexes, 2.8–3.9 mm).

PNG. Fairfax Harbour, S.M. Rayner, Aug 1971, NMV J15487 (male, 1.9 mm, with 1 slide), NMV J15475 (3 males, 2.1, 2.2, 2.7 mm, non-ovig. female, 2.2 mm, ovig. female, 2.5 mm, juv., 1.3 mm); Alotau, Milne Bay Province, NMV J15477 (non-ovig. female). Motupore Island, Central Province, S.M. Cragg, 8 Jun 1984, NMV J15492 (male, 2.3 mm); Tahira, Bootless, 3 Oct 1983, NMV J15479 (male, 4.0 mm, with 1 slide), NMV J15480 (male, ovig. female).

Cocos Islands. Pine bait block no. 242 after 5 months, R.D. Turner, J.V. Marshall and J. Beesley, Nov 1970, AM P38924 (male pleotelson, ovig. female).

Types. USNM.

Diagnosis. Pleonite 5 dorsally with slightly raised transverse carina near anterior margin, with shorter transverse carina near posterior margin; with or without pronounced medial hump or carina between transverse carinae. Pleotelson without distinctive carinae or tubercles, but some males with pleotelson deeply cup-shaped and lateral crests well developed; pleotelson slightly raised to anterior dorsomedial point. Pleonite 5 0.3 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine spikes. Perimeter of pleotelson with dorsal row of tubercles; posterior margin fringed with 4 unsheathed setae between which are shorter long-sheathed setae, lacking scale spikes.

Antenna 1 with 3 flagellar articles; second article with about 8 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible with 2 curved pointed apical branches. Epipod of maxilliped broad, 3.1 times as long as wide, reaching past palp articulation; epipod lacking true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 4, 5, 6 and 7. Uropod peduncle laterally compressed, with prominent claw-like tubercles; endopod 1.7 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.8 times length of exopod. Appendix masculina may or may not reach beyond endopod tip, articulating distal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.7 times as long as endopod of pleopod 2; peduncle of pleopod 5 with comb seta laterally.

Additional characters. Body length up to 4.0 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Distribution. Serua, Fiji (type locality); Guam Island; Palmyra Island; Ponape, Caroline Islands (Menzies, 1957); Andaman Islands (Ganapati and Rao, 1960); Kilindini, Kenya (McKoy-Hill, 1964); Cocos Islands; Northern Territory; Barrow Island, WA; Queensland; Papua New Guinea. So far only recorded from tidal zone (current study).

Substrates. Coconut tree trunk (Menzies, 1957); wooden plank (Ganapati and Rao, 1960); *Pinus*, sawn jarrah heartwood (*E. marginata* Donn ex Sm.), and turpentine (present study).

Remarks. This species varies considerably in some characters. None of the specimens from

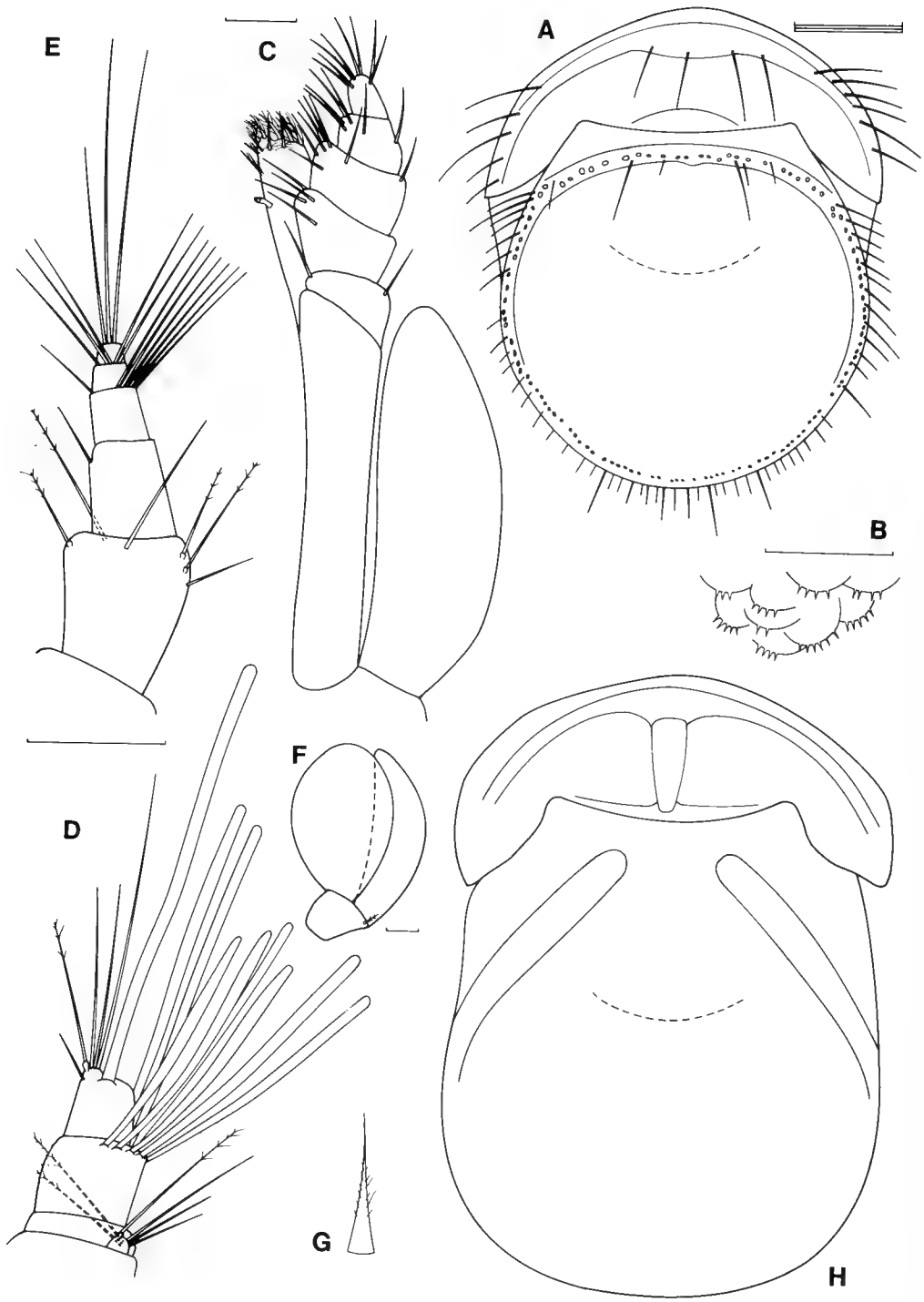

Figure 27. *Limnoria insulae* Menzies. A–G, male, NMV J15222: A, pleonite 5 and pleotelson, dorsal view; B, dorsal structure of pleotelson; C, maxilliped; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2; F, pleopod 5; G, comb seta on peduncle of pleopod 5. H, male, NMV J15479, pleonite 5 and pleotelson, setae omitted, dorsal view.

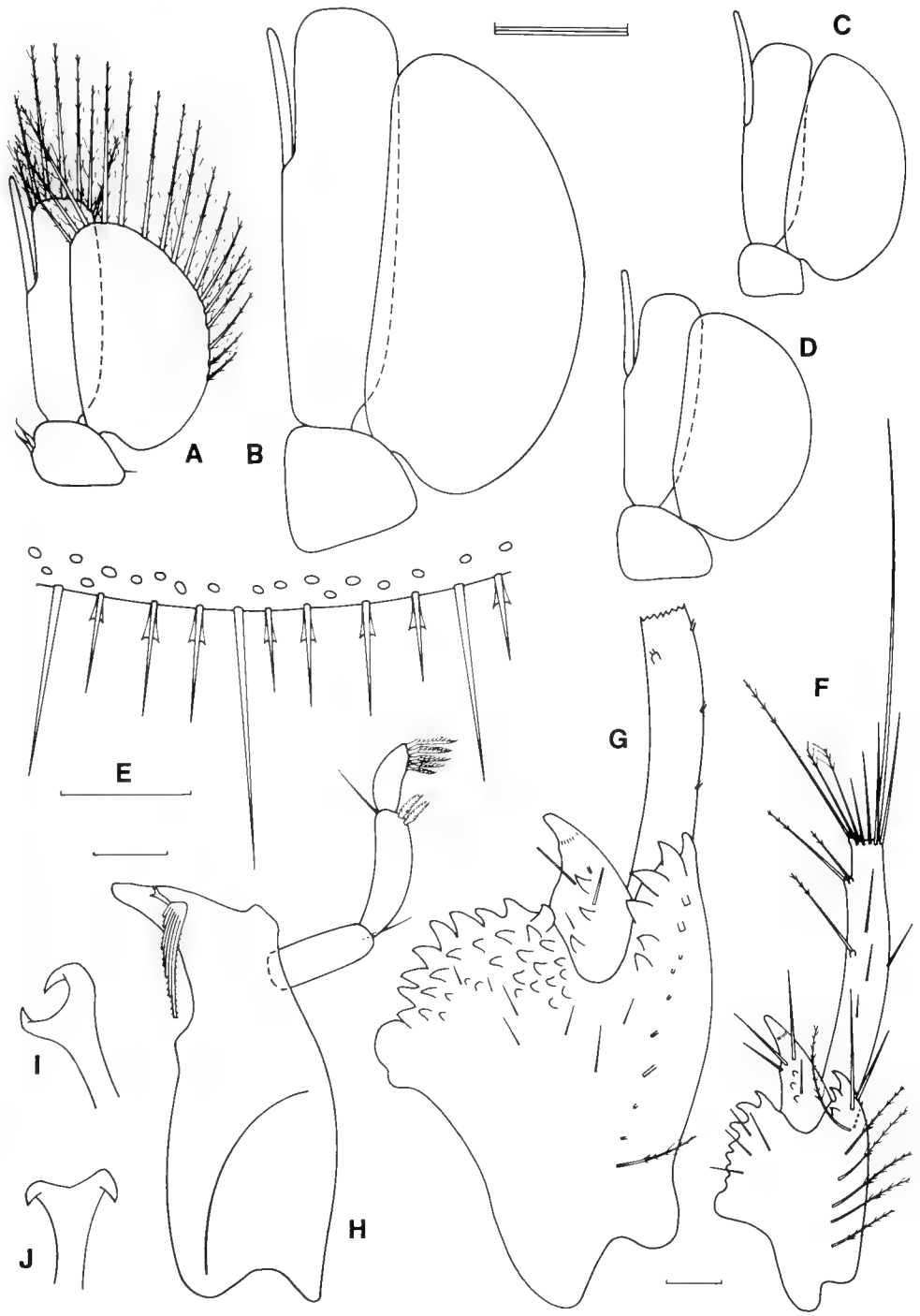

Figure 28. *Limnoria insulae* Menzies. A, E, F, J, male, NMV J15222: A, pleopod 2; E, posterior margin of pleotelson, dorsal view; F, uropod, ventrolateral view; J, lacinia mobilis of right mandible. B,G, male, NMV J15479: B, pleopod 2, setae omitted; G, uropod, endopod broken, ventrolateral view. C, male, NMV J15487, pleopod 2, setae omitted. D, male, NMV J14956, pleopod 2, setae omitted. H, I, male, NMV J15223: H, right mandible; I, lacinia mobilis of right mandible.

Barrow Island or Queensland had the deep cup-shaped pleotelson found in some specimens from Papua New Guinea (Plates 2a, b). However, some males from Fairfax Harbour, Papua New Guinea, from the deep cup-shape forms, to the slightly concave forms also commonly found in Australia. Females did not have the deeply cup-shaped pleotelson. Associated with increased cupping of the pleotelson was increased prominence of the medial carina hump on pleonite 5. Menzies did not mention such variation and his figure shows a male pleotelson with the deep cup-shaped form.

Specimens from Magnetic Island which have been kept since July 1985 in laboratory aquaria at 27–28°C did not produce any forms with the deep cup-shaped pleotelson when examined bimonthly. This situation may change if certain culture parameters were to be altered in the aquaria.

A male from Barrow Island (NMV J14956) had a 3-articled flagellum on antenna 2. The number of claw-like tubercles on the uropod peduncle shown in Plate 2a was fewer than sometimes found in other specimens from Magnetic Island. Uropods with most tubercles were found on males from Papua New Guinea which also had deeply cup-shaped pleotelsons. The relative size, and articulation position of the appendix masculina, also differed between specimens – those with a large body size (and deep cup-shaped pleotelson) had relatively short and distally articulating appendix masculina, as well as short plumose setae. The male figured by Menzies (1957) follows this pattern.

L. insulae is most similar to *L. platycauda* and *L. multipunctata*. *L. insulae* may be distinguished most readily by its laterally compressed uropod peduncle, and the form of the lacinia mobilis of the right mandible. The deep cup-shape of the pleotelson is also useful, when this character is developed.

Limnoria kautensis Cookson and Cragg

Figures 2, 29–31

Limnoria kautensis Cookson and Cragg, 1988: 1508–1512, figs.1–3.

Material examined. Holotype: PNG, Kaut Harbour, New Ireland Province (2°46′03″S, 150°54′28″E), 8 m, dense log, S.M. Cragg, 10 Oct 1985, NMV J14773 (male, 2.9 mm, with 1 slide).

Paratypes: Type locality, NMV J14774 (non-ovig. female, 2.8 mm, = allotype), NMV J14775 (3 non-ovig. females, 2.3–2.6 mm, juv., 1.3 mm); 9 m, 20 Nov 1982, NMV J14776 (non-ovig. female, 2.6 mm, with 1 slide), NMV J14777 (male, 2.6 mm, with 1 slide), NMV J14778 (5 males, 2.1–2.5 mm, 3 non-ovig. females, 2.7–3.0 mm, 2 ovig. females, 2.9, 3.1 mm, juv.), PNGNM (3 males, 2.2–2.7 mm, 2 non-ovig. females, 2.7, 2.9 mm, ovig. female, 2.8 mm, juv., 1.4 mm).

Diagnosis. Pleonite 5 lacking carinae and tubercles dorsomedially. Pleotelson with long horseshoe-shaped dorsomedial carina. Pleonite 5 0.7 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine spikes. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson; margin fringed with long-sheathed setae, without scale spikes and stout setae.

Antenna 1 with 4 flagellar articles; second article bears 3–4 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible bilobed, each lobe bears 3–4 teeth. Epipod of maxilliped broad, oval, 2.5 times as long as wide, reaching past palp articulation; epipod lacking simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopods 6 and 7 and carpus of pereopods 2–7. Uropod peduncle with few small lateral tubercles; endopod as long as peduncle.

Pleopod 2 with short plumose setae, up to 0.3 times length of exopod. Appendix masculina short, not reaching beyond endopod of pleopod, articulating distal to midlength of endopod. Endopod of pleopod 5 posterior to exopod, triangular, 0.9 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Secondary unguis of pereopod 7 small. Exopod of uropod with small apical claw, exopod with row of about 8 long setae, exopod long. Body length up to 3.1 mm. Colour in alcohol white with dark reticulate pigment.

Distribution. Kaut, Papua New Guinea (Type locality). 8–9 m depths.

Substrate. Dense log.

Remarks. The species is re-illustrated here in more detail than in the original description. *L. kautensis* has more plesiomorphic characters than any other species of *Limnoria*. It has: the longest uropodal exopod, although not as long as the exopod of *P. andrewsi*, many simple setae on the uropodal exopod and endopod, relatively long pleonite 5, large pleopod 5 with endopod

posterior to exopod, absence of stout setae on the posterior margin of the pleotelson, and broad maxillipedal epipod. However, *L. kautensis* has a four rather than five segmented flagellum on antenna 2.

L. kautensis is most similar to *L. pfefferi* as both species have two longitudinal carinae on the pleotelson, small uropodal exopod claws, similar pleopods, lack stout setae and scale spikes on the posterior margin of the pleotelson, have similar maxillipedal epipods, and four flagellar articles on both antennae. Unlike *L. kautensis*, *L. pfefferi* has a Y-shaped carina on pleonite 5, a distally undivided lacinia mobilis on the right mandible, a more distally rounded maxillipedal epipod, longer first article on the flagellum of antenna 2, longer uropodal peduncle, and pappose setae on the uropod peduncle which arises from a ridge.

Limnoria loricata sp. nov.

Figures 1, 32

Limnoria quadripunctata Holthuis.—Poore, 1981: 342 (stn SA 3369).

Material examined. Holotype: NZ, The Snares, Senecio Pool (48°07′S, 166°38′E), 1.5 m, from *Lessonia variegata* holdfast, G.D. Fenwick, 6 Jan 1977 (stn SA 3369), NMNZ Cr. 6456 (male, 3.2 mm, 0.9 mm wide pleotelson with 1 slide).

Paratypes: Type locality. NMNZ Cr. 6457 (male, 3.1 mm, with 1 slide, male, without cephalon or uropods, 4.7 mm [allowing for head length]).

Diagnosis. Pleonite 5 dorsomedially with X-shaped carina, with anterior axes not reaching anterior pleonite margin but diverging laterally to join lateral crests, posterior axes reaching posterior pleonite margin, following margin laterally. Pleotelson with 2 subparallel dorsomedial carinae which diverge posteriorly, each carina with small anterior punctum; with 2 pairs of more lateral carinae, followed by lateral crests. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, surface with pits bordered by carinae on pleonite 5 and anterior portion of pleotelson. Dorsal row of short scale spikes extend from lateral crests to posterior margin of pleotelson; posterior margin with 4 large stout setae between which are scale spikes and short-sheathed setae.

Antenna 1 with 4 flagellar articles; second article with about 8 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible with 2 apical branches with long serrations. Epipod of maxilliped subtriangular, 3.1 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 6 and 7. Uropod peduncle without lateral tubercles; endopod 0.8 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.7 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Lacinia mobilis of left mandible long. Body length up to 4.7 mm. Colour in alcohol pale yellow.

Etymology. From the Latin for mail-clad, *loricata*, describing the rings of small carinae on pleonite 5.

Distribution. The Snares, southern New Zealand. 1.5 m depth.

Substrate. Holdfast of *Lessonia variegata.*

Remarks. Limnoria has also been found in floating (adrift) *Lessonia* near the Auckland Islands, New Zealand (Hale, 1937) and were later identified by Menzies (1957), using Hale's figures, as *L. stephenseni*. The specimens could not have been *L. loricata* as the uropod drawn by Hale (1937) is similar to that found in *L. stephenseni* and *L. antarctica.*

L. loricata is most similar to *L. rugosissima.* Both species have a rugose appearance (more so in *L. loricata*), generally similar carinae on pleonite 5 and the pleotelson, similar pleopodal shapes, an almost strap-like maxillipedal epipod, and absence of a rasp and file. However, these species can be separated by finer details of the shape of the maxillipedal epipod, ornamentation on pleonite 5 and the pleotelson, and structure of the lacinia mobilis on the right mandible. Also, unlike *L. loricata*, *L. rugosissima* has a simple seta on the endopod of pleopod 5, cleaved incisor on the right mandible, and reduced spine row of the left mandible.

Limnoria multipunctata Menzies

Figures 33, 34

Limnoria (*Limnoria*) *multipunctata* Menzies, 1957: 170–173, figs 30–31.—Menzies, 1959: 19.—Kühne,

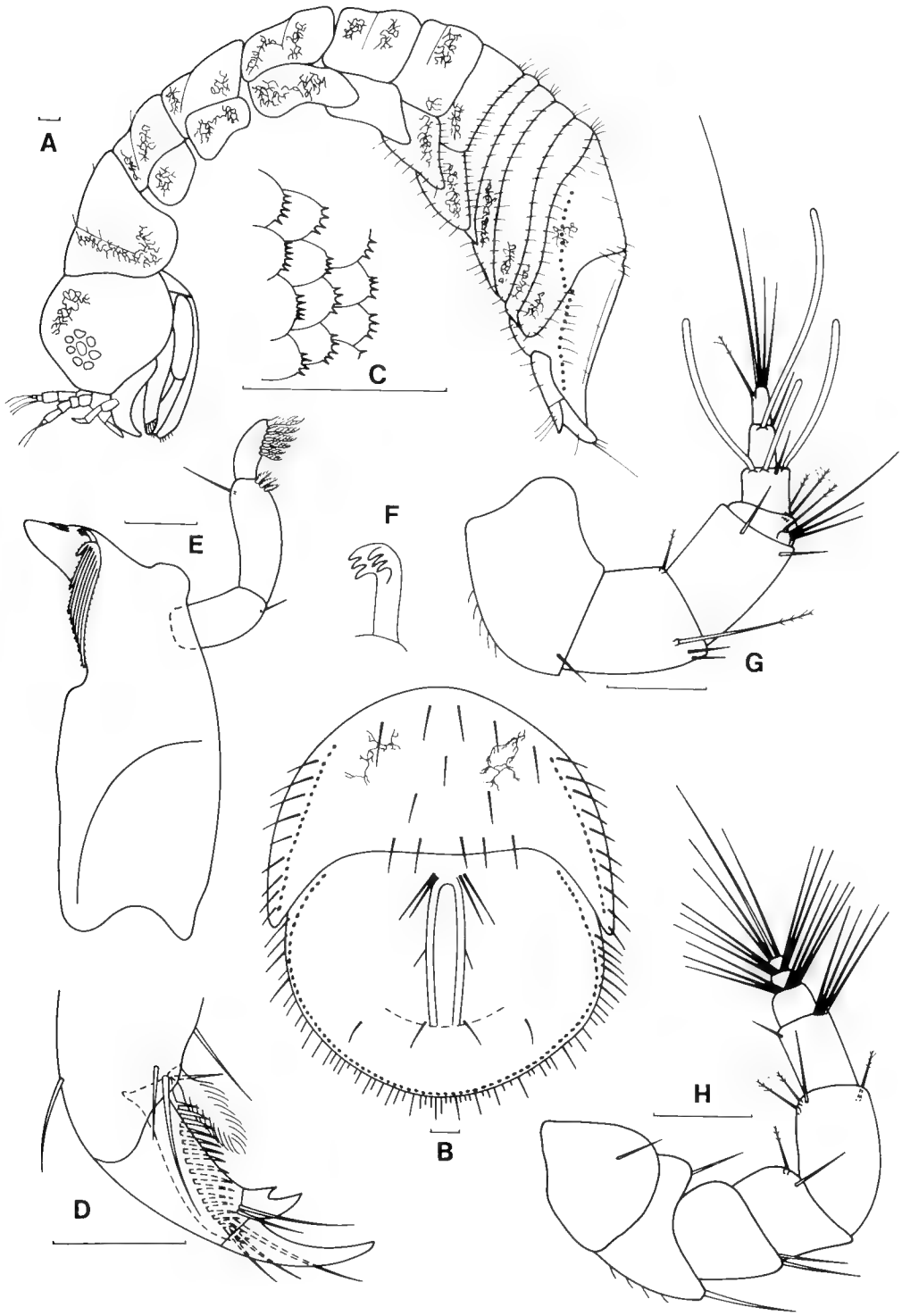

Figure 29. *Limnoria kautensis* Cookson and Cragg. A–D, male, NMV J14773, holotype: A, lateral view; B, pleonite 5 and pleotelson, dorsal view; C, dorsal structure of pleotelson; D, distal articles of pereopod 1, lateral view. E,F, male, NMV J14777, paratype: E, right mandible; F, lacinia mobilis of right mandible. G,H, female, NMV J14776, paratype: G, antenna 1; H, antenna 2.

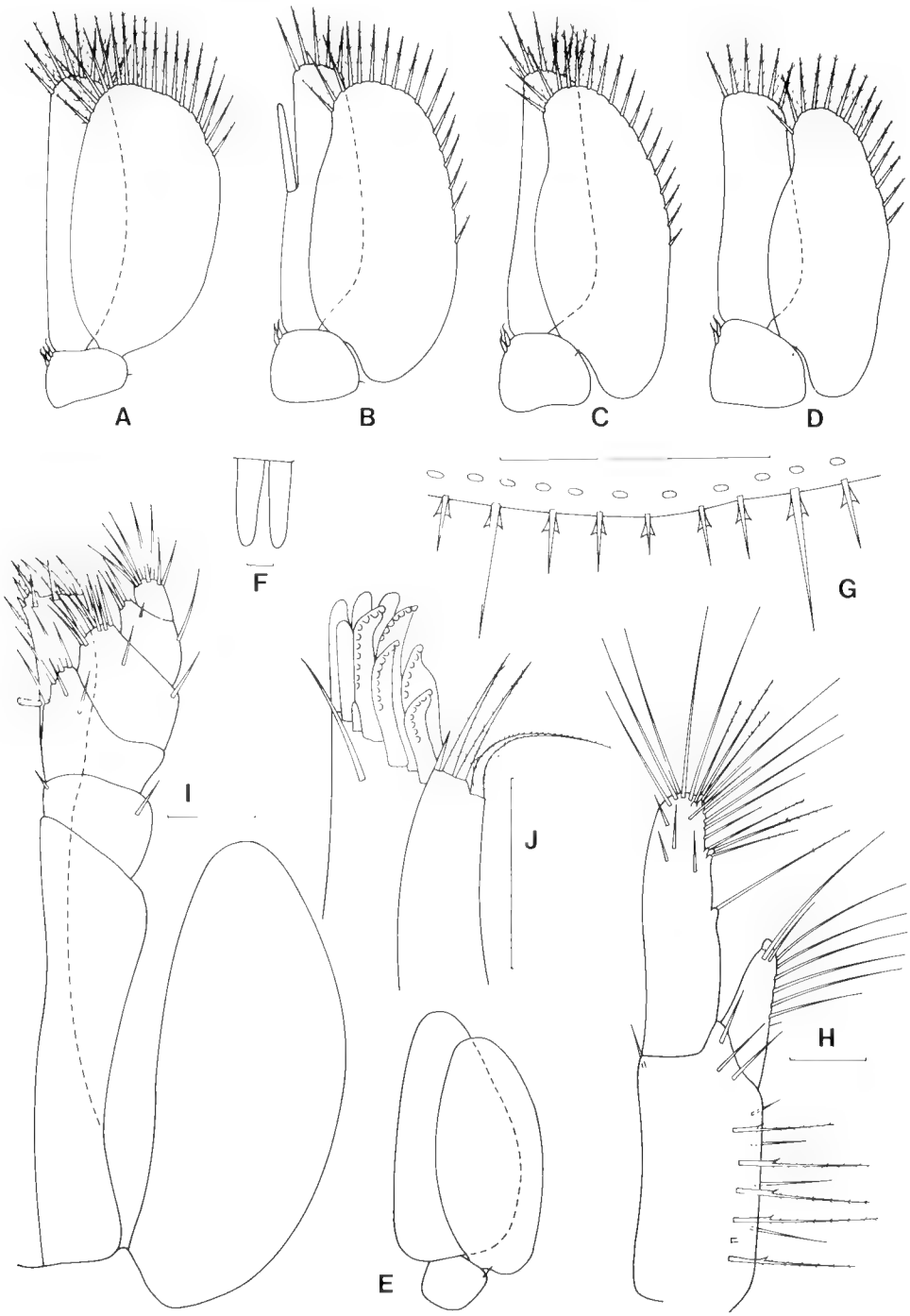

Figure 30. *Limnoria kautensis* Cookson and Cragg. A–H, male, NMV J14773, holotype: A–E, pleopods 1–5; F, penes; G, posterior margin of pleotelson, dorsal view; H, uropod, ventral view. I, J, female, NMV J14776, paratype: I, maxilliped; J, maxilla 1.

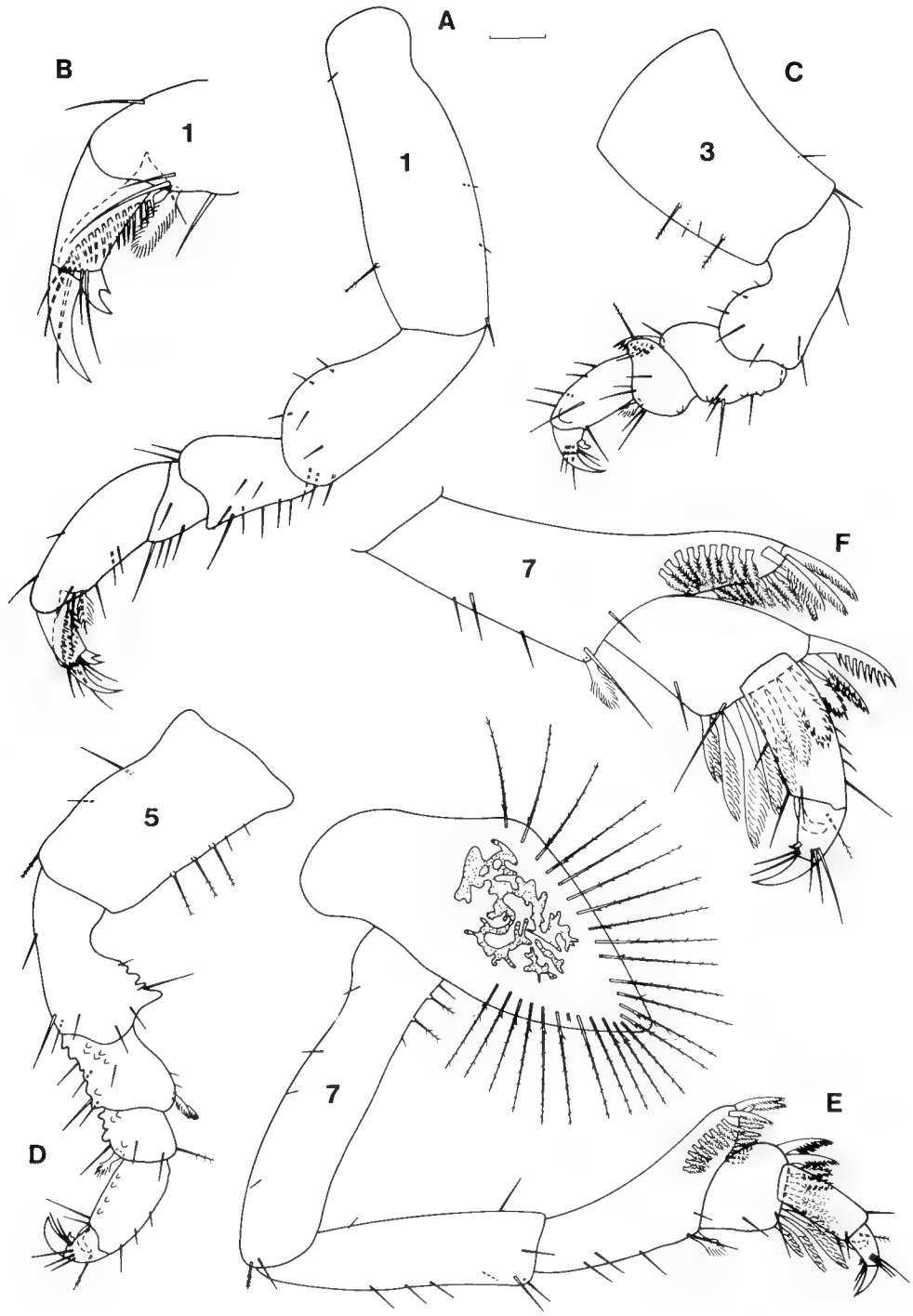

Figure 31. *Limnoria kautensis* Cookson and Cragg. A–F, male, NMV J14773, holotype: A, pereopod 1; B, dactylus of pereopod 1; C, pereopod 3; D, pereopod 5; E, pereopod 7 with coxa; F, distal articles of pereopod 7; all lateral views.

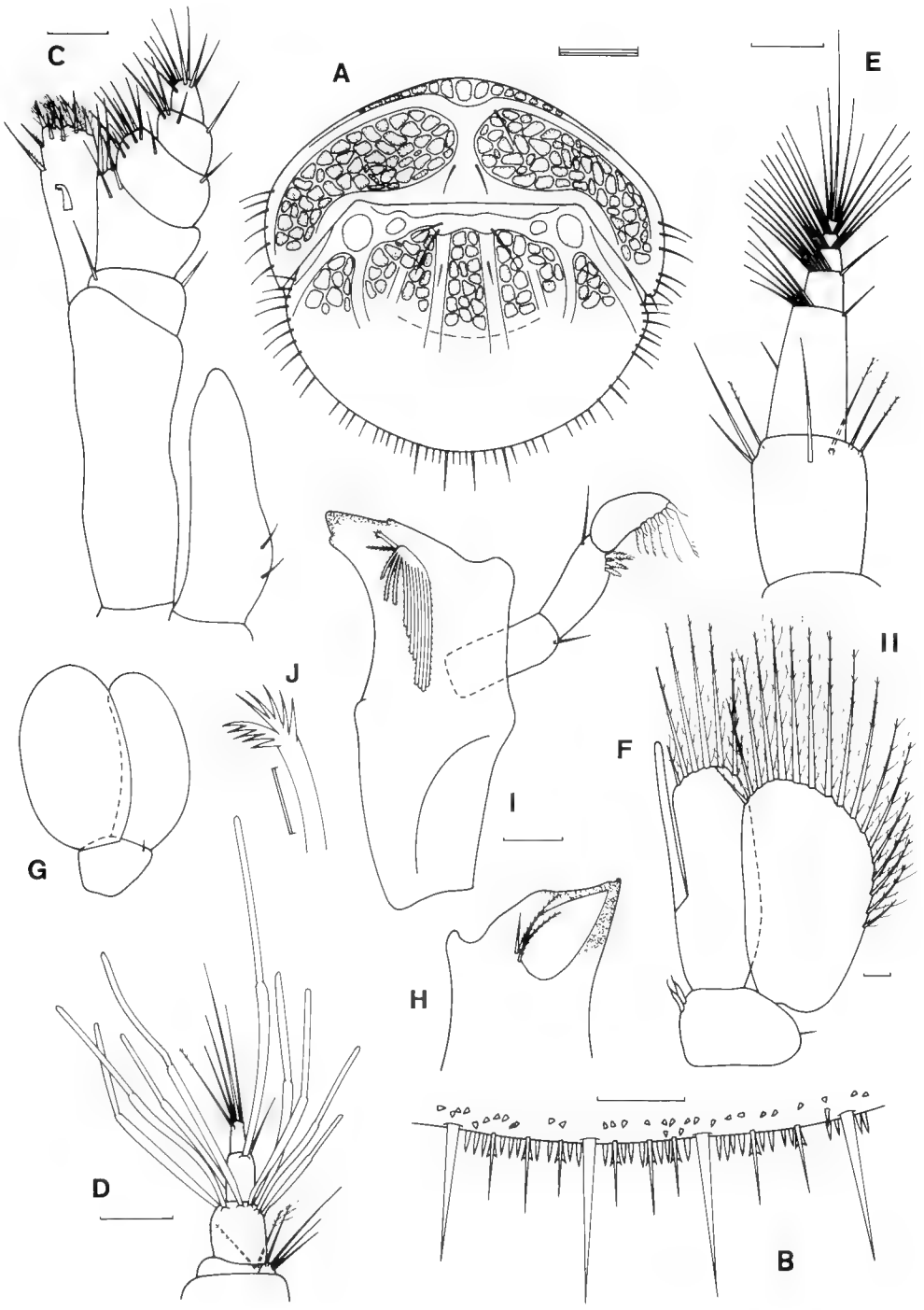

Figure 32. *Limnoria loricata* sp. nov. A–J, male, NMNZ Cr. 6456, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2; F, pleopod 2; G, pleopod 5; H, incisor of left mandible; I, right mandible; J, lacinia mobilis of right mandible.

1975: 453.—Kühne, 1976: 548, figs 8–9.—Kensley and Schotte, 1987: 222, fig. 5.

Limnoria multipunctata.—Jones et al., 1972: 105, 109.—Jones et al., 1976: 122, 134.—Kensley and Schotte, 1989: 196–197, figs 86D, 87A.

Material examined. Holotype: near Kai Islands (15°–6°5′S, 131°5′–133°15′E), 13 m, 12 Jun 1922, Zoologisk Museum, Copenhagen (male, 1.9 mm).

Paratypes: Type locality. Zoologisk Museum, Copenhagen (non-ovig. female, 2.0 mm, = allotype, male, 1.8 mm, with 1 slide, non-ovig. female, without cephalon and uropods, juv., without cephalon and right uropod).

Other material. Cocos Islands, pine bait block no. 242 after 5 months, R.D. Turner, J.V. Marshall and J. Beesley, Nov 1970, AM P38923 (male, 2.9 mm, 0.7 mm wide pleotelson, with 1 slide), AM P38922 (male, 2.5 mm, with 1 slide), AM P38921 (male, 2.2 mm, with 2 slides), AM P35429 (15 males, 2.2–2.7 mm, 10 non-ovig. females, 2.5–3.1 mm, 9 ovig. females, 2.8–3.2 mm).

Qld. Green Island, 10 m from jetty, 2 m, hardwood sawn plank on sand, L.J. Cookson, 16 Sep 1988, NMV J15452 (male, 2 juvs.).

PNG. Alotau, Milne Bay Province, S.M. Rayner, Aug 1971, NMV J15478 (male, 6 non-ovig. females).

Types. Zoologisk Museum, Copenhagen; USNM (not examined).

Diagnosis. Pleonite 5 dorsomedially convex, without carinae and puncta; lateral crests slightly developed on pleonite 4. Pleotelson with longitudinal distal row of dorsomedial puncta and tubercles. Pleonite 5 0.4 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine spikes. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson; margin fringed with 4 unsheathed setae between which are long-sheathed setae, lacking scale spikes.

Antenna 1 with 3 flagellar articles; second article with about 8 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible very short, without teeth or serrations. Epipod of maxilliped broad, 2.8 times as long as wide, reaching past palp articulation; epipod lacking true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 2, 3, 4, 5, 6 and 7. Uropod peduncle with few small distolateral tubercles, median projection between rami tuberculate; endopod 1.1 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.7 times length of exopod. Appendix masculina reaching beyond endopod tip, articulating just distal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, elongated, oval, 0.7 times as long as endopod of pleopod 2; peduncle of pleopod 5 with comb seta laterally.

Additional characters. Exopod of uropod with 2 sometimes pointed tubercles. Body length up to 3.2 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Distribution. Near the Kai Islands (type locality); Saipan Island; Guam Island; Canton Island (Menzies, 1957); Puerto Rico; Jamaica; Koniya, Japan (Kühne, 1976); Belize (Kensley and Schotte, 1987); Milne Bay, PNG; Cocos Islands; Green Island, Qld (current study). 2-13 m depths (Menzies, 1957; current study).

Substrates. *Teredo* infested wood (Menzies, 1957), dead red mangrove wood (Kensley and Schotte, 1987), *Pinus sylvestris* L. (Jones et al., 1972), hardwood plank, *Pinus* (present study).

Remarks. The vestigial coupling hooks found on the pleopod 5 peduncle in a male paratype (Fig. 34) were not found in the other four dissected specimens. The male specimen from the Cocos Islands (AM P38923) had 21 rather than 8 aesthetascs on article 2 of the flagellum on antenna 1.

The sculpturing of the pleotelson varied within populations. In some specimens such as the paratype figured by Menzies (1957), there were two pairs of anterior puncta, as well as the longitudinal medial tuberculate ridge similar to that shown in Fig. 33. These puncta were most developed in the holotype, although still not with the prominence suggested in Menzies' figure. In the other types the two pairs of anterior puncta were absent, or represented by slightly raised blunt humps. In some specimens from Milne Bay and the Cocos Islands, no sculpturing on the pleotelson was found, although in most specimens there was at least a ridge or tuberculate ridge medially. The most anterior pair of puncta were more often found than the posterior pair. These variations did not appear to be due to sexual dimorphism. The anterior pairs of puncta were also absent in specimens from Belize (Kensley and Schotte, 1987), Puerto Rico and Jamaica (Kühne, 1976).

The degree of variation in pleotelsonal sculpturing led Kühne (1976; see also Jones et al., 1976) to suggest that *L. platycauda* was just a transitional stage or variety of *L. multipunctata*. However, there are several other important differences between the species. *L. multipunctata*

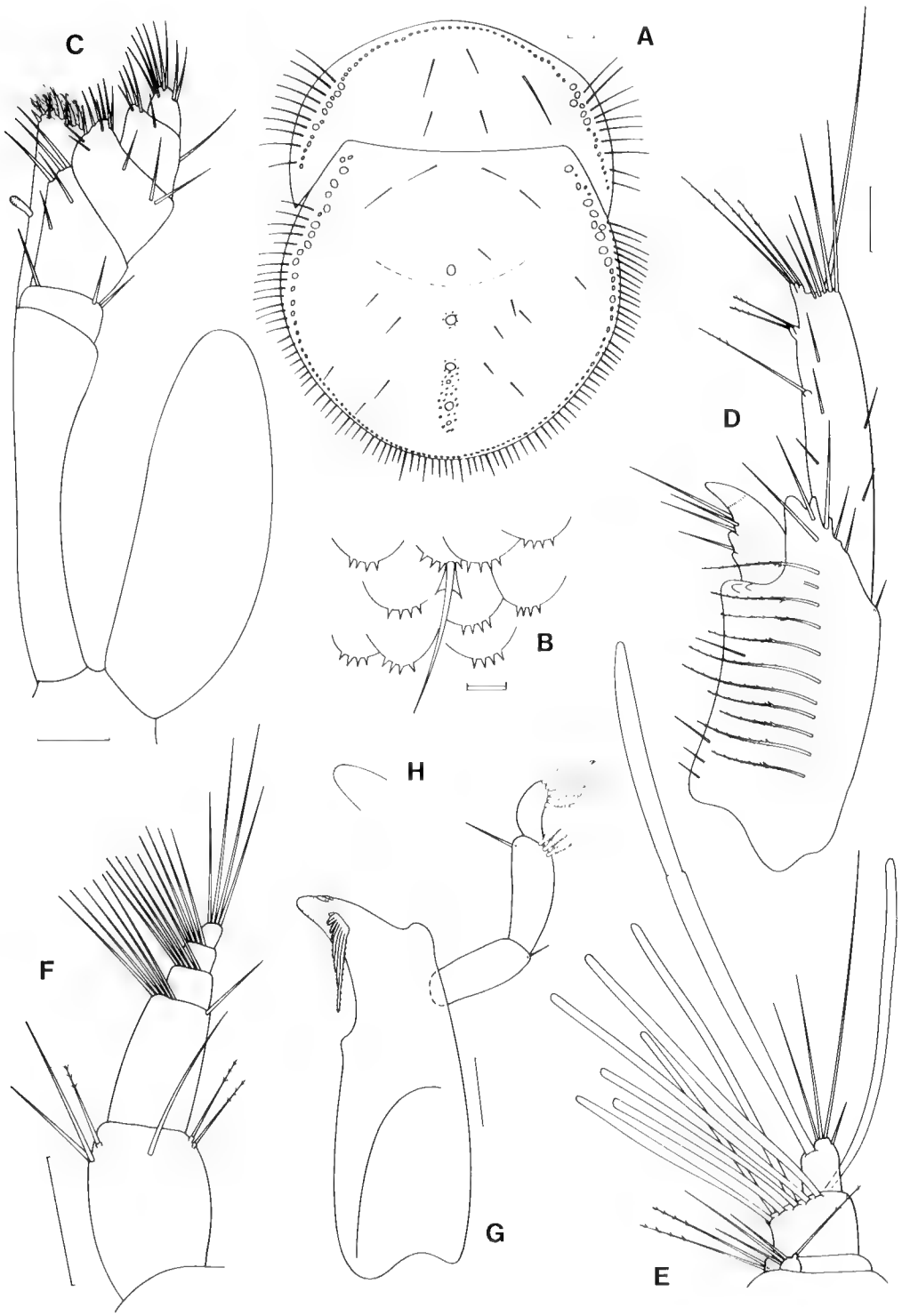

Figure 33. *Limnoria multipunctata* Menzies. A–D, F–H, male, AM P38923: A, pleonite 5 and pleotelson, dorsal view; B, dorsal structure of pleotelson; C, maxilliped; D, uropod, ventral view; F, peduncle article 5 and flagellum of antenna 2; G, right mandible; H, lacinia mobilis of right mandible. E, male, AM P38921, flagellum of antenna 1.

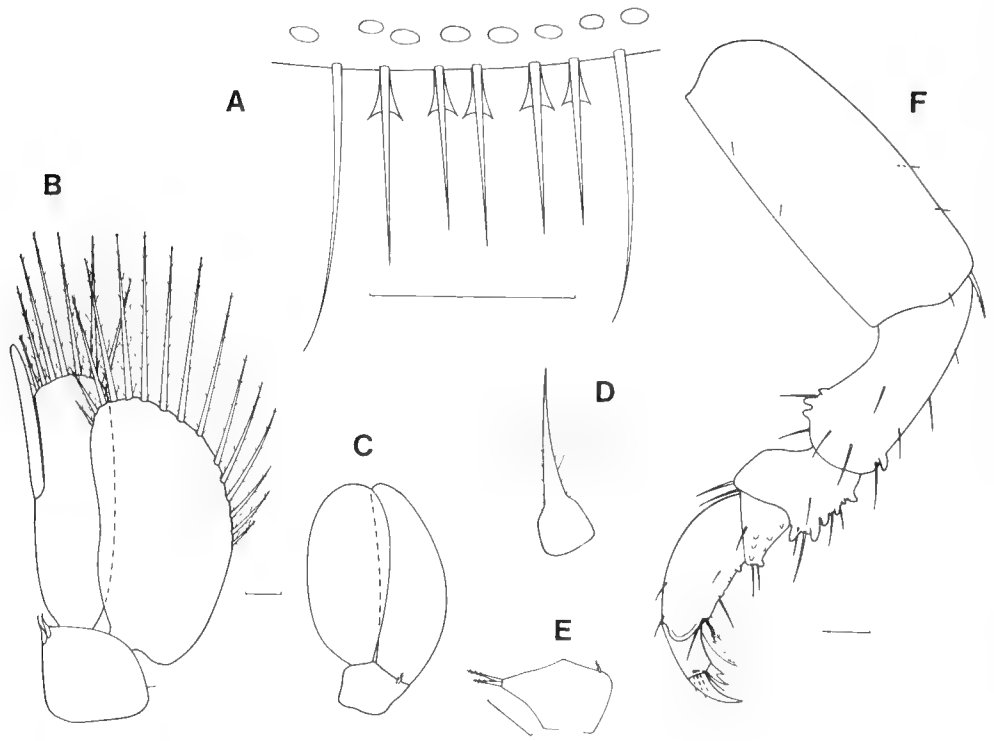

Figure 34. *Limnoria multipunctata* Menzies. A–D, F, male, AM P38923: A, posterior margin of pleotelson, dorsal view; B, pleopod 2; C, pleopod 5; D, lateral seta on peduncle of pleopod 5; F, pereopod 1, lateral view. E, male, paratype, peduncle of pleopod 5.

lacks sexual dimorphism in the pleotelson; the lacinia mobilis of the right mandible is quite different in shape; and pleonite 5 is dorsomedially convex whereas in *L. platycauda* there is at least a median elevation or inflection.

Limnoria nonsegnis Menzies

Figure 35

Limnoria (*Phycolimnoria*) *nonsegnis* Menzies, 1957: 186, fig. 39.—Pillai, 1957: 150.—Menzies, 1959: 29.

Phycolimnoria nonsegnis.—Edgar, 1987: 599–610.

Material examined. Paratypes: Tas. Port Arthur (43°8′S, 147°50′E), *Macrocystis* holdfast, A.B. Cribb, Jun 1951, AM P38931 (4 non-ovig. females, 3.3–3.9 mm, 8 ovig. females, 3.0–4.0 mm).

Other material. Tas. Variety Bay (43°12′S, 147°24′E), 6.8 m, *Macrocystis* holdfast, G. Edgar, 1984, NMV J15359 (male, 2.7 mm, 0.8 mm wide pleotelson, with 1 slide), NMV J15357 (ovig. female, 4.1 mm, with 1 slide), NMV J15358 (juv., 2.2 mm, with 1 slide), NMV J15356 (male, 3.0 mm, 7 non-ovig. females, 2.3–3.5 mm, 2 ovig. females, 3.5 4.0 mm, juv., 1.3 mm). Maria Island, 500 m west of Darlington (42°35′S, 148°2′E), 30 m, algal and drift holdfast, trawl, R.S. Wilson, 23 Apr 1985 (stn TAS 27), NMV J15371 (male, 2.7 mm).

Vic. Aireys Inlet, drift *Macrocystis* holdfast on beach, L.J. Cookson, 30 Mar 1988, NMV J15322 (male, 2.1 mm, with 1 slide), NMV J15321 (juv., 2.1 mm, with 1 slide), NMV J15320 (4 juvs., 1.7–2.0 mm).

Diagnosis. Pleonite 5 dorsomedially elevated, with depressed zones sublaterally, with oblique carinae laterally. Pleotelson with anterior raised dorsomedial region followed posteriorly by 2 parallel carinae and laterally by pair of short oblique carinae and lateral crests. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine scale spikes, surface anteriorly slightly pitted. Posterior margin of pleotelson with dorsal row of scale spikes; margin fringed with 6 long stout setae between which are short unsheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 6 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles, article 3 reduced, with several apical comb setae. Mandibular incisors without rasp

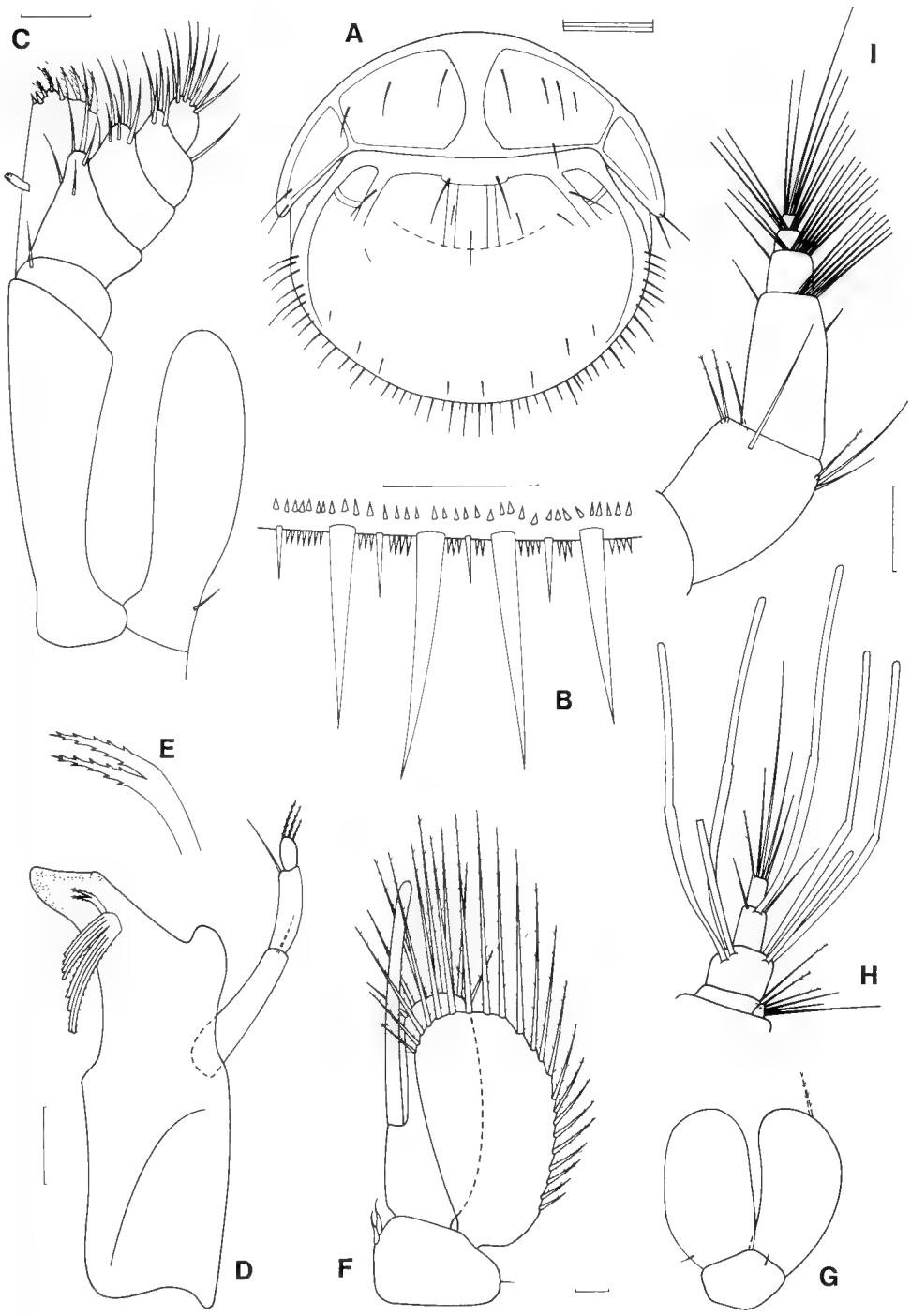

Figure 35. *Limnoria nonsegnis* Menzies. A–I, male, NMV J15359: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, right mandible; E, lacinia mobilis of right mandible; F, pleopod 2; G, pleopod 5 (dashed plumose seta found only on female NMV J15357); H, flagellum of antenna 1; I, peduncle article 5 and flagellum of antenna 2.

and file. Lacinia mobilis of right mandible branched at midlength, branches serrated. Epipod of maxilliped club-shaped, apically rounded, 3.6 times as long as wide, reaching beyond palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta absent on merus, present on carpus of pereopods 6 and 7. Uropod peduncle with few small lateral tubercles bearing short spikes; endopod 0.75 times as long as peduncle.

Pleopod 2 with long plumose setae up to 0.9 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.65 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Large medial seta on maxilla 2 sinuous. Body length up to 4.1 mm. Colour in alcohol pale yellow.

Distribution. Port Arthur, Tasmania (type locality) (Menzies, 1957; current study); Tasmania; Aireys Inlet, Victoria. 0–30 m depths (current study).

Substrates. Macrocystis holdfasts (Menzies, 1957; current study).

Remarks. The prominence of the sculpturing on pleonite 5 and the pleotelson varies, and in some specimens is so indistinct as to look like the sculpture on *L. convexa*, although these specimens at least still have the sublateral depressions or concavity on pleonite 5. The plumose seta drawn on pleopod 5 (Fig. 35) was not found on other specimens. Menzies (1957) described the maxillipedal epipod as strap-like, although his figure of the epipod has a club-shaped appearance. Other types and specimens examined by me had club-shaped maxillipedal epipods.

L. nonsegnis is most similar to *L. convexa*, for the reasons given with that species. *L. nonsegnis* is also similar to *L. antarctica* in the form of the sculpturing on the pleotelson. The setal structure on the posterior margin of the pleotelson is also similar: both species have lost sheathing on the "sheathed" setae, and *L. nonsegnis* has six stout setae while *L. antarctica* may have four or six stout setae. The club-shaped maxillipedal epipod may have arisen from a strap-shaped epipod (strap-shape retained in *L. convexa*). Both *L. nonsegnis* and *L. antarctica* have four flagellar articles on antenna 2, similar pleopods, and a large oval body shape. Based on the reduction of the mandibular palp, *L. nonsegnis* evolved after *L. antarctica*.

L. nonsegnis also is similar to *L. poorei*, both have: similar mandibular palp, slightly sinuous inner seta on maxilla 2, and similar ventral comb setal sequence on the pereopods. But *L. poorei* lacks stout setae on the posterior margin of the pleotelson, has a much broader maxillipedal epipod, elongated pleopod 5 shape, small size, and modified secondary unguis on pereopod 1.

Limnoria orbellum sp. nov.

Figures 36–39, Plate 2c

Material examined. Holotype: NT, Cape Don, Cobourg Peninsula (11°18′S 131°46′E), R.D. Turner and J.V. Marshall, 26 Oct 1970, AM P38926 (male, 2.2 mm, 0.5 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, AM P38927 (male, 2.1 mm, with 2 slides), AM P38928 (non-ovig. female, 2.3 mm, 0.55 mm wide pleotelson, with 1 slide), AM P38929 (damaged juv. and ovig. female, with 1 slide), AM P38925 (12 males, 1.3–2.0 mm, 20 non-ovig. females, 2.0–2.45 mm, 7 ovig. females, 2.1–2.45 mm, 6 juvs., 1.2–1.9 mm), NMV J15451 (4 males, 1.6–2.0 mm, 4 non-ovig. females, 2.2–2.4 mm, ovig. female, 2.2 mm, juv. 1.3 mm); separate collection, AM P35425 (male, 2.0 mm, 2 non-ovig. females, 2.4, 2.45 mm, ovig. female, 2.4 mm). It is not known how the two collections differ, presumably they were from different timbers or positions on timbers.

Diagnosis. Pleonite 5 without dorsomedial carinae and tubercles. Pleotelson with anteromedial punctum followed posteriorly by pair of puncta. Pleonite 5 0.75 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine spikes. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson, each tubercle with row of several short dorsal spikes. Posterior margin of pleotelson with 4 large stout setae between which are short unsheathed setae and thin scale spikes.

Antenna 1 with 4 flagellar articles; second article with 1 aesthetasc. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible with several apical teeth. Epipod of maxilliped triangular, 2.6 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta absent on merus, present on carpus of pereopods 6 and 7. Uropod peduncle with many small lateral tubercles; endopod 1.4 times as long as peduncle.

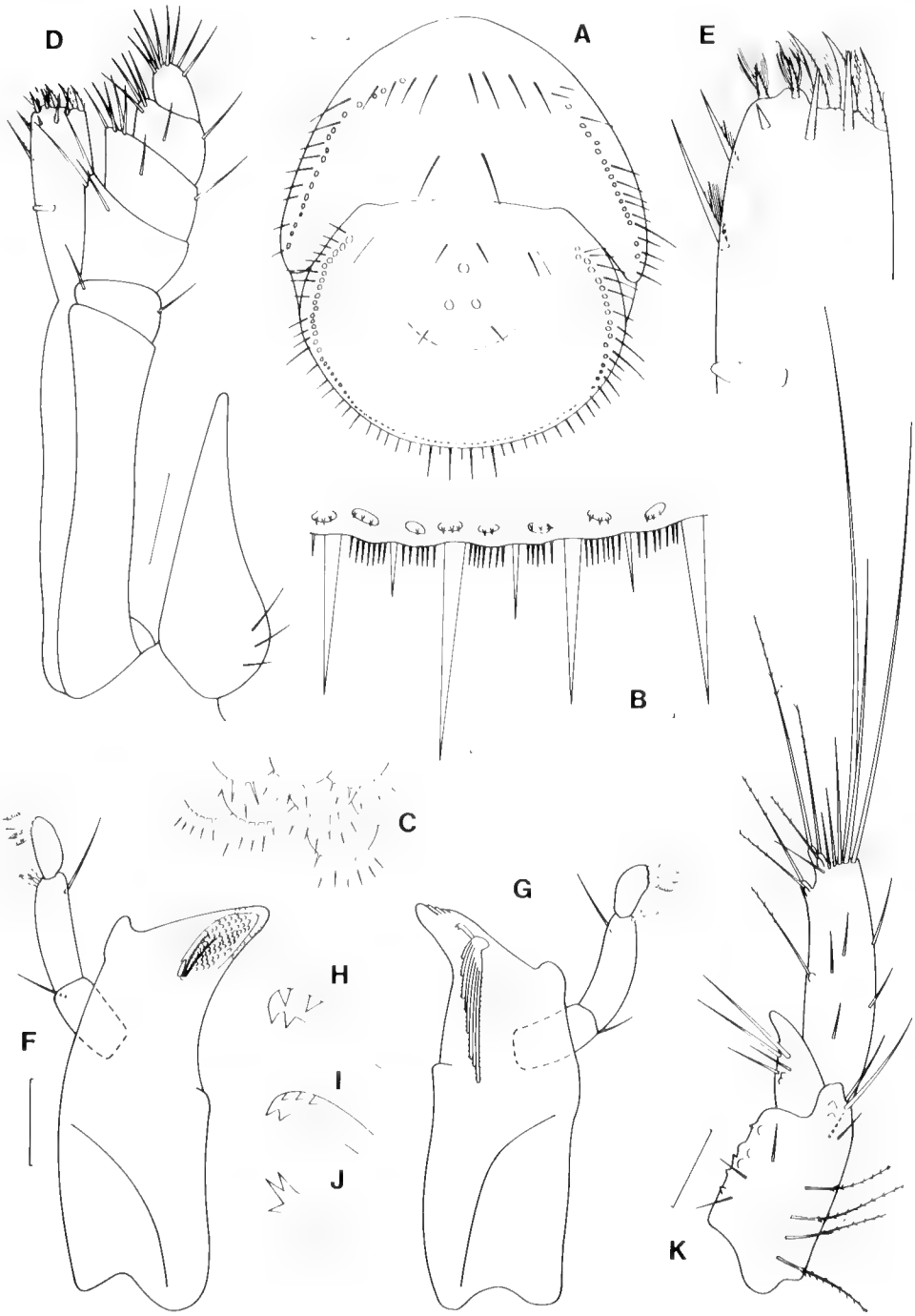

Figure 36. *Limnoria orbellum* sp. nov. A–C, F–H, male, AM P38926, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, dorsal structure of pleotelson; F, left mandible; G, right mandible; H, lacinia mobilis of right mandible. D,E,I,K, male, AM P38927, paratype: D, maxilliped; E, endite of maxilliped; I, lacinia mobilis of right mandible; K, uropod, ventrolateral view. J, female, AM P38928, paratype, lacinia mobilis of right mandible.

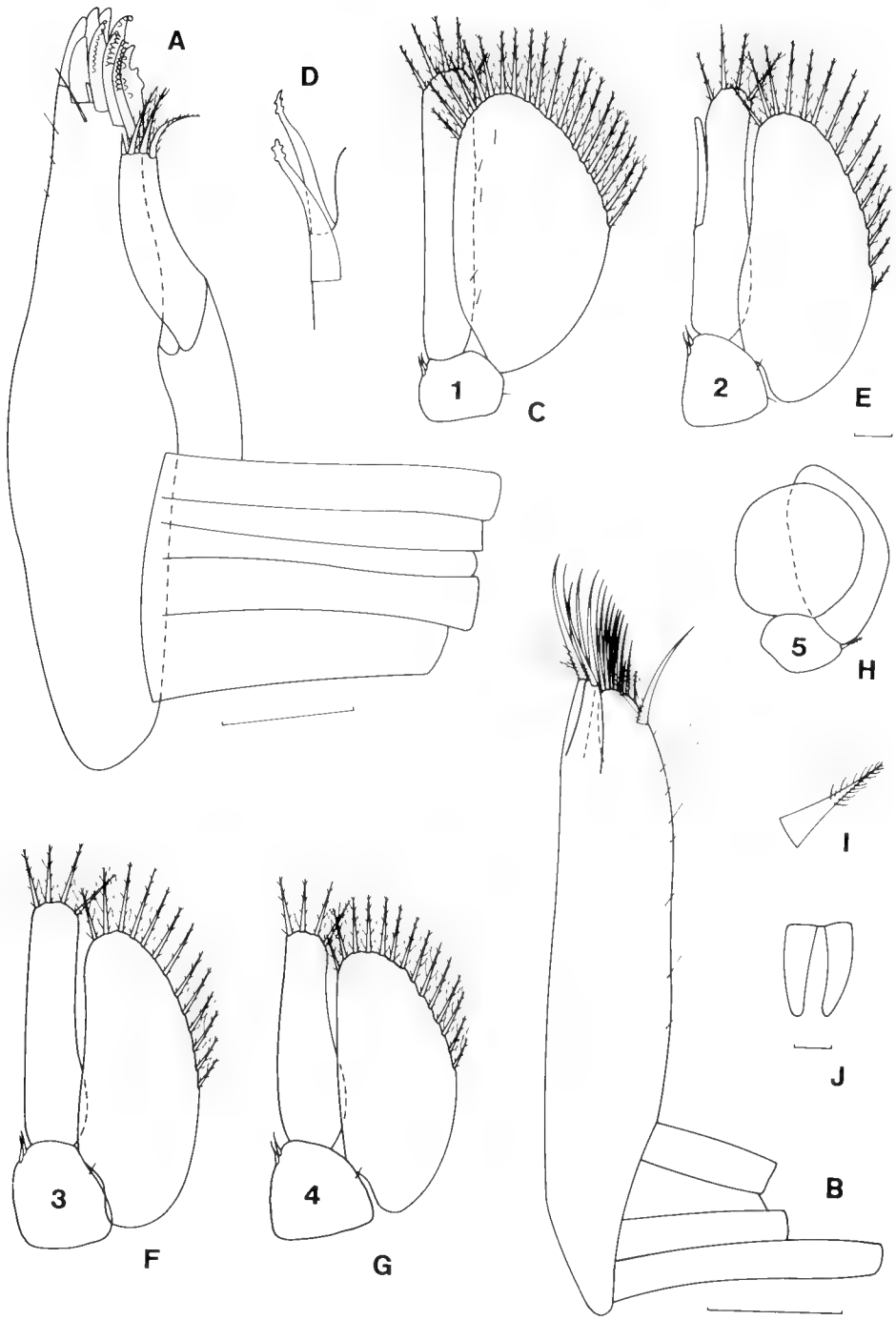

Figure 37. *Limnoria orbellum* sp. nov. A–I, male, AM P38926, holotype: A, maxilla 1 and associated muscle; B, maxilla 2 and associated muscle; C, pleopod 1; D, coupling hooks on pleopod 1; E–H, pleopods 2–5; I, comb seta on pleopod 5. J, male, AM P38927, paratype, penes.

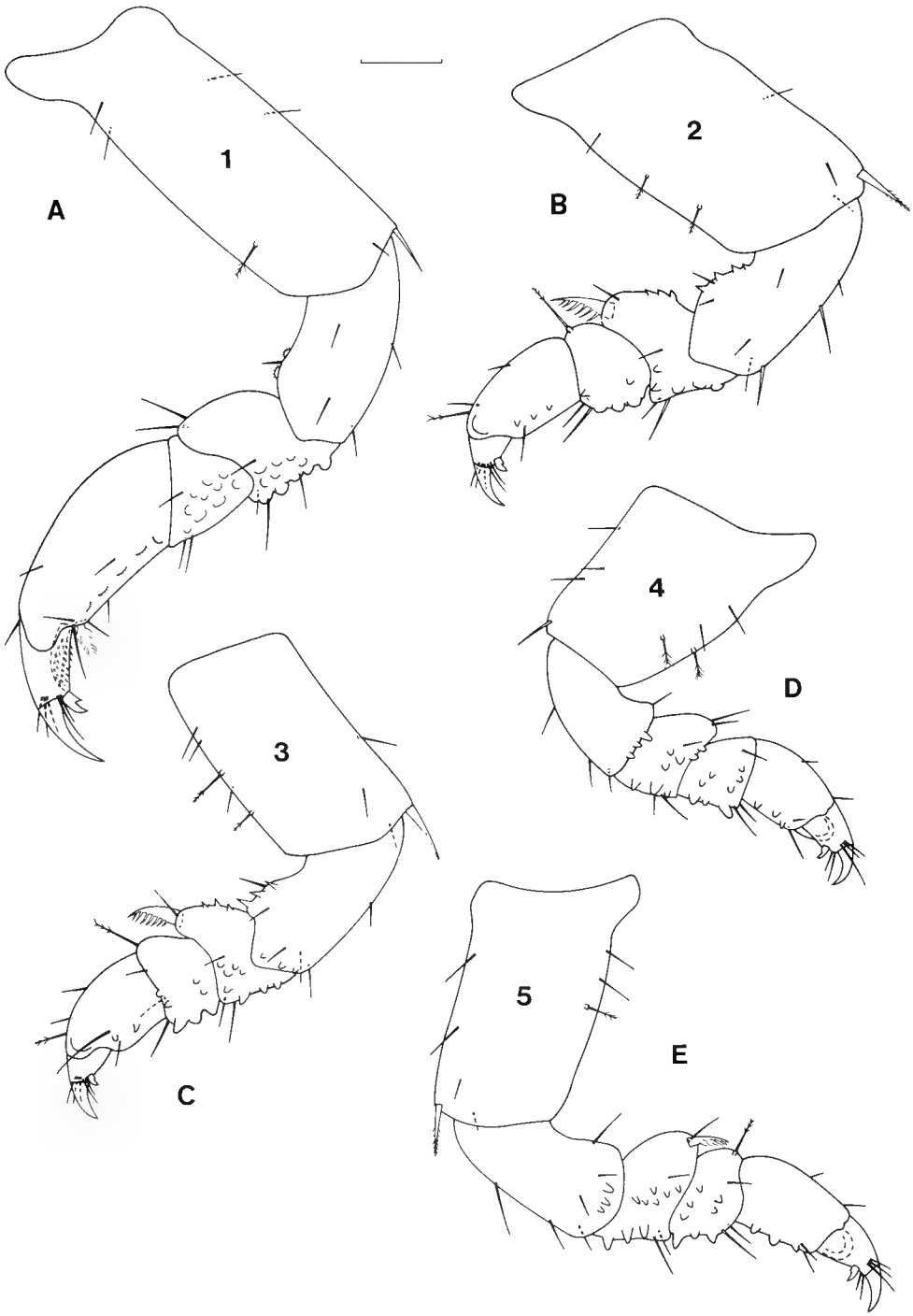

Figure 38. *Limnoria orbellum* sp. nov. A–E, male AM P28926, holotype: A–E, pereopods 1–5, lateral views.

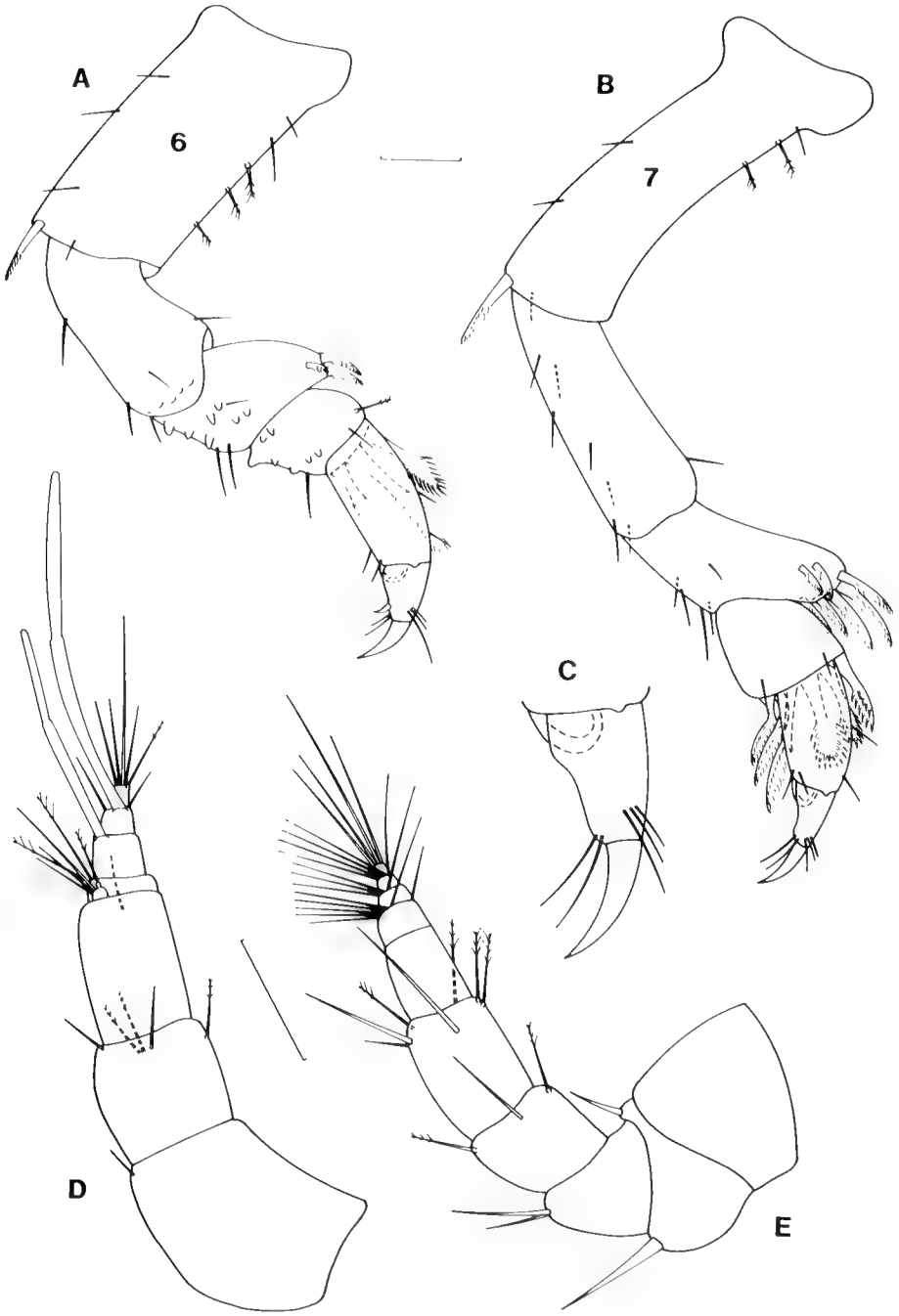

Figure 39. *Limnoria orbellum* sp. nov. A–E, male, AM P38926, holotype: A, pereopod 6, lateral view; B, pereopod 7, lateral view; C, dactylus of pereopod 7, lateral view; D, antenna 1; E, antenna 2.

Pleopod 2 with short plumose setae up to 0.3 times length of exopod. Appendix masculina short, not reaching endopod tip, articulating slightly proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, circular, 0.5 times as long as endopod of pleopod 2; peduncle of pleopod 5 with comb seta laterally.

Additional characters. Pleopod 1 with only 2 coupling hooks. Pereopod 7 without secondary unguis. Body length up to 2.5 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Etymology. Derived from *orbis*, Latin for circle, and *flabellum*, Latin for fan and describes the almost perfectly round endopod on pleopod 5.

Distribution. Cape Don, Northern Territory. Precise depths unknown, shallow water.

Substrates. Although no data was provided, the specimens were collected during an Australia-wide teredinid survey, when borers were collected from pine bait panels or submerged timbers. Baits were not sent to Cape Don, and so the timber must have been a local pile or log. *L. orbellum* was collected with *L. insulae*, a known wood-borer.

Remarks. L. orbellum is similar to *L. tripunctata*, *L. japonica*, *L. borealis* and *L. magadanensis* in that all species possess three puncta on the pleotelson, while both *L. orbellum* and *L. magadanensis* also do not have carinae connected to the puncta. *L. orbellum* seems most similar to *L. tripunctata*. Both species have five flagellar articles on antenna 2, a triangular maxillipedal epipod, and a circular endopod on pleopod 5. However, *L. orbellum* also has affinities with *L. kautensis*: both have short pleopodal plumose setae and appendix masculina, long pleonite 5 segment, and reduced or absent secondary unguis on pereopod 7.

L. orbellum is most readily distinguished by pleotelsonal sculpturing, presence of scale spikes on the dorsal row of tubercles near the posterior margin of the pleotelson, almost perfectly round pleopod 5 endopod, lack of a secondary unguis on pereopod 7, and presence of only two coupling hooks on pleopod 1.

Limnoria pfefferi Stebbing

Figures 40, 41

Limnoria pfefferi Stebbing, 1904: 714–715, pl. LIIIa.—Chilton, 1914a: 382, 387.—Moll, 1915: 184–185, 188, fig. 7.—Kofoid and Miller, 1927: 309.—Holthuis, 1949: 170.—Menzies and Becker, 1957: 87, fig. 1.—McCoy-Hill, 1964: 46.—Nair, 1984: 208.—Kensley, 1988: 41.—Kensley and Schotte, 1989: 198, fig. 87B.

Limnoria (*Limnoria*) *pfefferi.*—Menzies, 1957: 135–137, fig. 15.—Becker and Kampf, 1958: fig. 4.—Becker and Kampf, 1959: fig. 4.—Menzies, 1959: 18.—Ganapati and Rao, 1960: 275–276.—Pillai, 1961: 25, text-fig. 13.—Menzies and Glynn, 1968: 48, fig. 21E.—Rao and Ganapati, 1969: 226, 229.—Schultz, 1969: 144, fig. 212.—Kühne, 1975: 454.—Kühne, 1976: 547–548, fig. 7.—Krishnan et al., 1980: 20.—Kensley and Schotte, 1987: 222–224.

Not *Limnoria pfefferi.*—Stephensen, 1927: 361–362 (= *Limnoria stephenseni*).

Material examined. Syntypes: Minikoi Atoll, Indian Ocean, in rotten log in lagoon, S. Gardiner, British Museum (Natural History) 1928.12.1: 1275–80 (male, 2 non-ovig. females).

Other material. PNG. Rabaul, timber piles from main wharf, S.M. Cragg, NMV J15485 (male, 4.7 mm, 1.1 mm wide pleotelson, with 1 slide), NMV J15486 (male, 4.6 mm, with 2 slides), NMV J15484 (20 males, 2.7–4.7 mm, 9 non-ovig. females, 3.8–4.7 mm, 3 ovig. females, 3.8, 4.0, 4.0 mm, juv., 1.6 mm); 15 Nov 1982, NMV J15483 (6 males, 4 females). Port Moresby, harbour, S.M. Rayner, Jan 1973, NMV J15471 (4 ovig-females); timber piles, S.M. Cragg, 20 Jun 1983, NMV J15494 (3 males, 4 non-ovig. females, juv.). Tahira, Bootless, S.M. Cragg, 3 Oct 1983. NMV J15481 (7). Madang, low tide, pine bait block no. 27 after 2 months, R.D. Turner, J.V. Marshall and J. Beesley, 30 Aug 1970, AM P35430 (10 males, 5 non-ovig. females, 2 ovig. females, 3 juvs.).

Cocos Islands, pine bait block no. 242 after 5 months, R.D. Turner, J.V. Marshall and J. Beesley, Nov 1970, AM P38916 (3 males, non-ovig. female, ovig. female).

Qld. Green Island, 10 m from jetty, 2 m, hardwood sawn plank on sand, L.J. Cookson, 19 Sep 1988, NMV J15453 (112).

Types. British Museum (Natural History).

Diagnosis. Pleonite 5 dorsomedially with Y-shaped longitudinal carina. Pleotelson with 2 dorsomedial parallel carinae. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of scales, most with single central spike. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson; margin fringed with long-sheathed setae, without scale spikes and stout setae.

Antenna 1 with 4 flagellar articles; second article with 5-6 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible short, rounded apically, with fringe of small teeth. Epipod of maxilliped broad, clavate, 2.4 times as long as wide,

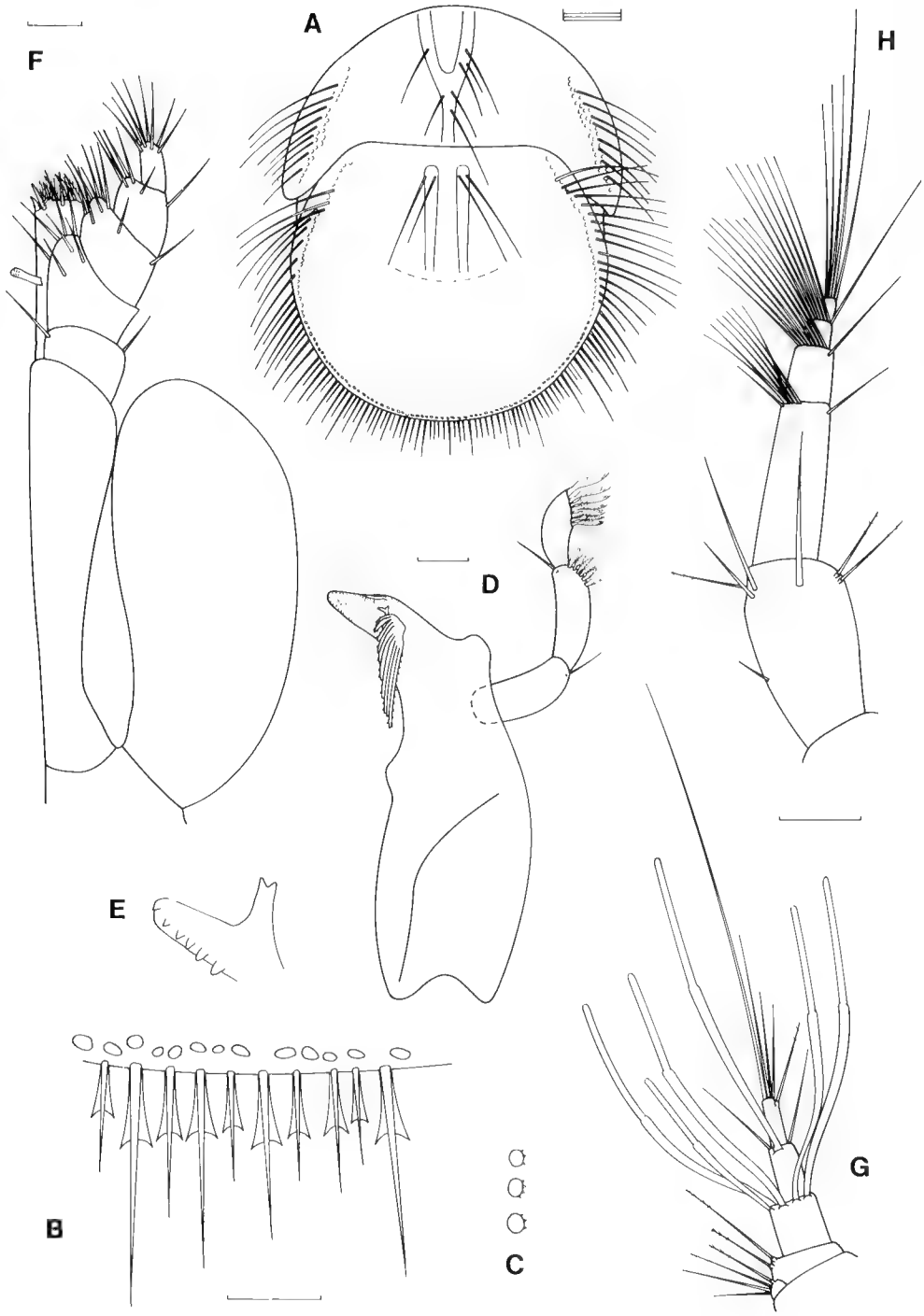

Figure 40. *Limnoria pfefferi* Stebbing. A–H, male NMV J15485: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, tubercles on lateral crests of pleotelson; D, right mandible; E, lacinia mobilis of right mandible; F, maxilliped; G, flagellum of antenna 1; H, peduncle article 5 and flagellum of antenna 2.

reaching past palp articulation; epipod without simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopods 6 and 7, and carpus of pereopods 2, 3, 6 and 7. Uropod peduncle with small lateral tubercles, with small tubercles between pappose setae, pappose setae situated on ridge; endopod 0.75 times as long as peduncle.

Pleopod 2 with short plumose setae, up to 0.3 times length of exopod. Appendix masculina short, not reaching beyond endopod, articulating distal to midlength of endopod. Endopod of pleopod 5 posterior to exopod, subtriangular, 0.9 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Exopod of uropod with small apical claw; exopod with row of about 7 long setae. Body length up to 4.7 mm. Colour in alcohol pale yellow.

Distribution. Minikoi Atoll, Indian Ocean (type locality) (Stebbing, 1904); Andaman Islands (Ganapati and Rao, 1960); Miami, Florida (Menzies, 1957); Aldabra Atoll (Kensley, 1988); Belize (Kensley and Schotte, 1987); Puerto Rico (Menzies and Glynn, 1968; Kühne, 1976); Papua New Guinea; Philippines; Panama (Kühne, 1976); Cocos Islands; PNG; Green Island, Qld (current study). 0-3 m depths (Kensley and Schotte, 1987).

Substrates. Rotten wood (Stebbing, 1904); wooden plank (Ganapati and Rao, 1960); palm pile (Menzies and Glynn, 1968); red mangrove wood, algal mat under red mangrove roots (Kensley and Schotte, 1987); decayed wood (Kensley, 1988); pine blocks, hardwood plank (current study).

Remarks. Menzies (1957) stated that the lateral crests and posterior margin of the pleotelson were devoid of tubercles. However, they were present on all material examined here, although slightly smaller in the syntypes. It is possible they were absent on the "cotype" (= syntype) figured by Menzies (1957), and so this character may be variable. The tubercles on the pleotelson's lateral crests on some Papua New Guinea material bear a row of tiny spikes, which may have arisen from spikes which posteriorly fringe the dorsal scales of the pleotelson found in some other species. The lacinia mobilis of the right mandible on the figured specimen is bifid, in

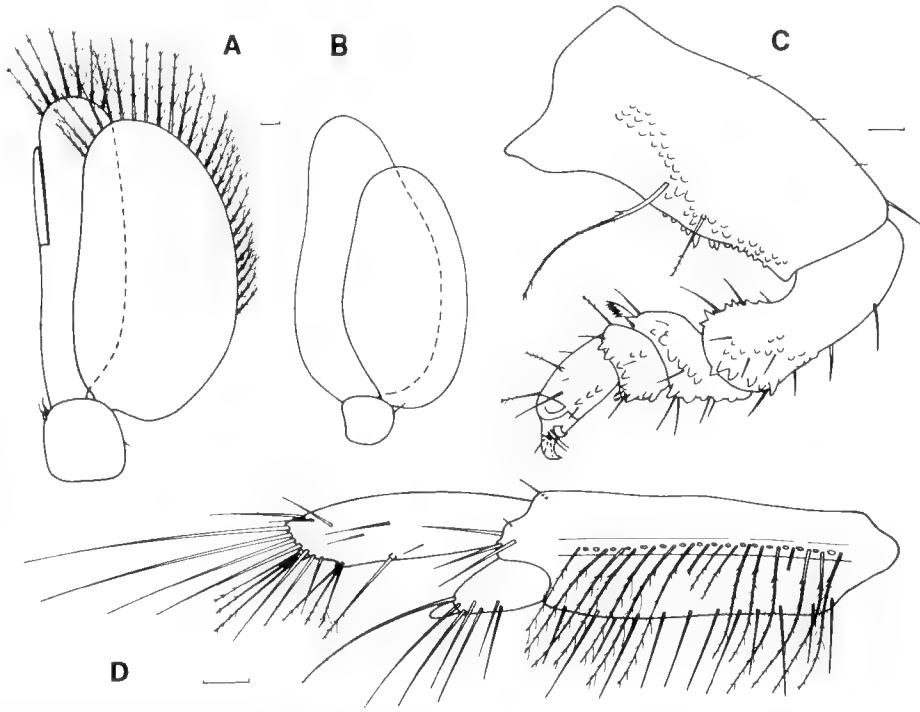

Figure 41. *Limnoria pfefferi* Stebbing. A–C, male, NMV J15485: A, pleopod 2; B, pleopod 5; C, pereopod 3, lateral view. D, male, NMV J15484, uropod, ventral view.

most specimens it is undivided as described in the diagnosis. Menzies (1957) stated that the lacinia mobilis had five denticles, but the number is more variable than this.

In the original description, Stebbing (1904) figured uropods which were similar to those of *Paralimnoria*, leading Menzies (1957) to suggest that Stebbing had a mixture of two species. Specimens from the Auckland Islands identified by Stephensen (1927) as *L. pfefferi*, with uncertainty, were actually *L. stephenseni* (Menzies 1957).

L. pfefferi is most similar to *L. sexcarinata* and *L. andamanensis*. These species have similar pleopods and maxillipedal epipods, four flagellar articles on antennae 2 (sometimes five in *L. sexcarinata*) and 1, similar lacinia mobilis of the right mandible, and similar scale structure on the dorsal surface of the pleotelson. *L. andamanensis* differs from *L. pfefferi* mainly by the sculpturing on the pleotelson and pleonite 5, presence of dorsal rows of tubercles on somites pereonite 6 to pleonite 4, comparatively short uropod peduncle, comparatively large uropod exopod claw, and lack of a median ridge on the uropod peduncle. *L. sexcarinata* differs from *L. pfefferi* as the Y-shaped carina on pleonite 5 has a much shorter stem than on *L. pfefferi*. Also, *L. sexcarinata* has a transverse carina on the posterior margin of pleonite 5 (part of splayed base of Y-shaped carina) which is almost as well developed as in *L. andamanensis*. *L. sexcarinata* also has many long flexible vestigial proximally bifurcate pappose setae on the basis of pereopod 4, similar to those found in *L. torquisa*.

Limnoria platycauda Menzies

Figures 42, 43

Limnoria (*Limnoria*) *platycauda* Menzies, 1957: 139–141, fig. 17.—Menzies, 1959: 20.—Menzies and Glynn, 1968: 48, fig. 21F.—Schultz, 1969: 143, fig. 211.—Rao and Ganapati, 1969: 226.—Kühne, 1975: 452–453.—Kühne, 1976: 548.—Ortiz, 1983: 7.—Kensley and Schotte, 1987: 224.

Limnoria platycauda.—Jones et al., 1976: 122, 134.—Nair, 1984: 208.—Kensley, 1988: 41.—Kensley and Schotte, 1989: 198, fig. 87C.

Material examined. Paratypes: West Indies, mouth of Curaçao Harbour (12°12′N, 68°56′W), in greenheart timber, J.W. Gonggrip, 1923, USNM 91747 (12 males, 16 females, 7 juvs., with 2 slides prepared from a male, 2.0 mm).

Other material. Qld. Mackay, 1 m, *P. radiata* bait block after 4 months under jetty, L.J. Cookson, 21 Apr 1987, NMV J15425 (male, 2.8 mm, 0.7 mm wide pleotelson, with 1 slide), NMV J15426 (male, 2.8 mm, with 1 slide), NMV J15427 (non-ovig. female 2.8 mm, 0.55 mm wide pleotelson, with 1 slide); NMV J15424 (92 males, 1.8–3.0 mm, 27 non-ovig. females, 2.1–3.1 mm, 27 ovig. females, 2.3–3.5 mm, 2 juvs., 1.9, 2.2 mm). Red Wallis Island, 0.5 m, turpentine fender piles after 7 years, P. Pink, Jul 1986, NMV J15233 (male, 2.0 mm, with 1 slide), NMV J15234 (male, 2.0 mm, with 1 slide), NMV J15232 (9 males, 1.9–2.1 mm, 10 non-ovig. females, 1.9–2.0 mm, 4 juvs., 0.9–1.9 mm). Magnetic Island, Nelly Bay, *P. taeda* bait block after 2.5 months, J.V. Marshall, 15 Oct 1971, AM P38912 (male, 2.6 mm, with 1 slide), AM P38913 (male, 2.6 mm, with 1 slide), AM P38914 (non-ovig. female, 2.8 mm, with 1 slide), AM P35401 (3 males, 2.5–3.0 mm, 5 non-ovig. females, 3.0–3.2 mm, 2 juvs., 1.8, 2.1 mm). Magnetic Island, Arcadia, low tide, turpentine pile stump, J.E. Barnacle, 12 Jul 1985, NMV J15219 (2); dry pulled turpentine piles on beach, NMV J15220 (6). Lady Musgrave Island, Capricorn-Bunker group, 3 m, *Melaleuca* wood block from shipwreck, L.J. Cookson and P. Gestner, 25 May 1986, NMV J15230 (ovig. female, 2.6 mm, with 1 slide), NMV J15229 (9). Wreck Reef, Cato shipwreck of 1803 (22°11′S, 155°15′E), 12 m, *Casuarina* wood wedged in reef, L.J. Cookson and W. Delany, 18 May 1988, NMV J15211 (54).

Types. USNM.

Diagnosis. Pleonite 5 dorsomedially slightly elevated longitudinally; lateral crests slightly developed on pleonite 4. Pleotelson with short dorsomedial longitudinal elevation anteriorly. Pleonite 5 0.3–0.4 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine spikes. Dorsal row of tubercles extend from lateral crests to posterior margin of pleotelson; margin fringed with 4 unsheathed setae between which are shorter long-sheathed setae, lacking scale spikes.

Antenna 1 with 3 flagellar articles; second article with about 18 aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible long, thin, apically recurved and fringed with several teeth. Epipod of maxilliped broad, narrowed distally, 2.6 times as long as wide, just reaching palp articulation; epipod lacking true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta present on merus of pereopod 7 and carpus of pereopods 2, 3, 4, 5, 6 and 7. Uropod peduncle with anterolateral tubercles; endopod 1.2 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.7 times length of exopod. Appendix masculina reaching tip of endopod, articulating just proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.65 times as long as

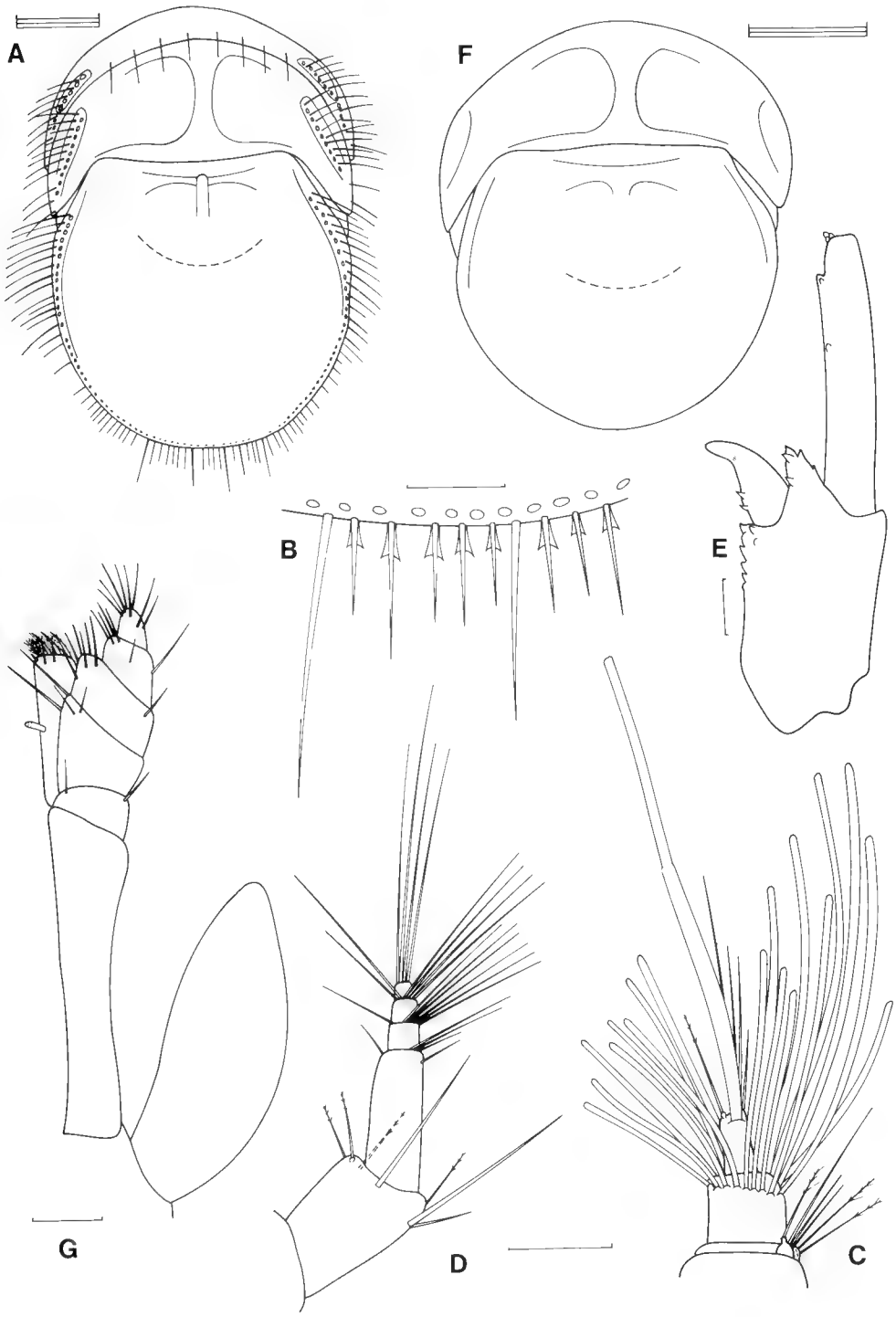

Figure 42. *Limnoria platycauda* Menzies. A–E, male, NMV J15426: A, pleonites 4, 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, flagellum of antenna 1; D, peduncle article 5 and flagellum of antenna 2; E, uropod, ventral view, setae omitted. F, G, female, NMV J15427: F, pleonite 5 and pleotelson, dorsal view, setae omitted; G, maxilliped.

endopod of pleopod 2; peduncle of pleopod 5 with comb seta laterally.

Additional characters. Dorsal surface of pleotelson without true setae other than near perimeter of pleotelson. Pleotelson with sexual dimorphism, region posterior to hind margin of ventral pleopodal cavity longer in males than females. Body length up to 3.5 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Distribution. Curaçao, West Indies (type locality); Puerto Rico (Menzies, 1957; Menzies and Glynn, 1968); Andaman Islands (Ganapati and Rao, 1960); Aldabra Atoll (Kensley, 1988); Koniya, Japan; Satta Hip, Thailand (Kühne, 1975); Admiralty Islands (Kühne, 1976); Belize (Kensley and Schotte, 1987); Cuba (Ortiz, 1983); Queensland. 0–12 m depths (current study).

Substrates. Greenheart timber (Menzies, 1957); mangrove root (Menzies and Glynn, 1968); wooden plank (Rao and Ganapati, 1969); red mangrove wood (Kensley and Schotte, 1987); decayed wood (Kensley, 1988); *Pinus*, *P. radiata*, *Syncarpia*, *Melaleuca*, *Casuarina* (present study).

Remarks. In Fig. 42 the sexual dimorphism of the pleotelson is best judged in relation to pleotelson width. In most males examined pleonite 5 is 0.3 times as long as the pleotelson. The prominence of the elevations on pleonite 5 and the pleotelson varies, in some specimens they appear as slightly raised carinae, in others as elevations which gradually merge with the general surface. The epipod of the maxilliped appears longer in the figure given by Menzies (1957) than in most material examined here, including the dissected male paratype. However, the maxillipedal epipod is similarly long in some Australian specimens (e.g., NMV J15233 from Red Wallis Island). The maxillipedal epipod is also more apically rounded in some specimens.

There were some other small variations in characters between specimens. The endopod of the uropod was found to vary between 1.05–1.3 times the length of the peduncle. Plumose setae on pleopod 2 were up to 0.7–0.8 times the length of the exopod. The appendix masculina on specimens from Red Wallis Island reached beyond the endopod, and articulated just distal to the midlength of the endopod; in the dissected male paratype the appendix masculina was level with the endopod tip, and articulated midlength to the endopod. The number of aesthetascs on the second flagellar article of antenna 1 varied from 13 (paratype, some Magnetic Island specimens) to 3 (some Red Wallis Island specimens).

Menzies (1957) noted that the underlying structure of the scales on the dorsal surface of the pleotelson appeared to be hexagonal units, which were not obscured by scale spikes. In the Australian specimens, except those from Lady Musgrave Island, the scales were fringed with scale spikes. Of the 34 paratypes examined, scale spikes were present on only three specimens.

L. platycauda is most similar to *L. multipunctata* and *L. insulae*. These species have three

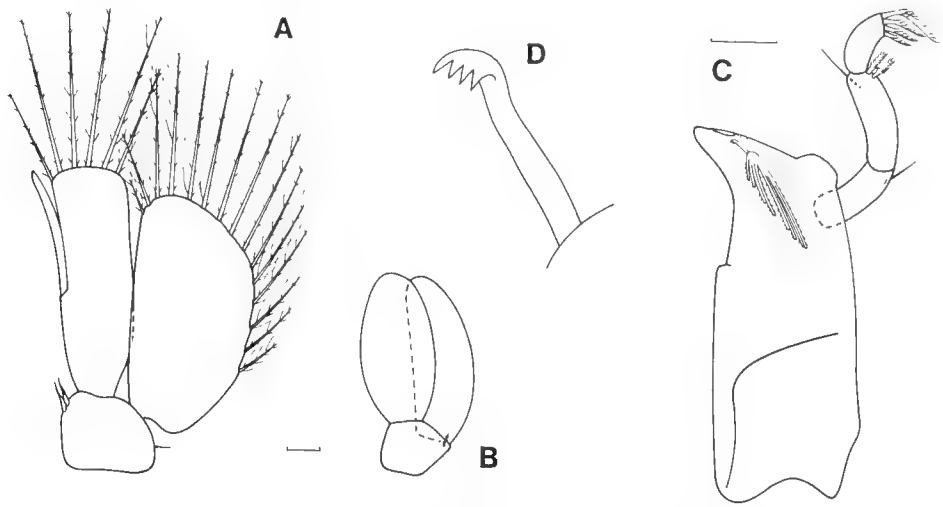

Figure 43. *Limnoria platycauda* Menzies. A–D, male, NMV J15426: A, pleopod 2; B, pleopod 5; C, right mandible; D, lacinia mobilis of right mandible.

flagellar articles on antenna 1, and four flagellar articles on antenna 2; broad maxillipedal epipods which lack true setae; similar structure on the posterior margin of the pleotelson; uropod peduncles with tubercles on the median projection between both rami; comb setae on the peduncle of pleopod 5; and, at least in some specimens, a single median carina or tuberculate row on the pleotelson or pleonite 5. The pleopods of *L. multipunctata* and *L. platycauda* are also similar.

Limnoria poorei sp. nov.

Figures 44, 45

Material examined. Holotype: SA. NE end of West Island (35°37′S, 138°36′E), 12 m, red algae, SCUBA, G.C.B. Poore and H.M. Lew Ton, 20 Mar 1985 (stn SA 39), NMV J15337 (male, 2.1 mm, 0.45 mm wide pleotelson, with 1 slide).

Paratype: SA. NE side of Topgallant Island, Topgallant Island, Investigator Group (33°43′S, 134°36.6′E), 16 m, *Cystophora*, SCUBA, S. Shepherd and G.C.B. Poore on FV "Limnos", 22 Apr 1985, NMV J15338 (male, 1.9 mm, broken between pleonite and pereonite, with 1 slide).

Diagnosis. Both pleonite 5 and pleotelson lacking carinae and puncta dorsomedially; pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson with scales bearing fine spikes posteriorly. Lateral crests with tuberculate swellings, tubercles with dorsal rows of scale spikes. Posterior margin of pleotelson with dorsal row of small scale spikes; margin fringed with thin scale spikes and short-sheathed setae, lacking stout setae.

Antenna 1 with 4 flagellar articles; second article with about 15 aesthetascs. Flagellum of antenna 2 with 3–4 articles. Mandibular palp with 3 articles, third article reduced, palp without comb setae. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible straight, serrated. Epipod of maxilliped broad, narrowed to blunt apical point, 1.9 times as long as wide, reaching articulation of articles 1 and 2 of palp; epipod with simple true seta.

Secondary unguis of pereopod 1 undivided, with 2 spiky protuberances subproximally. Ventral comb seta absent on merus, present on carpus of pereopods 6 and 7. Uropod peduncle with small lateral tubercles, not prominent; endopod 0.9 times as long as peduncle.

Pleopod 2 with long plumose setae up to 1.2 times longer than exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, elongated, 0.9 times as long as endopod of pleopod 2; peduncle of pleopod 5 may be without simple seta laterally.

Additional characters. Inner lobe of maxilla 2 with slightly sinuous medial seta. Left mandible with small lacinia mobilis, without accompanying spine row. Apical simple setae on articles 1 and 2 of mandibular palp long. Body length up to 2.1 mm. Colour in alcohol pale yellow.

Etymology. Named for Dr Gary C. B. Poore, Museum of Victoria, who collected this and many other species of *Limnoria*.

Distribution. South Australia. 12–16 m depths.

Substrates. Red algae, and the brown alga *Cystophora*.

Remarks. Although the peduncle of pleopod 5 was damaged when dissected, the lateral seta appears to be absent. The flagellum of antenna 2 has three segments in the holotype and four in the paratype.

L. poorei can be easily placed in the evolutionary sequence between *L. gibbera* and the group of species which have completely lost the mandibular palp, *L. uncapedis*, *L. segnoides*, and *L. bituberculata*. *L. poorei* seems most similar to *L. uncapedis*, which is also found in red algae. Both species have broad maxillipedal epipods, reduced mandibular palps, modified secondary unguis, modified (curved or sinuate) inner seta on maxilla 2, lack sculpturing on pleonite 5 and the pleotelson, and lack stout setae on the posterior margin of the pleotelson.

L. nonsegnis is similar to *L. poorei* in that both have a reduced mandibular palp. However, *L. nonsegnis* differs by having a narrower maxillipedal epipod, and well developed stout setae posteriorly on the pleotelson.

Limnoria quadripunctata Holthuis

Figures 46–48, Plate 2d

Limnoria quadripunctata Holthuis, 1949: 167–172, fig. 2.—Menzies and Mohr, 1952: 81–86.—Ralph and Hurley, 1952: 15–16.—Menzies and Becker, 1957: 85–92, fig. 1.—Eltringham and Hockley, 1958: 1659–1660.—Mohr, 1959: 88–89.—McQuire, 1964: 35–44.—McQuire, 1965: 34, 36, 39.—Hall and Saunders, 1967: 1–17.—Jones et al., 1972: 105, 108–109.—Jones et al., 1976: 122, 134.—Kussakin, 1979: 316–322, figs 183–186.—Rutherford et al., 1979: 527–530.—Bultman et al., 1980: 201.—Poore, 1981: 342.—Haderlie, 1983: 182–184.—Cookson, 1987b:

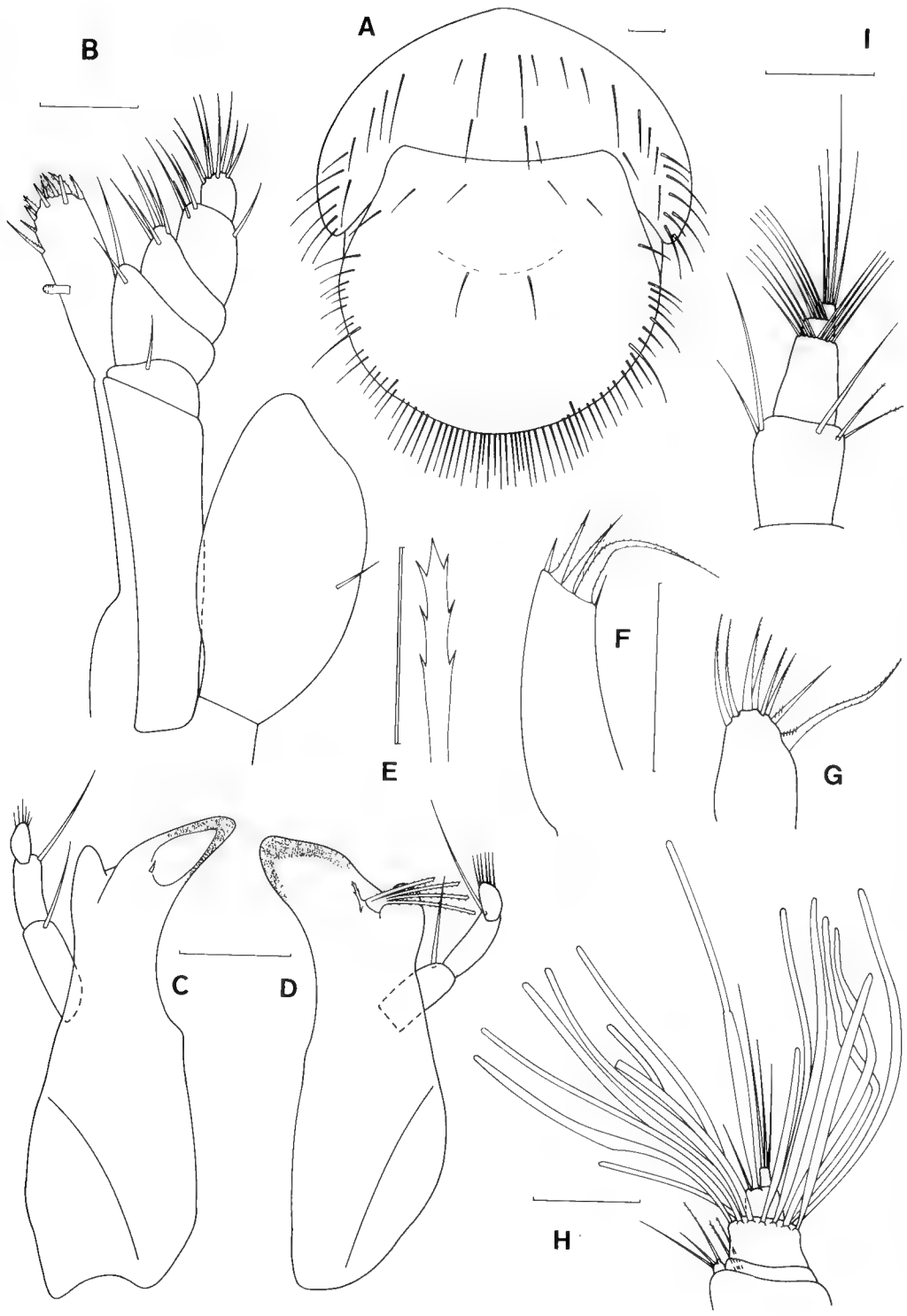

Figure 44. *Limnoria poorei* sp. nov. A, B, F–I, male, NMV J15337, holotype: A, pleonite 5 and pleotelson, dorsal view; B, maxilliped; F, inner lobe of maxilla 1; G, inner lobe of maxilla 2; H, flagellum of antenna 1; I, peduncle article 5 and flagellum of antenna 2. C–E, male, NMV J15338, paratype: C, left mandible; D, right mandible; E, lacinia mobilis of right mandible.

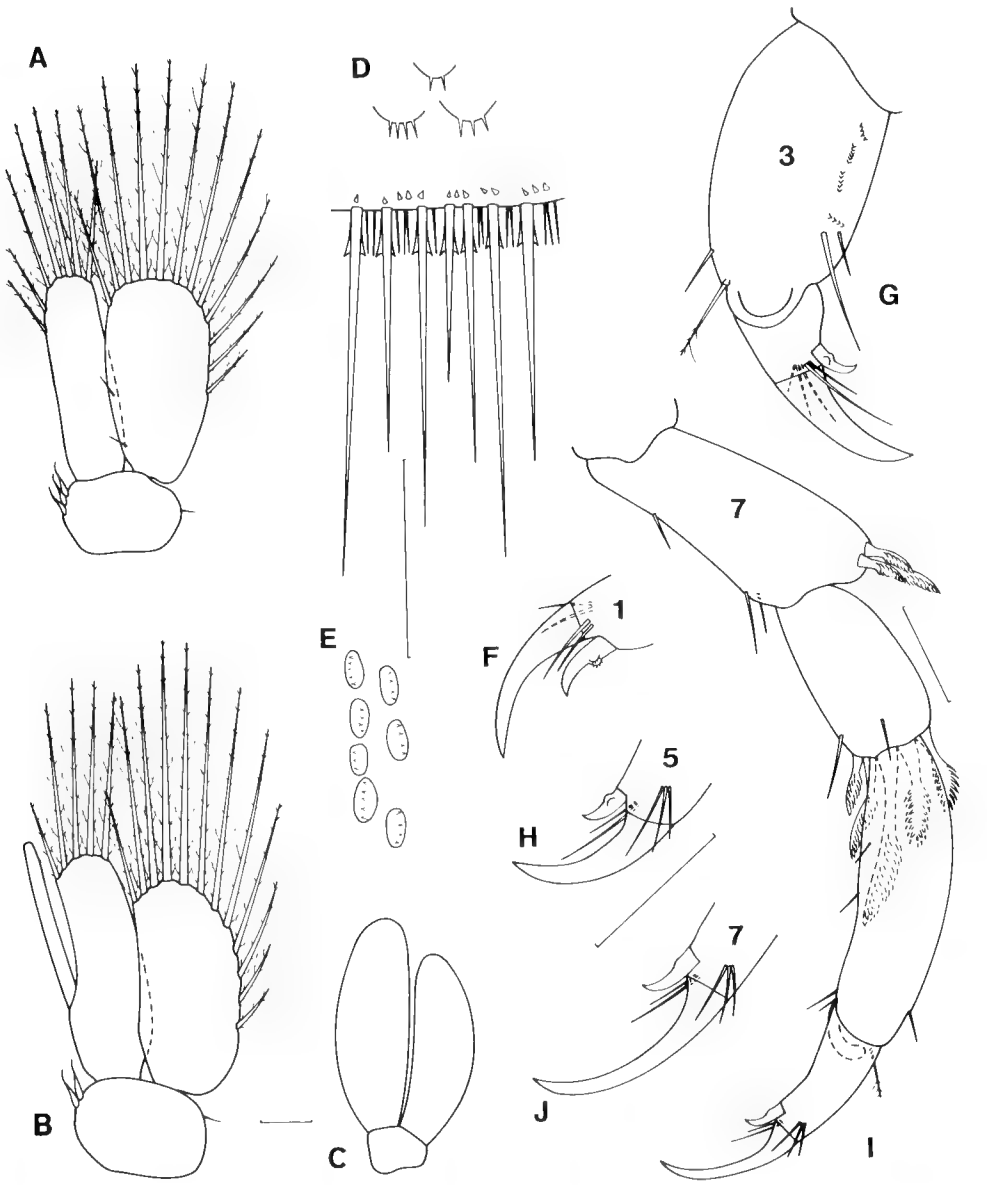

Figure 45. *Limnoria poorei* sp. nov. A–J, male, NMV J15337, holotype: A–C, pleopods 1, 2 and 5; D, posterior margin and dorsal structure of pleotelson; E, tubercles on lateral crest of pleotelson; F, unguis of pereopod 1; G, propodus and dactylus of pereopod 3; H, unguis of pereopod 5; I, distal articles of pereopod 7; J, unguis of pereopod 7; pereopods all lateral views.

85–89.—Eaton, 1988: 4.—Hicks, 1988: 646, 675.—Eaton et al., 1989: 63.

Limnoria (*Limnoria*) *quadripunctata*.—Menzies, 1957: 127–133, figs 10–14 (synonymy).—Menzies, 1959: 25.—Hurley, 1961: 266, 283.—Oliver, 1962: 32–91, figs 2, 4.—Menzies et al., 1963: 97–120.—Antezana, 1968: 293–301, figs 1–3.—Schultz, 1969: 143, fig. 210.—Kühne, 1971: 71, figs 2, 6–7.—Kühne, 1975: 454.—Kühne, 1976: 545.—Barnacle et al., 1983: 1–10.

Limnoria carinata.—Hicks, 1988: 654, 668, 669 (probable).

Biology and wood preservation literature.

Hochman et al., 1956: 1–37, fig. 13.—Vind et al., 1957: 35–48, fig. 10.—Drisko and Hochman, 1957: 325–329.—Hochman, 1959: 45–48, fig. 5.—Eltringham, 1961a: 512–513.—Eltringham, 1961b: 785–797.—Eltringham and Hockley, 1961: 467–482.—Vind and Hochman, 1961: 1–17, fig. 1.—Jones, 1963: 589–603.—Eltringham, 1964: 675–

683.—Eltringham, 1965a: 149–157.—Eltringham, 1965b: 145–152.—Schafer, 1966: 109–115.—Anderson and Reish, 1967: 56–59.—Eltringham, 1967: 521–529.—Hochman, 1967: 138–150.—Kühne, 1968: 107–118.—Reish and Hetherington, 1969: 137–139.—Hochman, 1970: 38–42.—Eltringham, 1971: 61–67.—Hochman, 1973a: 254–255.—Cookson and Barnacle, 1985: 8.—Eaton, 1986: 356, 361.—Barnacle, 1987: 7–23.—Cookson, 1987a: 1–14.—Cookson and Barnacle, 1987a: 139–160.—Cookson and Barnacle, 1987b: 287–293.

Material examined. Vic, Port Phillip Bay. Brighton, pier, 0–3 m, heartwood of pulled river red gum pile, L.J. Cookson, 31 May 1983, NMV J14971 (male, 2.5 mm, 0.75 mm wide pleotelson, with 1 slide), NMV J14969 (male, 2.9 mm, with 1 slide), NMV J14970 (non-ovig. female, 2.6 mm, with 1 slide), NMV J14968 (9 males, 1.8–2.9 mm, 11 non-ovig. females, 2.1–3.3 mm, ovig. female, 2.8 mm, 14 juvs. 1.4–2.3 mm). Various depths, collectors, dates; St Kilda, *E. obliqua* L'Herit. crossbrace, NMV J15240 (262); St Kilda, eucalypt pile NMV J15238 (24); Ellwood, *E. obliqua* pile, NMV J14993 (18); Sandringham, *E. pilularis* crossbrace, NMV J14965 (25); Sandringham, river red gum pile, NMV J14901 (20); Melbourne, pine, AM P35410 (5); Williamstown, pine, AM P35411 (24); Williamstown, cellery top pine, NMV J14907 (3); South Channel Light, river red gum and jarrah piles, NMV J14898 (46); Geelong, ironbark pile, NMV J15247 (4); Point Cook, eucalypt pile, NMV J14986 (45); Seabird shipwreck, NMV J14988 (8); Queenscliff, *P. radiata* bait, NMV J15236 (26); Queenscliff, yellow stringybark piles, NMV J15237 (53); Port Arlington, river red gum piles, NMV J14908 (32); Rye, eucalypt pile, NMV J14895 (3).

Vic., west of Port Phillip Bay. Various depths, collectors, dates; Lorne, driftwood, NMV J14894 (133); Wye River, log, NMV J14990 (26); Warrnambool, *P. radiata* bait, NMV J15201 (20); Portland, pine bait, AM P35416 (28); Portland, *P. radiata* bait, NMV J14960 (42). Western Port: various depths, collectors, dates; Rhyll, *E. obliqua* pile, NMV J15255 (9); Hastings, grey gum pile, NMV J14904 (15); HMAS Cerberus, eucalypt pile, NMV J14900 (11); Sunday Island, eucalypt pile, NMV J14897 (15). E of Western Port: various depths, collectors, dates, eucalypt piles; Cape Woolamai, NMV J15246 (9); Inverloch, NMV J15202 (25); Corner Inlet, NMV J14903 (10); Port Welshpool, *E. obliqua* pile, NMV J14902 (12); Port Albert, eucalypt pile, NMV J14950 (18); Port Albert, *E. regnans* pile, NMV J14896 (28); Lakes Entrance, pine bait, AM P35409 (16); Lakes Entrance, boat, NMV J14899 (17).

Tas. Various depths, collectors, dates, pine baits; King Island, Currie, NMV J14917 (17); Deal Island, AM P35404 (7); Stanley, NMV J14916 (36); Burnie, NMV J14913-15 (131); Devonport, NMV J14911, J14912 (85); Launceston, AM P35400 (45); Port Huon, AM P35428 (18), AM P35431 (302); Hobart, CCA-treated *E. obliqua* pile, NMV J14909 (15); Hobart, *E. globulus* Labill. pile, NMV J14910 (21); Hobart, timber, TM G1063 (9); D'Entrecasteaux Channel, wood, TM G926 (2).

SA. Various depths, collectors, dates; Robe, wooden cable reel, AM P35412 (69); Port Adelaide, *P. radiata* bait, NMV J15243-44 (11); Port Lincoln, jarrah crossbrace, NMV J14989 (8); Port Lincoln, identified as *L. lignorum* by H. Hale, SAM C4199 (5 on slide); Port Lincoln, pine bait, AM P37026 (5).

WA. Various depths, collectors, dates, pine baits; Esperance, AM P37031 (8); Albany, NMV J14918–J14920 (8), NMV J14922 (1); Bunbury, NMV J14940 (1); Bunbury, AM P37027–P37030 (61), AM P37032 (26).

NSW. Various depths, collectors, dates; Eden, pine baits, AM P37023–P37025 (16); Pambula, black wattle post, NMV J14985 (12); Merimbula, eucalypt pile, NMV J14983 (56); Wallagoot Lake, log, NMV J14984 (21); Marks Point, near Newcastle, *P. taeda* bait, AM P35397 (25). Sydney Harbour: various depths, collectors, dates, pine baits; Watsons Bay, AM P35376 (1), AM P37014–P37016 (87); Rose Bay, AM P37017 (3); Cabarita, AM P35391 (12); Bantry Bay, AM P35380 (2). Goat Island, many substrates including pine, eucalypt, turpentine, *Acacia*, AM P37018–P37021 (74), AM P37033 (1), NMV J15318 (7), J15256 (12), J15261–J15262 (18), J15267 (7), J15269 (26), J15273 (55), J15277 (50).

NZ. Portobello, *P. radiata* bait block near mud-line, J.E. Barnacle and L.J. Cookson, 24 Mar 1987, NMV J14992 (male, with 1 slide), NMV J15323 (male, 3.2 mm, with 1 slide), NMV J15324 (non-ovig. female, 3.7 mm, with 1 slide), NMV J14991 (58). Auckland Harbour, from piles, determined R.J. Menzies, AM P12767 (7). Auckland Harbour, H. Larkin, 1913, AM P3865 (9). The Snares islands, Station Cove, 0.5 m, from algae in pool, C.E. Holmes, 23 Jan 1975 (stn SA 3369), NMV J678 (male, female, with 2 slides); Mollymawk Bay, 24–27 m, algae, D.S. Horning, 6 Dec 1974 (stn SA 676), NMNZ Cr. 6461 (1); Ho Ho Bay, 30 m, under algae-covered boulders on coarse shelly sand, G.D. Fenwick, 16 Jan 1977 (stn SA 3497), NMNZ Cr. 6462 (1).

England. Southsea Beach, Bramley, driftwood on beach, S.M. Cragg, Jan 1988, NMV J15296 (male, 2.9 mm, with 1 slide), NMV J15295 (3).

Types. USNM and Rijksmuseum van Natuurlijke, Leiden.

Diagnosis. Pleonite 5 dorsomedially with X-shaped carina, anterior axes longer than posterior axes. Pleotelson with 2 subparallel anteromedial carinae converging slightly posteriorly, carinae with pair of anterior and subanterior puncta; with 2 pairs of more lateral short carinae, followed by lateral crests. Pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, surface pitted on pleonite 5 and anteriorly on pleotelson. Dorsal row of short scale spikes extend from lateral crests to posterior margin of pleotelson. Posterior margin with 4 large stout setae between which are short-sheathed setae and scale spikes.

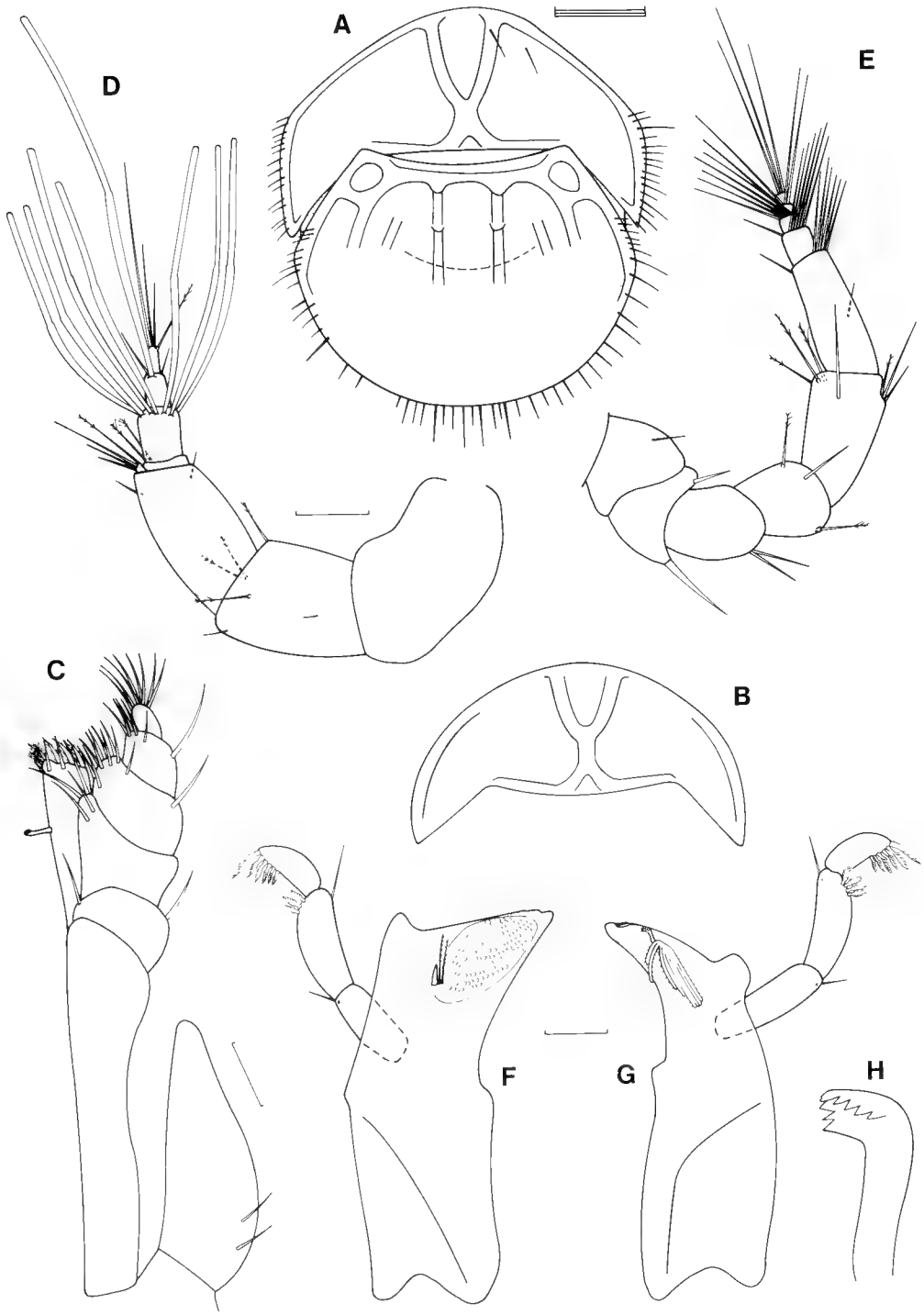

Figure 46. *Limnoria quadripunctata* Holthuis. A, C–H, male, NMV J14971: A, pleonite 5 and pleotelson, dorsal view; C, maxilliped; D, antenna 1; E, antenna 2; F, left mandible; G, right mandible; H, lacinia mobilis of right mandible. B, female, NMV J14970, pleonite 5, dorsal view, setae omitted.

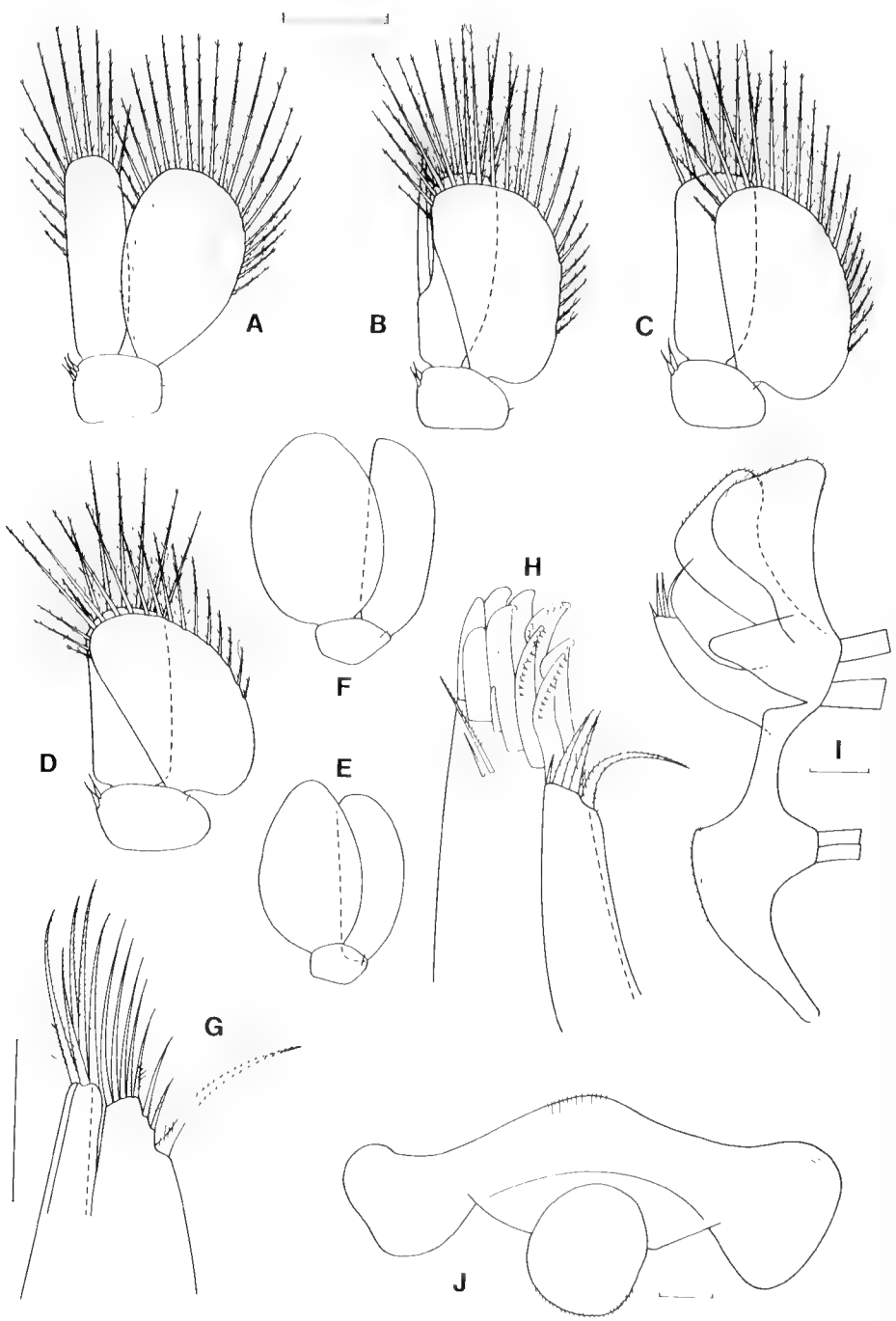

Figure 47. *Limnoria quadripunctata* Holthuis. A–E, G, H, male, NMV J14971: A–E, pleopods 1–5; G, maxilla 1; H, maxilla 2. F, male, NMV J678, pleopod 5. I, labium, with associated muscle, lateral view, also showing position of inner lobe of maxilla 1. J, male, NMV J14992, labrum and clypeus, anterior view.

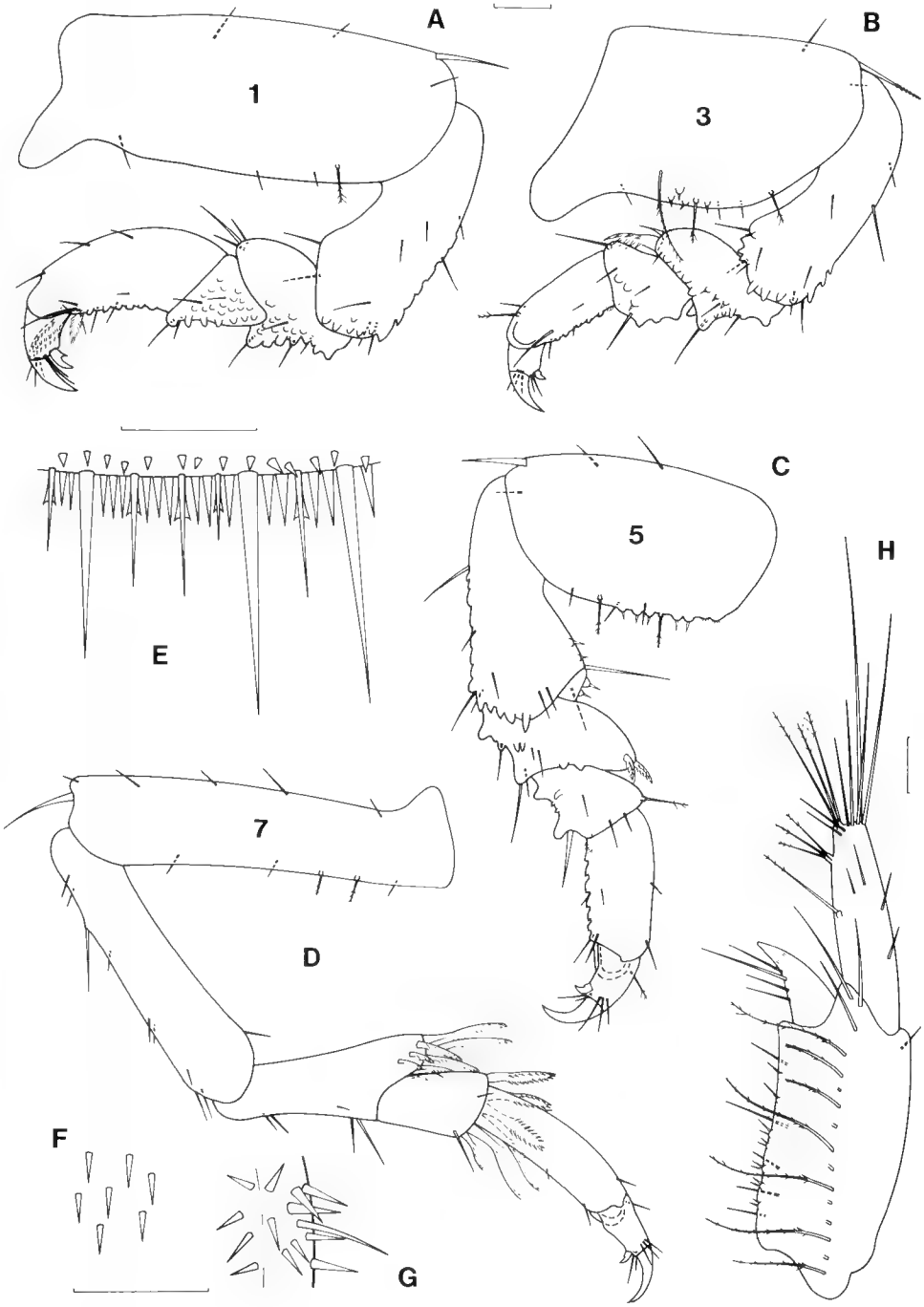

Figure 48. *Limnoria quadripunctata* Holthuis. A–H, male, NMV J14971: A–D, pereopods 1, 3, 5 and 7, lateral views; E, posterior margin of pleotelson, dorsal view; F, dorsal surface of pleotelson; G, lateral crest of pleotelson, dorsal view; H, uropod, ventral view.

Antenna 1 with 4 flagellar articles; second article with about 7 aesthetases. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible with fringe of teeth on apical curved process. Epipod of maxilliped triangular, 2.8 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta absent on merus, present on carpus of pereopods 2,3,4,5,6 and 7. Uropod peduncle without prominent lateral tubercles; endopod 0.8 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.8 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.85 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Body length up to 4.0 mm (Antezana, 1968). Colour in alcohol pale yellow.

Distribution. Widespread cool temperate distribution including: North Sea coast of Zuid-Holland near Leiden, Holland (type locality) (Holthuis, 1949); New Zealand (McQuire, 1964); California, USA (Menzies, 1957); Chile (Antezana, 1968); France (Jones et al., 1972); Trieste, Italy (Menzies and Becker, 1957); England (Jones, 1963); Tasmania, Victoria, SA, WA as far west as Bunbury, NSW north to Marks Point. 0–5 m depths; material from The Snares to 30 m (current study).

Substrates. Algae covered piece of driftwood (Holthuis, 1949); *P. sylvestris* (Jones et al., 1972); oak and Douglas fir (Haderlie, 1983); *P. radiata* (McQuire, 1964); CCA-treated *P. radiata* piles (Barnacle, 1987); CCA-treated wood (Barnacle et al., 1983); various untreated eucalypts, pines, *Acacia*; algae in pool and under boulders at The Snares (current study).

Remarks. Menzies and Becker (1957) stated that unlike *L. carinata*, the pleotelson surface of *L. quadripunctata* was not foveolate; however, SEM photographs of *L. quadripunctata* paratypes taken by M. Schotte (pers. comm.) show foveolate patterns on the pleotelson. Australian specimens also show foveolate patterns, although the degree can vary slightly within a population (Plate 2d). In some specimens, including some from The Snares (Station Cove and Mollymawk Bay), the pits are bordered by small carinae, almost to the degree found in *L. loricata*. This character can vary within a population (such as at St Kilda, Victoria). The exact shape of the X-shaped carina on pleonite 5 can vary slightly between specimens, depending on where adjacent pits are situated.

On most specimens within a population, the anterior pair of puncta on the pleotelson are separated slightly more than the posterior pair. This situation did not occur on the figured specimen, but it was the case for most other specimens from Brighton.

The four specimens from The Snares found under rocks and amongst algae were without the attached wood debris usually associated with *L. quadripunctata*. Unlike other specimens of *L. quadripunctata* examined, The Snares specimens: lack ventral comb setae on the carpus of pereopods 2 and 3, have slightly wider than usual endopod on pleopod 5, and the dorsal row of short scale spikes on the posterior margin of the pleotelson are broader than usual. However these differences are not enough to constitute a new species, especially when so few specimens were available for examination.

Limnoria raruslima sp. nov.

Figures 49, 50

Material examined. Holotype: SA. North side of West Island (35°37′S, 138°36′E), 5 m, sediment at base of *Heterozostera*, SCUBA, G.C.B. Poore and H.M. Lew Ton, 21 Mar 1985 (stn SA 49), NMV J15363 (male, 3.5 mm, 0.85 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J15364 (non-ovig. female, 3.5 mm, 0.8 mm wide pleotelson, with 1 slide), NMV J15365 (male, 3.6 mm, with 1 slide), NMV J15374 (male, 3.6 mm, with 1 slide), NMV J15366 (7 males, 3.2–4.5mm, 5 non-ovig. females, 2.8–4.3 mm, 3 ovig. females, 4.0, 4.2, 4.5 mm, 3 juvs., 2.8 mm); 4 m, sand patch in *Heterozostera* meadow (stn SA 48), NMV J15367 (3 males, 2.5, 3.0, 3.5 mm, 3 non-ovig. females, 2.5, 3.1, 3.2 mm, ovig. female, 4.2 mm, 3 juvs., 1.9 (with 1 slide), 2.1, 2.2 mm).

Other material: SA. NE end of West Island (35°37′S, 138°36′E), 12 m, red algae, SCUBA, G.C.B. Poore and H.M. Lew Ton, 20 Mar 1985 (stn SA 39), NMV J15362 (non-ovig. female). Tiparra Reef, Tiparra Light, Tiparra Bay (34°4′S, 137°23′E), 5 m, *Amphibolis* and sand, SCUBA, G.C.B. Poore and H.M. Lew Ton, 15 Mar 1985 (stn SA 16), NMV J15360 (male, 2 females). Salt Creek Bay, southern shore (35°3′S, 137°44′E), low tide, sandy patches between *Posidonia* beds, dredge, G.C.B. Poore and H.M. Lew Ton, 19 Mar 1985 (stn SA 31), NMV J15361 (female).

Small forms: Vic. Western Port, (38°15.31′S, 145°22.38′E), 0 m, in sandy clay, Smith-McIntyre grab, N. Coleman et al., 8 Jan 1974 (stn WBES 1706), NMV J15388 (male, 2.0mm, with 1 slide), NMV

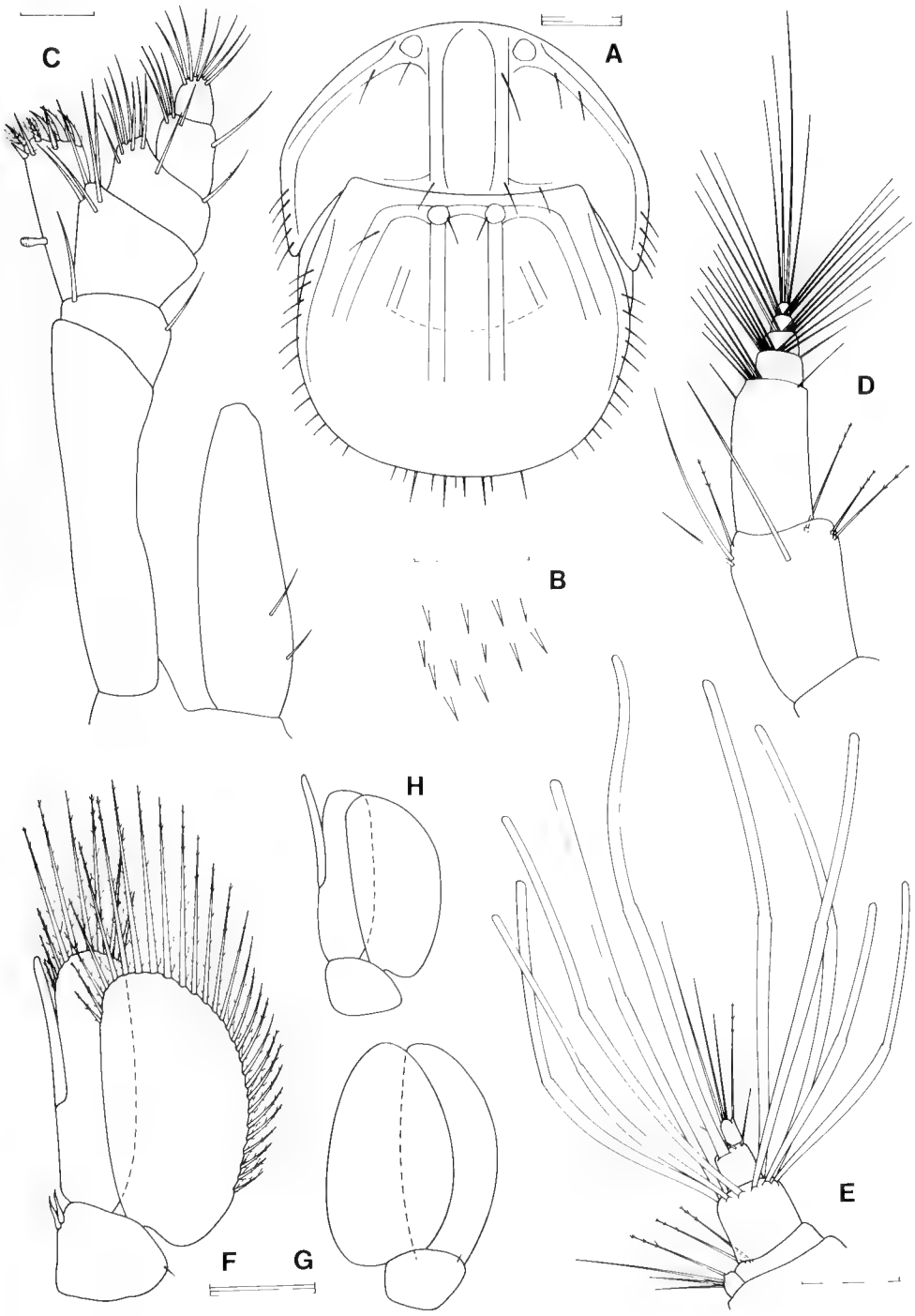

Figure 49. *Limnoria raruslima* sp. nov. A–G, male, NMV J15363, holotype: A, pleonite 5 and pleotelson, dorsal view; B, dorsal structure of pleotelson; C, maxilliped; D, peduncle article 5 and flagellum of antenna 2; E, flagellum of antenna 1; F, pleopod 2; G, pleopod 5. H, male, NMV J15389, pleopod 2, setae omitted.

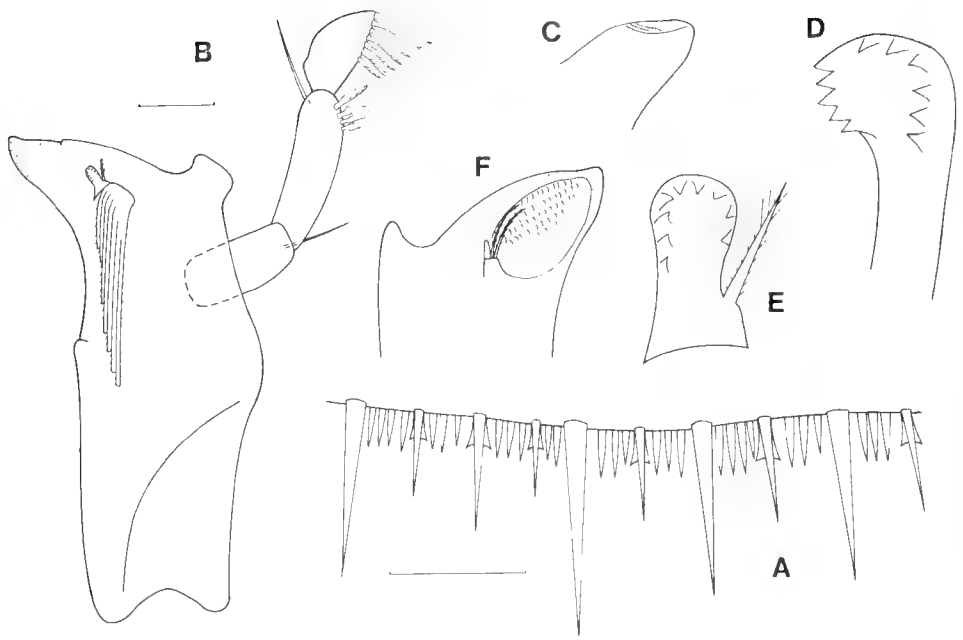

Figure 50. *Limnoria raruslima* sp. nov. A, B, E, F, male, NMV J15363, holotype: A, posterior margin of pleotelson, dorsal view; B, right mandible; E, lacinia mobilis of right mandible; F, incisor of left mandible. C, male, NMV J15374, paratype, incisor of right mandible. D, male, NMV J15365, paratype, lacinia mobilis of right mandible.

J15389 (male, 2.6 mm, with 1 slide), NMV J15390 (non-ovig. female, 1.7 mm, with 1 slide), NMV J4250 (12); (38°21.65′S, 145°15.21′E), 2 m, in sandy mud, S-M grab, A.J. Gilmour, 13 Apr 1965 (stn CPBS-S 03), NMV J15387 (male, 2.8 mm, with 1 slide), NMV J4245 (4); (38°21.17′S, 145°13.15′E), 2 m, sandy mud, S-M grab, A.J. Gilmour, 6 Apr 1965 (stn CPBS 000), NMV J4243 (2); (38°20.56′S, 145°15.08′E), 2 m, S-M grab, A.J. Gilmour, 5 Apr 1965 (stn CPBS 03N), NMV J4244 (2); (38°20.15′S, 145°15.0′E), 3 m, fine sand mud, S-M grab, A.J. Gilmour, 5 Apr 1965 (stn CPBS 10E), NMV J4246 (non-ovig. female, 3.7 mm); (38°19.98′S, 145°15.13′E), 2 m, mud and *Zostera*, S-M grab, A.J. Gilmour, 16 Mar 1965 (stn CPBS 12N), NMV J4247 (ovig. female); (38°25.53′S, 145°20.38′E), 0 m, sand, S-M grab, N. Coleman et al., 10 Jan 1974 (stn WBES 1717), NMV J4248 (crushed male); (38°25.45′S, 145°20.45′E), 0 m, silty clay, S-M grab, N. Coleman et al., 10 Jan 1974 (stn WBES 1716), NMV J4249 (2 females). Geelong Arm of Port Phillip Bay (38°9.3′S, 144°42.7′E), 3 m, sand and seagrass, S-M grab, G.C.B. Poore et al., 11 Jun 1971 (stn PPBES 953) NMV J15380 (non-ovig. female, 2.3 mm, with 1 slide), NMV J15381 (male, 3.6 mm, with 1 slide), NMV J15382 (male, 2.6 mm, with 1 slide), NMV J15383 (male, 2.7 mm, with 1 slide), NMV J13891 (4 males, 5 non-ovig. females, ovig. female), NMV J15384 (male, 2.7 mm, with 1 slide), NMV J15385 (male, 2.4 mm, with 1 slide), NMV J15386 (non-ovig. female, 2.8 mm, with 1 slide), NMV J13890 (5 males, 6 non-ovig. females, 2 juvs.), NMV J13892 (non-ovig. female, 2.5 mm with 1 slide, juv., 1.6 mm, with 1 slide).

Diagnosis. Pleonite 5 dorsomedially with pair of longitudinal parallel carinae. Pleotelson with longitudinal parallel pair of long dorsomedial carinae, produced slightly anteriorly as puncta; carinae followed laterally by pair of short carinae and pair of longer carinae, as well as lateral crests. Pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson composed of partly fused scales, covered with solitary scale spikes. Posterior margin of pleotelson with or without dorsal row of scale spikes; margin fringed with 4 stout setae between which are short-sheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 9 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with reduced rasp and file. Lacinia mobilis of right mandible short, apically circular, fringed with teeth. Epipod of maxilliped subtriangular, not apically pointed, 3.5 times as long as wide, just short of palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 5,6 and 7. Uropod peduncle with small lateral tubercles; endopod 0.7 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.8 times length of exopod. Appendix masculina reaching endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, subtriangular, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Body length up to 4.5 mm. Colour in alcohol white.

Etymology. From the Latin for scanty (*rarus*) and file (*lima*).

Distribution. South Australia and Victoria. 0–12 m depth.

Substrates. Rhizomes of the seagrasses *Heterozostera*, *Zostera*, *Posidonia* and *Amphibolis*. Red algae also listed.

Remarks. The small forms of *L. raruslima* from Victoria also differ from the type material by having: an appendix masculina of variable length, which may or may not reach beyond the endopod tip; a maxillipedal epipod of variable length, although always shorter than the palp articulation; and 2–7 aesthetases on flagellar article 2 of antenna 1, rather than about 9. Size is not sufficient to suggest a separate species as it may merely reflect slightly different habitats or food substrates. Nearly all specimens examined, including the types, were without a dorsal row of scale spikes on the posterior margin of the pleotelson; however, a few specimens were found which possessed patches of a dorsal row of scale spikes.

L. raruslima seems most similar to *L. sublittorale*. Both species have strongly developed longitudinal carinae on pleonite 5 and the pleotelson. Also, the pleopods are fairly similar, other than for the coupling hook sequence. A few specimens of *L. raruslima* have an interrupted row of dorsal scale spikes on the pleotelson hind margin, which approaches the condition found in *L. sublittorale*. *L. raruslima* also has similarities to *L. simulata*. Both species are seagrass-borers with reduced rasp.

L. raruslima may be distinguished from *L. sublittorale* by the details of the shapes of the maxillipedal epipod, endopod of pleopod 5, and the lacinia mobilis of the right mandible. Other differences are that *L. raruslima* has: a pleopod coupling hook sequence of 32220, lateral carinae on the pleotelson, a reduced rasp and file, relatively longer pleonite 5 segment, and a different sequence of ventral comb setae on the pereopods.

Limnoria rugosissima Menzies

Figures 51, 52

Limnoria (*Phycolimnoria*) *rugosissima* Menzies, 1957: 189, fig. 40.—Pillai, 1957: 150.—Menzies, 1959: 30.

Limnoria quadripunctata Holthuis.—Poore, 1981: 342 (stns SA 3459 and 893).

Material examined. Holotype: NSW, Port Jackson, Sydney Harbour (33°50′S, 151°15′E), C. Chilton collection, Canterbury Museum, New Zealand (male, 2.0 mm, 0.55 mm wide pleotelson).

Paratypes: Type locality, Canterbury Museum (ovig. female, 1.9 mm, 0.5 mm wide pleotelson = allotype, male dissected and figured by R.J. Menzies, 2.0 mm, male, 1.9 mm, dissected by L.J. Cookson, with 1 slide, 3 males 1.9, 1.9, 2.3 mm, 2 non-ovig. females, 2.2, 2.6 mm, 3 juvs. 1.6, 1.6 ,1.7 mm).

Other material: NSW, Port Jackson, Sydney Harbour, W.A. Haswell, 1918, C. Chilton collection, identified as *L. pfefferi* by C. Chilton, Canterbury Museum (male, 2.8 mm, with 1 slide, 6 males, 2.1–2.6 mm, 4 non-ovig. females, 1.9–3.3 mm, 4 ovig. females, 2.6–3.3 mm, 2 juvs., 2.0, 2.2 mm).

SA. North side of West Island, SA (35°37′S, 138°36′E), 4 m, *Ecklonia* holdfasts, SCUBA, G.C.B. Poore and H.M. Lew Ton, 21 Mar 1985 (stn SA 45), NMV J15344 (male, 2.4 mm 0.65 mm wide pleotelson, with 1 slide), NMV J15345 (male, 2.0 mm, with 1 slide), NMV J15346 (non-ovig. female, 2.5 mm, with 1 slide), NMV J15343 (53 males, 1.7–2.6 mm, 22 non-ovig. females, 1.8–2.8 mm, 11 ovig. females, 2.3–3.1 mm, 5 juvs., 1.4–1.6 mm). "The Hotspot", reef 5 n. miles W of north end of Flinders Island (33°40.5′S, 134°22′E), 17 m, *Cystophora* holdfasts on exposed rock bottom, G.C.B. Poore, 19 Apr 1985 (stn SA 61), NMV J15439 (non-ovig. female, 2.2 mm, with 1 slide).

Vic. Aireys Inlet, in tan coloured haptera (not old dark brown or fresh green haptera) of *Ecklonia radiata* holdfast adrift on beach, L.J. Cookson, 30 Mar 1988, NMV J15319 (male, 1.9 mm, juv., 0.9 mm).

Tas. Maria Island, 500 m W of Darlington (42°35′S, 148°2′E), 30 m, algal and drift holdfast epifauna, trawl, R.S. Wilson, 23 Mar 1985 (stn TAS 27), NMV J15348 (male, 2.8 mm, with 1 slide), NMV J15349 (male, 2.5 mm, with 1 slide), NMV J15350 (non-ovig. female, 2.4 mm, with 1 slide), NMV J15347 (male, 2.6 mm, 2 non-ovig. females, 2.2 2.5 mm).

NZ. The Snares. NW corner of Ho Ho Bay, 14 m, among clumps of concentric crustose coralline algae, G.D. Fenwick, 19 Dec 1976 (stn SA 3459), NMV J677 (2 males, 2.4, 2.6 mm, with 1 slide of 2.6 mm specimen). E end of Seal Point, 2–4 m, brown algae, D.S.

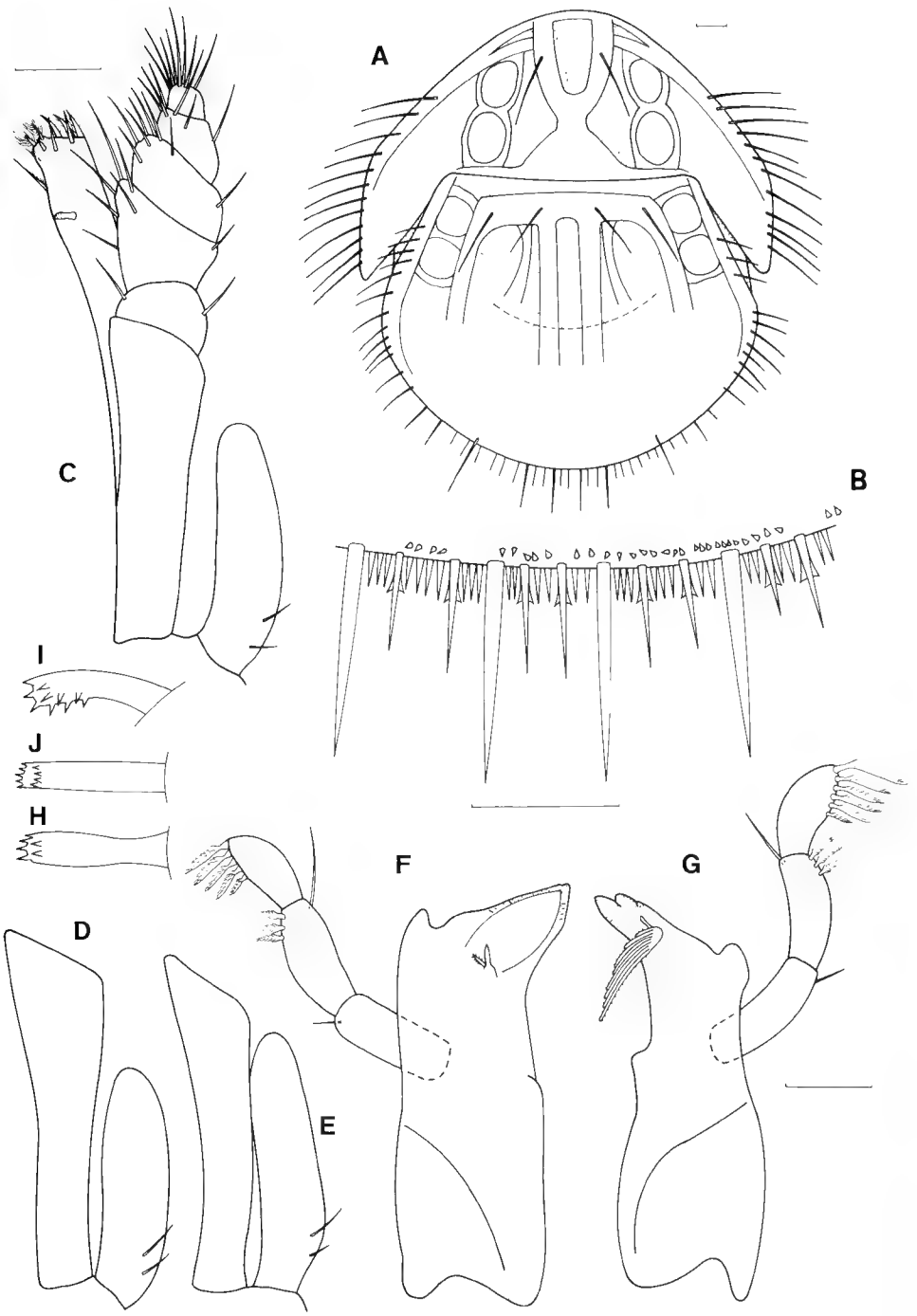

Figure 51. *Limnoria rugosissima* Menzies. A–C, F–H, male, NMV J15344: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; F, left mandible; G, right mandible; H, lacinia mobilis of right mandible. D, J, male, NZNM: D, epipod and basis of endopod of maxilliped; J, lacinia mobilis of right mandible. E, I, male, Canterbury Museum, paratype: E, epipod and basis of endopod of maxilliped; I, lacinia mobilis of right mandible.

Horning, 1 Feb 1975 (stn SA 893), NMNZ Cr. 6459 (juv., 1.6 mm, with 1 slide).

Diagnosis. Pleonite 5 dorsomedially with Y-shaped carina with splayed base, with less distinct figure 8-shaped carinae more laterally. Pleotelson with pair of longitudinal parallel dorsomedial carinae, followed laterally by 2 pairs of short carinae, and lateral crests. Pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, with pits anteriorly. Posterior margin of pleotelson with dorsal row of scale spikes; margin fringed with 4 large stout setae between which are short-sheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 12 aesthetases. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors without rasp and file; incisor of right mandible deeply cleaved. Lacinia mobilis of right mandible small, with small apical teeth. Epipod of maxilliped strap-like, 3.7 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 5, 6 and 7. Uropod peduncle with small lateral tubercles; endopod 1.1 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.8 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval but produced medially, 0.85 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Lacinia mobilis of left

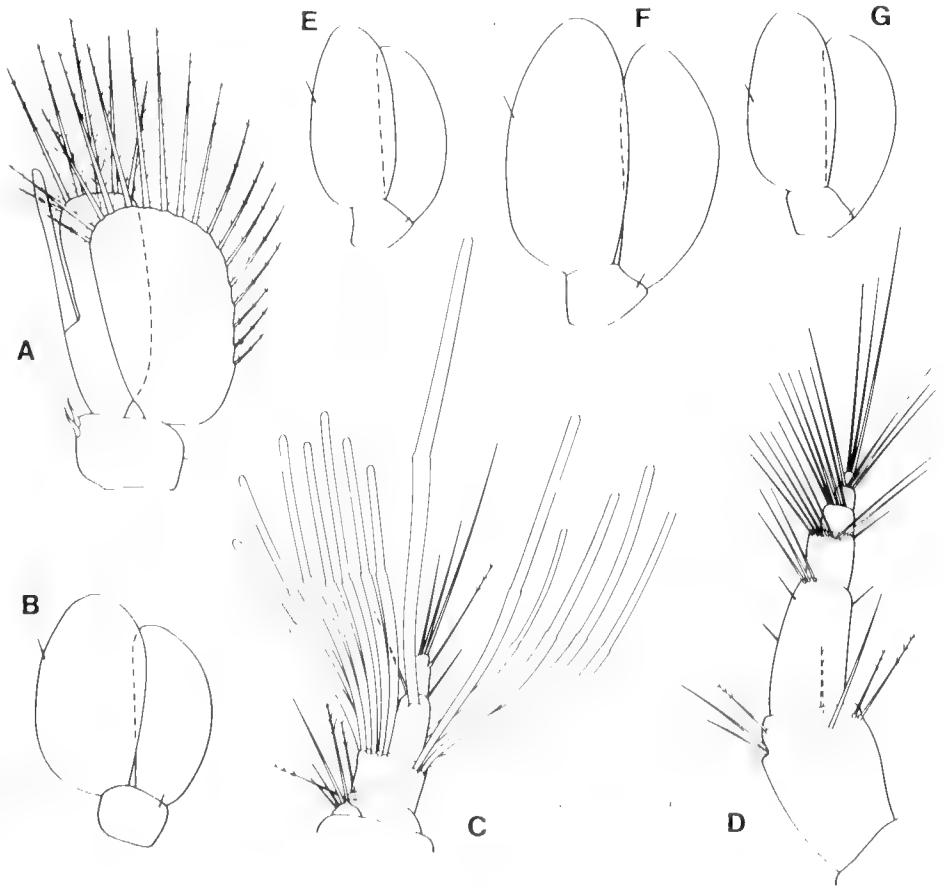

Figure 52. *Limnoria rugosissima* Menzies. A–D, male, NMV J15344: A, pleopod 2; B, pleopod 5; C, flagellum of antenna 1; D, peduncle article 5 and flagellum of antenna 2. E, male, NMV J677, pleopod 5. F, male, NMV J15348, pleopod 5. G, male, paratype, pleopod 5.

mandible accompanied by only 1 very short serrated seta. Endopod of pleopod 5 with medial simple seta near midlength. Body length up to 3.3 mm. Colour in alcohol pale yellow, some specimens with small amount of brown-blue reticulation (approaching condition of *L. glaucinosa*).

Distribution. Port Jackson, NSW (type locality) (Menzies, 1957); SA, Victoria, Tasmania; The Snares, New Zealand. 0–30 m depths (current study).

Substrates. Ecklonia holdfasts, *Cystophora* holdfasts, coralline algae (present study).

Remarks. The sculpture on pleonite 5 and the pleotelson of *L. rugosissima* is more regular in pattern than indicated by Menzies (1957). The distinctiveness of the sculpturing can vary between populations and individuals within a population. On specimen NMV J15439, the carinae on pleonite 5 cannot be clearly seen. The types are not in good condition, however accompanying specimens collected from Sydney Harbour, possibly from the same original lot, are in good condition and the sculpture pattern very clear.

Menzies (1957) did not know the substrate of *L. rugosissima*, however he correctly surmised, based on the lack of a rasp and file, that it was algae.

L. rugosissima appears most similar to *L. echidna*. *L. rugosissima* may be distinguished by finer details of the sculpturing on pleonite 5 and the pleotelson, shape of the lacinia mobilis of the right mandible, cleaved incisor on the right mandible, presence of a dorsal row of scale spikes on the posterior margin of the pleotelson, reduced spine row on left mandible, and the presence of a simple seta on the endopod of pleopod 5.

Limnoria stephenseni Menzies

Figure 53

Limnoria antarctica Pfeffer.—Hale, 1937: 21–23, fig. 6.

?*Limnoria pfefferi* Stebbing.—Stephensen, 1927: 361–362.

Limnoria (*Phycolimnoria*) *stephenseni* Menzies, 1957: 189–191, figs 41–42.—Pillai, 1957: 150.—Menzies, 1959: 27.

Limnoria stephenseni.—Hicks, 1990: 451–456.—Wolff, 1990: 311–318.

Material examined. Lectotype (selected by Wolff, 1990): 1 mile east of Auckland Island, NZ (50°35′S, 166°E), in floating "*Lessonia*", T. Mortensen expedition, 28 Nov 1914, Zoologisk Museum, Copenhagen (male, 6.9 mm).

Paralectotypes: Type locality, NMV J17240 (male, 4.3 mm, non-ovig. female, 4.5 mm).

Other material. Macquarie Island. Handspike Point, intertidal holdfasts of *Durvillaea antarctica*, D.S. Horning and J.K. Lowry, 21 Dec 1977 (stn MA 135), NMV J15421 (male, 5.0 mm, 1.8 mm wide pleotelson, with 1 slide), NMV J15422 (male, 6.2 mm, with 2 slides), NMV J15423 (ovig. female, 8.5 mm, with 1 slide), NMV J15400 (122 males, 3.7–8.7 mm, 91 non-ovig. females, 5.0–7.5 mm, 12 ovig. females, 7.0–7.5 mm, 62 juvs., 2.0–4.5 mm). SE corner of Gorilla Head Rock, 8 m, small exposed *D. antarctica* holdfast, SCUBA, J.K. Lowry, 23 Dec 1977 (stn MA 147), NMV J15395 (male). 19 Oct 1983 (stn CI 1), NMV J15445 (12 males, 5 non-ovig. females, 3 ovig. females up to 8.7 mm, 6 juvs.). 19 Oct 1983 (stn CI 6), NMV J15446 (11 males, 9 non-ovig. females, 5 ovig. females). Kelp root washing, R. Kenny, 7 Feb 1949, WAM (1). Roots of kelp, SAM C4104 (ovig. female, 10 juvs., incorrectly identified as *L. antarctica* by H. Hale). Roots of kelp, Aug 1913, SAM C4105 (4 males, 3 females).

Marion Island (46°54′S, 37°45′E), intertidal, holdfasts of *Durvillaea antarctica*, P.G. Haxen, 4 Aug 1979, NMV J17241 (5).

Types. Zoologisk Museum, Copenhagen, and NMV.

Diagnosis. Pleonite 5 convex dorsomedially, both pleonite 5 and pleotelson without dorsomedial carinae and puncta. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of indistinct partly fused scales which bear single scale spike; with 2 groups of irregular patches clear of scale spikes located submedially just proximal to midlength of pleotelson. Posterior margin of pleotelson with dorsal row of short blunt scale spikes in clusters of 2–5; margin fringed with more than 20 stout setae between which are small unsheathed (vestigial sheathed) setae and thin scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 9 short aesthetases. Flagellum of antenna 2 with 4 articles. Mandibular palp with 3 articles. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible with 2 serrated branches. Epipod of maxilliped strap-like, 4.2 times as long as wide, reaching beyond palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid, ventral branch very short; with small seta near branching point. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 5,6 and 7. Uropod peduncle without lateral tubercles; endopod 0.8 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.5 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 without seta laterally.

Additional characters. Articles 1 and 2 of mandibular palp with more than 1 simple seta. Incisor of right mandible with 3 cusps. Body length up to 9.8 mm. Colour in alcohol pale yellow.

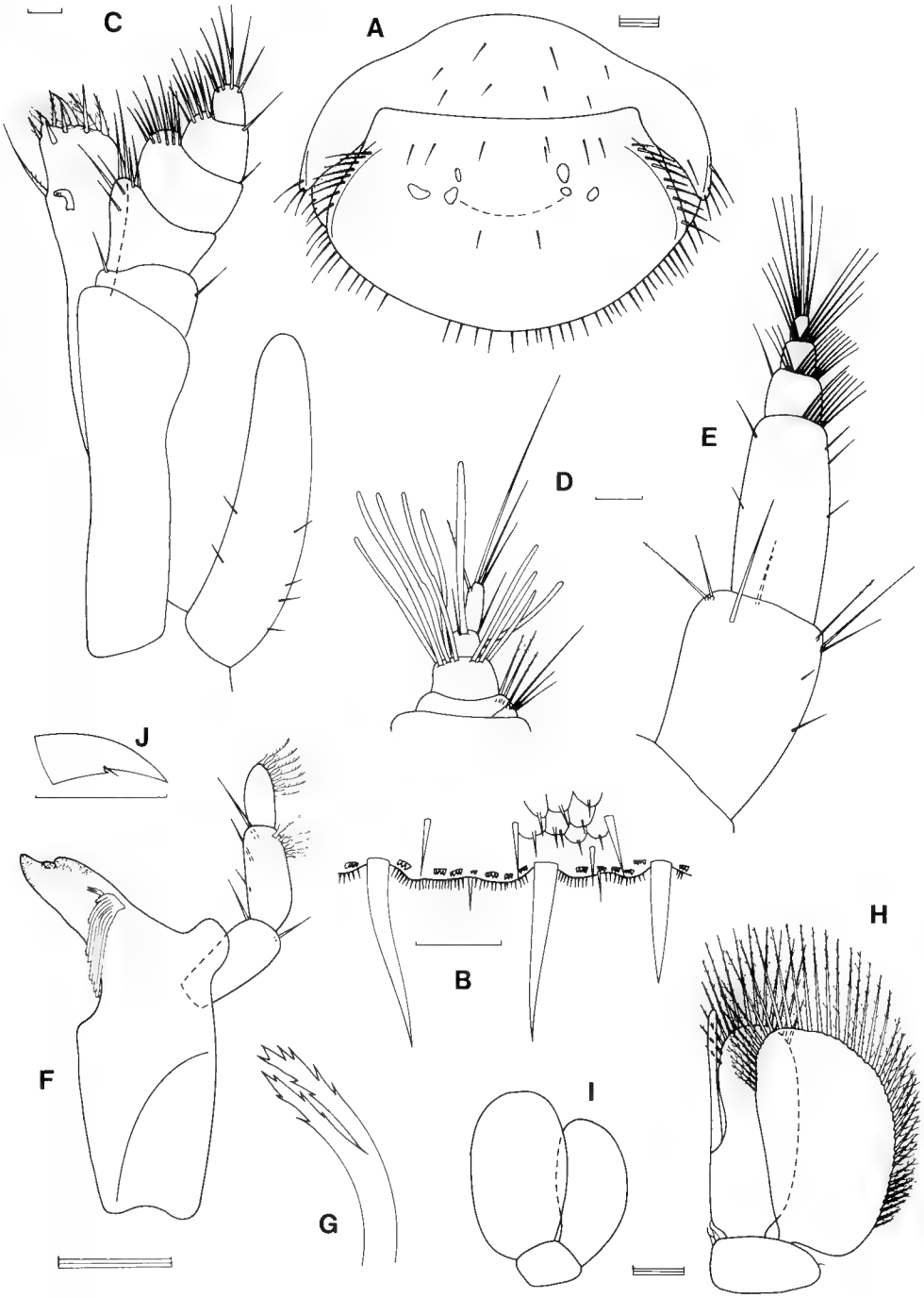

Figure 53. *Limnoria stephenseni* Menzies. A–J, male, NMV J15421: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2; F, right mandible; G, lacinia mobilis of right mandible; H, pleopod 2; I, pleopod 5; J, secondary unguis of pereopod 1.

Distribution. Auckland Islands (type locality); Macquarie Island (Menzies, 1957; current study); Marion Island (Wolff, 1990). 0–8 m depths (current study).

Substrates. Floating *Lessonia* (Stephensen, 1927), *Macrocystis* holdfasts (Hale, 1937); *Durvillaea antarctica* holdfasts (Wolff, 1990; present study).

Remarks. The longest specimen examined by Menzies (1957) was an 8.0 mm female. From Macquarie Island there is a male 8.7 mm long. From Marion Island there is a male 9.8 mm long (Wolff, 1990). Previously the largest limnoriid species known was *L. magadanensis* at 8.5 mm (Jesakova, 1961).

Menzies (1957) did not mention the dorsal row of scale spikes on the posterior margin of the pleotelson, although the fringing posteriorly directed stout setae with small scale spikes between them were noted. This dorsal row was found on all specimens examined here, although on the types the row was absent in patches. The lacinia mobilis of the right mandible was also stated to be undivided (Menzies, 1957) rather than bifid. The lacinia mobilis of the male paralectotype was bifid, although the branches were closed together.

Menzies (1957) assigned the specimens identified as *L. antarctica* by Chilton (1914a) and Hale (1937) to *L. stephenseni*, based on their figures of uropods which showed a shorter exopod than Menzies found on *L. antarctica*. However, uropod length can be variable and the exopod of *L. antarctica* in Fig. 13 is 0.5 times the endopod length, a condition Menzies thought belonged to *L. stephenseni*. The specimens identified by Chilton (1914a) were *L. antarctica*, while Hale's specimens were *L. stephenseni*. Menzies (1957) noted that specimens from the Deception and South Shetland Islands also may not be *L. antarctica* as was determined by Richardson (1913).

L. stephenseni is most similar to *L. antarctica*. The similarities are: the strap-like maxillipedal epipod, four flagellar articles on antennae 1 and 2, strongly indented incisors on the right mandible, article 2 of the mandibular palp with more than one simple seta (*L. glaucinosa* also), short uropodal endopods, lack of sheathed setae on the posterior margin of the pleotelson, similar pleopod 5 shapes, large relatively oval bodies, and antarctic habitats. *L. stephenseni* has more apomorphic characters than *L. antarctica* as it has lost the sculpturing on the abdominal segments, has a modified secondary unguis on pereopod 1 (as does *L. segnis* and *L. chilensis*), and stout setae have replaced sheathed setae along the entire hind perimeter of the pleotelson.

In some specimens the pleotelson also has oblique grooves near the patches that lack large scale spikes, grooves similar to those found in *L. glaucinosa*.

Limnoria sublittorale Menzies

Figure 54

Limnoria (*Limnoria*) *sublittorale* Menzies, 1957: 175–178, fig. 34.—Menzies, 1959: 23.

Material examined. Holotype: NSW. Off coast, 110 m, from oregon fir timber forming part of the frame of otter board of otter fish trawl net, retrieved by trawler, F.A. McNeill, AM P12765 (male, 5.0 mm, 1.3 mm wide pleotelson).

Paratype: Type locality, AM P38932 (male, 4.0 mm, cephalon and uropod previously dissected and now missing, with 1 slide of pleopods). Description of mandibular incisors and lacinia mobilis based on Menzies (1957).

Diagnosis. Pleonite 5 dorsomedially with pair of parallel longitudinal carinae. Pleotelson with pair of parallel longitudinal dorsomedial carinae, with small anterior puncta. Pleonite 5 0.45 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, covered with solitary scale spikes, surface not pitted. Posterior margin of pleotelson with dorsal row of scale spikes; margin fringed with 4 stout setae between which are short-sheathed setae and scale spikes.

Antenna 1 with 4 flagellar articles. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible with 2 recurved apical teeth. Epipod of maxilliped triangular, 3.1 times as long as wide, reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 2, 3, 4, 5, 6, and 7. Uropod peduncle with small lateral tubercles; endopod 0.9 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.6 times length of exopod. Appendix masculina reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Pleopods 1–4 each with 3 coupling hooks. Body length up to 5.0 mm. Colour in alcohol pale yellow.

Distribution. Off the NSW coast (type locality). 110 m depth.

Substrate. Oregon (*Pseudotsuga menziesii* (Mirb.) Franco).

Remarks. Only two specimens of *L. sublittorale* are known. *L. sublittorale* may be restricted to deeper waters off NSW. It has not been collected from the many timbers sampled on the NSW coast at 0–3 m depths.

Menzies' (1957) figure of the setae on the posterior margin of the pleotelson did not indicate

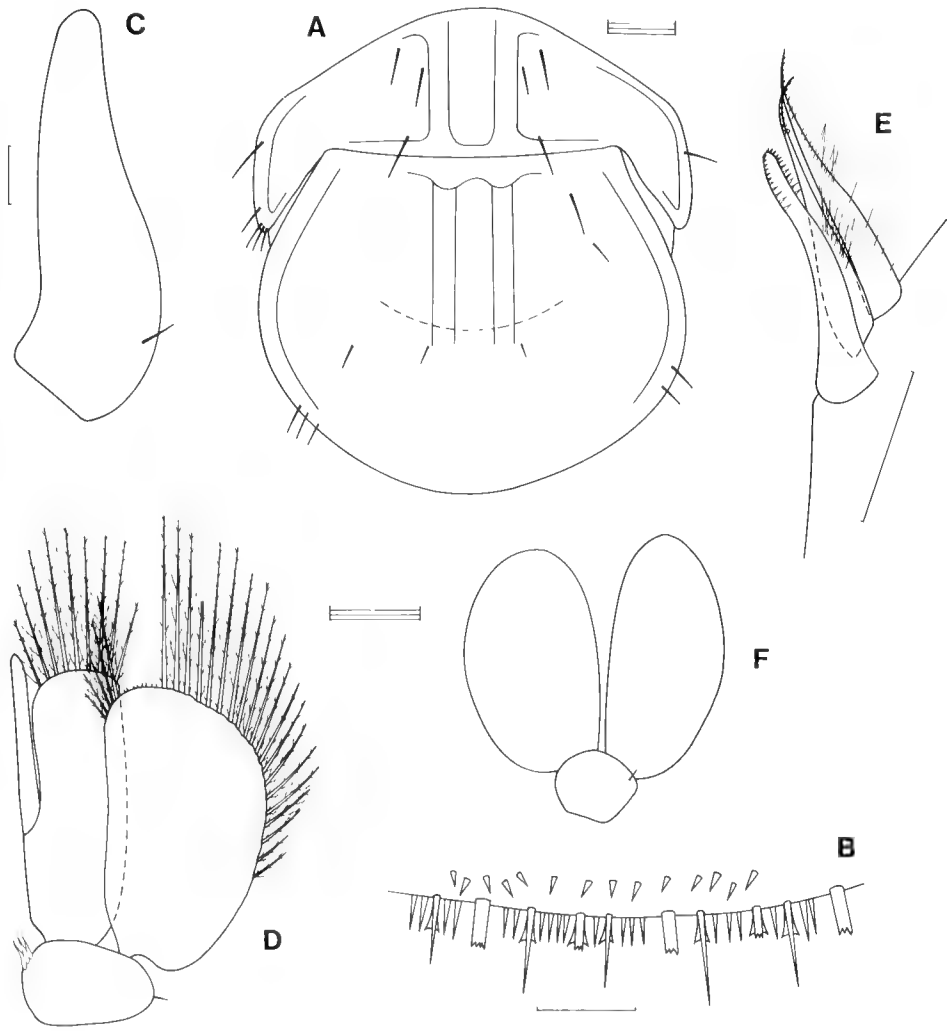

Figure 54. *Limnoria sublittorale* Menzies. A, B, D–F, male, AM P38932, paratype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, stout setae broken, dorsal view; D, pleopod 2; E, coupling hooks on pleopod 2; F, pleopod 5. C, male, AM P12765, holotype, epipod of maxilliped.

that some of the setae were sheathed. The presence of three coupling hooks on pleopods 1-4, on both specimens, was also not noted.

L. sublittorale is similar to *L. raruslima*, *L reniculus*, *L. indica* females, *L. saseboensis* and *L. foveolata* in that all species have a longitudinal pair of carinae on both pleonite 5 and the pleotelson, and a triangular or subtriangular maxillipedal epipod. *L. sublittorale*, *L. reniculus, L. indica*, *L. saseboensis* and *L. foveolata* also have a similar lacinia mobilis of the right mandible, as they have two or several large apical teeth. *L. sublittorale*, *L. reniculus, L. foveolata* and *L. raruslima* all lack tubercles on the margins of the pleotelson. *L. sublittorale* seems most similar to *L. reniculus* as both species also have three coupling hooks on pleopod 2, and are large deep- sea wood-borers from the Tasman Sea. The two species may be most readily separated by sculptural differences on pleonite 5 and the pleotelson.

Limnoria torquisa sp. nov.

Figures 55–57

Material examined. Holotype: Vic. Aireys Inlet (38°28′S, 144°6′E), extracted from *Hormosira banksii* with Pronoxfish (rotenone), W.F. Seed, 23 Jan 1968, NMV J15377 (male, 2.2 mm, 0.55 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J15378 (male, 2.3 mm, with 1 slide), NMV J15379 (ovig. female, 3.0 mm, with 1 slide), NMV J13895 (5 males, 1.8–2.1 mm, 3 non-ovig. females, 1.9, 2.0, 2.1 mm, 2 ovig. females, 2.1, 2.2 mm).

Other material: Vic. Bunurong Coast, The Oaks (38°40′S, 145°38′E), algae in LWM rock pools, G.C.B. Poore, 5 Mar 1982 (stn CPA 21), NMV J15372 (male, 2.0 mm); algae in rock pools, NMV J12892 (male, juv.); Harmers Haven (38°40′S, 145°35′E), algae on LWM rocks, G.C.B. Poore, 6 Mar 1982 (stn CPA 23), NMV J12888 (non-ovig. female, 2.5 mm). Eagles Nest, Venus Bay (38°40′S, 145°40′E), from algae on rocks at low tide, G.C.B. Poore, 5 Mar 1982 (stn CPA 19), NMV J12884 (male, 1.6 mm). 75 m SW of Eagles Nest, Venus Bay (38°40′S, 145°40′E), 8 m, rocky habitat, SCUBA, R. Wilson and G. Barber, 5 Mar 1982 (stn CPA 3), NMV J12886 (crushed juv.). Apollo Bay, rock pools, W.F. Seed, 22 Dec 1970, NMV J15373 (male). Marengo, near Apollo Bay, W.F. Seed, 28 Dec 1970, NMV J13897 (2 males, 4 non-ovig. females, 2 ovig. females). Shoreham, from old and living colonies of *Galeolaria*, W.F. Seed, 28 Feb 1957, NMV J13893 (male, 1.8 mm, non-ovig. female 2.8 mm); under encrusting calcareous algae, W.F. Seed, 28 Feb 1959, NMV J13898 (male).

Diagnosis. Pleonite 5 and pleotelson dorsomedially without carinae and tubercles. Pleonite 5 0.7 times as long as pleotelson. Dorsal surface of pleotelson composed of scales fringed posteriorly with fine scale spikes. Posterior margin of pleotelson with dorsal row of small scale spikes; margin fringed with 6 very long stout setae between which are short-sheathed and scale spikes.

Antenna 1 with 3 flagellar articles; second article with about 8 aesthetases. Flagellum of antenna 2 with 4 articles, article 4 very short. Mandibular palp with 3 articles. Mandibular incisors without rasp and file. Lacinia mobilis of right mandible unbranched, bent at midlength, serrated. Epipod of maxilliped club-shaped, 3.9 times as long as wide, reaching beyond palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 long, bifid, but ventral branch with 2 small branches. Ventral comb seta absent on merus, present on carpus of pereopods 5, 6 and 7. Uropod peduncle without lateral tubercles; endopod as long as peduncle.

Pleopod 2 with long plumose setae up to 0.9 times length of exopod. Appendix masculina long, reaching beyond endopod tip, articulating proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.6 times as long as endopod of pleopod 2; peduncle of pleopod 5 without setae laterally.

Additional characters. Body shape wide. On maxilliped, articulation of palp with basis of endopod indistinct, suggesting partial fusion. Lacinia mobilis of left mandible accompanied by only 1 serrated seta in spine row. Endopod of pleopod 5 with proximomedial simple seta. Endopod of uropod with 4–5 well developed proximally bifurcate pappose setae. Some paratypes with uropod exopod claw smaller than figured, even absent. Basis of pereopod 4 with many well developed proximally bifurcate pappose setae. Secondary unguis on all pereopods with accessory branches or spinules. Pereopods, especially pereopod 4, with many spines and spikes; pereopods 2–6 with large ventral apical spine seta on propodus opposing secondary unguis. Body length up to 3.0 mm. Colour in alcohol white.

Etymology. From the latin *torquis*, necklace, named for one of the host plants, Neptune's necklace (*Hormosira banksii*).

Distribution. Victoria. Mainly rock pools in tidal zone on beaches, also at 8 m depth.

Substrates. May feed on algal surfaces and films without boring, found on *Hormosira*, *Galeolaria*, and under encrusting algae.

Remarks. L. torquisa was often found with *L. glaucinosa*.

The pereopods of *L. torquisa*, especially pereopod 4, have many spines and appear well suited for clinging to various substrates in the tidal zone. This would be important if it was not enclosed in a burrow. The body shape is wider than the tubular shape commonly found for burrow dwelling species. An exposed habitat may also explain the presence of the pappose (possibly sensory) setae on pereopod 4 and the uropod peduncle. The well developed spines on the propodus of the pereopods in some ways parallel the barbs found on the propodus of *L. uncapedis*, although in *L. torquisa* the spines have developed from setae while in *L. uncapedis* the barbs are projections of the integument.

L. torquisa is most similar to *L. nonsegnis*, although with more plesiomorphic characters such as a fully developed mandibular palp and relatively longer pleonite 5. Both species are similar in that they have six stout setae on the posterior margin of the pleotelson, although these are much longer in *L. torquisa* where they may no longer be required for bracing the pleotelson in burrows. Both species also have a club-shaped maxillipedal epipod, similarly serrated lacinia mobilis of the right mandible, and simi-

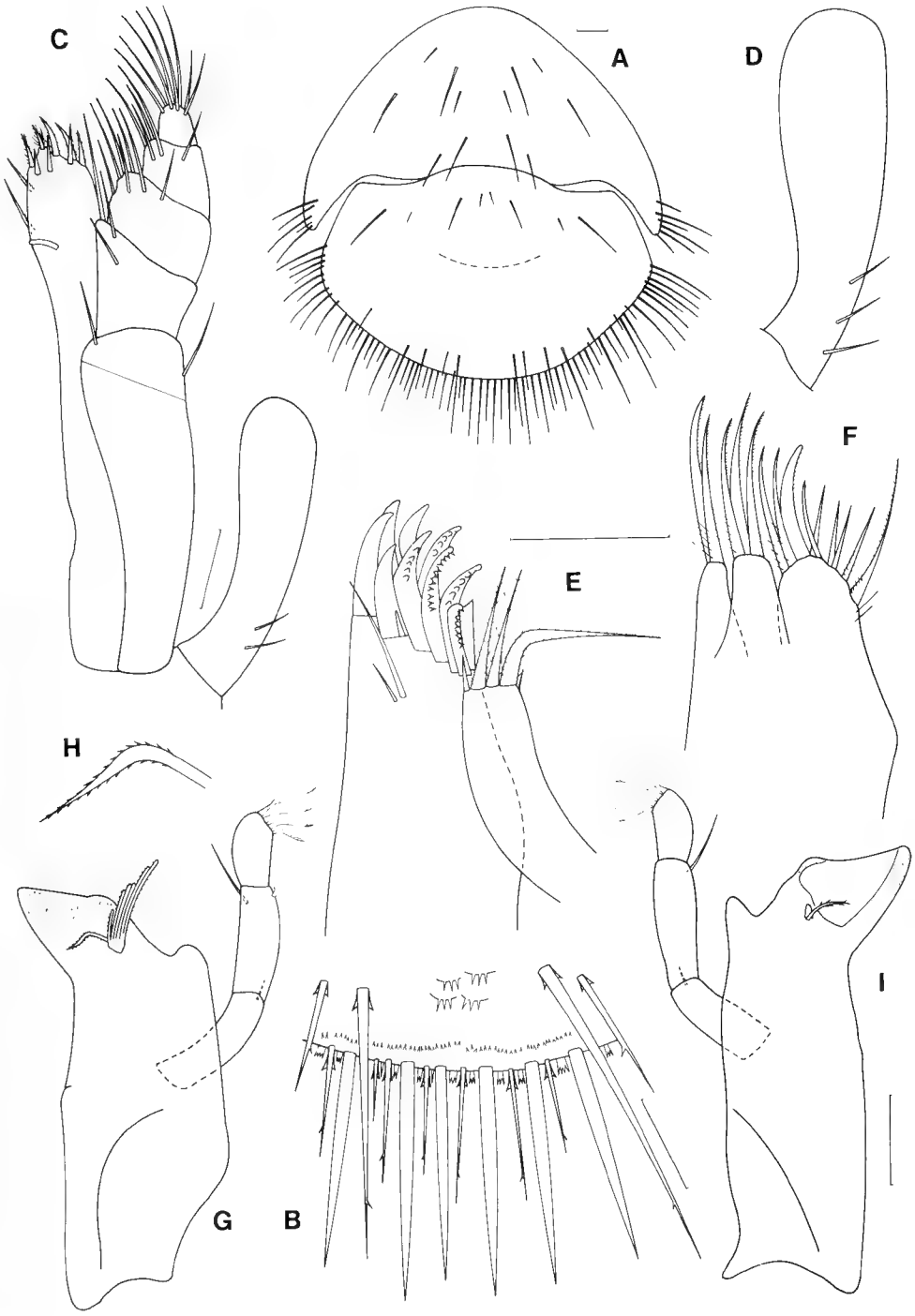

Figure 55. *Limnoria torquisa* sp. nov. A–C, E–I, male, NMV J15377, holotype: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped; E, maxilla 1; F, maxilla 2; G, right mandible; H, lacinia mobilis of right mandible; I, left mandible. D, female, NMV J15379, paratype, epipod of maxilliped.

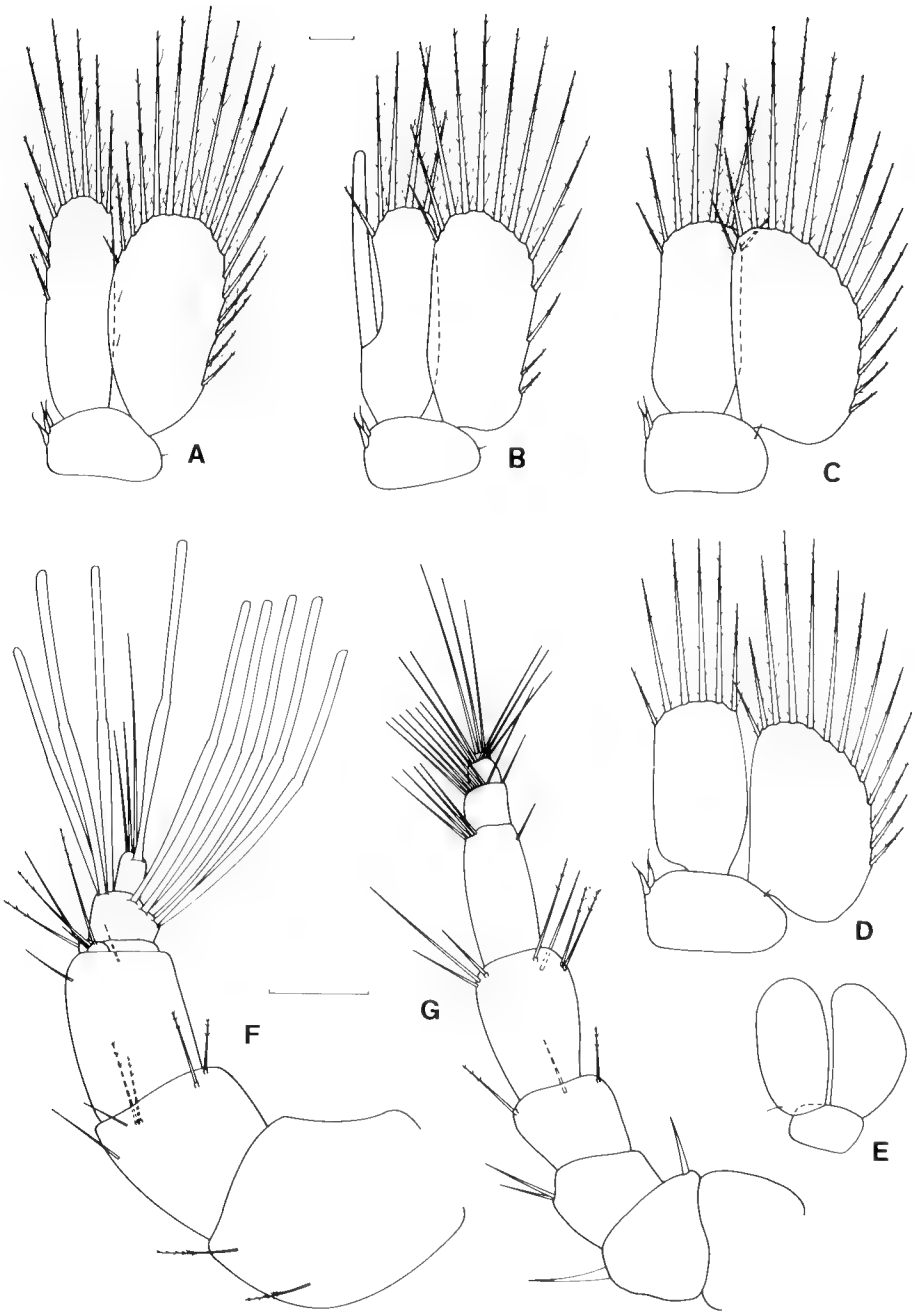

Figure 56. *Limnoria torquisa* sp. nov. A–G, male, NMV J15378, paratype: A–E, pleopods 1–5; F, antenna 1; G, antenna 2.

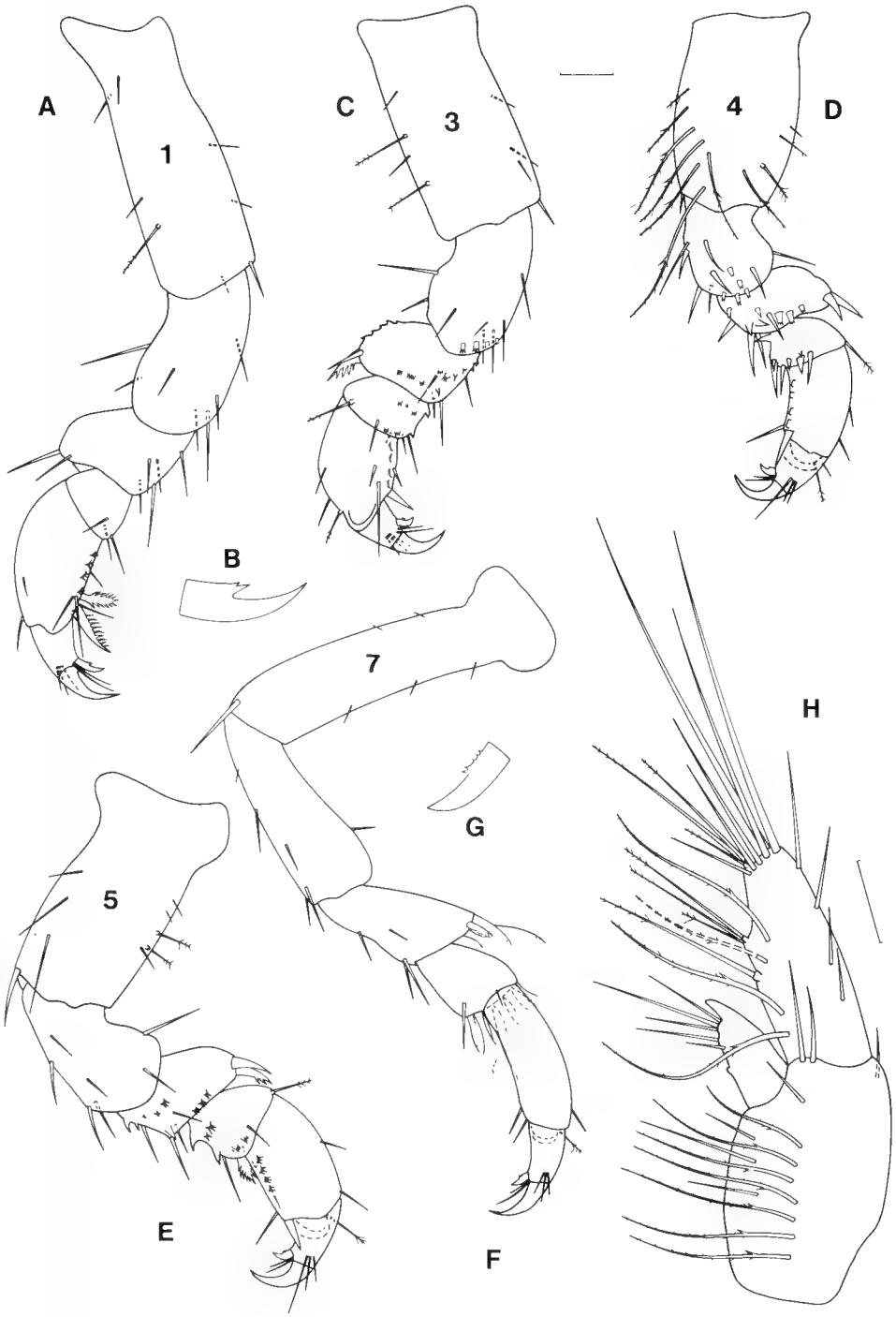

Figure 57. *Limnoria torquisa* sp. nov. A–H, male, NMV J15377, holotype: A, pereopod 1, lateral view; B, secondary unguis of pereopod 1; C, pereopod 3, lateral view; D, pereopod 4, lateral view; E, pereopod 5, lateral view; F, pereopod 7, lateral view; G, secondary unguis of pereopod 7; H, uropod, ventral view.

lar pleopods, even to the point of having a simple seta on the endopod of pleopod 5. However, *L. torquisa* has only three flagellar articles on antenna 1, a situation also found in *L. platycauda*.

L. torquisa may be easily distinguished by the spines on the pereopods, the well developed pappose setae on pereopod 4 and uropod peduncle, the number of flagellar articles on antenna 1, shape of the maxillipedal epipod, and the shape and lack of sculpturing on the abdominal segments.

Limnoria tripunctata Menzies

Figures 58, Plates 1a, b, d, e

Limnoria tripunctata Menzies, 1951b: 86–88, pl. 36.—Menzies, 1951a: M1–M7.—Menzies and Becker, 1957: 86–91, fig. 1.—Eltringham and Hockley, 1958: 1659–1660.—Jones, 1963: 589–603.—McCoy-Hill, 1964: 46.—McQuire, 1964: 35–44.—McQuire, 1965: 34, 36, 39.—Hall and Saunders, 1967: 1–17.—Fougerousse, 1968: 81–94.—Baechler et al., 1970: 47–64.—Menzies, 1972: 149–157, figs 1–2.—Jones et al., 1972: 105, 108–110.—Haderlie, 1974: 57–59.—Jones et al., 1976: 122, 134.—Cooke, 1977: 105–106.—Schultz, 1978: 9, fig. 4c.—Krishnan et al., 1980: 20.—Bultman et al., 1980: 201.—Barnacle et al., 1983: 1–10.—Gambetta and Orlandi, 1983: 27–37.—Nair, 1984: 208–209.—Barnacle et al., 1986: 12.—Cookson, 1987b: 85–89.—Cookson and Barnacle, 1987a: 139–160.—Cookson and Barnacle, 1987b: 287–293.—Eaton, 1989: 63.

Limnoria (*Limnoria*) *tripunctata*.—Menzies, 1957: 137–139, fig. 16 (synonymy).—Becker and Kampf, 1958: 3, 8, fig. 4.—Becker and Kampf, 1959: 13, 15, fig. 4.—Menzies, 1959: 22.—Pillai, 1961: 29, text-fig. 15.—Jesakova, 1961: 183–184, fig. 3.—Oliver, 1962: 32–91, figs 3–4.—Menzies et al., 1963: 97–120.—Menzies and Glynn, 1968: 49.—Santhakumaran, 1969a: 7–11.—Rao and Ganapati, 1969: 226.—Schultz, 1969: 142, fig. 209.—Bastida and Torti, 1972: 143–153, figs 1–4.—Kühne, 1971: 74, figs 3–5, 7.—Kühne, 1975: 453.—Barnacle and Ampong, 1975: 289–310.—Kühne, 1976: 545–546.—Kensley and Schotte, 1987: 224–225.

Biology and timber preservation literature.

Menzies, 1954: 363–388.—Menzies and Widrig, 1955: 149–152.—Barnard, 1955: 87–98.—Johnson and Menzies, 1956: 54–68.—Hochman et al., 1956: 1–37, fig. 12.—Beckman et al., 1957: 162t–164t.—Vind et al., 1957: 35–48, fig. 9.—Meyers and Reynolds, 1957: 969.—Kampf, 1957: 359–375, fig. 1.—Schafer and Lane, 1957: 289–296.—Drisko and Hochman, 1957: 325–329.—Kohlmeyer et al., 1959: 457–489.—Wakeman and Whiteneck, 1959: 37–39.—Lane, 1959: 34–45.—Becker, 1959a: 62–83.—Mohr, 1959: 88.—Becker, 1959b: 443–450.—Hochman, 1959: 45–48, figs 4–5.—Becker and Kampf, 1960: 301–307.—Beckman and Menzies, 1960: 9–16.—Eltringham and Hockley, 1961: 467–482.—Vind and Hochman, 1961: 1–17, fig. 1.—Eltringham, 1961a: 512–513.—Becker and Kühne, 1961: 1352–1356.—Eltringham, 1961b: 785–797.—Vind and Hochman, 1962: 170–178.—Eltringham, 1964: 675–683.—Hochman, 1964: 1–13.—Eltringham, 1965a: 149–157.—Eltringham, 1965b: 145–152.—Walden and Trussel, 1965: 14–15.—Schafer, 1966: 109–115.—Wakeman and Steiger, 1966: 6–7, 24–25.—Colley, 1967: 151–162.—Hochman, 1967: 138–150.—Anderson and Reish, 1967: 56–59.—Eltringham, 1967: 521–529.—Kühne, 1968: 107–118.—Menzies, 1968: 802–803.—Anderson and Stephens, 1969: 243–249.—Coull and Lindgren, 1969: 73–75.—Reish and Hetherington, 1969: 137–139.—Kühne and Becker, 1970: 307–319.—Hochman, 1970: 38–41.—Richards, 1971: 144–146.—Eltringham, 1971: 61–67.—Jones, 1971: 360.—Southwell and Bultman, 1971: 100–102.—Colley, 1972: 44–58.—Richards et al., 1972: 143–146.—Southwell and Bultman, 1972: 49–60.—Kühne, 1973: 814–820.—Sleeter and Coull, 1973: 97–102.—Hochman, 1973a: 254–255.—Hochman, 1973b: 31–36.—Montemartini, 1975: 227–237.—Richards and Webb, 1975: 30–35.—McCarthy, 1975: 902.—Sargent and Domnas, 1976: 317.—Kalnins, 1976: 250–262.—Barnacle, 1976: 57–66.—Fish and Webb, 1978: 260–267.—Sleeter et al., 1978: 329–336.—Bultman, 1978: 12, 15.—Boyle and Mitchell, 1978: 1157–1159.—Parrish and Bultman, 1978: 92–98.—Zachary and Colwell, 1979: 716–717.—Montemartini, 1979: 297–325.—Parrish and Bultman, 1979: 1–12.—Helsing, 1979: 20.—Rutherford et al., 1979: 527–530.—Serpa, 1980: 42–44.—Geyer and Becker, 1980: 53–78.—Boyle and Mitchell, 1980: 179–186.—Webb and Baldwin, 1981: 152–155.—Johnson and Gutzmer, 1981: 1–14.—Johnson, 1982: 704–705.—Richards, 1982: 267–268.—Kühne, 1982: 58.—Geyer, 1982: 77–89.—Zachary et al., 1983: 1–8.—Parrish et al., 1983: 1–17.—Gambetta and Orlandi, 1983: 1–4.—Bultman et al., 1983: 42.—Webb et al., 1984: 41–44.—Johnson and Gutzmer, 1984: 1–23.—Cookson and Barnacle, 1985: 8.—Ampong and Asare-Nyadu, 1985: 2.—Eaton, 1985: 157–191.—Eaton, 1986: 355–365.—Gambetta and Orlandi, 1986: 1–8.—Pendleton and O'Neill, 1986: 1–23.—Cookson, 1987a: 1–14.—Hong and Reish, 1987: 884–888.—Gambetta et al., 1988: 64, 76.—Johnson and Rowell, 1988: 147–156.—Lebow and Morrell, 1988: 25–30.

Limnoria tuberculata Sowinsky.—Geldiay and Kocates, 1972: 23 (possible).—Kussakin, 1979: figs 189–190.—Kensley and Schotte, 1987: 224–225 (probable).—Kensley and Schotte, 1989: 199, fig. 87F.

Material examined. Paratypes: USA, California, San Diego, Mission Bay (32°45′N, 117°10′W), R.J. Menzies, 23 Dec 1948, British Museum (Natural History) 1951.4.20: 6–9 (male, 2.4 mm, non-ovig. female, 2.5 mm).

Other material: USA. San Diego, H. Hemphill, AM P8371 (2, identified as *L. lignorum* by H. Richardson).

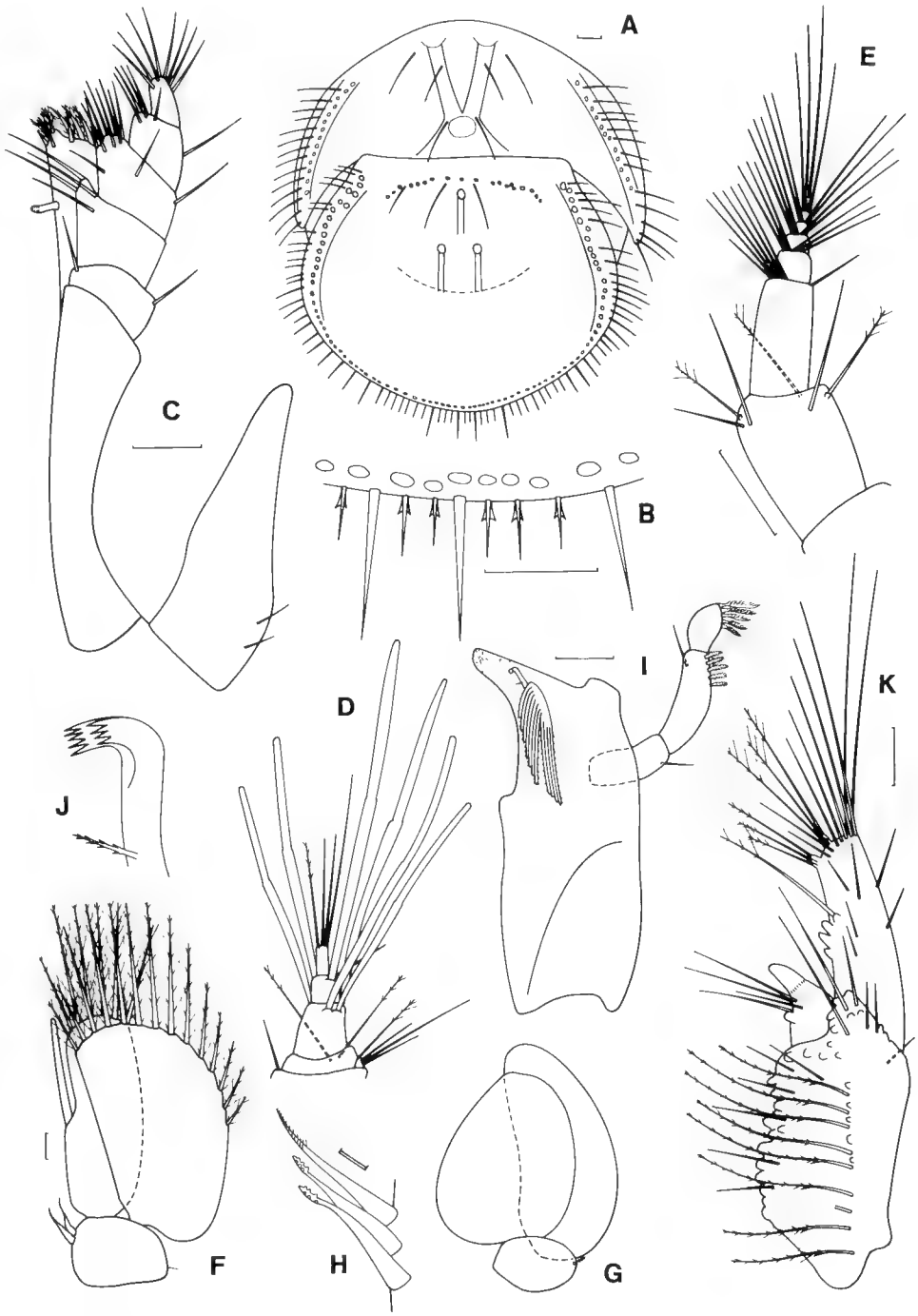

Figure 58. *Limnoria tripunctata* Menzies. A, B, F–K, male, NMV J15429: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; F, pleopod 2; G, pleopod 5; H, coupling hooks on pleopod 1; I, right mandible; J, lacinia mobilis of right mandible; K, uropod, ventral view. C, male, NMV J15431, maxilliped. D, E, male, NMV J15430: D, flagellum of antenna 1; E, peduncle article 5 and flagellum of antenna 2.

UK. Probably Southsea, aquaria at Portsmouth Polytechnic, S.M. Cragg, 8 May 1986, NMV J15293 (male, 2.2 mm, with 1 slide), NMV J15294 (male, 2.0 mm, with 1 slide), NMV J15292 (19).

PNG. Lorengau, Admiralty Islands, S.M. Rayner, 14 Jul 1971, NMV J15488 (juv., with 1 slide).

Vic. Port Phillip Bay: various depths, collectors, dates; Sandringham, *Eucalyptus pilularis* crossbrace, NMV J14893 (48); St Kilda, *E. obliqua* crossbrace, NMV J15239 (122); Williamstown, timber, 17 Jul, 1935, NMV J14889 (14); Williamstown, pine bait, AM P37038 (19), NMV J14890 (12); Williamstown, oregon, NMV J14887 (55); Williamstown, eucalypt, NMV J14888 (31). Western Port: various depths, collectors, dates; Sunday Island, eucalypt pile, NMV J14892 (1); Flinders Naval Base, AM P35413 (1); HMAS Cerberus, eucalypt pile, NMV J14891 (41); Rhyll, *E. obliqua* pile, NMV J15254 (4). Port Albert, *E. obliqua* pile, NMV J15253 (1); Port Albert, AM P35415 (24); Wingan Inlet, AM P35414 (6).

SA. Various depths, collectors, dates; Port Adelaide, *P. radiata* bait, NMV J15245 (42); Cowell, K55 creosoted *P. radiata* pile, NMV J14883 (27), NMV J14885 (19); Cowell, jarrah crossbrace, NMV J14884 (3); Port Lincoln, AM P6116 (12, identified as *L. lignorum* by Baker); Port Lincoln, pine bait, AM P35403 (17); Port Lincoln, K55 creosoted *P. radiata*, NMV J14879 (34), NMV J14881–J14882 (51); Port Lincoln, jarrah crossbrace, NMV J14880 (11); Tumby Bay, *P. radiata* bait, NMV J15242 (1); Arno Bay, *P. radiata* bait, NMV J15241 (2); Streaky Bay, pine bait, AM P35402 (59); Thevenard, K55 creosoted *P. radiata*, NMV J14886 (14).

WA. Various depths, collectors, dates, pine baits: Esperance, AM P35420 (7); Albany, NMV J14921 (12), NMV J14923–J14925 (25); Bunbury, NMV J14937–J14939 (5), AM P35421 (307), AM P35405–P35408 (801); Kwinana, CCA-*P. radiata*, NMV J14954 (20); Kwinana, NMV J14955 (33); Geraldton, NMV J14941–J14947 (178), AM P35422–P35423 (24); Carnarvon, K55 creosoted *P. radiata*, NMV J14935 (51); Carnarvon, NMV J14936 (31), AM P35424 (40); Point Samson, jarrah pile, NMV J15248 (1); Point Samson, CCA eucalypt pile, NMV J15249 (133); near Roebourne, NMV J14929–J149233 (11); Port Hedland, NMV J14928 (1).

NSW. Ulladulla, untreated *E. obliqua* pile heartwood after 5 years, L.J. Cookson and A. Maling, 23 Jul 1986, NMV J15429 (male, 2.7 mm, 0.7 mm wide pleotelson, with 1 slide), NMV J15430 (male, 2.9 mm, with 1 slide), NMV J15431 (male, 2.6 mm, with 1 slide), NMV J15432 (non-ovig. female, 2.9 mm, with 1 slide), NMV J15428 (28 males, 1.7–2.7 mm, 71 non-ovig. females, 2.0–3.3 mm, ovig. female, 3.4 mm, 20 juvs., 1.4–2.4 mm). Various depths, collectors, dates, pine baits; Eden, AM P35393–P35395 (138); Marks Point, AM P37038–P37040 (344); Forster, AM P35396 (7); Coffs Harbour, NMV J15250 (101). Port Stephens, Taylors Beach, 0.2 m, various collectors, dates, pine, eucalypts, creosoted eucalypts; NMV J15307–J15315 (247).

NSW. Sydney Harbour. Various depths, collectors, dates, pine baits; Darling Harbour, oregon, AM P9062 (10); Watsons Bay, AM P37037 (9), P35377 (58), P37035 (50), P35379 (102); Rose Bay, AM P35382 (5); Cabarita, AM P35392 (79); Cammeray, AM P35383 (6), P37036 (27); Bantry Bay, AM P37041 (7), P35381 (11); Goat Island, NMV J15272 (54), AM P35386–P35388 (458), P37034 (6); Goat Island, *Acacia*, NMV J15316 (92); Goat Island, creosoted *P. radiata*, NMV J15275 (33), J15279 (7); Goat Island, turpentine pith, NMV J15270 (10); Goat Island, eucalypt bait, NMV J15278 (13).

Qld. Various depths, collectors, dates, pine baits; Mooloolaba, NMV J14966 (52); Mackay, NMV J15209 (27); Townsville, NMV J15456, J15457 (345); Nelly Bay, AM P35401 (10); Cooktown, NMV J15202 (45); Bowen, AM P35419 (39); Bowen, CCA slash pine pile, NMV J15280 (81), J15284 (54); Bowen, turpentine sapwood, NMV J15281 (31); Bowen, turpentine, NMV J15283 (18), J15286 (19); Bowen, double-treated *P. radiata* pile, NMV J15282 (58), J15285 (35); Maryborough, turpentine pile, NMV J14998 (8); Cairns, creosoted eucalypts, NMV J14981 (7), J15218 (5).

Types. USNM, British Museum (Natural History) and Rijksmuseum van Natuurlijke Historie, Leiden.

Diagnosis. Pleonite 5 dorsomedially with anterior pair of nodes, followed by carinae which converge posteriorly to single node. Pleotelson with anterior dorsomedial punctum followed posteriorly by pair of puncta, each puncta followed posteriorly by carina. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of scales, some with posterior row of thin spikes. Dorsal row of tubercles follows entire perimeter of pleotelson; posterior margin with 4 large stout setae between which are long-sheathed setae, lacking scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 5 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible curved, bifid, with apical teeth. Epipod of maxilliped triangular, 2.9 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 2, 3, 6 and 7. Uropod peduncle with prominent, blunt lateral tubercles; endopod with 3 tubercles near midlength, endopod 0.9 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.6 times length of exopod. Appendix masculina reaching beyond endopod tip, articulating near midlength of endopod. Endopod of pleopod 5 anterior to exopod, circular, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 with comb seta laterally.

Additional characters. Body length up to 3.4 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Distribution. Numerous temperate and tropical locations, including: Mission Bay, California (type locality); USA and central America (Menzies, 1957); Ghana (Barnacle and Ampong, 1975); Hawaii (Cooke, 1977); Argentina (Bastida and Torti, 1972); southern England (Jones 1963); Mediterranean (unless confused with L. tuberculata) (Menzies and Becker, 1957); Madras, India (Becker and Kampf, 1958); Auckland, New Zealand (McQuire, 1964); Admiralty Islands; Australia, except Tasmania. 0–7 m depths (current study).

Substrates. Various treated and untreated timbers, including: creosote-treated softwoods (Menzies, 1957); pine baits (McQuire, 1964; Jones et al., 1972); red mangrove wood (Kensley and Schotte, 1987); TBTO-treated *P. sylvestris* (Gambetta et al., 1988); CCA- and CCB-treated timbers (Cookson and Barnacle, 1985); various eucalypts, pines and treated timbers (current study).

Remarks. Menzies (1957) did not mention or figure the row of small tubercles near the anterior margin of the pleotelson. This row was present in all material examined, including the paratypes. It was also present in specimens from Argentina (Bastida and Torti, 1972). The sculpture pattern on pleonite 5 described by Menzies (1951b) was incorrect (Menzies, 1957). The lacinia mobilis of the right mandible can vary slightly in shape, generally it is apically curved and has a serrated fringe, however the serrated fringe may also be produced as two branches.

For Australia it is noteworthy that *L. tripunctata* does not appear to normally occur in Tasmania. Therefore, creosote-treated softwoods should provide long service lives in this region (Cookson, 1987a). Similarly, *L. tripunctata* has not yet been found on the coast of Victoria west of Port Phillip Bay. Although *L. tripunctata* can be found on the eastern coast of Victoria, it appears to be partly confined to the more sheltered locations of Westernport Bay and Port Phillip Bay.

L. tripunctata is very similar to *L. tuberculata.* Another species with similarities to *L. tripunctata* is *L. orbellum*, for reasons given in the discussion with that species.

Limnoria tuberculata Sowinsky

Figure 59

Limnoria terebrans var. *tuberculata* Sowinsky 1884: 264, pl. 6 figs 31–34, pl. 7 figs 37–47.—Sowinsky, 1898: 505.—Sowinsky, 1904: 108–109.

Limnoria tuberculata.—Menzies and Becker, 1957: 86.—Jesakova, 1965: 456–458, figs 1–2.—Menzies, 1972: 149–157.—Geldiay and Kocatas, 1972: 23 (possible).—Jones et al., 1976: 122, 134.—Kussakin, 1979: 322–325, figs 187–188.—Richards, 1983: 192.

Not *Limnoria tuberculata.*—Menzies and Glynn, 1968: 49.—Kussakin, 1979: figs 189–190.—Kensley and Schotte, 1987: 224–225.—Kensley and Schotte, 1989: 199, fig. 87F (= *Limnoria tripunctata*).

Material examined: Origin of culture unknown, from aquaria at the Bundesanstalt für Materialprüfung, West Germany, S.M. Cragg, May 1988, NMV J15326 (non-ovig. female, 2.8 mm 0.7 mm wide pleotelson, with 1 slide), NMV J15327 (non-ovig. female, 2.8 mm, with 1 slide), NMV J15325 (4 non-ovig. females, 2.4–2.7 mm, 2 ovig. females, 2.7, 2.5 mm).

Types. Not known to exist.

Diagnosis. Pleonite 5 dorsomedially with anterior pair of nodes, followed by carinae which converge posteriorly at single node. Pleotelson with anterior dorsomedial punctum followed posteriorly by pair of puncta, posterior puncta followed by long diverging carinae bearing tubercles, anterior punctum followed posteriorly by shorter carina. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson composed of scales, some with posterior row of thin spikes. Dorsal row of tubercles follows entire perimeter of pleotelson; posterior margin with 4 large stout setae between which are long-sheathed setae, lacking scale spikes.

Antenna 1 with 4 flagellar articles; second article with about 8 aesthetascs. Flagellum of antenna 2 with 5 articles. Mandibular palp with 3 articles. Mandibular incisors with rasp and file. Lacinia mobilis of right mandible curved, with fringe of small apical teeth. Epipod of maxilliped triangular, 2.9 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta on merus of pereopod 7 and carpus of pereopods 2, 3, 6 and 7. Uropod peduncle with prominent, blunt lateral tubercles; endopod with 3 tubercles near midlength, endopod 1.1 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.7 times length of exopod. Structure of appendix masculina unknown. Endopod of pleopod 5 anterior to exopod, oval, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 with comb seta laterally.

Additional characters. Body length up to 2.8 mm. Colour in alcohol pale yellow, with dark reticulate pigment.

Distribution. Sevastopol Bay, Black Sea (type locality) (Sowinsky, 1884). Possibly Massachusetts, southern England (Menzies, 1972), and the Aegean Sea (Geldiay and Kocatas, 1972).

Substrate. Wood.

Remarks. The figure of the pleotelson of *L. tuberculata* from the Black Sea given by Jesakova (1965) is very similar to the pleotelson of the specimen figured here. The shape of the carinae on the pleotelson of *L. lignorum* is similar to the shape on *L. tuberculata*, except that in *L. tuberculata* the carinae also bear tubercles and puncta.

Menzies (1951b) described *L. tripunctata*, unaware of Sowinsky's (1884) description of *L. terebrans* var. *tuberculata*. He later suggested the two may be synonymous (Menzies and Becker, 1957; Menzies and Glynn, 1968). Jesakova (1965) synonymised the species accordingly. Menzies (1972) conducted breeding experiments between so-called *L. tuberculata* from Massachusetts and *L. tripunctata* from several other locations in the USA. He found that viable offspring were not produced, thus concluding that the species were separate. In the same experiment, viable offspring were produced in crosses between different populations of *L. tripunctata*. Menzies (1972) did not draw or describe the pleotelson of his *L. tuberculata* specimens from Massachusetts, other than to say there were a few additional tubercles to the pattern found on *L. tripunctata*. Whether these tubercles were as numerous as shown in the figure given by Jesakova (1965) of a specimen of *L. tuberculata* from the Black Sea is not known.

Menzies (1972) also stated that *L. tuberculata* could be found in southern England, and these also had a few more tubercles than found in the pattern for *L. tripunctata*. Of the specimens from southern England which I examined, only one specimen had extra puncta, but I still consider them all to be *L. tripunctata* as the posterior pair of carinae were not long or tuberculate. The extra puncta on the specimen mentioned were only an extra pair of puncta found immediately behind and partly fused to the normal posterior pair of puncta. More comparisons are required of specimens from different geographical locations to determine the variations. Also, any extra puncta found on *L. tripunctata*/*L. tuberculata* forms should be described or drawn in detail.

Unfortunately the origin of the specimens from the BAM is unknown. These specimens were received, incorrectly labelled as *L. tripunctata*. As well as the long tuberculate carinae on the pleotelson of *L. tuberculata* which distinguishes it from *L. tripunctata*, may be added a difference in the fifth pleopod. The specimens

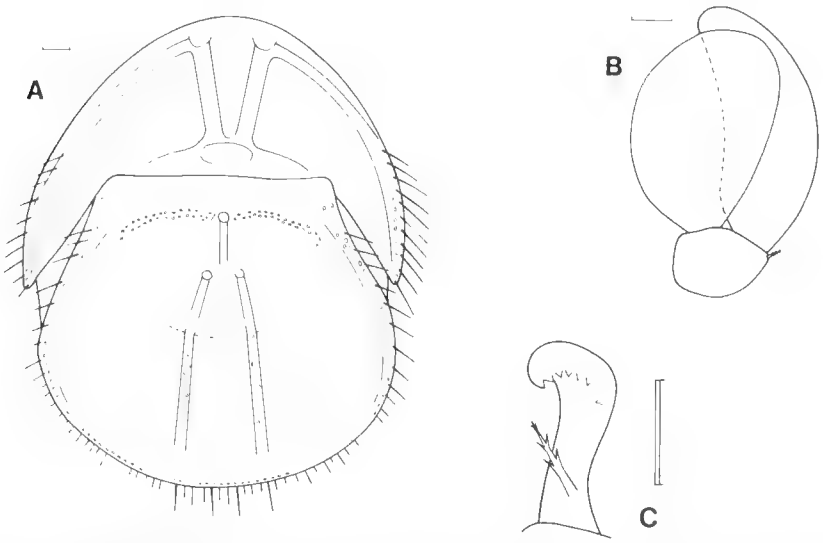

Figure 59. *Limnoria tuberculata* Sowinsky. A, B, female, NMV J15327: A, pleonite 5 and pleotelson, dorsal view; B, pleopod 5. C, female, NMV J15326, lacinia mobilis of right mandible.

from BAM had a less circular shape in the endopod of pleopod 5 than in *L. tripunctata*. In *L. tripunctata*, including the paratypes and the specimens from southern England, the endopod was more produced proxomedially.

Citing unpublished research by Gonor, Richards (1983) stated that unlike *L. tripunctata*, *L. tuberculata* did not attack creosote-treated wood. But this research has not been done (Gonor, pers. comm., 1988).

Limnoria uncapedis sp. nov.

Figures 60–63

Material examined. Holotype: SA, NE side of Topgallant Island, Investigator Group (33°43′S, 134°36.6′E), 7 m, *Acrocarpia aniculata* and red algae, SCUBA, S. Shepherd and G.C.B. Poore, 22 Apr 1985 (stn SA 83), NMV J15330 (male, 1.75 mm, 0.45 mm wide pleotelson, with 1 slide).

Paratypes: Type locality, NMV J15331 (non-ovig. female, 1.6 mm); 12 m, algae, bryozoa and sponges (stn SA 81), NMV J15328 (male, 2.1 mm). "The Hotspot" reef, 5 n. miles W of Flinders Island (33°40.8′S, 134°22.5′E), 21 m, tufted red algae and soft erect bryozoa, SCUBA, G.C.B. Poore, 20 Apr 1985 (stn SA 72), NMV J15333 (male, 1.7 mm, with 1 slide), NMV J15332 (male, 1.6 mm, non-ovig. female, 1.8 mm, juv., 1.1 mm). Tiparra reef, Tiparra Bay (34°4′S, 137°23′E), 11 m, algae on sponges and ascidians, SCUBA, G.C.B. Poore and H.M. Lew Ton, 15 Mar 1985 (stn SA 18), NMV J15334 (non-ovig. female, 1.9 mm).

WA, SW corner of Breaksea Island (35°3.9′S, 118°2.5′E), 15 m, *Ecklonia* holdfast, SCUBA, G.C.B. Poore and H.M. Lew Ton, 7 Apr 1984 (stn SWA 13), NMV J15329 (non-ovig. female, 2.2 mm, with 1 slide). NE end of Vancouver Peninsula (35°3.4′S, 117°56.2′E), 10 m, red algae, SCUBA, G.C.B. Poore and H.M. Lew Ton, 8 Apr 1984 (stn SWA 24), NMV J15305 (2 non-ovig. females, 1.6 1.8 mm); 3 m, tufted red algae, soft coral and sponges (stn SWA 22), NMV J15306 (non-ovig. female, 1.6 mm). Eastern end of Thistle Cove (34°S, 122°12′E), 8 m, brown algae, SCUBA, G.C.B. Poore and H.M. Lew Ton, 11 Apr 1984 (stn SWA 28), NMV J15303 (male, 1.6 mm, non-ovig. female, 1.8 mm); brown algae and corallines (stn SWA 32), NMV J15304 (non-ovig. female, 1.7 mm). Seven Mile beach, north of Dongara (29°12′S, 114°53′E), 1 m, *Padina* and seagrass detritus on sand, G.C.B. Poore and H.M. Lew Ton, 24 Apr 1986 (stn SWA 88), NMV J15335 (non-ovig. female, 2.0 mm, with 1 slide).

Other material: WA, Rat Island, Abrolhos Islands (16°24′S, 123°7′E), reef crest rubble, P.A. Hutchings, 24 Aug 1981, NMV J12877 (juv., 1.7 mm, with 1 slide).

NT, McCluer Island, NW end of Bommies (11°2′S, 132°58′E), 8 m, brown algae, G.C.B. Poore, 16 Oct 1982 (stn NT 32), NMV J12878 (ovig. female, 1.7 mm, with 1 slide), NMV J15336 (ovig. female, 1.8 mm).

Diagnosis. Pleonite 5 and pleotelson dorsomedially without carinae and puncta. Pleotelson slightly raised anteromedially. Pleonite 5 0.6 times as long as pleotelson. Dorsal surface of pleotelson with scales bearing fine spikes posteriorly. Posterior margin of pleotelson with dorsal row of small scale spikes; margin fringed with thin scale spikes and long short-sheathed setae, lacking stout setae.

Antenna 1 with 4 flagellar articles; second article bears about 7 aesthetases. Flagellum of antenna 2 with 4 articles. Mandibular palp absent, replaced by simple seta. Mandibular incisors lack rasp and file. Lacinia mobilis of right mandible with 2 serrated branches. Epipod of maxilliped clavate, 2.2 times as long as wide, reaching articulation of articles 1 and 2 of palp; epipod with simple true setae.

Secondary unguis of pereopod 1 undivided, with about 7 ventral spinules. Ventral comb seta absent on merus, present on carpus of pereopods 6 and 7. Uropod peduncle with few very small lateral tubercles; endopod 0.8 times as long as peduncle.

Pleopod 2 with long plumose setae up to 1.3 times length of exopod. Appendix masculina long, reaching beyond endopod, articulating just proximal to midlength of endopod. Endopod of pleopod 5 anterior to exopod, elongated, oval, 0.75 times as long as endopod of pleopod 2; peduncle of pleopod 5 with simple seta laterally.

Additional characters. Inner lobe of maxilla 1 with 3 pappose setae similar in length. Inner lobe of maxilla 2 with strongly recurved medial seta. Lacinia mobilis of left mandible accompanied by only 1 thick serrated seta. Propodus of pereopods 2–4 with prominent barbed projection opposing secondary unguis of dactyl; projection reduced on pereopod 5, absent on pereopods 1,6 and 7. Secondary unguis of all pereopods with undivided claw fringed by several spinules. Body length up to 2.2 mm. Colour in alcohol pale yellow.

Etymology. From the latin for *uncus* (barb) and *pedis* (foot), relating to the barbed projection on the propodus of some pereopods.

Distribution. South Australia, southern Western Australia, and Northern Territory. 1–21 m depths.

Substrates. A variety of red and brown algae, and possibly bryozoans and sponges.

Remarks. The specimens from the Northern Territory and Abrolhos Islands had all typical

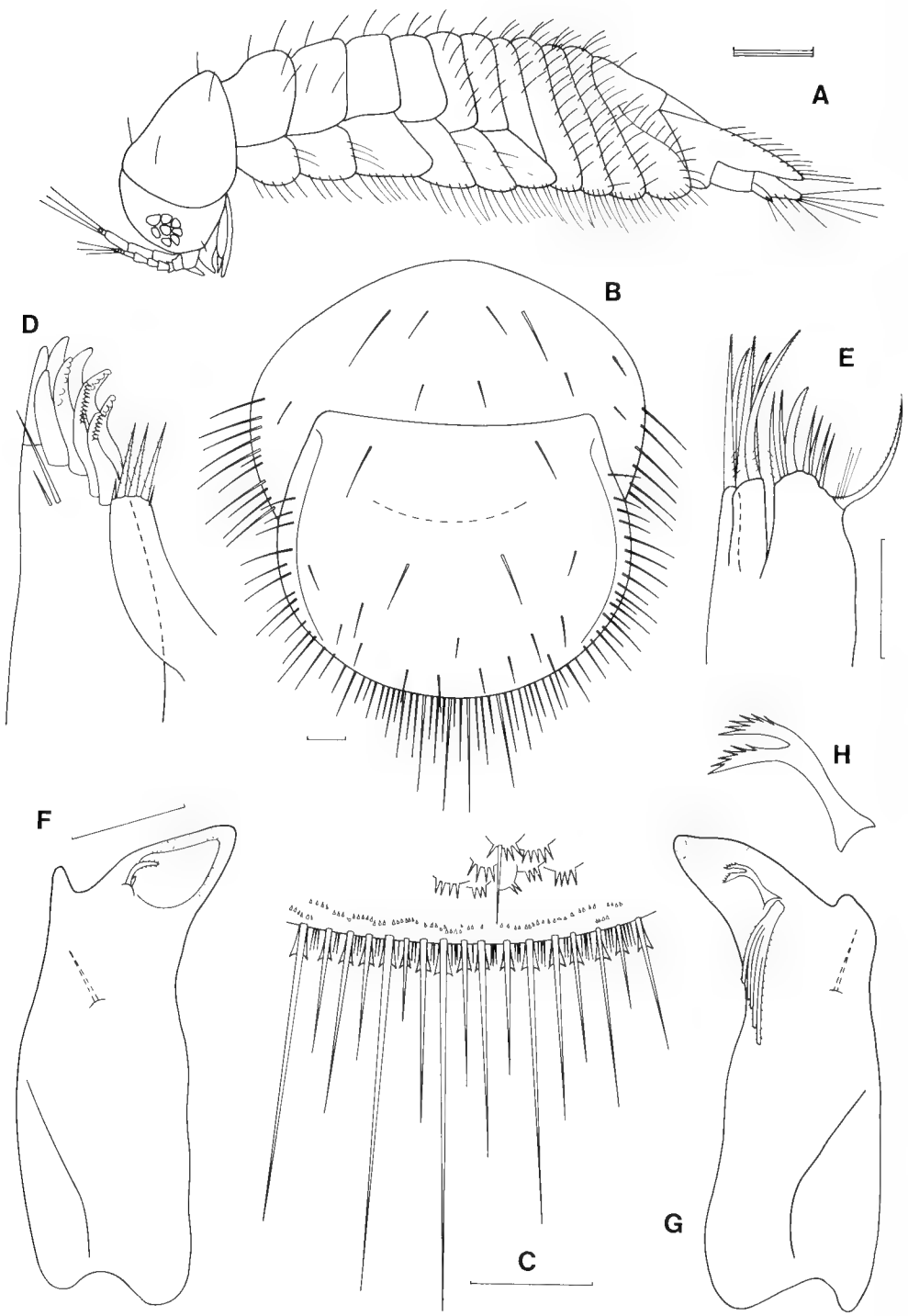

Figure 60. *Limnoria uncapedis* sp. nov. A–H, male, NMV J15330, holotype: A, lateral view; B, pleonite 5 and pleotelson, dorsal view; C, posterior margin of pleotelson, dorsal view; D, maxilla 1; E, maxilla 2; F, left mandible; G, right mandible; H, lacinia mobilis of right mandible.

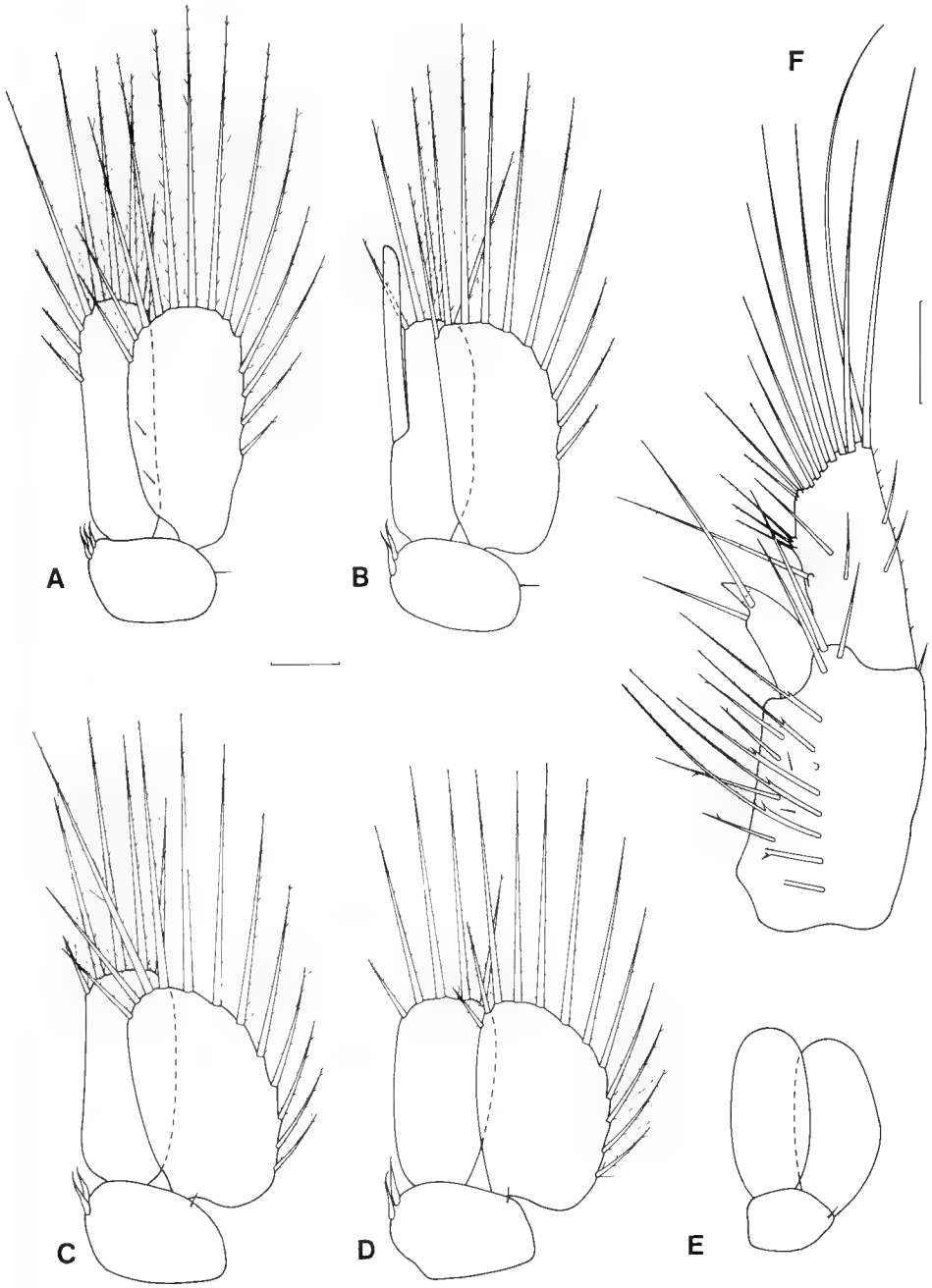

Figure 61. *Limnoria uncapedis* sp. nov. A–E, male, NMV J15333, paratype: A–E, pleopods 1–5. F, male, NMV J15330, holotype, uropod, ventral view.

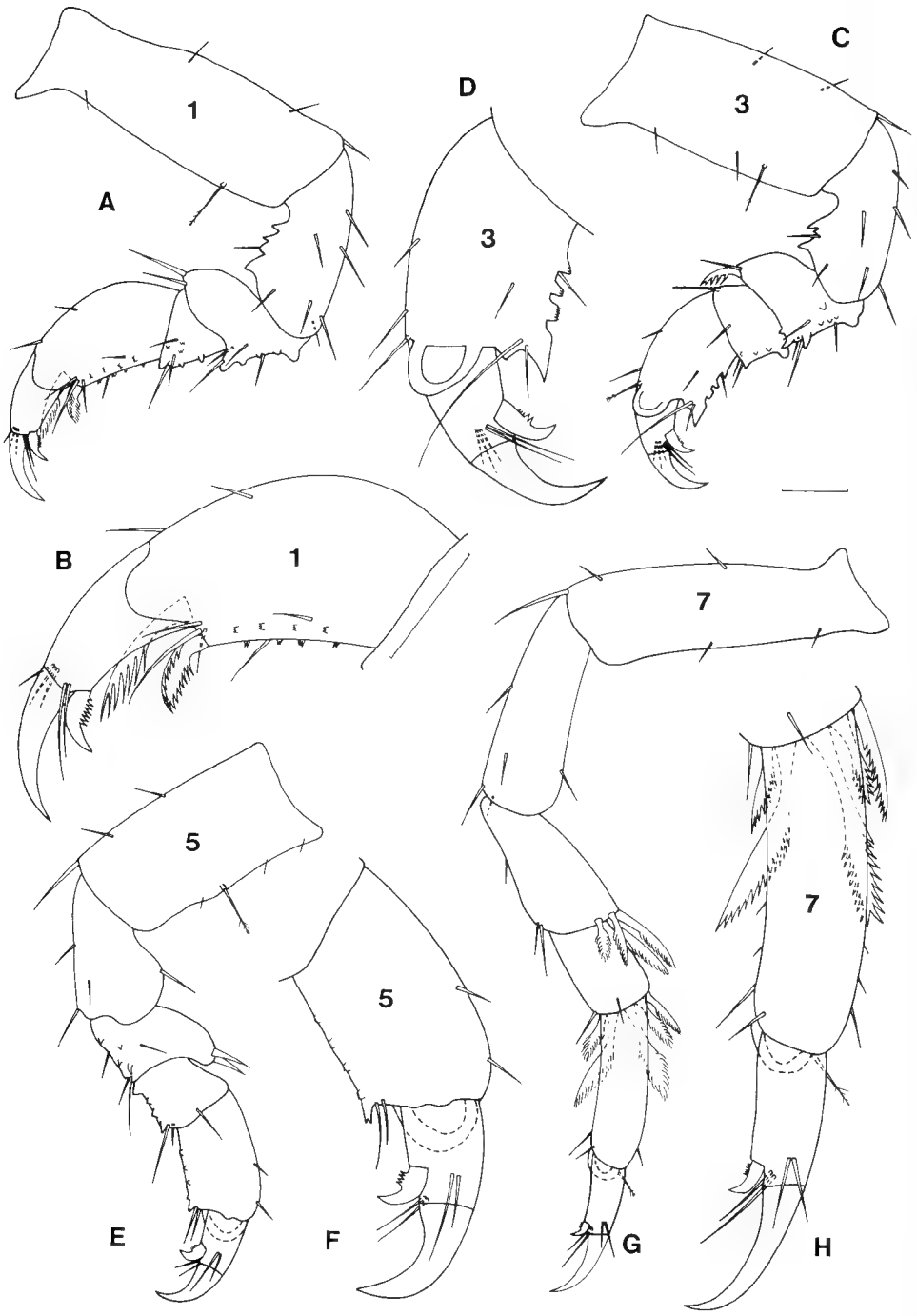

Figure 62. *Limnoria uncapedis* sp. nov. A–H, male, NMV J15330, holotype: A, pereopod 1; B, propodus and dactylus of pereopod 1; C, pereopod 3; D, propodus and dactylus of pereopod 3; E, pereopod 5; F, propodus and dactylus of pereopod 5; G, pereopod 7; H, propodus and dactylus of pereopod 7; all lateral views.

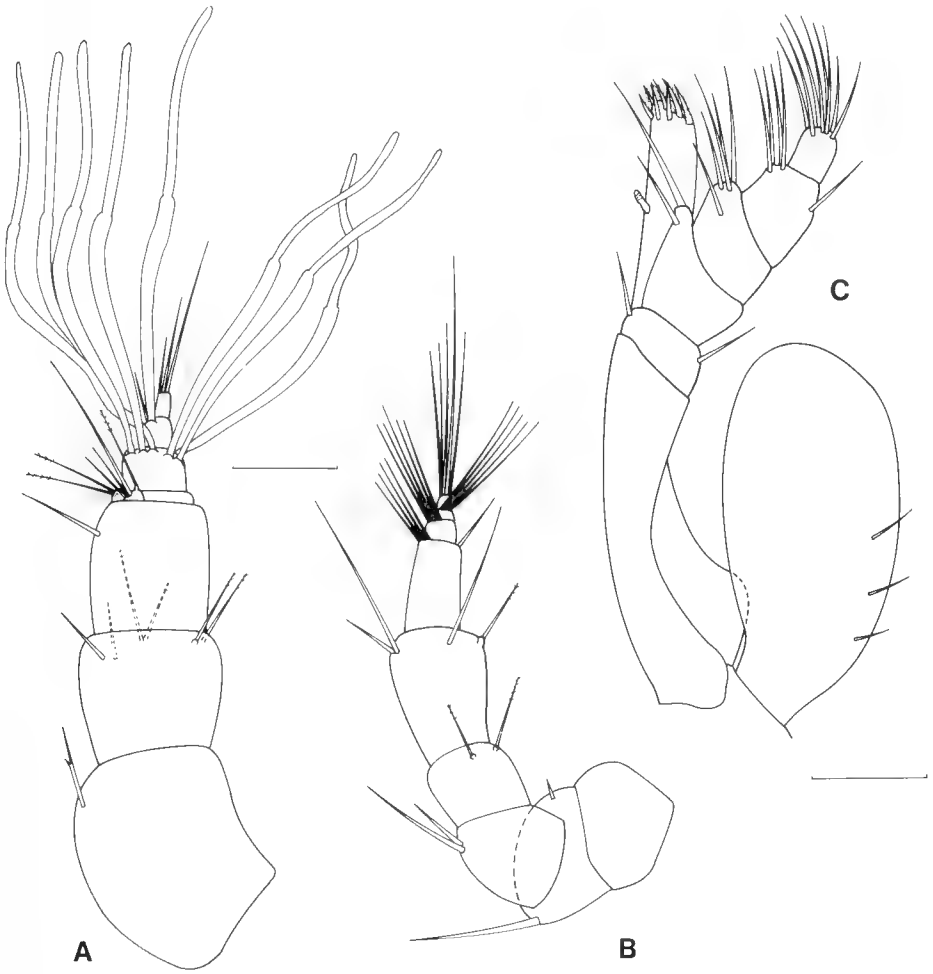

Figure 63. *Limnoria uncapedis* sp. nov. A–C, male, NMV J15330, holotype: A, antenna 1; B, antenna 2; C, maxilliped.

features, except that they lacked the dorsal row of scale spikes on the posterior margin of the pleotelson, although NMV J15336 from the Northern Territory had a row of scale spikes in one small area.

L. uncapedis, *L. segnoides* and *L. bituberculata* all share the following features: broad maxillipedal epipod, loss of mandibular palp, similar shape of the lacinia mobilis of the right mandible, and modification of the secondary unguis on pereopod 1. *L. bituberculata* also appears to have a recurved inner seta on maxilla 2 (Pillai, 1961), and strong barbed projections on the propodus of at least pereopod 2 similar to those found in *L. uncapedis*. *L. uncapedis* can be separated from *L. segnoides* by the lack in *L. segnoides* of accessory spinules on the secondary unguis of pereopod 1. Also, *L. segnoides* has distinctive sculpturing on pleonite 5 and the pleotelson while *L. uncapedis* does not. *L. bituberculata* differs by having two puncta joined by an arcuate carina on the pleotelson, fewer spinules (four) on the secondary unguis of pereopod 1 (*L. uncapedis* has about seven), and by lacking a dorsal row of scale spikes on the posterior margin of the pleotelson (although this is also found in *L. uncapedis* from the Northern Territory and Abrolhos Islands). Without examining some type specimens of *L. bituberculata*, the most reliable difference between the two species appears to be the pleotelsonal ornamentation on *L. bituberculata*. *L. bituberculata* was collected from the holdfast of *Sargassum* rather than red algae.

L. uncapedis lives on small seaweeds and fragile substrates and so may be relatively exposed.

It may have developed the pereopodal barbs to help maintain a firm grip on substrates.

Limnoria unicornis Menzies

Figures 64, 65, Plates 1c, 2e, f

Limnoria (*Limnoria*) *unicornis* Menzies, 1957: 173–175, fig. 32.—Ganapati and Rao, 1960: 275–276.—Rao and Ganapati, 1969: 226.

Limnoria unicornis.—Nair, 1984: 208.—Kensley and Schotte, 1987: 225–226, fig. 6.—Cookson, 1987a: 3, 7.—Cookson et al., 1989: 1–8.—Kensley and Schotte, 1989: 199, fig. 88A, B.

Material examined. Qld. Port Douglas, tidal zone, sapwood of CCA-treated turpentine pile, J.E. Barnacle and L.J. Cookson, 29 May 1986, NMV J15352 (male, 2.5 mm, 0.7 mm wide pleotelson, with 1 slide), NMV J15353 (male, 2.6 mm, with 1 slide), NMV J15354 (male, 2.4 mm, with 1 slide), NMV J15355 (male, 1.9 mm, with 1 slide), NMV J15351 (57 males, 1.5–2.9 mm, 54 non-ovig. females, 1.5–2.8 mm, 32 ovig. females, 2.2–3.2 mm, 7 juvs. 1.0–1.4 mm); 0.5 m, turpentine pile, J.E. Barnacle, 29 May 1984, NMV J14958 (1); 0 m, sapwood of CCA-treated turpentine pile, J.E. Barnacle, 29 May 1984, NMV J14967 (5); 1.5 m, sapwood and heartwood of turpentine pile no 5, L.J. Cookson, 15 Dec 1987, NMV J15216 (4); tidal zone, sapwood of CCA-treated turpentine pile no 1, L.J. Cookson, 16 Dec 1987, NMV J15217 (47).

WA. Point Samson, low tide near mud-line, untreated eucalypt pile, J.E. Barnacle and L.J. Cookson, 15 Sep 1985, NMV J14963 (45); sapwood of CCA-treated eucalypt, NMV J14964 (6). Port Hedland, midtide, jarrah pile stump, L.J. Cookson and R. Morrison, 26 Jun 1986, NMV J14953 (13). Broome, 0.5 m, untreated sawn jarrah after 2 years, L.J. Cookson, 26 Sep 1986, NMV J14952 (17).

PNG. Lae, sapwood of CCA-treated *E. maculata* CSIRO test stake, S.M. Rayner, NMV J15302 (male, non-ovig. female). Wewak, tidal zone, CCA-treated *Diospyros papuana* pile in wharf, S.M. Cragg, 1985, NMV J15493 (5 males, 1.7-2.0 mm, 2 non-ovig. females, 1.7, 1.9 mm, 2 ovig. females, 1.8, 1.9 mm, juv., 0.8 mm).

Types. Returned to Dr C.H. Edmondson at Bernice P. Bishop Museum, Honolulu, by Menzies.

Diagnosis. Pleonite 5 dorsomedially with Y-shaped carina. Pleotelson with large anterior dorsomedial punctum. Pleonite 5 0.5 times as long as pleotelson. Dorsal surface of pleotelson with scales fused, surface pitted, covered with sparsely distributed solitary scale spikes. Posterior margin of pleotelson without dorsal row of tubercles or scale spikes; margin fringed with 4 large stout setae between which are short short-sheathed setae and thin scale spikes.

Antenna 1 with 4 flagellar articles; second article with 3 long aesthetascs. Flagellum of antenna 2 with 4 articles. Mandibular palp with 1 reduced article, without comb setae but with 2 long apical simple setae. Mandibular incisors with a rasp and file. Lacinia mobilis of right mandible very short, without teeth or serrations. Epipod of maxilliped triangular, 3.0 times as long as wide, not reaching palp articulation; epipod with simple true setae.

Secondary unguis of pereopod 1 bifid. Ventral comb seta absent on merus of pereopods, present on carpus of pereopods 2, 3, 4, 5, 6 and 7. Uropod peduncle with few small lateral tubercles; endopod 0.8 times as long as peduncle.

Pleopod 2 with plumose setae up to 0.7 times length of exopod. Appendix masculina reaching tip of endopod, articulating proximal to mid-length of endopod. Endopod of pleopod 5 anterior to exopod, oval, 0.8 times as long as endopod of pleopod 2; peduncle of pleopod 5 without seta laterally.

Additional characters. Pleotelson with sexual dimorphism, medial punctum much larger in males than females. Body length up to 3.2 mm. Colour in alcohol pale yellow.

Distribution. Ponape, Caroline Islands (type locality) (Menzies, 1957); Andaman Islands (Ganapati and Rao, 1960); Palau; Huahine Island, Society Islands; San Salvador; Belize (Kensley and Schotte, 1987); PNG; northern Western Australia; Port Douglas, Queensland. 0–1.5 m depths (current study).

Substrates. Wooden test sample (Menzies, 1957), wooden plank (Ganapati and Rao, 1960), red mangrove wood and roots, (Kensley and Schotte, 1987), jarrah, CCA-treated hardwoods (*E. marginata*, *S. glomulifera*, *E. maculata*, *Diospyros papuana*) (present study).

Remarks. Menzies (1957) had only one male specimen and a male pleotelson when describing this species, and so was unaware of the sexual dimorphism. Some of the setae which fringe the posterior margin of the pleotelson are sheathed, which was not indicated by Menzies' (1957) figure. Also, Menzies (1957) thought the lacinia mobilis of the right mandible was simple and apically spinulate. However, in the specimens examined here, the lacinia mobilis is a reduced blunt knob (Plate 2f). As Menzies had only one right mandible to examine, which was apparently mounted in a way that does not give the best view of the lacinia mobilis, it is likely the most apical seta in the spine row was mistaken for the lacinia mobilis.

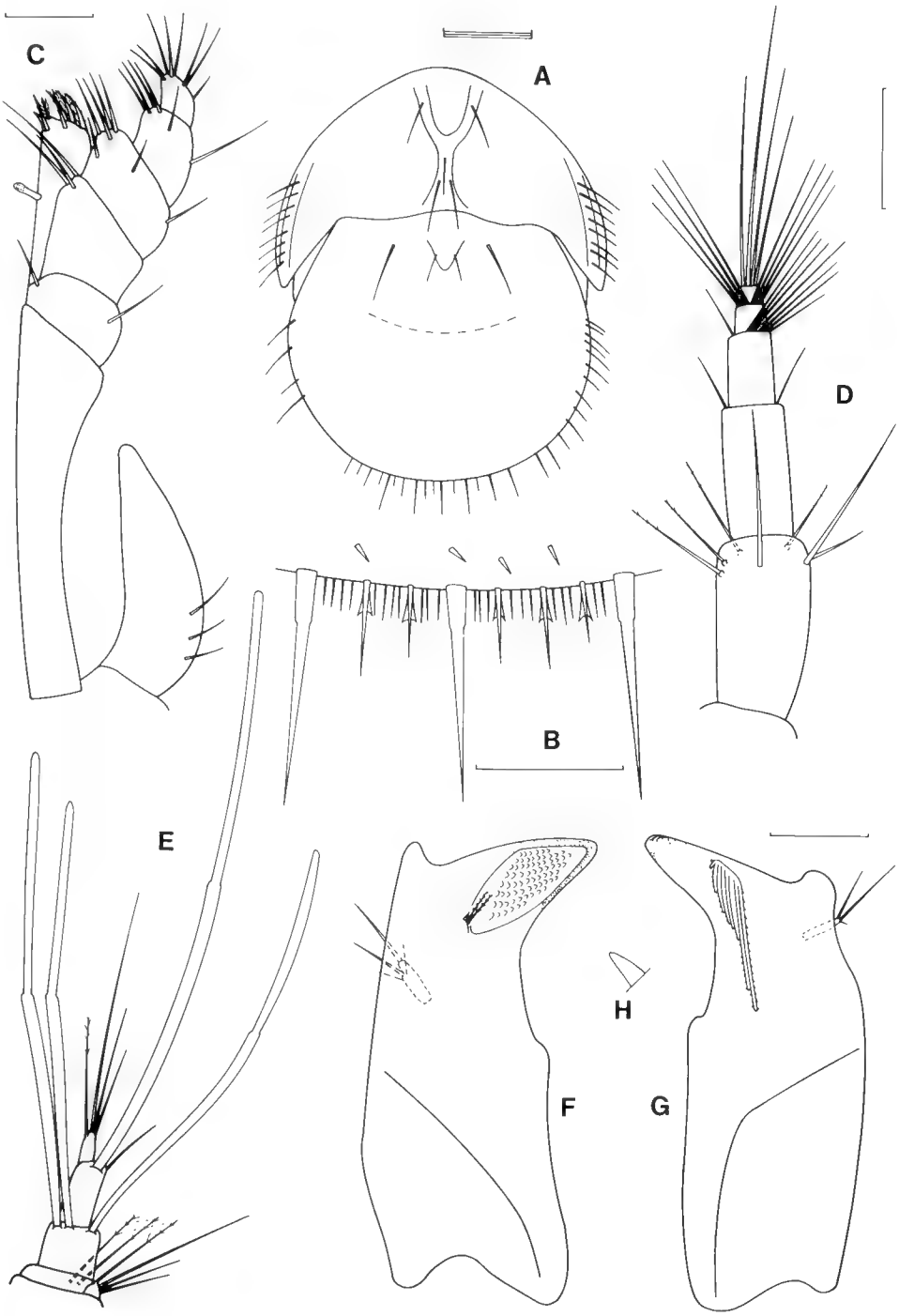

Figure 64. *Limnoria unicornis* Menzies. A–C, male, NMV J15352: A, pleonite 5 and pleotelson, dorsal view; B, posterior margin of pleotelson, dorsal view; C, maxilliped. D,E, male, NMV J15355: D, peduncle article 5 and flagellum of antenna 2; E, flagellum of antenna 1. F–H, male, NMV J15353: F, left mandible; G, right mandible; H, lacinia mobilis of right mandible.

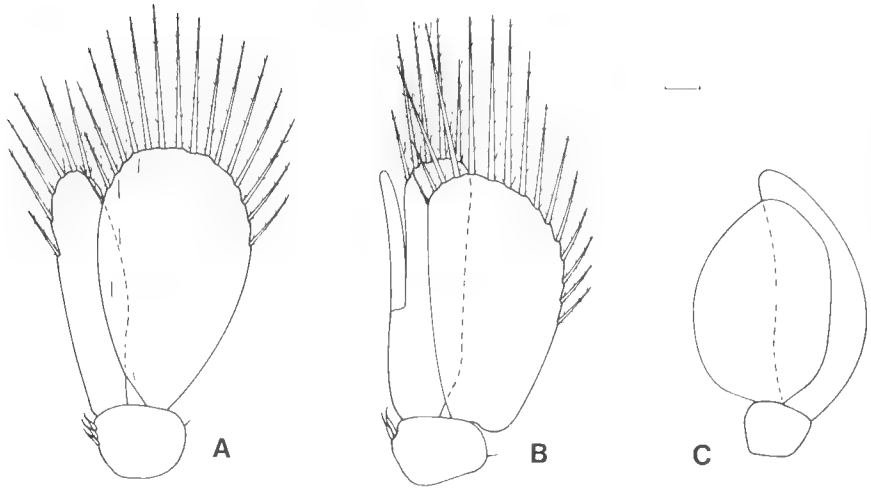

Figure 65. *Limnoria unicornis* Menzies. A–C, male, NMV J15352: A–C, pleopods 1, 2 and 5.

This species does not have obvious affinities with any other species, except possibly the seagrass-borer *L. zinovae*. Both species have one medial punctum on the pleotelson, the size of which is sexually dimorphic (Plate 2e); a Y-shaped carina on pleonite 5; four flagellar articles on antenna 2; and a reduced mandibular palp. The only other known wood-borer with a (slightly) reduced mandibular palp is *L. cristata*, which, like *L. unicornis*, has a triangular maxillipedal epipod, no dorsal row of tubercles or scale spikes on the posterior margin of the pleotelson (Plate 1c), and a similar arrangement of setae fringing the posterior margin of the pleotelson.

Menzies (1957) thought that *L. unicornis* was similar to *L. segnis* and *L. segnoides*. However, the pleotelsonal ornamentation on these species has a bilateral pattern (although joined anteriorly by a broad raised area), rather than one with an anterior medial punctum. Also in these particular species of algal-borers, the shape of the maxillipedal epipod is not triangular, and the ventral branch of the secondary unguis on pereopod 1 is reduced.

L. unicornis is most readily distinguished by the sculpturing on pleonite 5 and the pleotelson, and the possession of only one article on the mandibular palp.

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I would like to thank Dr Gary Poore for helpful discussions on limnoriid taxonomy and phylogeny, and the loan of specimens. John Barnacle also engaged in helpful discussions on taxonomy, and collected numerous limnoriids for examination. Dr Niel Bruce and Dr Ian Bayly provided many useful comments on the manuscript. John Ward helped with producing the SEM photographs. Dr Simon Cragg sent me a wealth of material from Papua New Guinea, and other countries. Alan Maling, Koppers Australia, provided funds to cover the sending of bait blocks to harbour authorities. John Crimmins made it possible for me to examine many timbers and condemned jetties in Victoria. Many other persons from various port authorities helped by placing and returning bait blocks. Hugo Ilic often identified the timber species of riddled timbers which had contained marine borers.

Loans of limnoriid material were generously provided by Roger Springthorpe, Australian Museum; Marilyn Schotte and Dr Brian Kensley, National Museum of Natural History, Washington, DC; Dr Geoff Hicks, National Museum of New Zealand; Wolfgang Zeidler, South Australian Museum; Dr Torben Wolff, Zoologisk Museum, Copenhagen; Joan Ellis, British Museum (Natural History); Dr Gary Morgan, Western Australian Museum; Alison Green, Tasmanian Museum and Art Gallery; and Anthony Savill, Canterbury Museum, Christchurch.

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Plates

Plate 1a.

Rasp incisor on left mandible of *Limnoria tripunctata* collected from Ulladulla, NSW. Partly concealed lacinia mobilis is left of two accompanying serrated setae. Scale = 10 μm.

Plate 1b.

Limnoria tripunctata collected from Goat Island, Sydney Harbour. Long-sheathed setae and dorsal row of tubercles on posterior margin of pleotelson. Dorsal view. Scale = 3 μm.

Plate 1c.

Limnoria unicornis collected from Port Douglas, Queensland. Posterior margin of pleotelson. Note the lack of a regular dorsal row of scale spikes. Shows a large stout seta (left), two short-sheathed setae (middle and right), and thin scale spikes. Scale = 5 μm.

Plate 1d.

Limnoria tripunctata collected from Goat Island, Sydney Harbour. Puncta found dorsomedially on pleotelson. Note scale structure of pleotelson. Scale = 10 μm.

Plate 1e.

Limnoria tripunctata collected from Goat Island, Sydney Harbour. Nodes found dorsomedially on pleonite 5. Note scale structure. In this specimen, only the posterior scales were fringed posteriorly with thin spikes. Scale = 20 μm.

Plate 1f.

Limnoria andamanensis collected from Buka Passage, Papua New Guinea. Lacinia mobilis of right mandible. Scale = 1 μm.

Plate 2a.

Limnoria insulae collected from Magnetic Island, Queensland. Pleonite 5 and pleotelson. Note claw-like tubercles on uropod peduncle. Scale = 100 μm.

Plate 2b.

Limnoria insulae collected from Tahira, Papua New Guinea. Pleonite 5 and pleotelson. Shows deep cup-shaped pleotelson. Scale = 100 μm.

Plate 2c.

Limnoria orbellum sp. nov. Pleonite 5 and the pleotelson. Note both the scale structure, and the four stout setae on the posterior margin of the pleotelson. Scale = 100 μm.

Plate 2d.

Limnoria quadripunctata collected from Sandringham, Victoria. Pleonite 5 and pleotelson. Note pitted structure. Scale = 100 μm.

Plate 2e.

Limnoria unicornis, male, collected from Port Douglas, Queensland. Pleotelson and pleonite 5. Note pitted structure. Scale = 100 μm.

Plate 2f.

Limnoria unicornis collected from Port Douglas. Lacinia mobilis, and setal row, of right mandible. Scale = 3 μm.

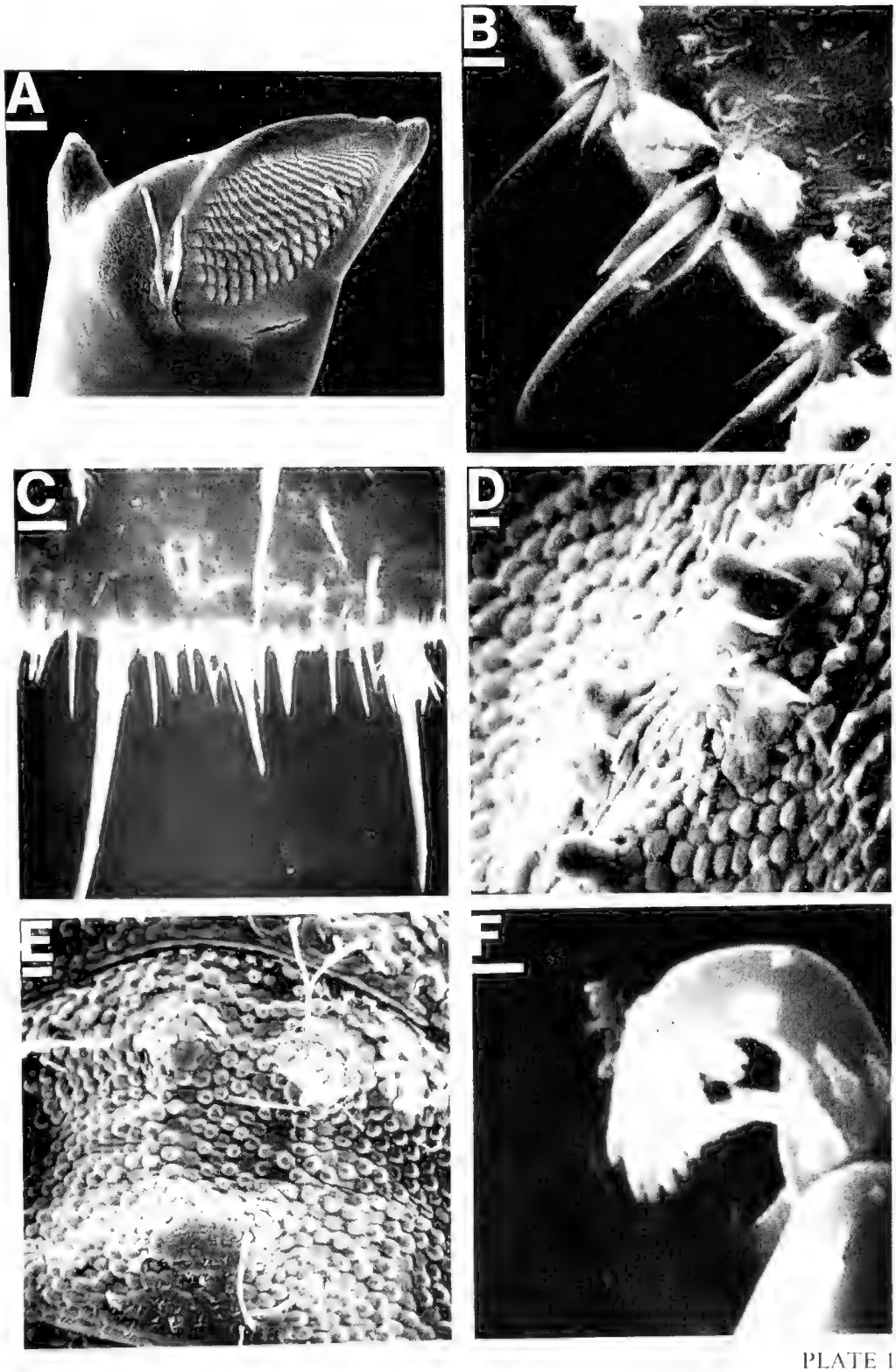

PLATE 1

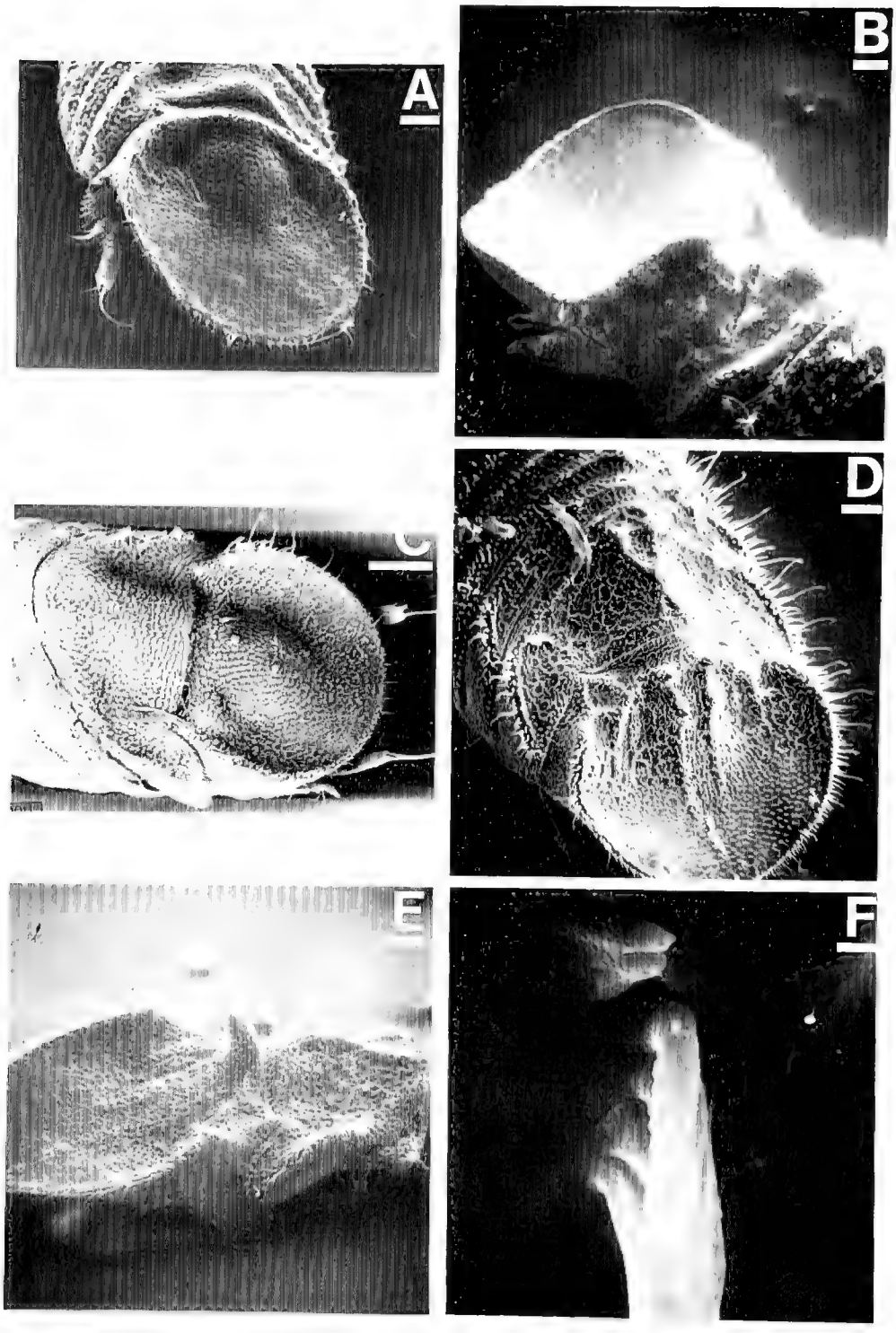

PLATE 2

Memoirs of the Museum of Victoria 52(2): 263–275 (1991) ISSN 0814-1827

NEW RECORDS OF MARINE ISOPOD CRUSTACEANS (SPHAEROMATIDAE, CIROLANIDAE) FROM SOUTH-EASTERN AUSTRALIA

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Abstract

Bruce, N.L., 1991. New records of marine isopod crustaceans (Sphaeromatidae, Cirolanidae) from south-eastern Australia. *Memoirs of the Museum of Victoria* 52: 263–275.

The sphaeromatid genus *Bathycopea* Tattersall, 1905, is recorded for the first time from Australia and is the first record of the subfamily Ancininae from Australian waters. *B. typhlops* Tattersall, 1905 is figured. *Cirolana binyana* sp. nov. is described from a single specimen and its systematic position briefly discussed. The genus *Politolana* Bruce, 1981, previously recorded only from the Atlantic, is recorded for the first time from Australia, and *P. dasyprion* sp. nov. is described from a specimen taken in Bass Strait.

Introduction

The revisionary work on Australian Sphaeromatidae by Keith Harrison and David Holdich (summarised in Harrison and Holdich, 1984) and on Australian Cirolanidae (Bruce, 1986) resulted in a considerable increase in the number of genera and species known from Australia. This paper records three species and a further two genera new to Australian waters. This demonstrates that even for these recently revised families our knowledge is far from complete. *Bathycopea typhlops* Tattersall is the first record of the sphaeromatid subfamily Ancininae from Australia.

Material is from the Australian Museum, Sydney (AM) and the Museum of Victoria, Melbourne (NMV).

Bathycopea Tattersall

Bathycopea Tattersall, 1905a: 601.—Tattersall, 1905b: 12.—Loyola e Silva, 1971: 215.—Kussakin, 1979: 366.

Ancinella Hansen, 1905: 114.

Type species. *Bathycopea typhlops* Tattersall, 1905, by monotypy.

Remarks. This genus has been diagnosed most recently by Loyola and Silva (1971) and Kussakin (1979). Although the valid date of publication for both *Bathycopea* and *Ancinella* appears to be 1905, the name *Bathycopea* is well established, and *Ancinella* has long been regarded as the junior synonym (initially by Hansen, 1916). The genus is here recorded for the first time from Australian waters.

The four species of the genus are known to occur from a depth of 135 metres (present record) to 4070 metres (Kussakin, 1979: 372).

Bathycopea typhlops Tattersall

Figures 1–3

Bathycopea typhlops Tattersall, 1905a: 601.—Tattersall, 1905b: 3, 12, 65, pl. 3 figs 1–13.—Hansen, 1916: 179, 180, figs 7a–7l.—Omer-Cooper and Rawson, 1934: 48, pl. IV figs 1–13.—Loyola e Silva, 1971: 216, Figs 2, 3.—Kensley, 1978a: 144, fig. 13.—Kensley, 1978b: 115, fig. 50.—Kussakin, 1979: 366, figs 227, 228.—Iverson, 1982: 249 (table 1).

Ancinella profunda Hansen, 1905: 132, 133.

Material examined. NSW, E of Broken Bay (33°34.5′S, 151°41.0′E), 135 m, R.T. Springthorpe on RV Kapala, 10 Feb 1986 (AM P37257, non-ovigerous female, 6.3 mm).

Tas. Off Freycinet Peninsula (42°02.2′S, 148°38.7′E), 800 m, coarse shelly sand bottom, M.F. Gomon on RV Franklin, 27 Jul 1986 (NMV J19142, non-ovigerous female, 2 juveniles). 48 km ENE of Cape Tourville (42°00.25′S, 148°43.55′E), 1264 m, gravel with lumps of sandy mud aggregate, G.C.B. Poore et al. on RV Franklin, 30 Oct 1988 (NMV J19144, male, 2 females).

Vic. 67 km S of Point Hicks (38°23.95′S, 149°17.02′E), 1277 m, fine mud, G.C.B. Poore et al. on RV Franklin, 25 Oct 1988 (NMV J19143, 3 unsexed specimens). S of Point Hicks (38°21.9′S, 149°20.0′E), 1000 m, G.C.B. Poore et al. on RV Franklin, 23 Jul 1988 (NMV J19140, 20 unsexed specimens).

Remarks. A single female specimen (AM P37257) was examined and is figured. The species is reasonably well known, and the morphology of the pleotelson and uropods unambiguously distinguishes *B. typhlops* from the other three species (all figured by Kussakin, 1979).

Comparison of these specimens with the drawings of Tattersall (1905b), Loyola e Silva (1971) and Kensley (1978a, b) reveal few differences. Kensley and Loyola e Silva figured the cephalon fused to pereonite which is not the case

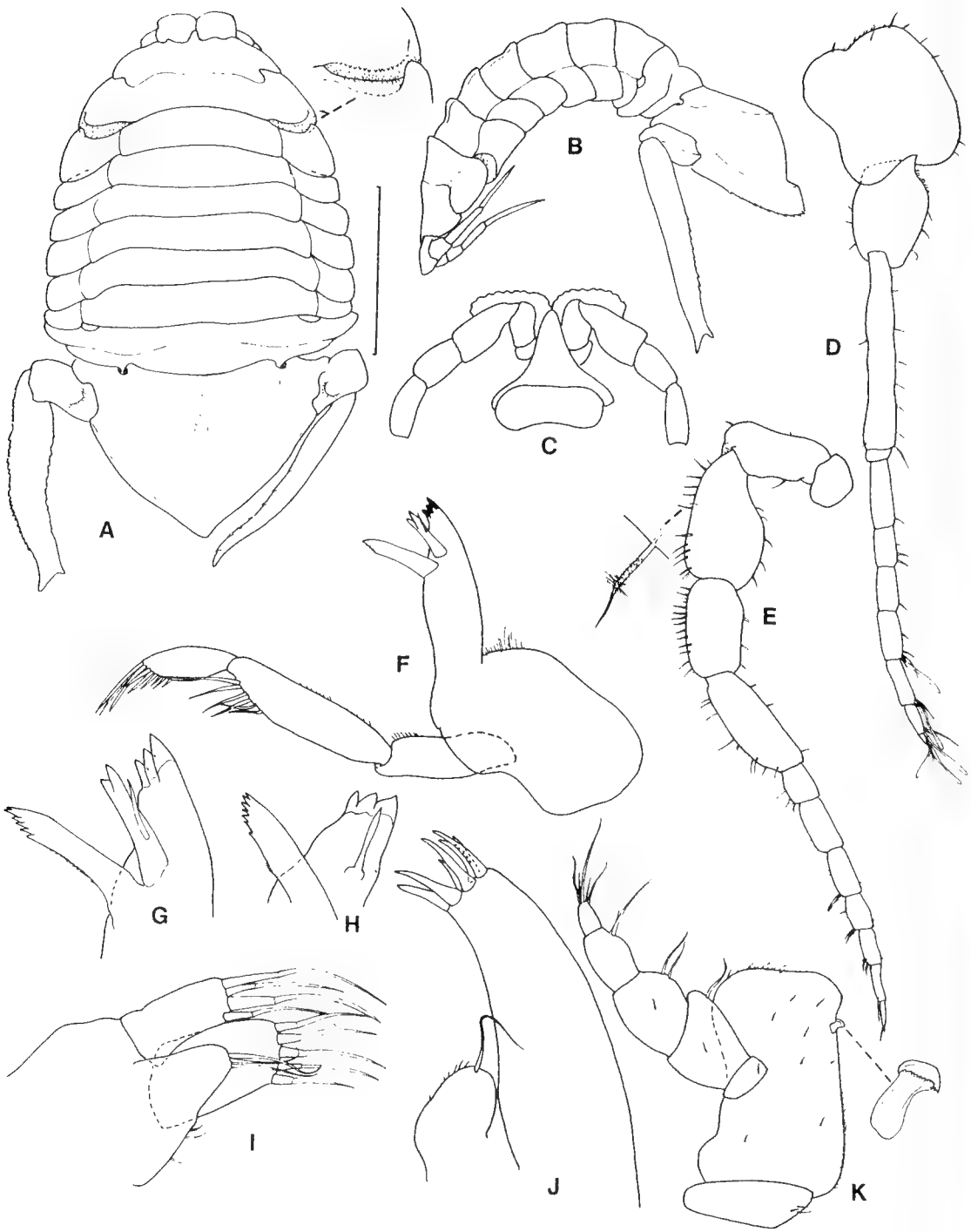


Figure 1. *Bathycopea typhlops* (AM P37257). A, dorsal view; B, lateral view; C, frons; D, antennule; E, antenna; F, left mandible; G, lacinia mobilis and molar process, left mandible; H, right mandible; I, maxilla; J, maxillule; K, maxilliped. Scale line 2.0 mm.

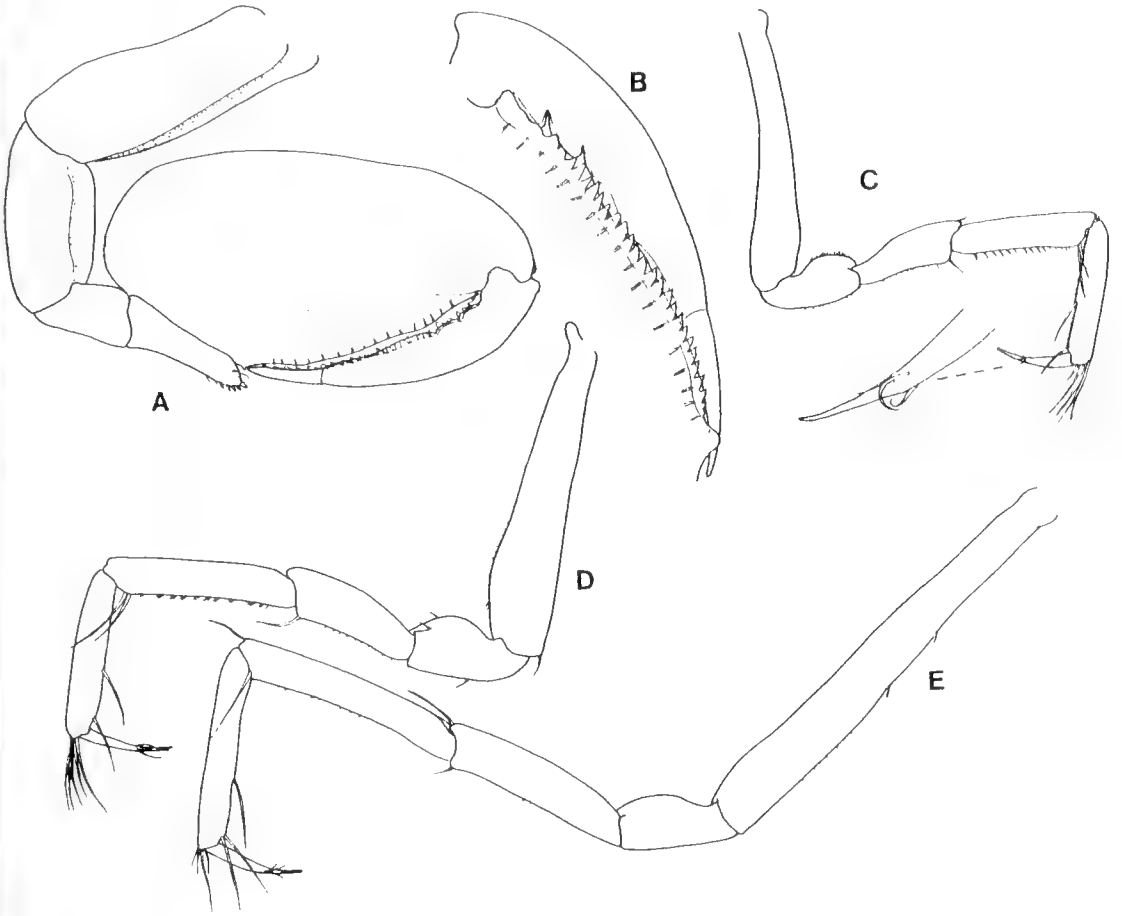


Figure 2. *Bathycopea typhlops* (AM P37257). A, pereopod 1; B, dactylus and propodus palm, pereopod 1; C, pereopod 2; D, pereopod 3; E, pereopod 7.

in the present material nor in the figures given by Tattersall (later reproduced in Omer-Cooper and Rawson, 1934 and Kussakin, 1979). The Australian material shows a variable degree of cephalic fusion, in some specimens the suture is distinct, in others it is scarcely discernable.

Distribution. Off Ireland, at about 800 m (Tattersall, 1905b, Loyola and Silva, 1971); off Natal, South Africa, 680 m (Kensley, 1978a), eastern Australia at 135 metres, the shallowest record, and Bass Strait at depths from 800 to 1277 m. Kussakin (1979) previously reported a depth range from 370 to 963 metres.

Cirolana Leach

See Bruce (1986: 139) for detailed synonymy.

Cirolana binyana sp. nov.
Figures 4–6

Material examined. Holotype, NSW, E of Crescent Head (31°12′S, 153°18′E), plankton tow at 221 m over 355–384 m bottom depth, Australian Museum staff, HMAS Kimbla, 14 Aug 1985 (AM P37256 male, 5.5 mm).

Description of holotype. Body smooth, unornamented, about 2.6 times as long as maximum width. Cephalon anterior margin smoothly rounded, with median shallow indentation; anterior margin with complete submarginal interocular furrow; partial furrow running from posteromedial angle of each eye. Eyes round, orange, together about 0.4 width of cephalon. Posterolateral angles of cephalon with submarginal groove indicating presence of maxillipedal somite. Pereonite 1 about 1.6 times as long as pereonite 2; pereonites 3–6 progressively increasing in length; pereonite 7 slightly shorter

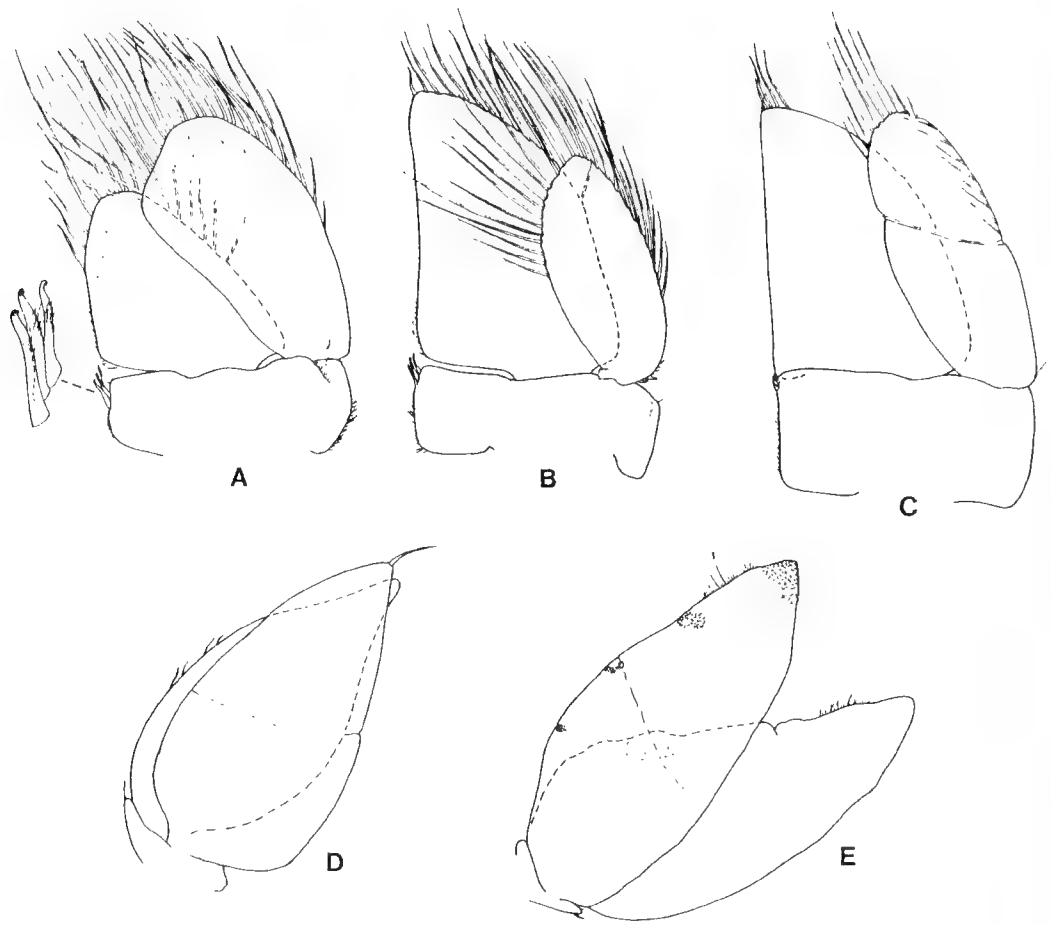
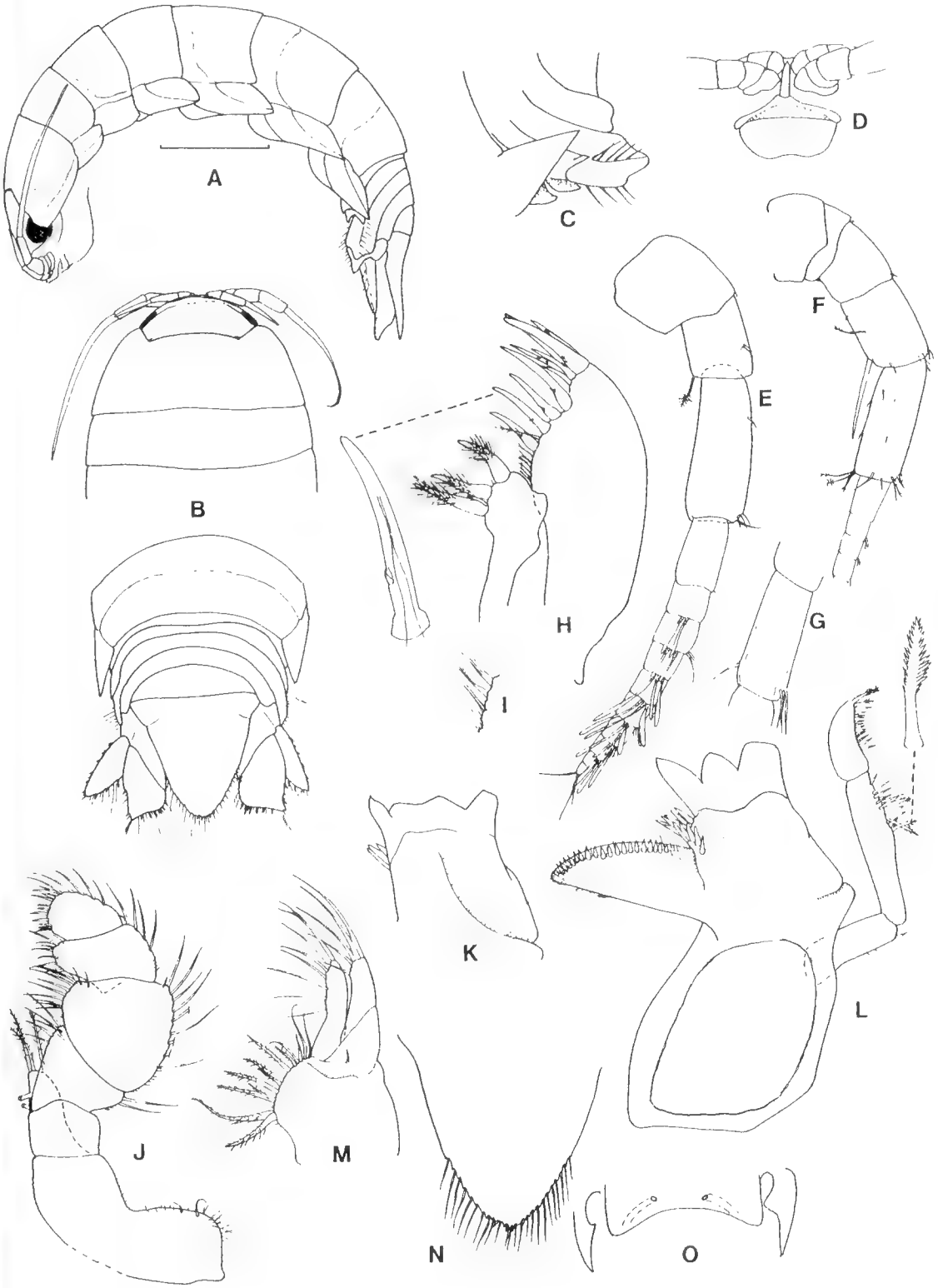


Figure 3. *Bathycopea typhlops* (AM P37257). A–E, pleopods 1–5.

than 6; pereonites 3–5 with incomplete transverse furrow, pereonites 6 and 7 with complete transverse furrow; pereonite 1 with 1 distinct and 1 indistinct lateral furrow. Coxae 2 and 4–7 with complete carina; coxae of pereonite 3 without carina; coxae 2–7 posterior margin becoming increasingly acute towards posterior. Pleonite 1 largely concealed by pereonite 7; pleonites 2–4 subequal in length, pleonite 5 twice a long as 4; lateral margin of pleonite 3 large, posteriorly produced, laterally overlapping pleonites 4 and 5, and extending beyond posterior of pleonite 5; ventral margin and medial carina provided with setae. Pleotelson linguiform, posterior margin serrate, with 4 apical spines set amongst marginal plumose setae.

Antennule with flagellum and peduncle subequal in length, flagellum extending to anterior of pereonite 1; peduncle article 2 shortest; article 3 longest, 2.2 times as long as article 2. Antenna with flagellum extending to posterior margin of pereonite 2, of about 15 articles; peduncle articles 1 and 2 short, article 4 1.5

Figure 4. *Cirolana binyana* sp. nov., holotype. A, lateral view; B, dorsal view of anterior and pleon and pleotelson; C, detail of pleonites, lateral view; D, clypeal region; E, antennule; F, antennal peduncle; G, antennal flagellum, article 11; H, maxillule; and detail of gnathal spine 10; I, maxillule, gnathal medial setae; J, maxilliped; K, incisor, left mandible; L, right mandible; M, maxilla; N, pleotelson; O, penial openings, sternite 7. Scale line 1.0 mm.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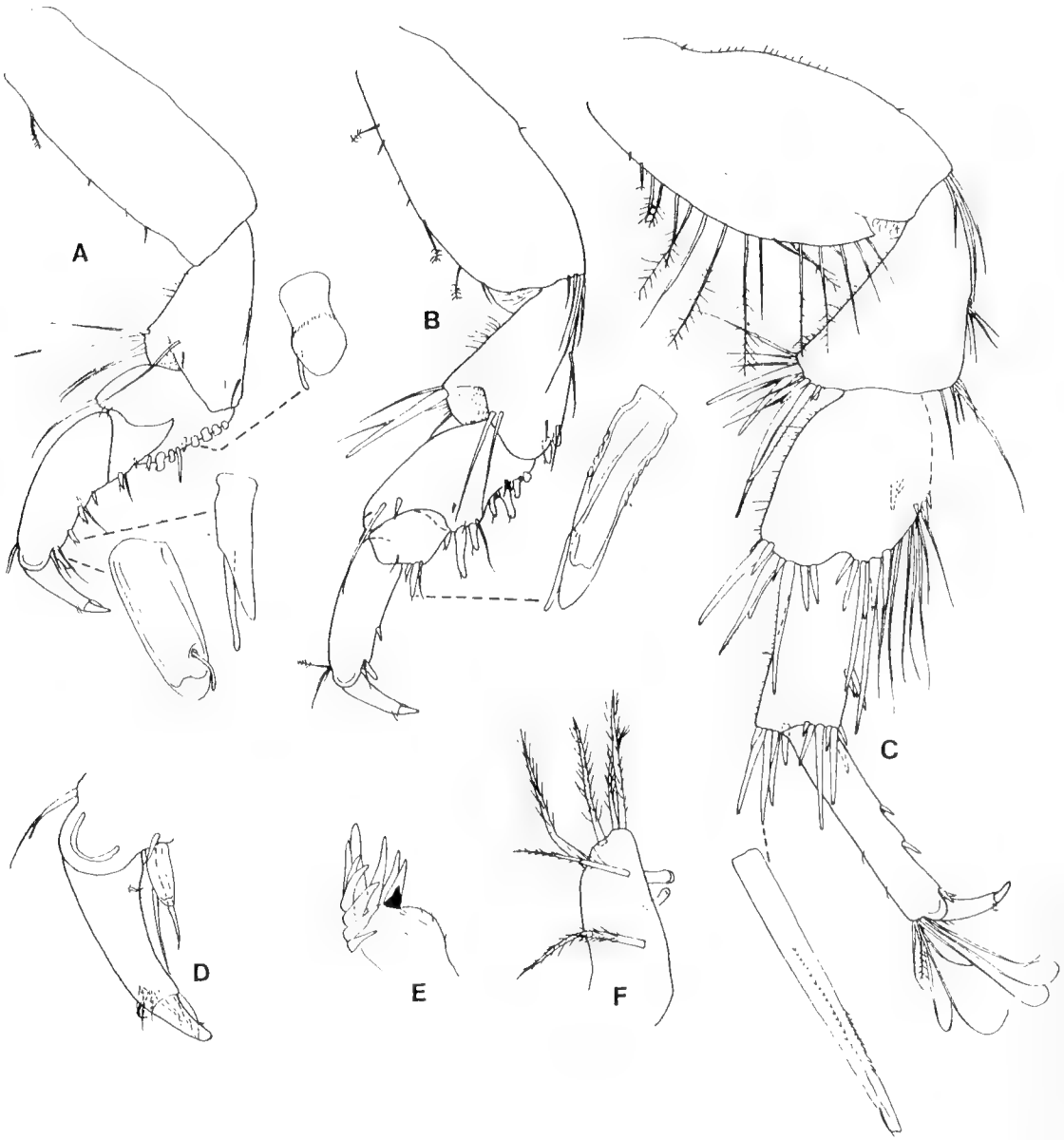

Figure 5. *Cirolana binyana* sp. nov., holotype. A, pereopod 1, with details of spines; B, pereopod 2, with details of spines; C, pereopod 7; D, dactylus, pereopod 1; E, spine row and lacinia mobilis (black); F, maxillipedal endite.

times as long as article 2, article 5 1.5 times as long as article 4 and 2.2 times as long as article 3.

Frontal lamina sessile, elongate, about 5 times a long as wide, lateral margins straight, anterior margins straight converging to distinct point. Mandible with spine row of 11 spines; molar process with distal group of setae; palp article 2 with 12 pectinate setae on distomedial margin, article 3 with 15 marginal setae, distal 3 being largest. Maxillule with 11 spines on gnathal surface of lateral lobe, each spine with 1–3 basal serrations; medial lobe with 3 large plumose spines, proximal spine largest. Maxilla with 8 plumose and 4 simple setae on medial lobe; central lobe with 7 simple setae, lateral lobe with 4.

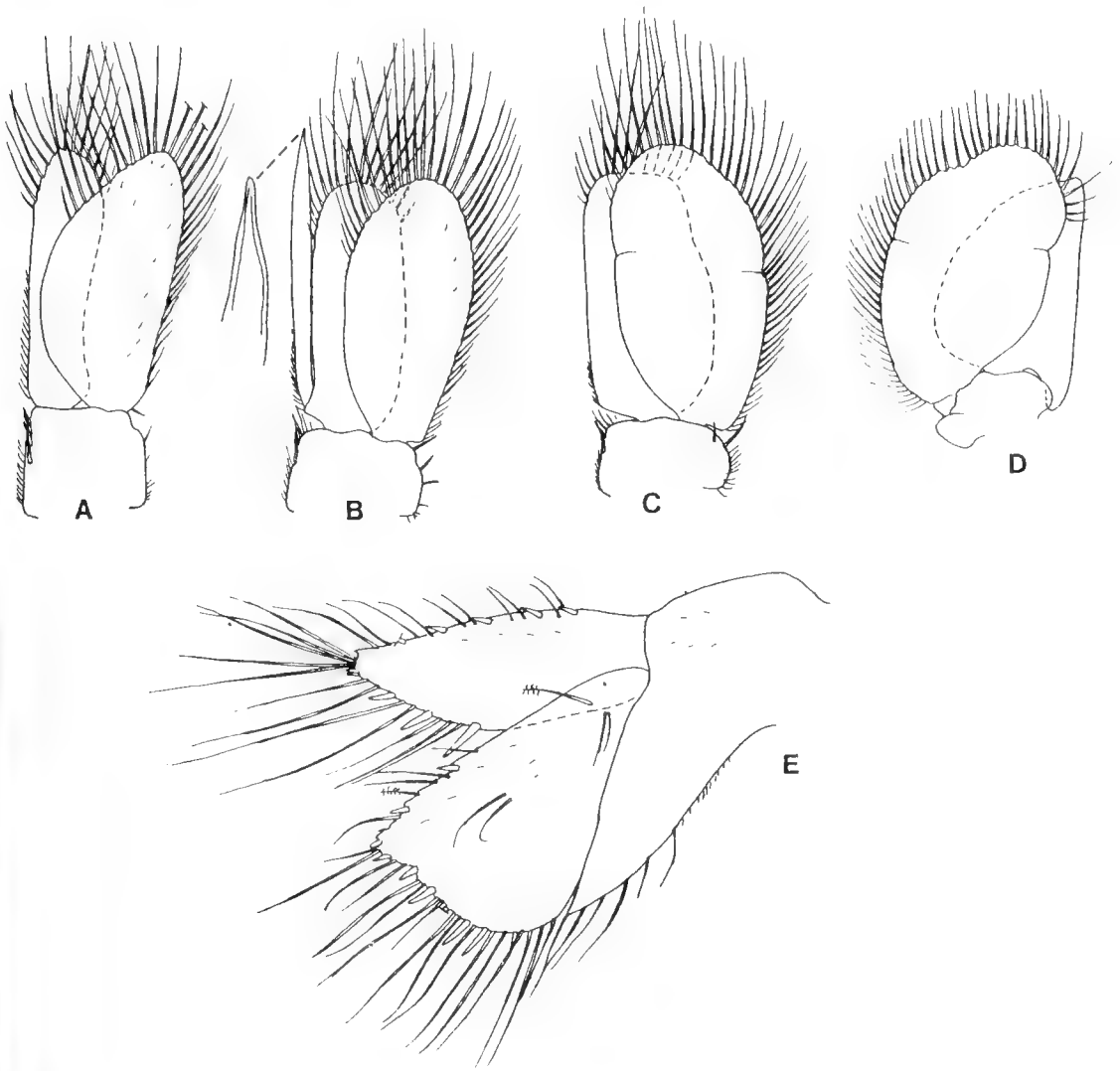

Figure 6. *Cirolana binyana* sp. nov., holotype. A–D, pleopods 1–3 and 5; E, uropod.

Maxilliped palp with simple setae only; endite with 6 plumose setae and 2 coupling hooks.

Pereopod 1 anterodistal angles of ischium and carpus not produced: ischium with 4 long setae at anterodistal angle: merus with single seta at anterodistal angle, posterior margin with 6 stout tubercular spines and 2 acute spines: carpus with single acute spine and seta at posterodistal angle: propodus with 3 acute spines on palm, and large blunt spine opposing base of dactylus; dactylus with prominent slender secondary unguis. Pereopods 2 and 3 similar to pereopod 1. Pereopod 2 with articles more slender than 1, and spines on ischium, merus and carpus more numerous and longer; propodus with only 1 spine on palm; anterodistal angle of ischium with long stout spine. Pereopods 5–7 similar to each other, becoming progressively longer posteriorly. Pereopod 7 with basis slightly expanded, anterior margin with row of feeble plumose setae: ischium and merus flattened and expanded; distal angles of ischium, merus and carpus with groups of large stout setae; anterior margins of ischium, merus and carpus with short setal fringe; propodus with 2 spines on palm, 2 spines opposing dactylus, anterodistal angle with clus-

ter of long recurved setae. Penes absent, gonopores opening flush with surface of sternite 7, separated by one-third width of sternite.

Pleopod 1 with peduncle 0.8 times as long as wide, medial margin with 4 coupling hooks; endopod slender, about 0.6 width of exopod, with concave lateral margin; exopod with strongly curved medial margin; both rami subequal in length. Pleopod 2 with peduncle slightly shorter than 1, with 3 coupling hooks; appendix masculina arising basally, terminating acutely, extending beyond distal margin of rami. Pleopods 3–5 exopod with weakly indicated marginal sutures. Uropodal rami not extending beyond posterior margin of pleotelson. Exopod slightly shorter than endopod, ovate with narrow apex; lateral margin with 5 medial spines and 3 large and 2 small spines adjacent to apex; apex with cluster of long, simple setae. Endopod with straight lateral margin with 2 spines, and 1 subapical spine; medial margin sinuate with 5 spines, and 1 subapical spine; medial margin with continuous plumose marginal setae.

Female not known.

Etymology. The epithet is an Aboriginal word meaning chisel.

Remarks. This species is easily distinguished from all other Australian species of *Cirolana* by the weakly indented anterior margin of the cephalon, the large lateral margins of pleonite 3 which overlap pleonites 4 and 5 and the flattened articles (ischium, merus and carpus) of the posterior pereopods.

The species is similar to the specimen described by Bruce (1986: 143, fig. 96) as *Cirolana* sp. but there are some differences. The frontal lamina was illustrated with the anterior margin rounded but this may be due to the perspective during observation. The posterior interocular furrow was complete while in the holotype of *C. binyana* it is not. The posterior margin of the pleotelson is broadly rounded with 7 spines while in the holotype it is narrowly rounded and has 4 spines. Lastly, the ischium and merus of pereopod 7 are more strongly expanded in *C. binyana* than in *Cirolana* sp. These differences could be due to the immaturity of *Cirolana* sp., but as the characters mentioned are all important in species discrimination, it would be unwise to assume that the two specimens are the same species.

This species does not entirely agree with the generic diagnosis of *Cirolana* given by Bruce (1986) but is here placed in *Cirolana* until such time as this and other species of uncertain systematic position (see Bruce, 1986: 223) can be assigned to genera.

Politolana Bruce

Politolana Bruce, 1981: 958.—Bruce, 1985: 714.—Bruce, 1986: 222.—Wetzer, Delaney and Brusca, 1987: 2.

Remarks. All species of this genus have previously been recorded only from the Atlantic with the exception of *P. obtusispina* (Kensley, 1975) which occurs off the southern coast of south-western South Africa. That species does not entirely agree with the generic diagnosis and should be regarded as *incerta sedis* until the genus is fully revised. Other than the recently described *Politolana wickstenae* Wetzer, Delaney and Brusca, 1987, all species remain inadequately described.

The description of *Politolana dasyprion* sp. nov. is the first record of the genus from Indo-Pacific and Australian waters. The species agrees entirely with the generic diagnosis, differing slightly only in proportions of peduncular articles of the antenna and antennule, and the relatively weakly indented uropodal endopod. The mandible spine row and lacinia mobilis are densely setose, a feature not recorded or illustrated for other species of the genus. Pleopod 1, while agreeing with the generic diagnosis, has the endopod shorter and narrower than in most other species, approaching the condition shown by *Orphelana* Bruce, 1981 and *Conilorpheus* Stebbing, 1905 (Stebbing, 1905, 1908).

Politolana dasyprion sp. nov.

Figures 7–9

Material examined. Holotype, Western Bass Strait (39°22.0′S, 143°28.4′E), 106 m, coarse sand, grab, G.C.B. Poore on HMAS Kimbla, 10 Oct 1980 (NMV J11562 male, 6.0 mm).

Description of holotype. Body about 2.5 times as long as maximum width. Cephalon without distinct rostral point; anterior margin with feeble submarginal furrow; eyes small, approximately rectangular, together occupying a little less than two-thirds (0.27) width of cephalon; posterior margin with groove at each side indicating maxillipedal somite.

Pereonite 1 1.5 times as long as pereonite 2; pereonites 2–6 becoming progressively longer from lateral view; pereonite 7 two-thirds as long as 6. Posterior margin of pereonite 7 finely crenulate. Coxae 2 and 3 each with posteroventral point and incomplete carina; coxae 4–7 with posteroventral point less clearly developed than

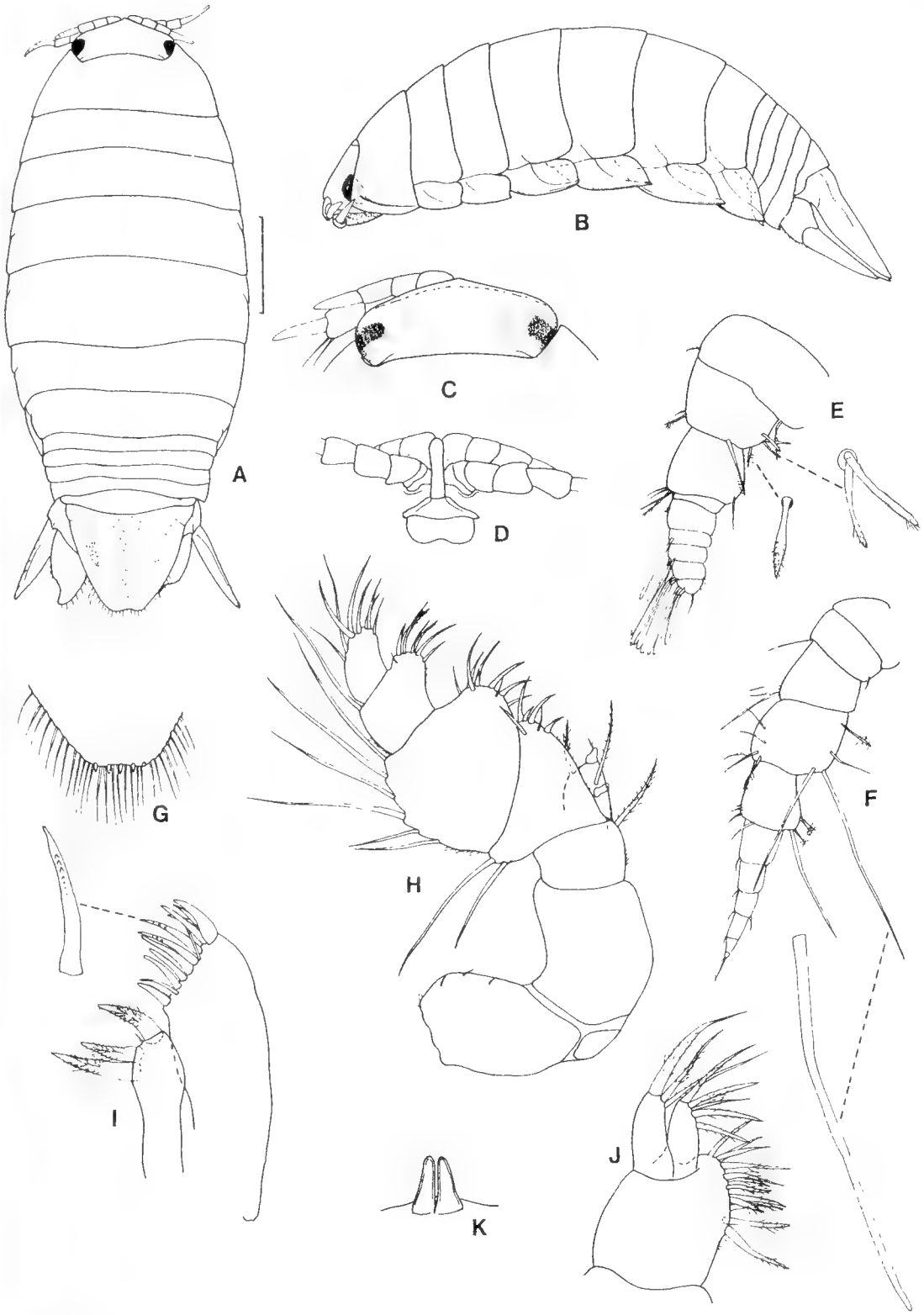

Figure 7. *Politolana dasyprion* sp. nov., holotype. A, dorsal view; B, lateral view; C, cephalon; D, clypeal region; E, antennule; F, antenna; G, pleotelson apex, ventral view; H, maxilliped; I, maxillule; J, maxilla; K, penes. Scale line 1.0 mm.

Figure 8. *Politolana dasyprion* sp. nov., holotype. A, mandible; B, spine row; C, percopod 1; D, propodus, percopod 1; E, tubercular spine, percopod 1; F, percopod 2; G, percopod 4; H, percopod 7.

on coxae 1 and 2, all with complete oblique carina. Pleonites 1–4 subequal in length, pleonite 1 not concealed by perconite 7; pleonite 5 about 1.5 as long as 4. Posterior margins of pleonites 1–4 finely crenulate. Pleotelson dorsal surface with 2 low rounded submedian longitudinal ridges; posterior margin weakly indented, with 5 spines amongst plumose marginal setae; lateral

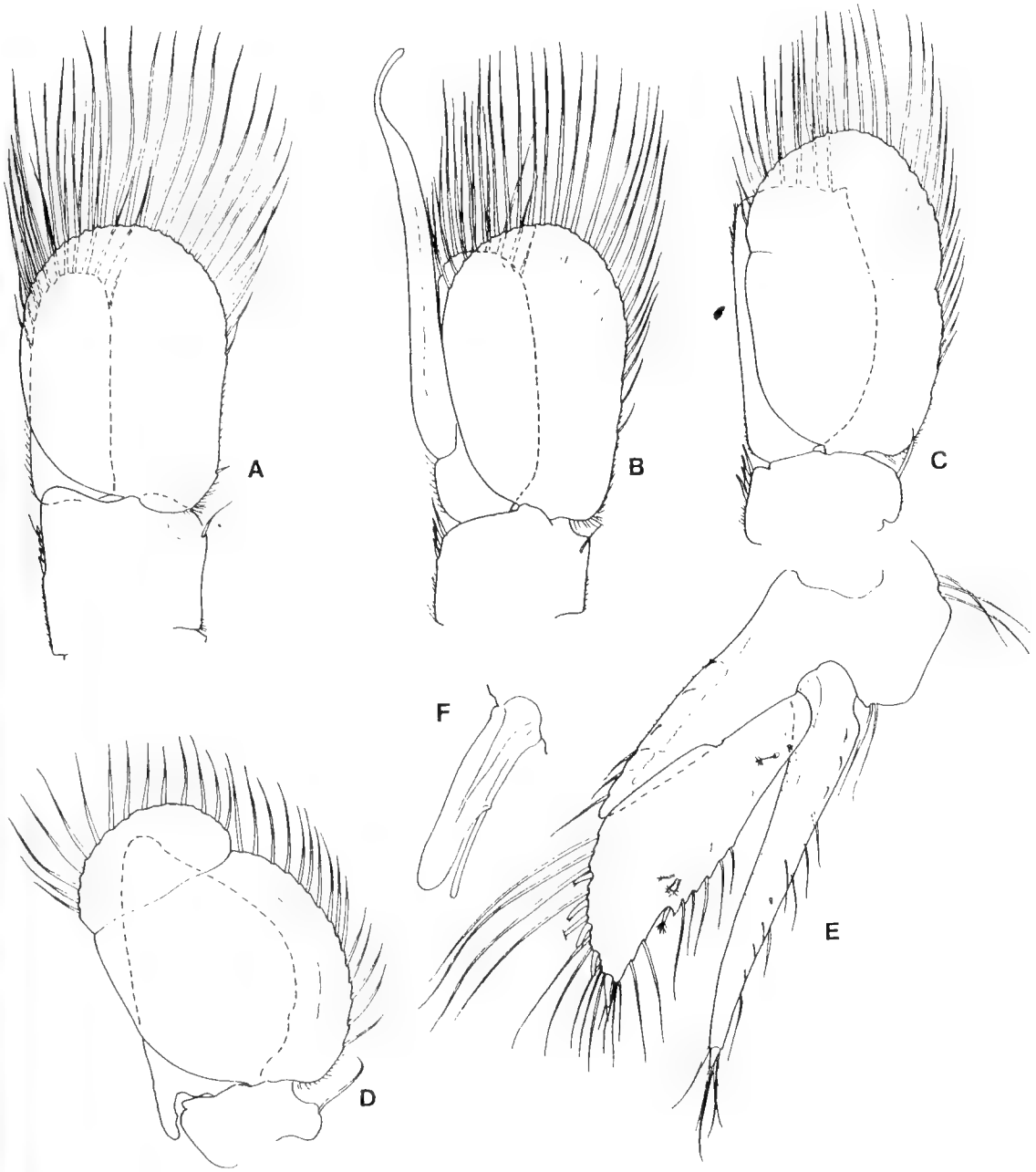

Figure 9. *Politolana dasyprion* sp. nov., holotype. A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 5; E, uropod; F, spine, uropod endopod, medial margin.

margins curving smoothly to posterior plumose marginal setae from about two-thirds of length to posterior.

Antennule short, peduncle articles 1–3 subequal in length, not reaching eyes; flagellum of 5 articles, first the longest, extending to anterior of pereonite 1, about half length of peduncle. Antenna short, extending to about middle of pereonite 1; peduncle articles 4 and 5 subequal in length and longest; articles 3 and 1 subequal in length, lower than article 2. Peduncle articles 4 and 5 with long setae, distal third of which is

distinctly flattened; flagellum of 6 articles: article 1 longest and article 6 minute; flagellum about half length of peduncle.

Frontal lamina elongate, about 4 times as long as wide; anterior margin bluntly rounded. Mandible with spine row of at least 4 spines, possibly others obscured by dense mass of setae; molar process with prominent teeth, densely setose; mandibular palp with 5 setae on distolateral margin of article 2, about 8 setae on article 3. Maxillule lateral lobe with 11 robust spines on gnathal surface, some of the larger spines partially serrate; medial lobe with 3 robust plumose spines, proximal spine largest. Maxilla medial lobe with 9 plumose setae, 3 simple setae distally; central lobe with 5 plumose and simple setae; lateral lobe with 3 weakly plumose setae, distalmost noticeably more robust than other 2. Maxilliped palp with serrate spines on medial margin of articles 4 and 5 only; endite with 4 plumose setae, 1 coupling hook and 1 simple stout spine at distomedial angle.

Pereopod 1 basis with cluster of setae at posterodistal angle and along anterior margin; ischium with long setae on anterodistal lobe and along posterior margin; merus with long setae on anterodistal lobe, posterior margin with 4 acute and 3 blunt spines; carpus with 3 setae and 1 large blunt spine at anterodistal angle; propodus with 2 stout spines on palm, third short blunt spine opposing the dactylus; dactylus with prominent secondary unguis. Pereopods 2 and 3 similar to 1; pereopod 2 with 2 large stout spines on posterodistal angle of merus; 2 spines on posterodistal margin of ischium; spines on posterior margin of merus, carpus and propodus larger than those of pereopod 1. Pereopods 5–7 similar, becoming longer posteriorly. Pereopod 7 with distal angles of ischium merus and carpus with groups of spines; those on anterior angle with more and larger spines than posterior angle; merus with additional medial cluster of spines; ischium, carpus and propodus with additional spines on posterior margins; posterodistal angle of basis and anterior and posterior margins of ischium and merus with long setae; carpus anterior margin with setae, posterior margin without setae. Paired medial penes present at posterior of sternite 7, each process tapering distally, about 4 times as long as basal width.

Pleopod 1 exopod 1.45 times as wide as peduncle; endopod 0.8 times length of exopod and 0.4 times width of exopod; peduncle .11 times as long as wide, medial margin with 4 coupling hooks.

Pleopod 2 with sub-basal appendix masculina extending beyond endopod by about half its length, apex abruptly narrowed curving medially with bluntly rounded tip; peduncle medial margin with 4 coupling hooks. Exopods of pleopods 3–5 all with complete transverse suture. Uropodal rami not extending beyond posterior of pleotelson; exopod very slender, slightly longer than endopod, apex with single stout spine; endopod lateral margin, without spines, weakly excised, medial margin with 5 stout spines set among long plumose setae.

Female not known.

Etymology. Greek *dasys* (hairy, shaggy, dense) and *prionos* (saw) alluding to the setose molar process.

Remarks. This species is not as elongate as others of the genus, nor is the excision of the uropodal endopod as clearly developed, but otherwise it accords entirely with the generic diagnoses given by Bruce (1981) and Wetzer et al. (1987). Other minor differences include the antennule peduncle articles being subequal in length (rather than article 3 longest). The antennal peduncle article 4 is slightly longer than article 5 and about 1.3 times as long as article 3. However, the antennal peduncle still conforms to the generic diagnosis with articles 1 and 2 short, 3–5 long.

Politolana dasyprion can readily be identified by the uropod and pleotelson characters and by the unique morphology of the appendix masculina.

Acknowledgements

I thank Dr J.K. Lowry, Australian Museum, Sydney and Dr G.C.B. Poore, Museum of Victoria, Melbourne for the opportunity to examine and describe these specimens.

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NEPELLE NELERA, A NEW GENUS AND SPECIES OF MARINE AMPHIPOD FROM AUSTRALIA (CRUSTACEA: AMPHIPODA: UROHAUSTORIIDAE)

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Abstract

Barnard, J.L. and Drummond, M.M., 1991. *Nepelle nelera*, a new genus and species of marine amphipod from Australia (Crustacea: Amphipoda: Urohaustoriidae). *Memoirs of the Museum of Victoria* 52: 277–282.

A new genus and species of marine urohaustoriid amphipod, *Nepelle nelera*, is described from Tasmania. It differs from its sympatriot, *Gheegerus*, in the much more modified coxae 1–2, cleft and bell-shaped telson, setose epimeron 1 and large tooth on male antenna 2.

Introduction

The Urohaustoriidae of Australia were treated by Barnard and Drummond (1982). That work was based mainly on materials collected from Western Port and Port Phillip Bay in Victoria. The new genus described here was found in Tasmania, across the strait from Victoria. South American genera of the family were summarized in the key of Clark and Barnard (1986).

Methods of morphological description follow those of Barnard and Drummond (1978, 1982). Upper case letters refer to parts; lower case letters to left of uppercase letters refer to specimens noted in legends; lower case letters to right of uppercase refer to adjectival modifications in list below: A, antenna; B, body; C, coxa; D, dactyl; G, gnathopod; H, head; I, inner plate or ramus; K, pleopodal coupling hooks; L, labium; M, mandible; O, outer plate or ramus; P, pereopod; S, maxilliped; T, telson; W, pleon; X, maxilla; Y, pleopod; d, dorsal; p, posterior; r, right; s, setae removed; t, left.

Urohaustoriidae Barnard and Drummond, 1982

Nepelle gen. nov.

Diagnosis. Rostrum short and broad, head poorly extended anteriad from antennal notch. Antennae of haustoriid (versus urothoid) form, thus peduncle of antenna 1 short, stout, articles 2 and 3 of peduncle progressively shortened, not geniculate, both flagella moderately long. Aesthetascs simple. Antenna 2 of full haustorius form, article 4 expanded, article 5 small, articles 4–5 with facial armaments, article 4 with 3 kinds of posterior setae, long plumes, subventral clusters of simple setae (called glassy spines) and a row of bulbar penicillate setules, article 5 with long plumes, weak glassy spines, no bulbars, facial armament rows on articles 4–5 composed of very slender setae and spinules; article 5 in male with large anteroapical claw-like tooth pointing medially. Mandibular incisors extended, of ordinary thickness, barely toothed, essentially with 2 teeth; lacinia mobilis narrow and spike like, blunt on right, sharp on left; rakers 2, only first raker serrate; molar large, extended, with accessory chopper; setae of palp article 3 weakly awned, apically bent. Inner plate of maxilla 1 of medium length, narrow, with 2 apical setae, outer plate with 11 spines, palp short, uniarticulate, with 3 large apical setae. Inner plate of maxilla 2 with weakly submarginal row of setae. Palp article 2 of maxilliped extraordinarily elongate, expanded, dactyl barely clavate, elongate, bearing 3 apical setae.

Coxae 1–2 very small, first pointed, second blunt, most of coxa 2 hidden by large, adze-shaped coxa 3, coxa 4 larger than 3, shaped like blunt arrowhead; coxae 2–5 with simple sac-like gills, gill 5 smallest; oostegites thin, strap-shaped.

Gnathopods small, grossly alike, carpi elongate, propodi somewhat smaller, mitelliform, first simple, second minutely chelate. Dactyls of pereopods 3–7 distinguishable but on pereopods 6–7 often hidden among similar spines, those of pereopods 3–5 large, those of pereopods 6–7 very small; dactyl of pereopod 5 blade-like, spinose. Article 5 of pereopods 3–4 fully spinose posteriorly. Article 2 of pereopods 5–7 expanded but less strongly on pereopod 6 than on 5 and 7; distal articles of pereopods 6–7

scarcely widened, on 5 much more expanded; pereopods 6–7 otherwise similar, not dominating pereopod 5.

Pleopod 1 strongly dominant in setation and articulation, inner ramus shorter than outer. Epimeron 1 present and setose; epimeron 2 dominantly setose, epimeron 3 dominant in size. Urosomites 1–2 produced laterally. Rami of uropods 1–2 evenly sublinguiform, widely setose medially and apically, poorly or not setose laterally, peduncles moderately setose. Uropod 3 with rami extending subequally, well setose marginally except on outer margin of inner ramus. Telson short, broader than long, basally expanded and somewhat bell-shaped, cleft halfway.

Description. Eyes absent, ocular ganglia visible. Dorsomedial surface of article 1 on antenna 1 furnished with small, poorly organized group of setae; article 2 strongly setose dorsally; article 3 poorly setose. Article 3 of antenna 2 short, sparsely setose, flagellum slightly longer than article 4 of peduncle. Calceoli absent. Lower lip with one cone on each outer lobe, mandibular lobes well developed. Several spines on outer plate of maxilla 1 bifid or toothed. Gnathopod 2 lacking surficial buttons.

Type species. Nepelle nelera sp. nov. Unique.

Etymology. An Aboriginal spirit.

Relationship. This genus is very similar to *Gheegerus* Barnard and Drummond (1982) but differs in the pointed coxa 1, the cleft telson with bell-shape, the presence of setae on epimeron 1, and the large tooth on male antenna 2. Coxae 1–2 are very distinctive because in *Gheegerus* they are much more evenly rectangular. The shape of the telson is strongly distinct. By those standards within the family, this entity represents a distinct genus even though it and *Gheegerus* are monotypic.

Nepelle nelera sp. nov.

Figures 1–3

Material examined. 2 males, 1 female, 1 juvenile, 18 other mixed specimens.

Holotype: Tasmania, Eddystone Point, D. Hoggins, Aug 1978, Museum of Victoria (NMV) J17654 (male "g", 4.95 mm, illustrated).

Paratypes: Type locality, NMV J17655 (female "f", 4.75 mm); NMV J17657 (male "h", 5.03 mm); NMV J17658 (juvenile "i", 2.58 mm); NMV J17656 (18 specimens).

Diagnosis. With the characters of the genus.

Description. Male "h", 4.95 mm; head about 70% as long as wide, rostrum about 6% as long as remainder of head, eyes represented by their attendant ganglia, actual ommatidia or pigment not discerned. Dorsal setae on article 1 of antenna 1, medial = 3 regular and 2 bulbar-penicillate, medial margin = 6 setae in facial row and apical cluster of several; article 2 with many dorsal setae, medial row of many setae; primary flagellum with 10 articles, accessory flagellum with 9 articles. Article 3 of antenna 2 with 5 medium setae; facial formula of spines on article 4 = numerous thin setae and spinules in jagged row; article 5 = 12 main setae dorsally (actually dorsal edge pointing medially) and facial row similar to article 4; flagellum with 11 articles.

Right and left mandibular incisors with 2 weak teeth each; article 3 of palp scarcely shorter than article 2, latter with 8 setae, setal formula on left and right article 3 = 1–1–1–8. Inner plate of maxilliped with 2 stout apical spines, one ventral locking spine, and 7 apical setae; medial margin of outer plate with ragged mixture of spines and scattered small setae, apex with 1 seta; article 2 of palp with row of 14 mediofacial setae; article 3 with row of 7 medial facial setae, 2 groups lateral setae.

Coxa 1 trapezoidal, bearing 4 setules on ventral margin, coxa 2 subconical and weakly bent, anterior margin convex, with 1 ventral setule near apex, coxa 3 adze-shaped, with about 6 ventral setae on narrow margin and about 10 setae on lower part of concave posterior margin, coxa 4 weakly and bluntly arrow-shaped, well setose on ventral, posterior, upper invaginated and upper lobed margins, coxae 5–6 well setose posteriorly, coxa 7 inferior and poorly setose.

Setal and spine formulas on pereopod 3 = 8–7, 13, 6–7, 6–1–4, and pereopod 4 = 6–5, 12, 5–6, 6–1–4. Article 2 of pereopods 5–7 well setose posteriorly, pereopod 5 with long mediofacial row of setae; dactyl of pereopod 5 with pair of apical spines and 4 anterior marginal spines.

Peduncular spine formulas of pleopods 1–3 = 2 and 1, 2 and 0, 2 and 1; segmental formulas = 30–19, 22–16, 18–15; basal setal formulas = 18–6–6–6, 11–2–4–4, 8–2–3–4, each inner ramus with complex basal bifid spine with double barb, posterior faces of peduncles with sets of medium facial setae, lateral and medial = 0–1, 0–2, 6–2.

Epimeron 1 rounded, with 3 facial setae posteroventrally; epimeron 2 extended into posteroventral tooth, posterior margin "crimped,"

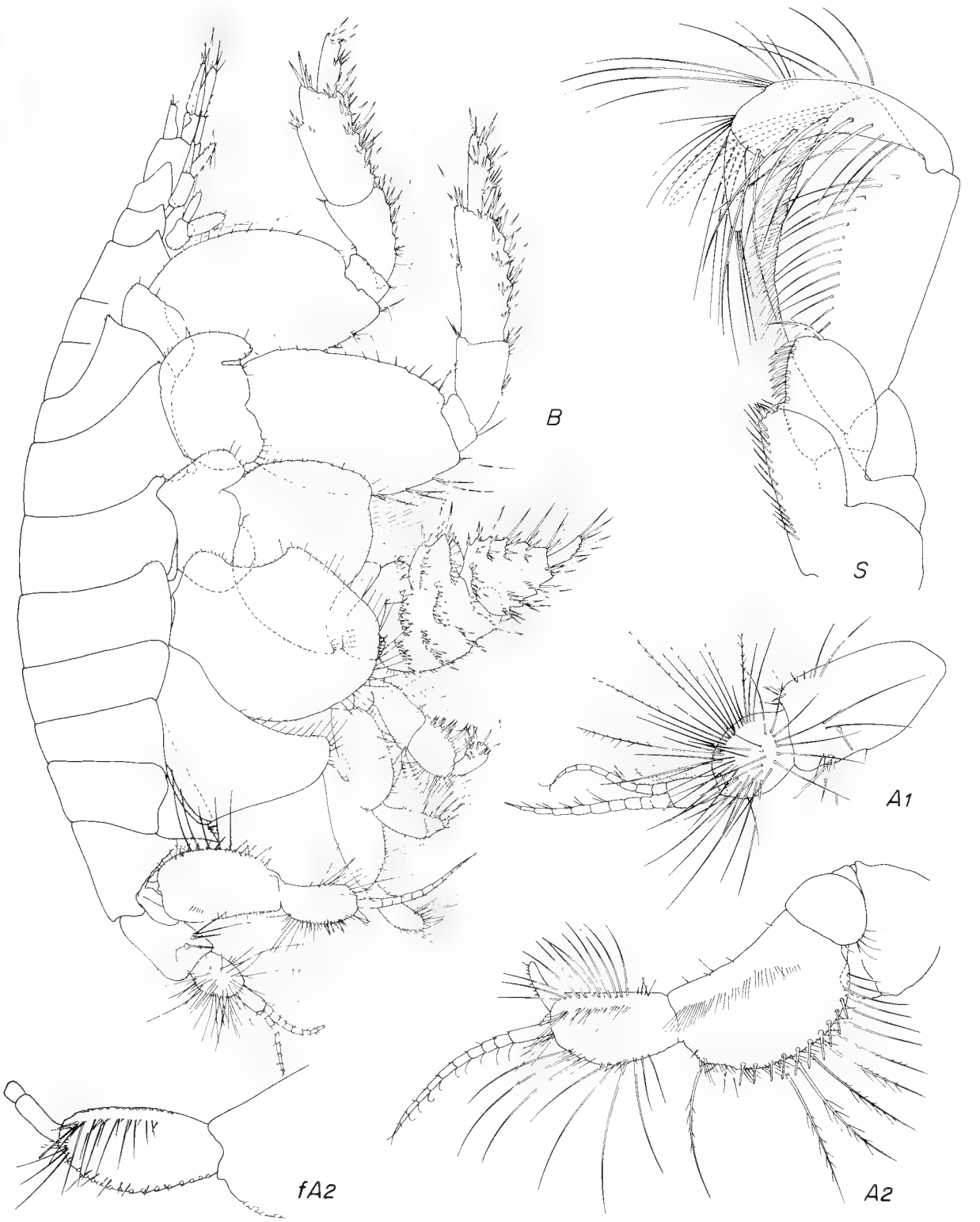

Figure 1. *Nepelle nelera,* unattributed figures = holotype male g, 4.95 mm; f = female 4.75 mm.

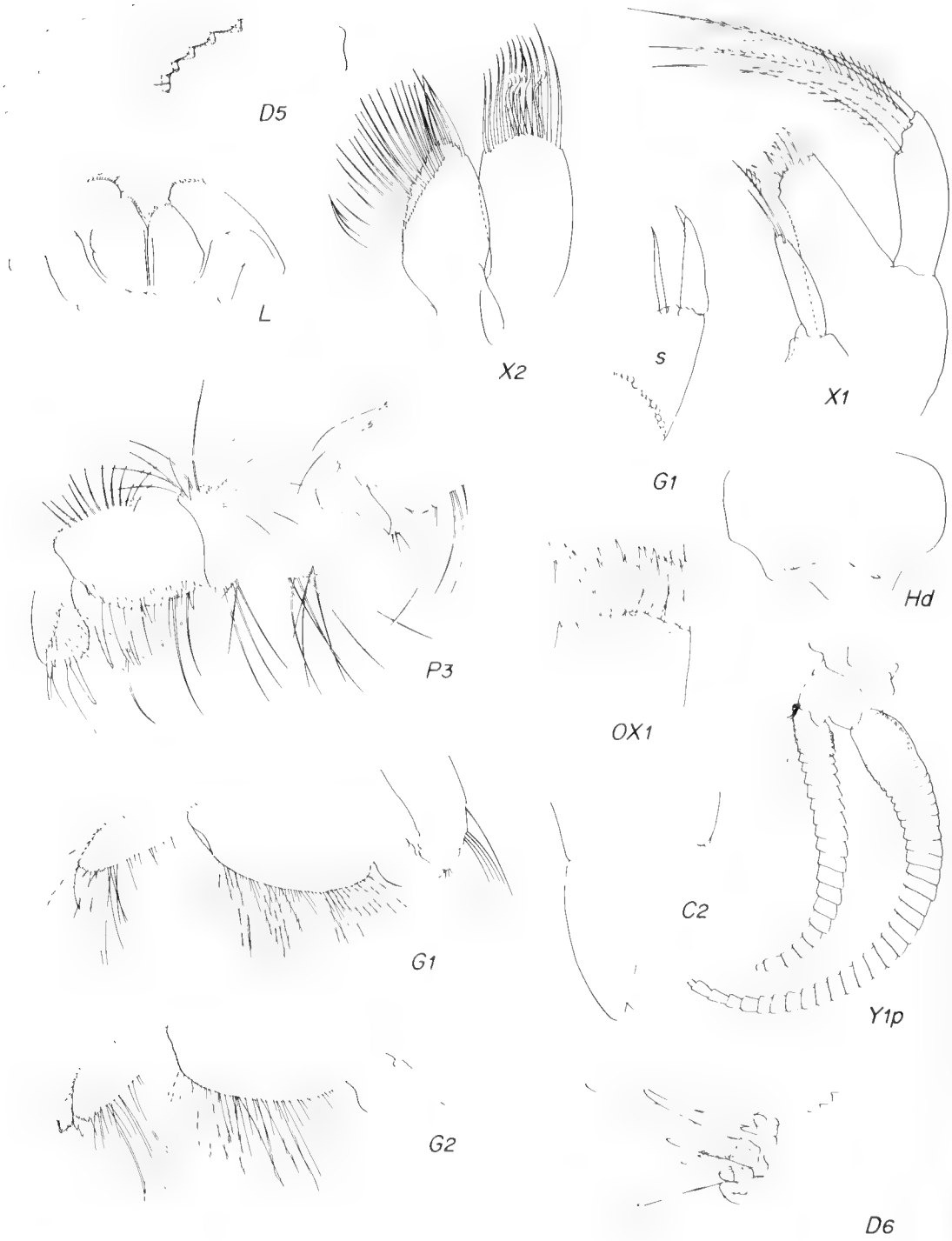

Figure 2. *Nepelle nelera*, holotype male "g", 4.95 mm. All setae not shown on pleopod.

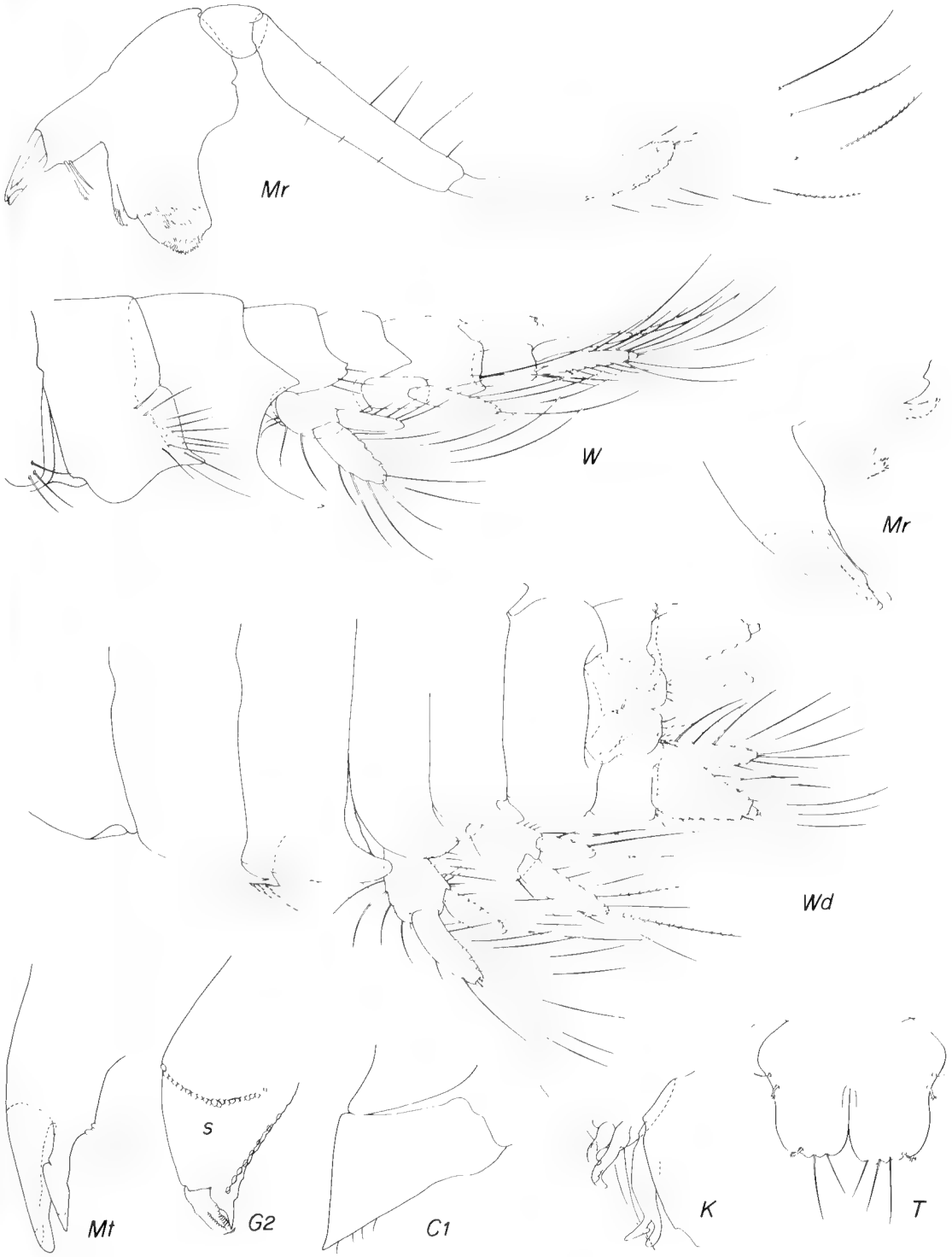

Figure 3. *Nepelle nelera*, holotype male "g", 4.95 mm.

face with 10 setae in semicircle of 7 and set of 3; epimeron 3 sharply and strongly produced posteroventrally.

Lateral margin of peduncle on uropod 1 with 4 setae, of uropod 2 with 1 seta, of uropod 3 with 1 spine. Uropod 3 with several ventral setae at base of outer ramus. Apicomedial corner of peduncle on uropod 1 with 4 setae, of uropod 2 with 4 setae; uropod 1 with 3 large dorsomedial setae; inner rami of uropods 1–2 extending 85 and 67% along outer; uropods 1–3 with 6, 4, 4 setae on medial margin of each outer ramus, 4, 3, 5 on inner ramus. Apical setae on outer and inner rami of uropods 1–3 = 3–1, 3–1, 2–2.

Telson about 1.3 times as wide as long, weakly alate basolaterally (thus somewhat bell-shaped), cleft about 50% of its length, each apex with 2–3 medium plumes, each side with small penicillate setule and second asymmetric pair basolaterally.

Female. "f", 4.75 mm. Differences from male very few: Antenna 1 lacking tooth on article 5 and slightly less setose; on all described parts of male pleon, female differing only by epimeron 1 bearing only 1 seta and peduncle of uropod 1 with only 3 (versus 4) lateral setae; pereopods less spinose, for example, article 4 of pereopod 4 with 8 and 3 anterodistal setae, article 5 with 10 anterior setae, 6 facial spines and 3 + 3 posterior marginal spines, formula on article 6 = 5–3–1.

Juvenile. "i", 2.58 mm. Generally much less setose as detailed below, principal oddity being shortened inner ramus of uropod 1, extending only 60% as far as outer ramus.

Examples of lesser armaments: Pereopod 3, anterior apical setae 7–2, article 5 anterior setae = 7, posterior spines 6–2, article 6 spines = 5–3–1; pereopod 4 article 5 posterior spines = 5–4; epimeron 1 with 1 seta, epimeron 2 = 6; peduncle uropod 1, 3 lateral, 2 medial, no dorsal setae, of uropod 2 = 1 lateral, no medial; setae of outer rami, uropod 1 = 2 lateral, 2 apical, 5 medial, of uropod 2 = 2 lateral, 2 apical, 4 medial; inner rami, uropod 1 = 1 apical, 3 medial, of uropod 2 = 1 apical, 2 medial; uropod 3 outer ramus = 5lateral, 3 medial, inner ramus = 2 apical, 4 medial; telson with 2 apical setae each lobe.

Etymology. Latinized version of Aboriginal word "pointing bone" referring to the odd teeth of antenna 2 pointing inward to resemble forceps.

Distribution. Tasmania, Eddystone Point, depth unknown.

Acknowledgments

We thank Dr Gary C. B. Poore of the Museum of Victoria for making this material available; Linda B. Lutz of Vicksburg, Mississippi, USA, for inking our drawings; and Elizabeth Harrison-Nelson for laboratory assistance at the Smithsonian Institution.

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Memoirs of the Museum of Victoria 52(2): 283–289 (1991) ISSN 0814-1827

YHI YINDI, A NEW GENUS AND SPECIES OF PARACALLIOPIIDAE (CRUSTACEA: AMPHIPODA) FROM THE GREAT BARRIER REEF

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Abstract

Barnard, J.L. and Thomas, J.D., 1991. *Yhi yindi*, a new genus and species of Paracalliopiidae (Crustacea: Amphipoda) from the Great Barrier Reef. *Memoirs of the Museum of Victoria* 52: 283–289.

The new genus and species, *Yhi yindi* was found in 4 m on coral-algal sand at Orpheus Island on the Great Barrier Reef. The genus differs from others in the family in the loss of carpal lobes on the gnathopods of both sexes, the strongly reduced male gnathopod 2 and reduced spination on the outer plate of the maxilliped. The antennae are unusually elongate and articles 2–3 of antenna 1 are as long as article 1, found otherwise only in *Doowia* which has short antenna 1 and fused eyes. Unlike *Paracalliope* and *Indocalliope* this genus plus *Katocalliope* and *Doowia* are characterized by fossorial pereopods 3–6.

Introduction

A review of Paracalliopiidae is presented to include the new genus and species, *Yhi yindi*, into new keys and into a newly revised diagnosis. This updates what will appear in Barnard and Karaman (in press). Three keys to the genera are presented to provide different starting points for identification.

Paracalliopiidae Barnard and Karaman, 1982

Diagnosis. Body plan ordinary but urosomites 2–3 amalgamated; rostrum and incision for antenna 2 ordinary, eyes paired (except *Doowia* but see *Remarks*); pereopod 7 elongate and different from shorter pereopods 5–6, dactyl of pereopod 7 elongate and setose; gnathopods sexually diverse or not, mittenform in female, enlarged mittenform in male, with thin wrists and expanded hands twisting inward on death, but males of *Yhi* with neotenic, female-like gnathopods. Telson longer than wide, but shorter than urosomites 2–3 combined, entire.

Remarks. The family comprises genera with pereopods 3–6 either fossorial or not and temporarily includes *Doowia* which has fused eyes but because of fused urosomites 2–3 is placed in Paracalliopiidae rather than Oedicerotidae. The gnathopods of *Doowia* conform to the facies in Paracalliopiidae rather than Oedicerotidae.

The family differs from Exoedicerotidae in the lack of apical spines on rami of uropods 1–2;

from Oedicerotidae in the paired eyes, fused urosomites (occasionally present in Oedicerotidae) and non-galeate head and odd gnathopods;

from Eusiridae-Calliopiidae in the fused urosomites 1–2 and odd gnathopods;

from Dexaminidae in the greatly elongate pereopod 7 with elongate setose dactyl and the uncleft telson.

List of genera. Paracalliope Stebbing (1899) (= *Paroediceropsis* Fearn-Wannan, 1968), (see J.L. Barnard, 1972 for analysis), *Indocalliope* Barnard and Karaman (1982), *Katocalliope* Barnard and Drummond (1984), and provisionally *Doowia* Barnard and Drummond (1987), differing from Paracalliopiidae in the fully appressed eyes dorsally.

Key 1 to genera of Paracalliopiidae

1. Mandibular palp absent 2
— Mandibular palp present 3
2. Male gnathopod 2 stout, carpus lobate and shorter than propodus, articles 2–3 of antenna 1 much shorter than article 1 ..... *Katocalliope*
— Male gnathopod 2 slender, feeble, carpus not lobate and longer than propodus, articles 2–3 of antenna 1 as long as article 1 ..... *Yhi*

3. Eyes fully appressed together on top of head, pereopods 3-6 fully fossorial (like Oedicerotidae) ..... *Doowia*
— Eyes separated and lateral, pereopods 3–6 non-fossorial (like Gammaridae) 4
4. Inner plate of maxilla 1 with 1 seta ..... *Indocalliope*
— Inner plate of maxilla 1 with 8+ setae ..... *Paracalliope*

Key 2 to genera of Paracalliopiidae

1. Inner plates of maxillae 1–2 densely setose medially 2
— Inner plates of maxillae 1–2 not setose medially 3
2. Pereopods 3-6 ordinary, like gammarids, article 3 of antenna 1 much shorter than article 1, eyes separated and lateral, epimera each with small posteroventral tooth ..... *Paracalliope*
— Pereopods 3–6 fully fossorial, like oedicerotids, article 3 of antenna 1 = article 1, eyes fully appressed dorsomedially, epimera rounded, lacking small posteroventral tooth ..... *Doowia*
3. Articles 2-3 of antenna 1 as long as article 1, carpus of gnathopods not lobate ..... *Yhi*
— Articles 2–3 of antenna 1 much shorter than article 1, carpus of gnathopods lobate 4
4. Mandibular palp present, peduncle of uropod 3 elongate, epimera with small tooth, palp of maxilliped strongly exceeding outer plate *Indocalliope*
— Mandibular palp absent, peduncle of uropod 3 short, epimera smooth, palp of maxilliped not exceeding outer plate ..... *Katocalliope*

Key 3 to genera of Paracalliopiidae

1. Articles 2–3 of antenna 1 as long as article 1 2
— Articles 2–3 of antenna 1 much shorter than article 1 3
2. Carpi of gnathopods lacking lobes ..... *Yhi*
— Carpi of gnathopods lobate ..... *Doowia*
3. Mandible lacking palp, peduncle of uropod 3 short, palp of maxilliped not exceeding outer plate ..... *Katocalliope*
— Mandible with long palp, peduncle of uropod 3 elongate, palp of maxilliped strongly exceeding outer plate 4
4. Medial margins of maxillae 1–2 naked ..... *Indocalliope*
— Medial margins of maxillae 1–2 setose ..... *Paracalliope*

Yhi gen. nov.

Diagnosis. Paracalliopiidae with elongate articles 2–3 of antenna 1, article 5 of antenna 2 thin and elongate, longer than article 4; eyes separate, ommatidia scattered (as in life); mandibular palp absent, raker spines reduced to 2 on each mandible, laciniae mobiles weakly diverse but simple, molars not extended on stalks; inner lobes of lower lip separate but appressed; inner plate of maxilla 1 foliate, poorly armed (generally with 2 setae only), outer plate with 11 almost straight spines, palp article 1 elongate; plates of maxilla 2 slender, inner plate lacking mediofacial setal row, with 1–2 subapical but medial marginal setae; inner plate of maxilliped with at least 2 short stout tooth-spines, palp article 3 extending beyond outer plate; coxae relatively long in context of family (compared to *Paracalliope*); coxa 1 extended forward to enfold ventral margin of head; ventral margins of coxae 3–4 weakly excavate; coxa 4 not excavate posteriorly; gnathopods in both sexes very feeble, carpi lacking lobes and longer than propodi, male gnathopod 2 scarcely broadened; pereopods 5–6 relatively shortened (compared to *Paracalliope*); coxal gills 2–6 present; brood plates unexpanded; epimera rounded (notches or small teeth vestigial); peduncle of uropod 3 elongate.

Type species. Yhi yindi sp. nov. Monotypic.

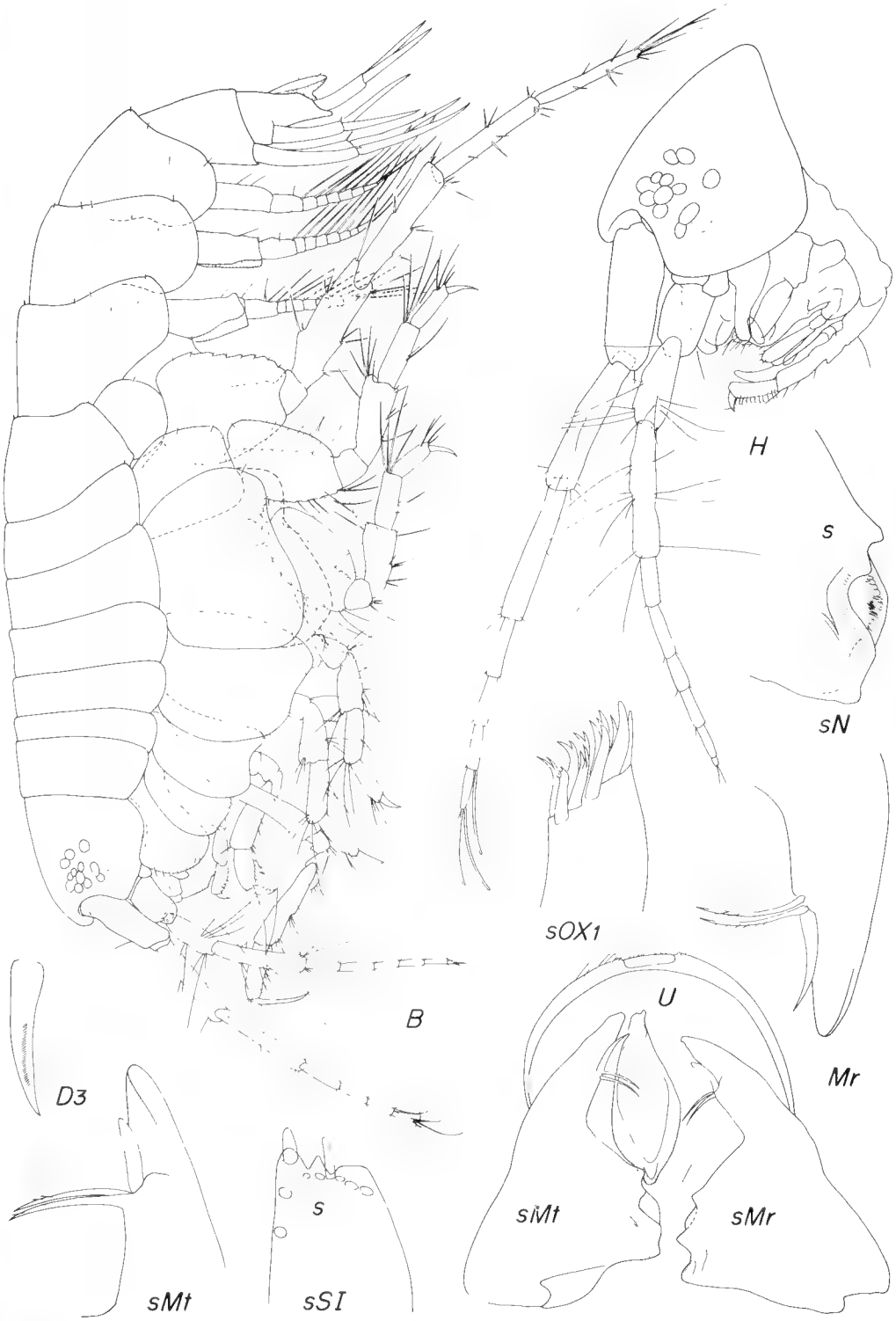

Figure 1. *Yhi yindi*, unattributed figures = holotype female "o"; s = female "s" 1.61 mm. Capital letters in figures refer to parts; lower case letters to left of capital letters refer to specimens and to the right refer to adjectives as described below: B, body; C, coxa; D, dactyl; G, gnathopod; H, head; I, inner plate or ramus; L, labium; M, mandible; N, right molar; O, outer plate or ramus; P, pereopod; R, uropod; S, maxilliped; T, telson; U, upper lip; X, maxilla; Y, gill; Z, oostegite; m, medial; r, right; s, setae removed; t, left.

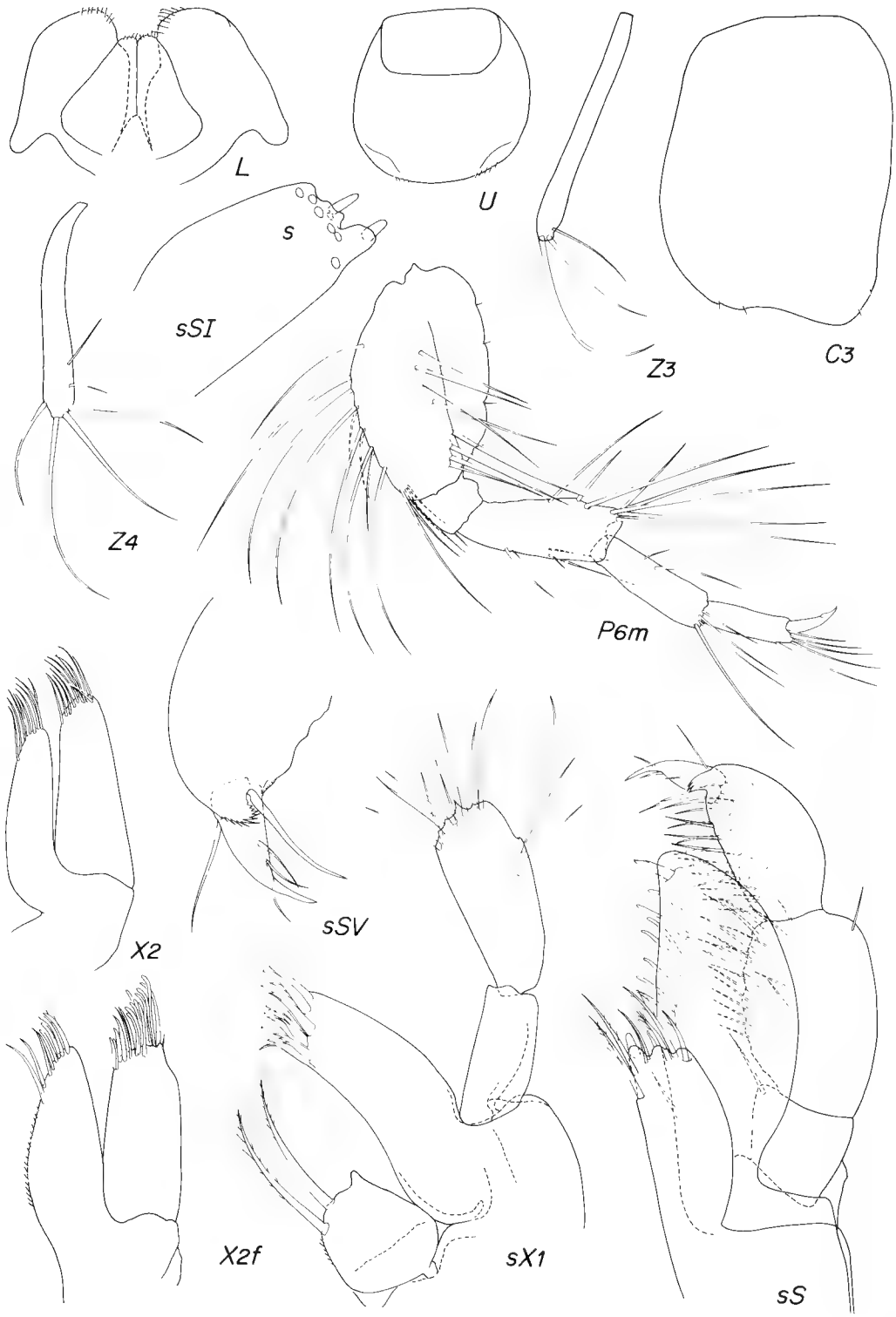

Figure 2. *Yhi yindi*, unattributed figures = holotype female "o"; s = female "s", 1.61 mm.

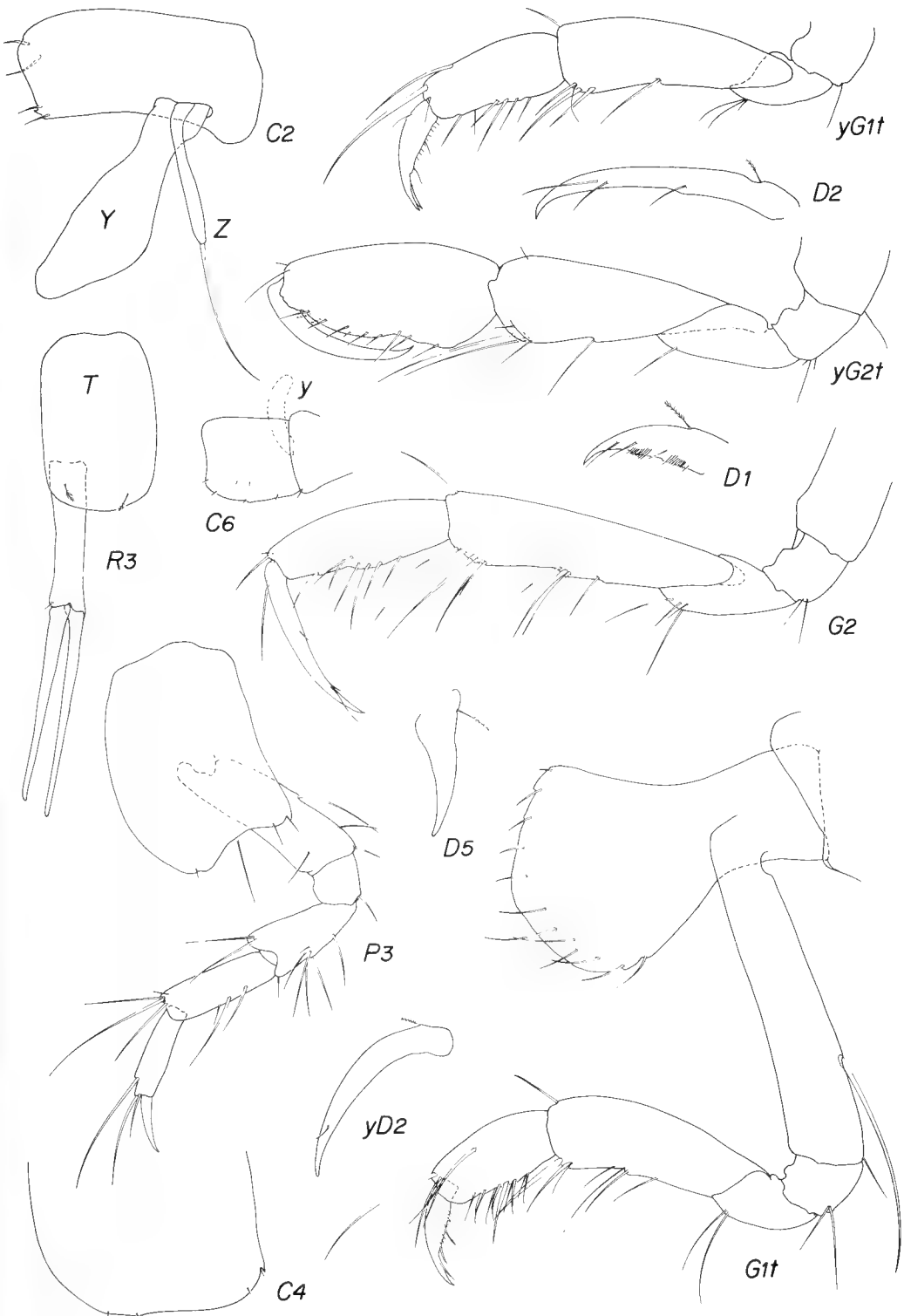

Figure 3. *Yhi yindi*, unattributed figures = holotype female "o"; y = male "y", 1.52 mm. Gnathopod 1 (G1t) and its coxa and gnathopod 2 (G2) greatly enlarged, but coxa 2 (C2) with gill and oostegite and all other oostegites and gills not strongly enlarged.

Etymology. Named for an aboriginal goddess of the sun in reference to the sunny climes from which this shallow-water species comes.

Remarks. Although the elongate and very slender antennae, and their articles, are generally foreign to Paracalliopiidae, this situation occurs frequently in other families, where unusually elongate antennae occur in the Oedicerotidae (such as *Synchelidium* and *Arrhis*) and in the Zobrachoidae, Urothoidae and Urohaustoriidae.

The lack of all but one medial spine on the outer plate of the maxilliped is relatively uncommon although this spination in *Paracalliope novizealandiae* is poor.

The genus combines apomorphies such as neotenic male gnathopods, loss of spines on outer plate of maxilliped and fossorial pereopods 3–6 (compared to *Paracalliope*) with possible plesiomorphies such as elongate articles of antennae, unfused inner lobes of the lower lip, and narrow lobes of maxilla 2.

The new genus differs from *Doowia* in the slender antennae, separated eyes, lack of carpal lobes on the gnathopods, the poor medial setation of the maxillae, the absence of mandibular palp, the presence of short tooth-spines on the inner plate of the maxilliped, the uncurved spines on the outer plates of maxilla 1, and the anteriorly extended coxa 1.

It differs from *Katocalliope* in the elongate articles 2–3 of antenna 1, the elongate article 5 of antenna 2, the non-pediculate molars, the longer and broader anterior coxae, uncurved spines on outer plate of maxilla 1, the longer peduncle of uropod 3, the divided inner lobes on the lower lip, the narrow plates of maxilla 2, and the anteriorly extended coxa 1.

Yhi yindi sp. nov.

Figures 1–3

Material examined. 3 males, 6 females, 2 unsexed: to 1.85 mm.

Holotype: Orpheus Island, Great Barrier Reef, Australia, 4 m, medium coral-algal sand (high density of amphipods including oedicerotids, phoxocephalids, dexaminids, platyischnopids), J.D. Thomas and J. Clark, 13 Feb 1989 (stn JDT-OPH 6), Museum of Victoria (NMV) J20847 (ovigerous female "o" with 2 eggs, 1.51 mm).

Paratypes: Type locality, NMV J20488 (female "p", 1.85 mm), NMV J20489 (unsexed "q", 1.78 mm), NMV J20490 (unsexed "r", 1.59 mm), USNM 253539 (female "s", 1.61 mm; female "t", 1.50 mm; female "u", 1.52 mm; female "v", 1.75 mm). Orpheus Island, reef front E of Iris Point, 4 m, same date, medium coral-algal sand, J.D. Thomas (stn JDT-OPH 6I), NMV J20491 (male "w", 1.30 mm), NMV J20492 (male "x", 1.31 mm), USNM 253538 (male "y", 1.52 mm).

Description. Female holotype "o". Complex of epistome and upper lip very bulky, projecting forward bluntly; gills of pereopods 3–5 like that illustrated for gnathopod 2, oostegite of pereopod 5 like pereopod 4 (with 6 setae) but also with one basal seta; pleopods ordinary, rami subequally extending, on pleopods 1–3 articles on outer ramus = 8–7–7, on inner ramus = 7–7–7, lengths of outer and inner rami on pleopods 1–3 (in relative units) = 37–32, 34–33, 34–33, each peduncle with 2 coupling hooks.

Male. "y". Flagella of antennae 1–2 each with 6 articles, calceoli absent, aesthetascs on articles 3–4–5–6 = 2–2–1–0, accessory flagellum absent.

Etymology. Yindi, from Aboriginal "sun".

Remarks. Very little description is needed for this species because the genus has so many distinctions from other genera of the group that most of the comments are made in the generic diagnosis. The figures are left to describe other details. The description of the female is limited to features not well seen in the illustrations; the description of the male is limited to distinctions from the female.

Acknowledgements

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Memoirs of the Museum of Victoria 52(2): 291–298 (1991) ISSN 0814-1827

REDESCRIPTION OF *MAXILLIPHIMEDIA LONGIPES* (WALKER, 1906) (CRUSTACEA: AMPHIPODA: IPHIMEDIIDAE) FROM THE ANTARCTIC PENINSULA

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Abstract

Coleman, C.O. and Barnard, J.L., 1991. Redescription of *Maxilliphimedia longipes* (Walker, 1906) (Crustacea: Amphipoda: Iphimediidae) from the Antarctic Peninsula. *Memoirs of the Museum of Victoria* 52: 291–298.

New figures and description of this species are presented. The genus is the most primitive in the Iphimediidae and the characters involved in this decision are listed.

Introduction

Only three previous records of *Maxilliphimedia longipes* have been published. We add here the fourth and redescribe and refigure the species in its entirety.

Maxilliphimedia K.H. Barnard

Maxilliphimedia K.H. Barnard, 1930: 355 (type species, *Iphimedia longipes* Walker, 1906, monotypy).—Watling and Holman, 1981: 202.

Diagnosis. Body with dorsal teeth. Antenna 1: peduncular article 2 shorter than 1. Bundle of mouthparts not projecting conically. Labrum bilobed; it and epistome very broad. Mandibular incisor broad, minutely serrate; raker row absent; molar absent. Lower lip:, inner lobes absent. Maxilla 1: palp 2-articulate, article 2 enlarged. Maxilla 2: inner plate without facial row of setae. Maxillipeds: inner plate much shorter and narrower than outer plate, latter elongate; palp article 2 weakly produced apicomedially, article 4 vestigial. Coxae ordinary: 1-3 extending subequally, coxa 4 slightly longer; coxa 4 bicuspidate. Gnathopods of linear form, minutely chelate. Telson deeply incised or distinctly cleft.

Remarks. This genus is characterized by the large article 2 of the palp on maxilla 1, and thereby differs from *Iphimedia* and *Iphimediella.*

Species. Monotypic. *M. longipes* (Walker, 1906, 1907) (K.H. Barnard, 1930) (Watling and Holman, 1981), marine, Antarctica, 183–769 m.

Maxilliphimedia longipes (Walker, 1906)

Figures 1–5

Iphimedia longipes Walker, 1906a: 151–152; 1907: 29–30, pl. 9 fig. 17.

Maxilliphimedia longipes.—K.H. Barnard, 1930: 355–356, fig. 28.—Watling and Holman, 1981a: 204, fig. 14.

Material examined. Antarctic Peninsula (60°49.9′S, 55°38.2′W), 392–384 m, RV Polarstern Cruise ANT VI/2, stn 12/087, fishery bottom trawl, USNM 253707 (male "a", 32 mm; female "b", 43 mm).

Description. Body (Fig. 1b, 2b): head longer than pereonite 1, rostrum strongly deflexed, lateral cephalic lobe produced, pointed, ocular lobe rounded, with ventral notch; eyes circular, pigmentary masses irregularly arranged.

Pereon slender in male, widened in female, coxal plates protruding somewhat laterally (seen from dorsal side); pereonite 2 shortest, pereonite 7 longest, posteromarginally with pair of strong, elongated teeth directed posteriorly; pleonites 1 and 2 with similar teeth; epimeron 1 rounded ventrally, ridged laterally, posterolateral margin acutely or subacutely produced; epimeron 2 ridged laterally, posteroventral corner pointed; pleonite 3 without dorsal armament, posterolateral margin drawn out as conspicuous cusp; no lateral ridge, posteroventral corner acute; urosomite 1 as long as urosomites 2 and 3 combined, anteriorly with hump, middorsally somewhat depressed; urosomite 3 excavate posteriorly, with weak medial depression.

Antenna 1 (Fig. 2c): peduncular article 1 stout, with long pointed terminal process, articles 2 and 3 slender; accessory flagellum uniarticulate (see detail in Fig. 2c); flagellar articles (37) stout, with long aesthetases and group of short setae (as in detail of Fig. 2c). Antenna 2 (Fig. 2a): peduncular articles 1 and 2 with acute processes, gland cone produced, article 3 widened distally, ar-

Figure 1. *Maxilliphimedia longipes*, male, 32 mm. a, lower lip; b, lateral view; c, mandibular palp; d, right incisor region; e, left mandible; f, labrum; g, maxilla 2.

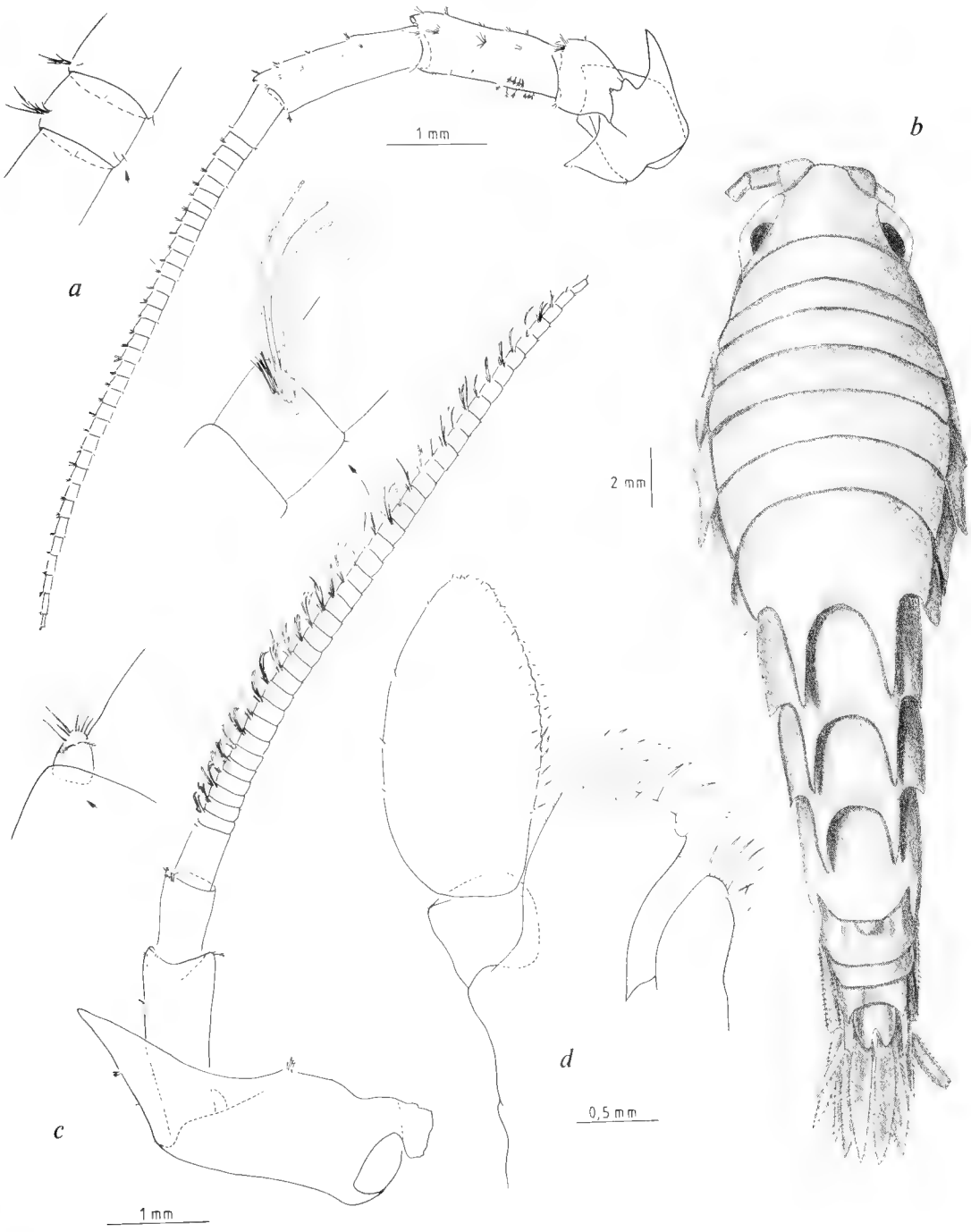

Figure 2. *Maxilliphimedia longipes*, male, 32 mm. a, antenna 2; b, dorsal view; c, antenna 1; d, maxilla 1.

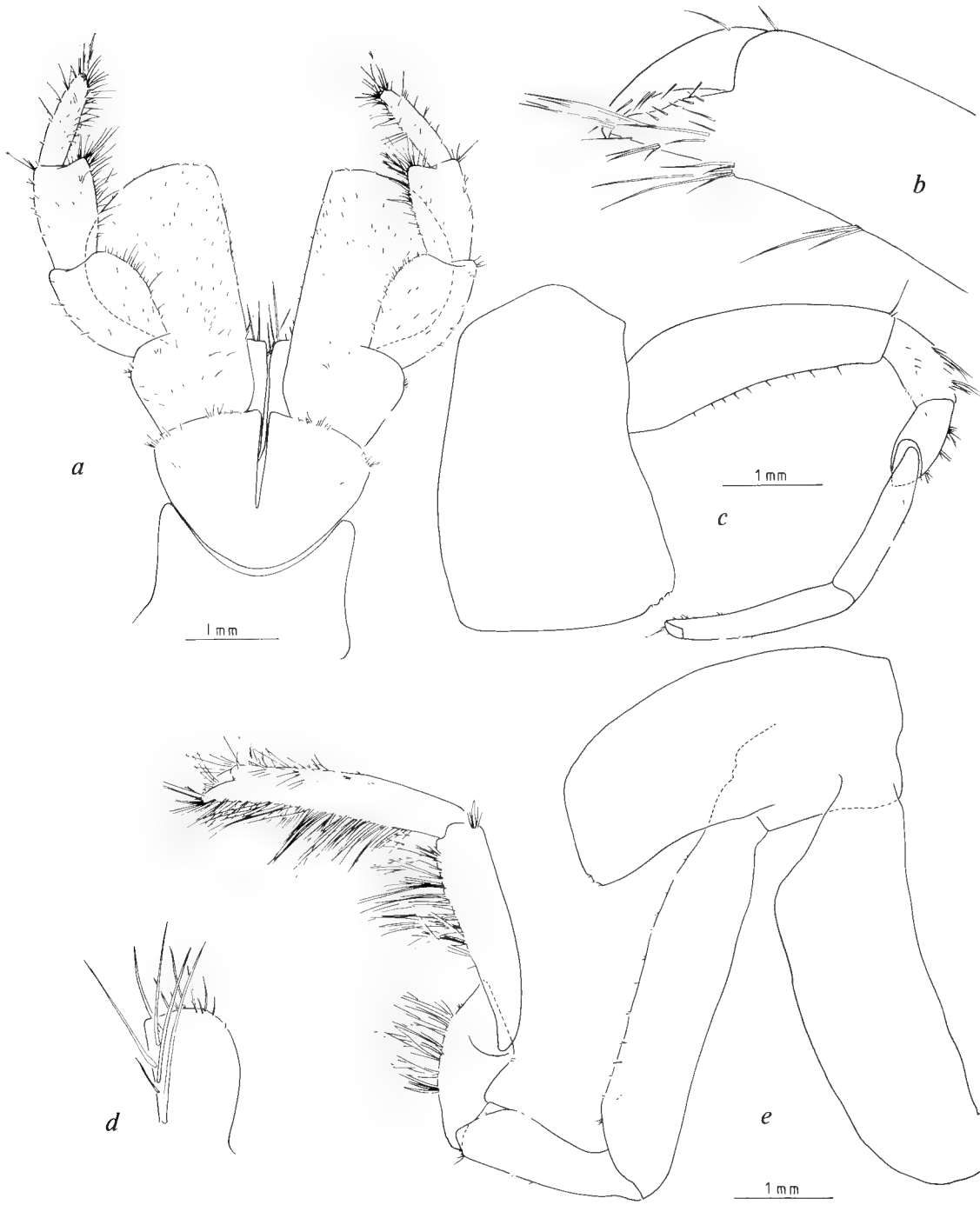

Figure 3. *Maxilliphimedia longipes*, male, 32 mm. a, maxilliped, ventral side; b, chela of gnathopod 1; c, gnathopod 1; d, inner plate of maxilliped, dorsal view; e, gnathopod 2.

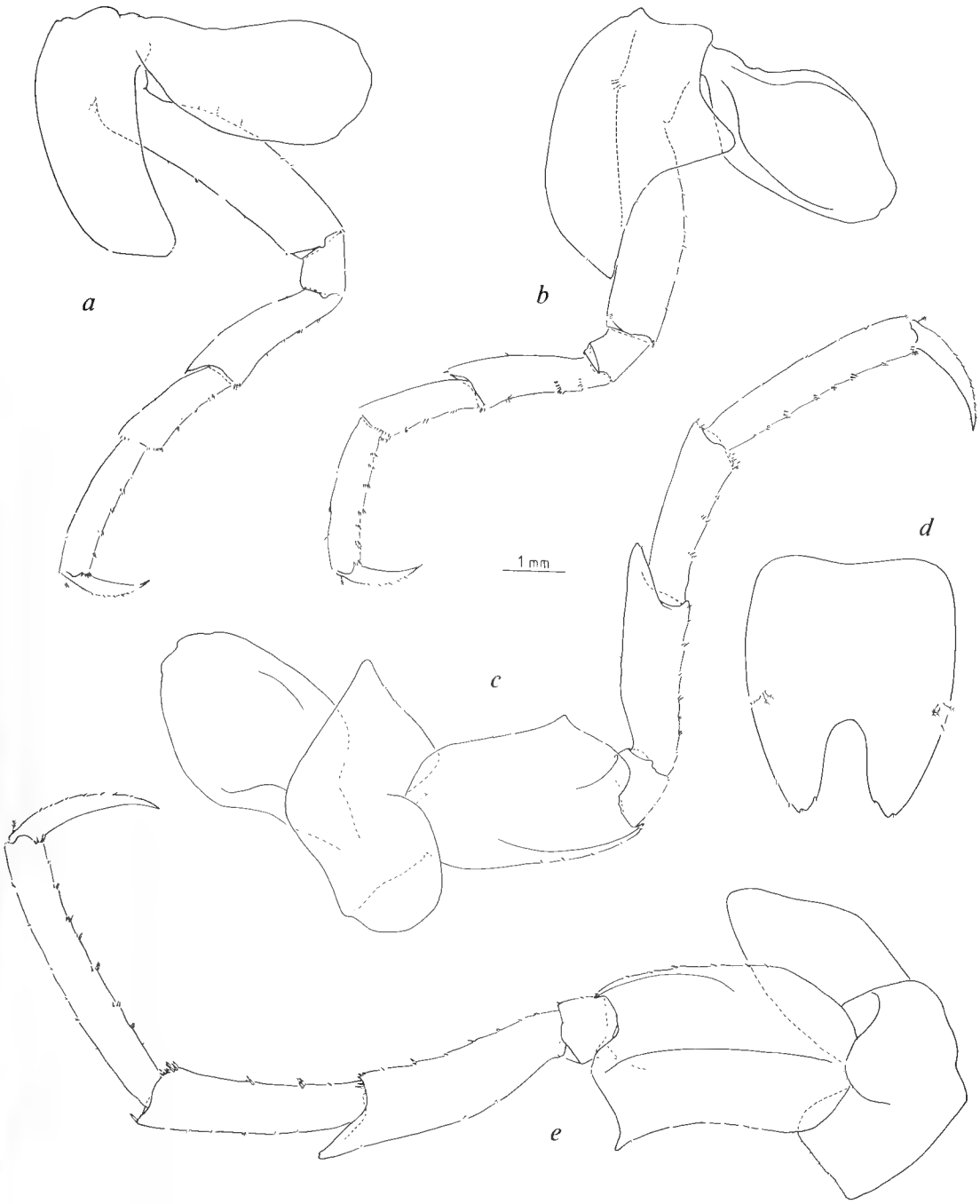

Figure 4. *Maxilliphimedia longipes*, male, 32 mm. a, pereopod 3; b, pereopod 4; c, pereopod 5; d, telson; e, pereopod 6.

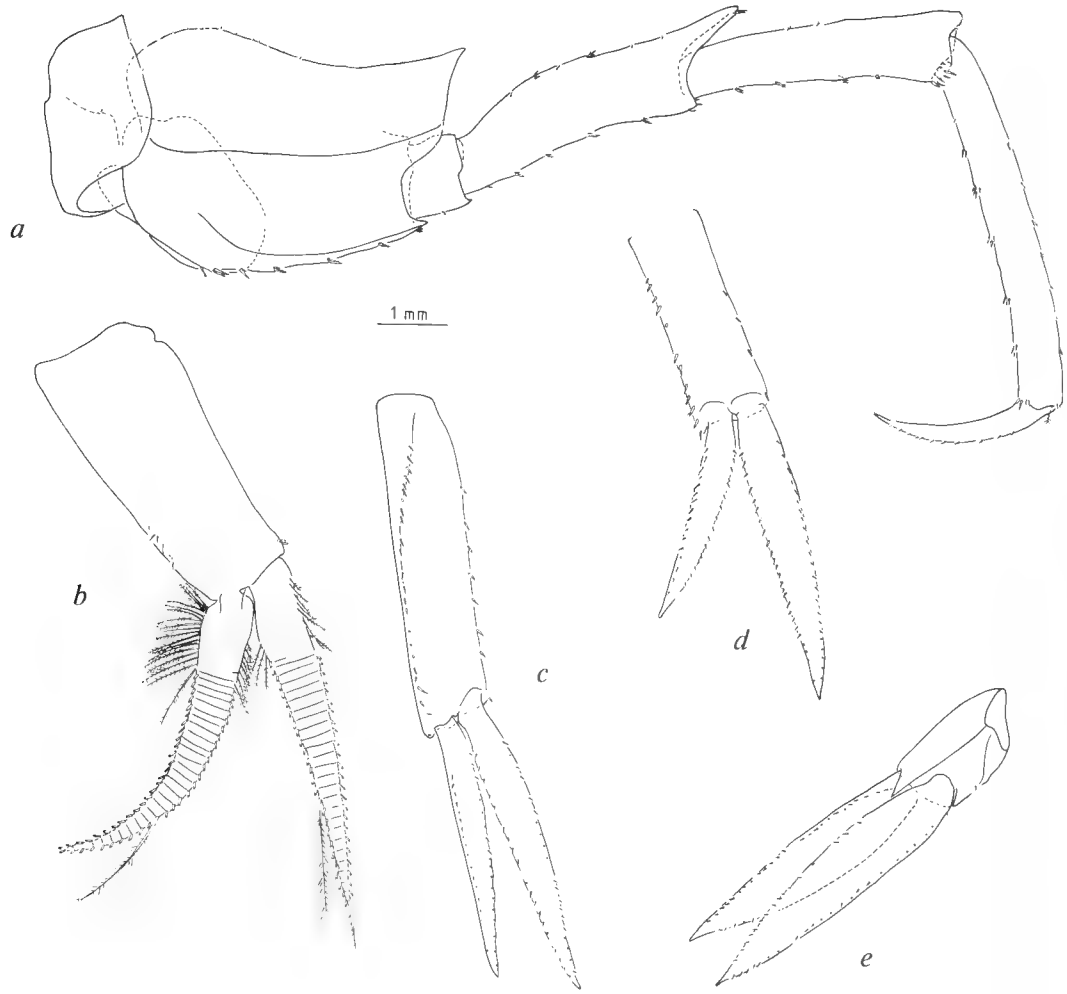

Figure 5. *Maxilliphimedia longipes*, male, 32 mm. a, pereopod 7; b, pleopod 1; c, uropod 1; d, uropod 2; e, uropod 3.

ticles 4 and 5 elongate, with groups of short setae; flagellar (33) articles with groups of setae distally.

Mouthparts bulky, not conically projecting ventrally. Labrum (Fig. 1f) broadly lobate, medially notched; epistome slightly produced dorsally from labral border, acute dorsal margin fused with acute process between second antennae. Mandible (Fig. 1c-d) broad, medially excavate; incisor minutely serrate, right incisor overlapping left; slender laciniae mobilis present on both mandibles; palp 3-articulate, article 2 longest, with group of setae distally, article 3 curved laterally, with ventral row of setae and some longer terminal setae. Lower lip (Fig 1a) truncate apically, mandibular process subacute. Maxilla 1 (Fig. 2d): inner plate with smooth setae medially and apically; outer plate truncate, with 14 smooth spiniform setae apically; palp biarticulate, article 2 elongate, ovally expanded, with row of short stout setae and row of slender setae extending along medial margin. Maxilliped (Fig. 3a, d): inner plate with long smooth setae mediomarginally and shorter setae distomarginally; outer plate broadened, ventral face and margins covered with short setae; palp 4-articulate, article 1 expanded, article 2 with slightly produced distomedial corner, article 3 slender, article 4 vestigial.

Only coxa 4 (of coxae 1–4) weakly acuminate; coxa 1 broadened distally, truncate apically; coxa 2 slightly tapering distally, truncate

apically; coxa 3 slightly curved posteriorly, distally truncate; coxa 4 rounded anteriorly, pointed ventrally, posterior margin drawn out as subacute cusp; coxa 5 wider than long, rounded anteriorly, pointed posteriorly; coxa 6 shorter than wide, rounded anteriorly, subacute processed posteriorly; coxa 7 smallest, acutely pointed posteriorly. Gill: of coxa 2 not reaching beyond apex of basis; of coxa 3 sack-like, shorter than basis; of coxa 4 sack-like, shorter than basis; of coxae 5–6 sack-like.

Gnathopod 1 (Fig. 3b, c): basis dilated proximally; ischium and merus with groups setae posteriorly; carpus and propodus elongate, length ratio = 31:37, propodus and dactylus forming chela. Gnathopod 2 (Fig. e): ischium slightly expanded distally, somewhat longer than merus; merus broadened distally; groups of long setae posteromarginally; carpus elongate, weakly expanded distally, groups of setae posteromarginally; propodus elongate, ratio to carpus = 51:46, forming chela together with dactylus; long setae posteromarginally and on lateral face. Pereopod 3 (Fig. 4a): basis subequal in length to coxa, slender; ischium smallest; merus slightly expanded distally, drawn out as acute process; carpus shorter than merus and propodus, weakly widened distally; propodus quite long; dactylus slender, with short spiniform setae anteriorly; merus to propodus with groups of short setae posteromarginally. Pereopod 4 (Fig. 4b): ischium to dactylus as in pereopod 3. Pereopod 5 (Fig. 4c): basis widened, with posterior cusp, overlapping coxa proximally; lateral face with 2 ridges; ischium short, partially hidden by basis; merus with posterodistal process; carpus weakly expanded distally; propodus slender, subequal in length to basis; ischium to propodus with setae anteromarginally; dactylus as in pereopod 2. Pereopod 6 (Fig. 4e): basis wider than in preceding pereopod, overlapping coxa posteroproximally, acutely produced posterodistally, lateral faces with 2 ridges; ischium to propodus as for pereopod 5, but longer. Pereopod 7 (Fig. 5a): basis larger than in pereopods 5 and 6, broadest proximally, with acute posterodistal process directed ventrally, 2 ridges on lateral face; ischium to dactylus as described for pereopod 5, but somewhat longer.

Pleopods (Fig. 5b) normal. Uropod 1 (Fig. 5c): peduncle longer (107%) than inner ramus, outer ramus shorter than inner (82%); margins of peduncle and rami bordered with short spine-like setae. Uropod 2 (Fig. 5d): peduncle shorter (70%) than inner ramus; outer ramus shorter than inner (70%); margins of peduncle and rami bordered with short spine-like setae. Uropod 3 (Fig. 5e): peduncle short, lateral margin turned upwards and pointed distally; outer ramus slightly shorter than inner; rami bordered with spiniform setae. Telson (Fig. 4d) notched slightly more than one-third, lateral margins turned dorsalwards, 3 plumose setae on each side.

Remarks. The material redescribed herein matches well with the descriptions of Walker (1906, 1907) and the additions given by K.H. Barnard (1930). The only characters differing from former descriptions are: (a) the upper lip is notched rather symmetrically (different from conditions described in the generic diagnosis by K.H. Barnard (1930); (b) the basis of gnathopod 1 is less setose compared to the specimen described by Watling and Holman (1981). A slight variability was observed in the posterior margins of the epimeral plates and coxae 5–7; they are acutely pointed in some specimens, but rather blunt in others. The depth of the mid-dorsal depression on pleonite 1 is variable.

Maxilliphimedia undoubtedly is the most primitive genus in the Iphimediidae (as defined and strongly restricted by Coleman and Barnard, 1991, but see the phylogenetic analysis of Watling and Thurston, 1989). Apart from the plesiomorphic state of the transverse cutting plane of the incisors there are some characters which are unique to *Maxilliphimedia* in the Iphimediidae, but can be found also in the Stilipedidae: (1) mouthparts not arranged in a conical bundle, but bulky, covered by large outer plate of the maxilliped; (2) outer plate of maxilla 1 with smooth spiniform setae apically; palp expanded distally and bordered with 2 rows of setae; (3) maxilla 2 inner and outer plates rounded distally, relatively broad; (4) maxillipedal outer plate with reduced setation marginally, but ventral face covered with short setae; (5) coxa 1 expanded distally (versus tapering coxa 1 in all other Iphimediidae); (6) pereopods 5 to 7 increasing in length; (7) pereopod 7 reaching beyond uropods (compare with the stilipedid *Bathypanoploea schellenbergi* Holman and Watling, 1983).

Two other synapomorphic features clearly designate *Maxilliphimedia longipes* as an iphimediid: (1) gnathopods both chelate, with the typical pattern of length, shape and setation; (2) paired teeth present on pereonite 7 and pleonites 1–2. It cannot yet be decided if the characters shared by the primitive Stilipedidae and the more advanced *Maxilliphimedia* are convergent

formations due to a similar mode of life or a result of phylogenetic vicinity.

Distribution. Coulman Island, 180 m (type locality); McMurdo Sound, 379 m; Bransfield Strait, 265–769 m; Antarctic Peninsula, 384–392 m.

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GUERNEA IPILYA AND *G. YAMMINYE*, NEW SPECIES (CRUSTACEA: AMPHIPODA: DEXAMINIDAE), FROM THE GREAT BARRIER REEF, AUSTRALIA

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Abstract

Thomas, J.D. and Barnard, J.L., 1991. *Guernea ipilya* and *G. yamminye*, new species (Crustacea: Amphipoda: Dexaminidae), from the Great Barrier Reef, Australia. *Memoirs of the Museum of Victoria* 52: 299–310.

A modern diagnosis of *Guernea* is given, its species listed with their biogeographical distributions based on Barnard and Barnard (1983). Two species, *Guernea ipilya* and *G. yamminye*, are described from rubble in shallow water on the Great Barrier Reef. *Guernea ipilya* differs from its sympatriot, *G. endota*, in: lack of mid-dorsal spines on the urosome, with the side spines smaller; spinose telson; much longer and denser setae on article 2 of pereopod 5; larger posterior lobe of coxa 5; shorter anterior lobe of coxa 6; stouter antennae; lack of hump on urosomite 1; short pereopod 6; lack of major posterior spines on article 6 of pereopods 3–4; and lack of spines on rami of female uropod 3. *Guernea yamminye* differs from *G. reticulatus* in the lack of serrations on article 2 of pereopod 7 and the weaker envelopment of article 6 by article 5 on pereopod 7.

Introduction

Two new species, *Guernea ipilya* and *G. yamminye*, are described from rubble in shallow-water on the Great Barrier Reef. Information about *Guernea* is updated, with a list of species and their important references, their distribution, including codes of distribution found in Barnard and Barnard (1983).

Dexaminidae Leach

Prophliantinae Nicholls

Guernea Chevreux

Helleria Norman, 1868: 418 [homonym, Isopoda] (type species, *Helleria coalita* Norman, 1868, monotypy).

Guernea Chevreux, 1887: 302 (replacement name).—Stebbing, 1906: 521 [in part].—Ledoyer, 1982: 346 [valid subgenus].

Prinassus Hansen, 1888: 82 (type species *Prinassus nordenskioldi* Hansen, 1888, original designation) [valid subgenus].

Dexamonica J.L. Barnard, 1958: 130 (type species, *Dexamonica reduncans* J.L. Barnard, 1958, monotypy) [subgeneric synonym of *Prinassus*].

Haustoriopsis Schellenberg, 1938a: 12 (type species *Haustoriopsis reticulatus* Schellenberg, 1938a, monotypy) [subgeneric synonym of *Guernea*].

Diagnosis. Only urosomites 2–3 coalesced. Article 5 of pereopod 7 normally rectangular. Article 4 of pereopod 5 not asymmetrically expanded. Uropod 2 shortened.

Description. Cephalic lobes rounded. Eyes present. Molar weakly to scarcely triturative; rakers weak, sparse or absent; mandibular palp absent; maxillae poorly setose, though inner plate often with medial setae; inner plate of maxilliped small to ordinary, palp slightly reduced, 4-articulate. Gnathopods ordinary though palms occasionally subtransverse. Pereopods simple, pereopods 5–7 typical of subfamily. Uropod 2 short; uropod 3 small, rami lanceolate. Telson deeply cleft. Gills narrow, ovate or elliptical, on coxae 2–6; oostegites slender.

Sexual dimorphism. Body of male thinner and more streamlined than in female, pleon enlarged, anterior coxae compacted; eyes enlarged; flagellum of antenna 2 elongate, multiarticulate; article 1 of antenna 1, article 4 of antenna 2 often swollen and brushy and often rugose; uropod 3 setose (only spinose in female). Mouthparts occasionally degenerate in varying degree.

Remarks. Ledoyer (1982) noted that the differences between *Guernea* and *Haustoriopsis* were bridged by species described since 1938 and therefore reduced *Haustoriopsis* to subgeneric level under *Guernea*. We now judge the differences between the two subgenera to be so insub-

stantial that *Haustoriopsis* must be submerged totally.

Identifying species in this genus is very difficult. Many are poorly described and lack detail about both sexes. Minor differences between sexes are probably important and should be illustrated. For example, the mouthparts of males in well known species differ from those of females but often male mouthparts are overlooked. Some of the coxae are unknown for most species. The precise microscopic appearance of the dorsal surface of the urosome is unknown for many species. Almost nothing has been published on intraspecific variation.

Variables. The following significant variations occur in the genus: palp of maxilla 1 uniarticulate (*G. endota*, etc.) or biarticulate (normal); inner plate of maxilla 2 very short (*G. timaru*); inner plate of maxilliped short (*G. gelane*), or long (*G. endota*); article 4 of pereopod 5 dilated (*G. latipes*) or not (*G. reticulatus*); article 5 of pereopod 7 strongly (*G. reticulatus*) or scarcely (type and *G. latipes*) enveloping article 6; inner rami of uropods 1–2 reduced (*G. gelane*, *G. tumulosa*); spines on uropods 1–2 shortened (*G. rhomba*, *G. tumulosa*).

Distribution. Marine, cosmopolitan except for Antarctica, 0–255 m, 25 species.

Species. See J.L. Barnard (1966a, b, 1970); Barnard and Barnard (1983) for explanation of geographic codes cited in brackets; Bulycheva (1957); Fage (1933); Gurjanova (1951); Karaman (1973); Shoemaker (1930, 1955).

Guernea (*Guernea*) *brevispinis* Ledoyer, 1982, Madagascar [698].

Guernea (*Guernea*) *coalita* (Norman, 1968) (= *laevis* Chevreux 1887) (Chevreux and Fage, 1925) (Lincoln, 1979) (Bellan-Santini, 1982) warm E. Atlantic, Mediterranean [352].

Guernea (*Guernea*) *endota* J.L. Barnard, 1972a, SW Australia [787].

Guernea (*Guernea*) *gelane* J.L. Barnard, 1972a, SE Australia [781].

Guernea (*Guernea*) *ipilya* Thomas and Barnard, herein, NE tropical Australia [633].

Guernea (*Guernea*) *latipes* Ledoyer, 1979 (= *petalocera* ID of Ledoyer, 1973), Madagascar [698].

Guernea (*Guernea*) *longicornis* Ledoyer, 1982, Madagascar [698].

Guernea (*Guernea*) *magnaphilostoma* Hirayama, 1985, S. Japan [395].

Guernea (*Guernea*) *melape* J.L. Barnard, 1972a, southern Australia [780].

Guernea (*Prianassus*) *nordenskioldi* (Hansen, 1888) (J.L. Barnard, 1970) (Just, 1980), amphi-Atlantic and Mediterranean [354+].

Guernea (*Prianassus*) *nullispina* Hirayama, 1985, S. Japan [395].

Guernea (*Guernea*) *petalocera* Ruffo, 1959, Red Sea [677].

Guernea (*Guernea*) *quadrispinosa* Stephensen, 1944 (Bulycheva, 1957), Sea of Japan [391].

Guernea (*Prianassus*) *rectocephala* Hirayama, 1985, S. Japan [395].

Guernea (*Prianassus*) *reduncans* (J.L. Barnard, 1958, 1970), warm-temperate California [373].

Guernea (*Guernea*) *reticulatus* (Schellenberg, 1938), Bismarck Archipelago [595].

Guernea (*Guernea*) *rhomba* Griffiths, 1974, 1975, southern Africa [743].

Guernea (*Guernea*) *spinicornis* Ledoyer, 1982, Madagascar [698].

Guernea (*Guernea*) *tenuipes* Ledoyer, 1979, Madagascar [698].

Guernea (*Prianassus*) *terelamina* Hirayama, 1985, S. Japan [395].

Guernea (*Guernea*) *timaru* J.L. Barnard, 1972b, NE New Zealand [773].

Guernea (*Prianassus*) *tomiokaensis* Hirayama, 1985, S. Japan [395].

Guernea (*Guernea*) *tumulosa* Griffiths, 1976, southern Africa, inquilinous [743I].

Guernea (*Guernea*) *unchalka* J. L. Barnard, 1972a, SW Australia [787].

Guernea (*Guernea*) *yamminye* Thomas and Barnard, herein, NE tropical Australia [633].

Guernea species, *laevis* ID of Walker, 1904, Ceylon [665].

Key to subgenera of *Guernea*

Urosomite 1 with weak dorsal hump in both sexes ..... *Guernea*
Urosomite 1 with retrorse dorsal process in female, high keel in male .....
..... *Prinassus*

Guernea (Guernea) ipilya sp. nov.

Figures 1–4 (part)

Material examined. 1 male, 2 females, 1 juvenile.

Holotype: Australia, Queensland, Lizard Island, 2.5 m, rubble sample near Lizard Head, J.D. Thomas and J. Clark, 31 Jan 1989, Museum of Victoria (NMV) J20494 (female "w" with 8 eggs, 1.99 mm).

Paratypes: Type locality, NMV J20495 (juvenile "y", 1.67 mm); USNM 253716 (female "x", 2.30 mm).

Additional material: Lizard Island, North Point, 13 m, 28 Jan 1989, rubble sample from vertical cliff and unconsolidated bottom, J.D. Thomas, 2 specimens. Lizard Island, Mermaid Island, 1–2 m, 26 Jan 1989, formalin wash of rubble, J.D. Thomas, 1 female.

Diagnosis. Accessory flagellum absent; antenna 2 unlobed but thick; mandibular incisors with 2–3 (right) or 3–4 (left) very weak teeth, spine row absent on right, with 1 large, 1 vestigial spine on left, molar with seta; inner lobes of lower lip large, fleshy and separate; palp of maxilla 1 reaching apex of outer plate, uniarticulate, apex with 1 spout and 2 setae; inner plate of maxilla 2 much shorter and broader than outer plate, bearing 3 apicomedial marginal setae, outer plate with medium, subtruncate apex, palp with 9 setae; inner plate of maxilliped small, outer plate reaching middle of palp article 3; gnathopod 2 as broad as but longer than gnathopod 1; coxa 5 with very large, lobuliform, rounded posterior lobe, anterior lobe on coxa 6 vestigial; anterior setae on article 2 of pereopod 5 well developed, article 6 elongate, articles 4–5 of pereopod 7 of broad form, article 5 not enveloping article 6, dactyl large; inner rami of uropods 1–2 as long as outer, peduncle of uropod 2 with 2 dorsal spines, apical spines of rami on uropods 1–2 of short form (in context of genus); telson only 1.1 times as long as broad; epimeron 3 with posteroventral margin smoothly rounded; urosomite 1 with weak rugose double dorsal crest, urosomites 2–3 (fused) of medium height, almost evenly rounded and sloping posteriorwards, bearing about 8–15 weak setules each; apical spines on rami of uropods 1–2 of short form (in context of genus); cuticle (light microscopy, 1000×) with arcuate or semicircular scale-serrations in lines, variable.

Description. Eyes with deep purple cores in alcohol; upper lip rounded-truncate below; right lacinia mobilis smaller and more weakly toothed (5 small, 2 large) than left (6 large); outer plate of maxilla 1 with 9 spines, palp apex with cusp-like spout and 2 setae; basis of gnathopod 1 s-shaped, palms of gnathopods smooth, medial faces of propodi with only 2–4 weak setae, dactyls bearing one large inner tooth; posterior margins on article 6 of pereopods 3–4 minutely ridged; pereopod 4 like 3 but article 5 with 1 less spine, article 4 with 1 less seta; epimeron 1 with enormous inward bending anteroventral lobe; uropod 2 with 2 basofacial setae in tandem; urosomite 1 naked ventrally. Oostegites: of coxa 2 half as long as basis of gnathopod 2, truncate apically, slender, subrectangular, with 2 apical setae, of coxae 3–4 similar but with additional posteroventral seta, of coxa 5 similar, with 4 setae. Gills of coxae 2–5 large sacs, of coxa 6 smaller, absent on coxa 7.

Pleopods: ratio of lengths of peduncle, outer and inner rami for pleopods 1–3 = 29:33:32, 25:28:28, and 26:28:26; articles of outer and inner rami for pleopods 1–3 = 7–7, 7–7, 7–7; coupling spines 2; each peduncle with 2 setae.

Etymology. From the Australian Aboriginal language, named after the giant lizard god creating monsoons and thunderstorms. Noun in apposition.

Distribution. Australia, Great Barrier Reef, Lizard Island, 1-3 m, rubble.

Relationship. Guernea ipilya differs from the Australian *G. endota* in: (1) lack of mid-dorsal spines on the urosome, with the side spines smaller; (2) spinose telson; (3) much longer and denser setae on article 2 of pereopod 5; (4) larger posterior lobe of coxa 5; (5) shorter anterior lobe of coxa 6; (6) stouter antennae; (7) lack of hump on urosomite 1; (8) short pereopod 6; (9) lack of major posterior spines on article 6 of pereopods 3-4; (10) lack of spines on rami of female uropod 3. There are also many differences in mandible, maxillae 1-2 and maxilliped.

It differs from the Australian *G. gelane* in points 2, 6, 8, 9, and 10 above, plus (11) long inner rami of uropods 1–2; and (12) the very spinulose rims of the urosome.

It differs from the Australian *G. melape* in points 1, 2, 4, 5, 6, 7, 9, 10 and 12.

We have compared our species to only those from other parts of the world which: (1) lack humps and large spines on the urosome; (2) lack cusps on antenna 2; (3) have coxa 5 with large well developed anterior lobe but a much larger rounded posterior lobe; (4) have equally extending rami of uropods 1–2; (5) have slightly oblique (versus transverse) palms on the gnathopods.

Our new species appears to be very close to the Madagascan *G. latipes* but differs mainly in the

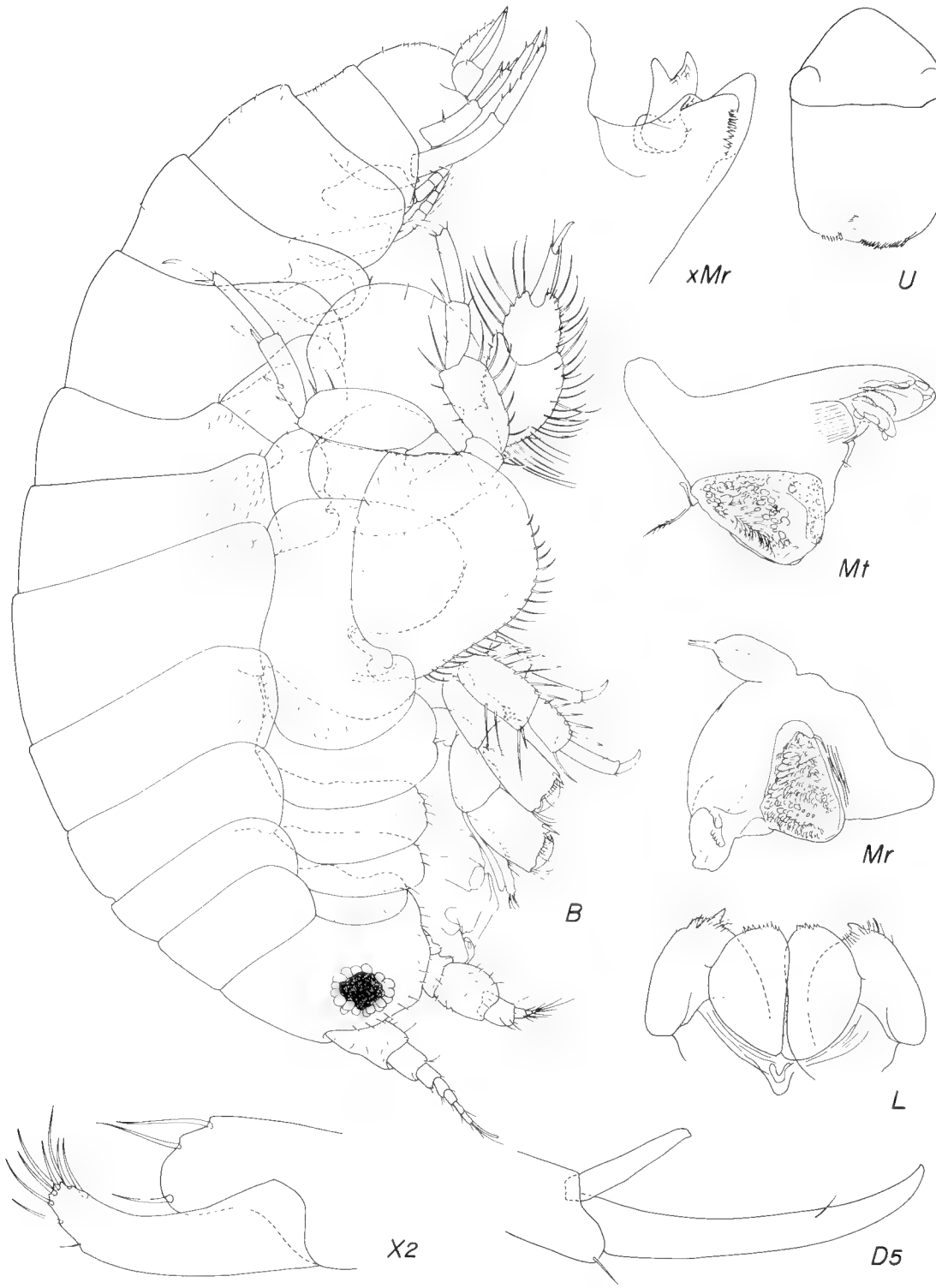

Figure 1. *Guernea ipilya*, unattributed figures = holotype female "w", 1.99 mm; x= female "x", 2.30 mm. Capital letters in figures refer to parts; lower case letters to left of capital letters refer to specimens and to the right refer to adjectives as described below; "unattributed" refers to main specimen for each figure lacking lower case letter to left of capital letter; abbreviations used in figures are: B, body; C, coxa; D, dactyl; G, gnathopod; H, head; I, inner plate or ramus; J, urosome; K, cuticle; L, labium; M, mandible; P, pereopod; R, uropod; S, maxilliped; T, telson; U, upper lip; W, pleon; X, maxilla; Y, gill; Z, oostegite; d, dorsal; f, flattened; m, medial; r, right; left. Right mandible (Mr) reduced to two-thirds of left (Mt).

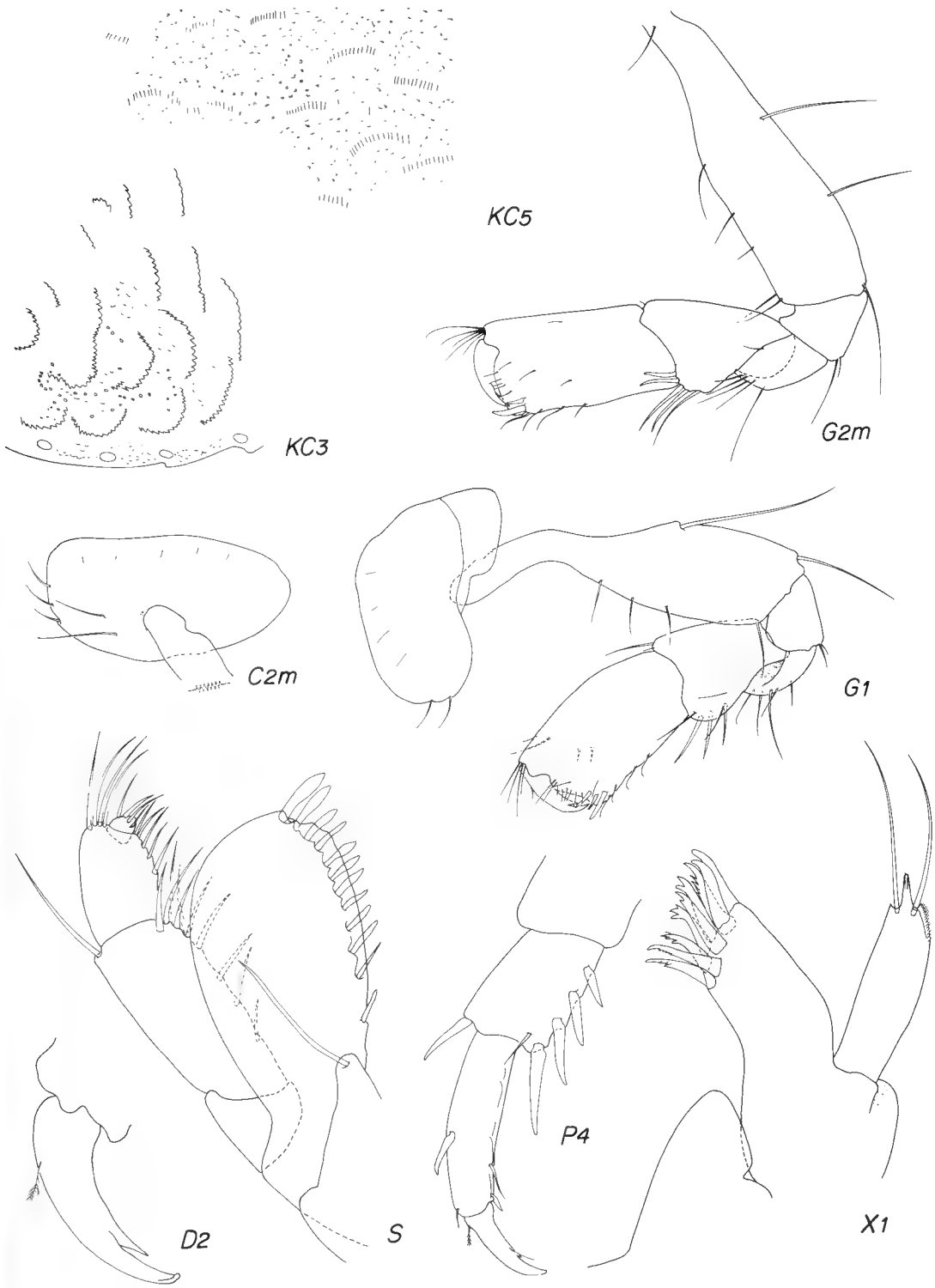

Figure 2. *Guernea ipilya*, holotype female "w", 1.99 mm.

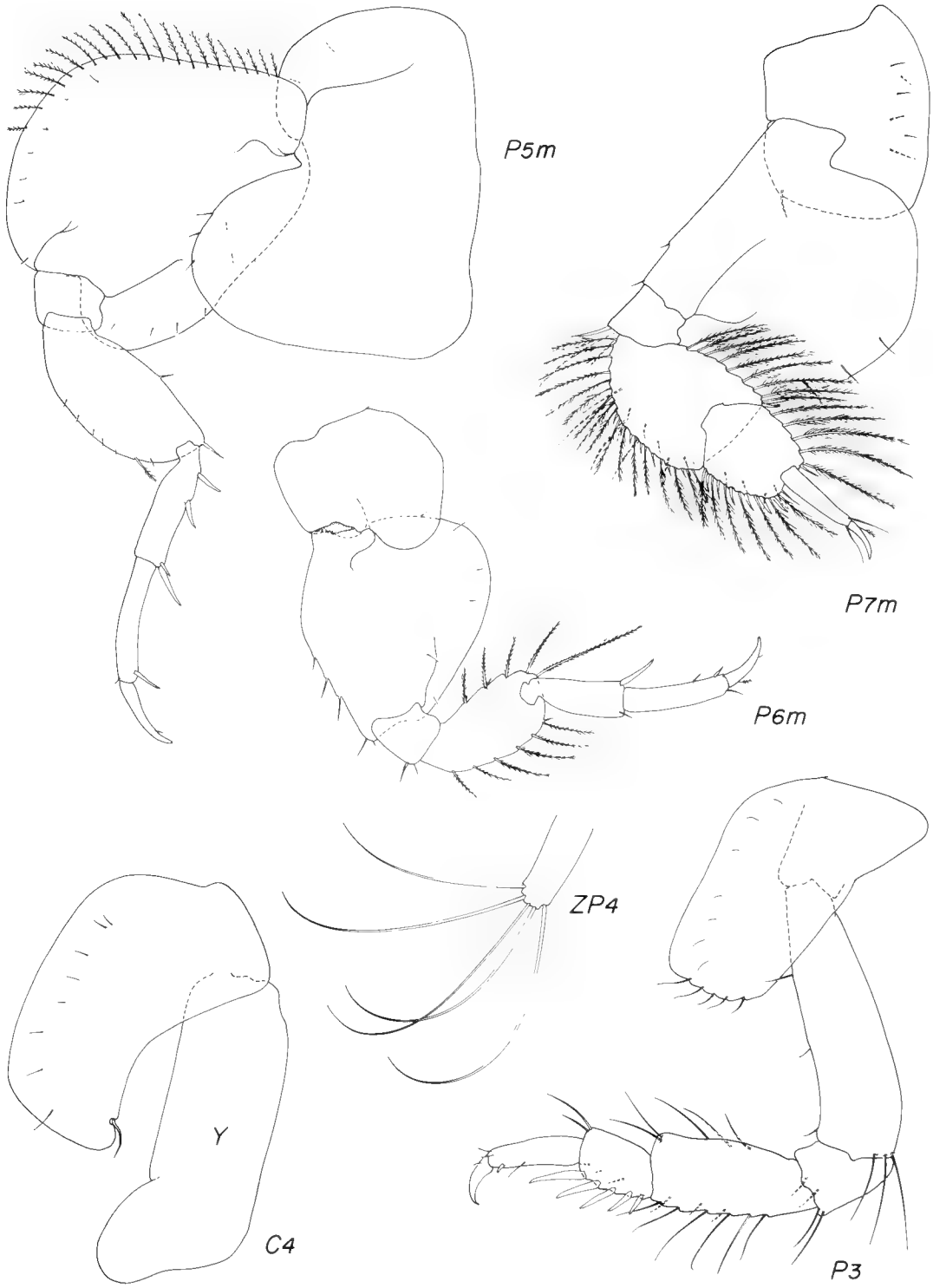

Figure 3. *Guernea ipilya*, holotype female "w", 1.99 mm.

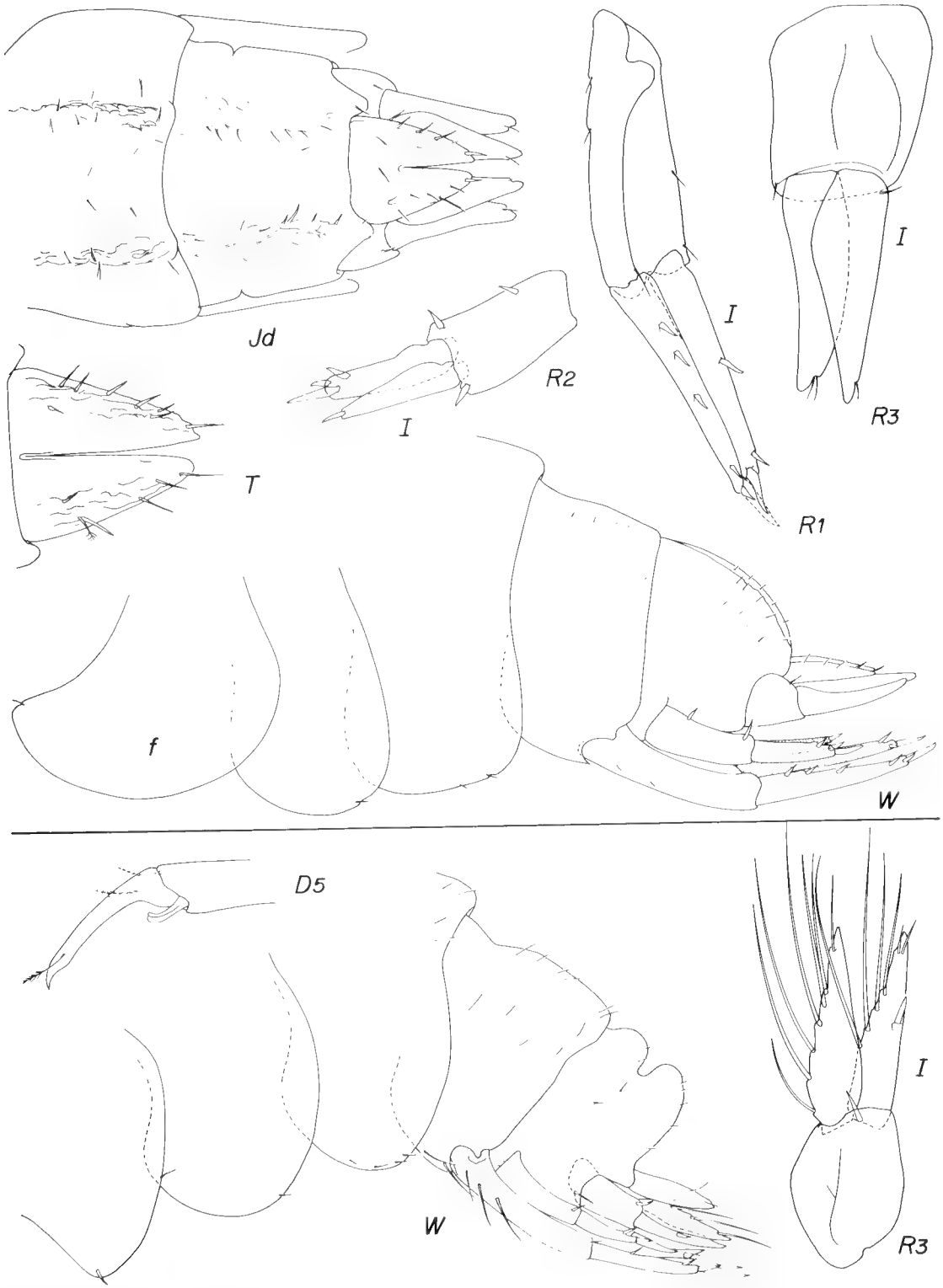

Figure 4. Upper, *Guernea ipilya*, holotype female "w", 1.99 mm.
Lower, *Guernea yamminye*, holotype, male "a", 1.82 mm. View of epimera (W) showing anterior lobe of epimeron 1 bent outward and flattened.

short apical spines on the rami of uropods 1–2.

It differs from *G. longicornis* in the short apical spines on the rami of uropods 1–2, the thick and short antenna 2, and the lack of the weak humping on urosomites 2–3 (so weak in *G. longicornis* that we included it for comparison despite item 1 above).

It differs from *G. coalita* in the short apical spines on the rami of uropods 1–2, thicker antenna 2, much broader article 2 of pereopod 6 and the lack of double hump on urosomites 2–3.

It differs from *G. tenuipes* in the thicker antenna 2, lack of marginal spines on the outer ramus of uropod 2, presence of marginal spines on the outer ramus of uropod 1, and the broadly expanded articles 4–5 of pereopod 7.

It differs from *G. timaru* in the short apical spines on the outer rami of uropods 1–2, broader articles 4–5 of pereopod 7, basally broader article 2 of pereopod 6, denser setae on article 2 of pereopod 5, more transversely arranged palms of the gnathopods, lack of a spine on the inner ramus of uropod 3, much more armamented telson, broader inner plate of maxilla 2, and lack of a thick spine-seta on the lateral margin of maxilla 2.

Guernea (Guernea) yamminye sp. nov.

Figures 4–6 (part)

Material examined. 1 male.

Holotype: Lizard Island, near Mermaid Beach, 1–2 m, rubble wash on extensive rubble plain, J.D. Thomas and J. Clark, 26 Jan 1989, NMV J20496 (male "a", 1.82 mm).

Additional material: Lizard Island, North Point, 25 m, sediment plain next to forereef, coral-algal mud with *Halimeda* flakes overlain by fine flocculent layer, J.D. Thomas, 26 Jan 1989, USNM 253723 (1 male).

Diagnosis. Accessory flagellum absent; antenna 2 unlobed but article 4 moderately thick; mandibular incisors with 4 weak teeth, spine row absent, molar without seta; inner lobes of lower lip large, fleshy and separate; palp of maxilla 1 degenerate, not reaching apex of outer plate, uniarticulate, lacking setae; inner plate of maxilla 2 much shorter and broader than outer plate, bearing 1 apicomedial seta, outer plate with medium subtruncate apex bearing 8 setae; inner plate of maxilliped small, narrow, outer plate reaching middle of palp article 3, most medial spines blunt; gnathopod 2 narrower but longer than gnathopod 1; coxa 5 with very large, lobuliform, rounded posterior lobe, anterior lobe weak and ragged; anterior lobe on coxa 6 weak; anterior setae on article 2 of pereopod 5 weak, article 6 moderately elongate; articles 4–5 of pereopod 7 of broad form (in context of genus), article 5 weakly enveloping article 6, dactyl large; inner rami of uropods 1–2 as long as outer, peduncle of uropod 2 with 2 dorsal spines; apical spines on rami of uropods 1–2 of elongate form (in context of genus); telson about 1.75 times as long as broad; epimeron 3 with posteroventral margin smoothly rounded; urosomite 1 with weak rugose, setulose double dorsal crest, urosomites 2–3 (fused) tall, with 2 almost evenly rounded dorsal humps, then sloping downward sharply posteriorwards, bearing about 1–7 setules each; cuticle (light microscopy, 1000×) with arcuate or semicircular scale-serrations in lines, variable.

Description. Eyes very large, lacking deep purple cores in alcohol; upper lip rounded-truncate below (as in *G. ipilya*); right lacinia mobilis smaller and more weakly toothed (4 small) than left (6 large); outer plate of maxilla 1 with 7 spines; basis of gnathopod 1 s-shaped, palms of gnathopods weakly serrate, medial faces of propodi with only 2–4 weak setae, dactyls bearing one large inner tooth; posterior margins on article 6 of pereopods 3–4 not minutely ridged; pereopod 4 like 3 but article 5 with 1 less spine, article 4 with 1 less seta; epimeron 1 with medium-small inward bending anteroventral lobe; uropod 1 with 3 basofacial setae in tandem; urosomite 1 with 2 setae ventrally. Gills of coxae 2–5 large sacs, of coxa 6 smaller, absent on coxa 7.

Pleopods: ratio of lengths of peduncle, outer and inner rami for pleopods 1–3 = 27:29:30, 27:26:26, and 25:27:28; articles of outer and inner rami for pleopods 1–3 = 6–6, 6–6, 6–5; coupling spines 2; each peduncle with 2 setae.

Summary of typical male dimorphic distinctions. Smaller head with bulging eye lobes and enlarged eye, elongate male-like antennae 1–2 with male setular tufts on articles 4–5 of antenna 2; some mouthparts degenerating, for example, right lacinia mobilis weak, outer plate of maxilla 1 with only 7 spines, palp obsolescent, maxilla 2 poorly setose, maxilliped reduced, spines on outer plate shorter and blunter; anterior coxae smaller relative to coxa 5; gnathopods slender; anterior setae on article 2 of pereopod 5 weak, posterior margin straight; pleonites 1–3 and pleopods more dominant; lobe on epimeron 1 weak; body rugose posterodorsally, urosomite 1 with 2 ventral setae; uropod 1 with long

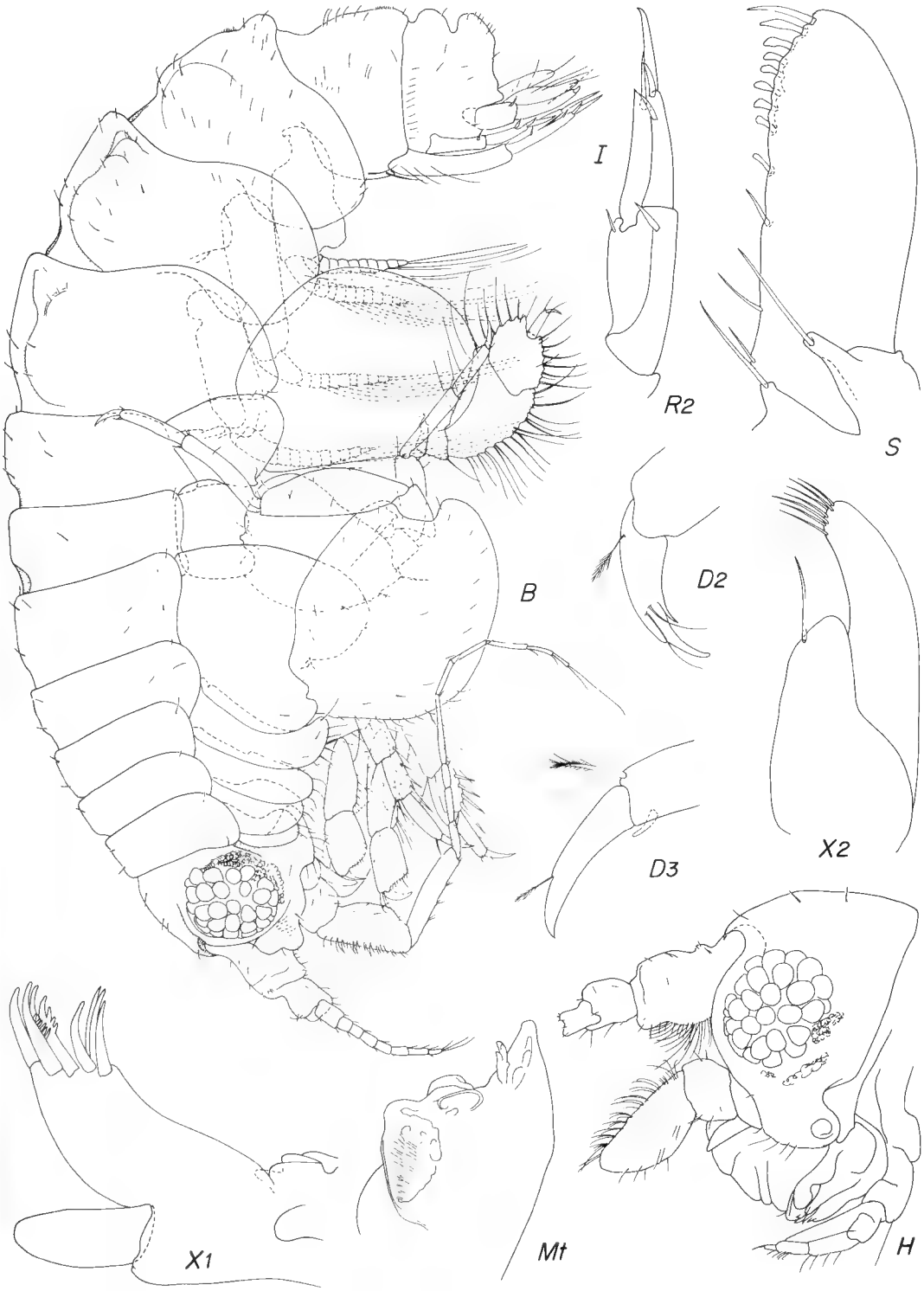

Figure 5. *Guernea yamminye*, holotype, male "a", 1.82 mm.

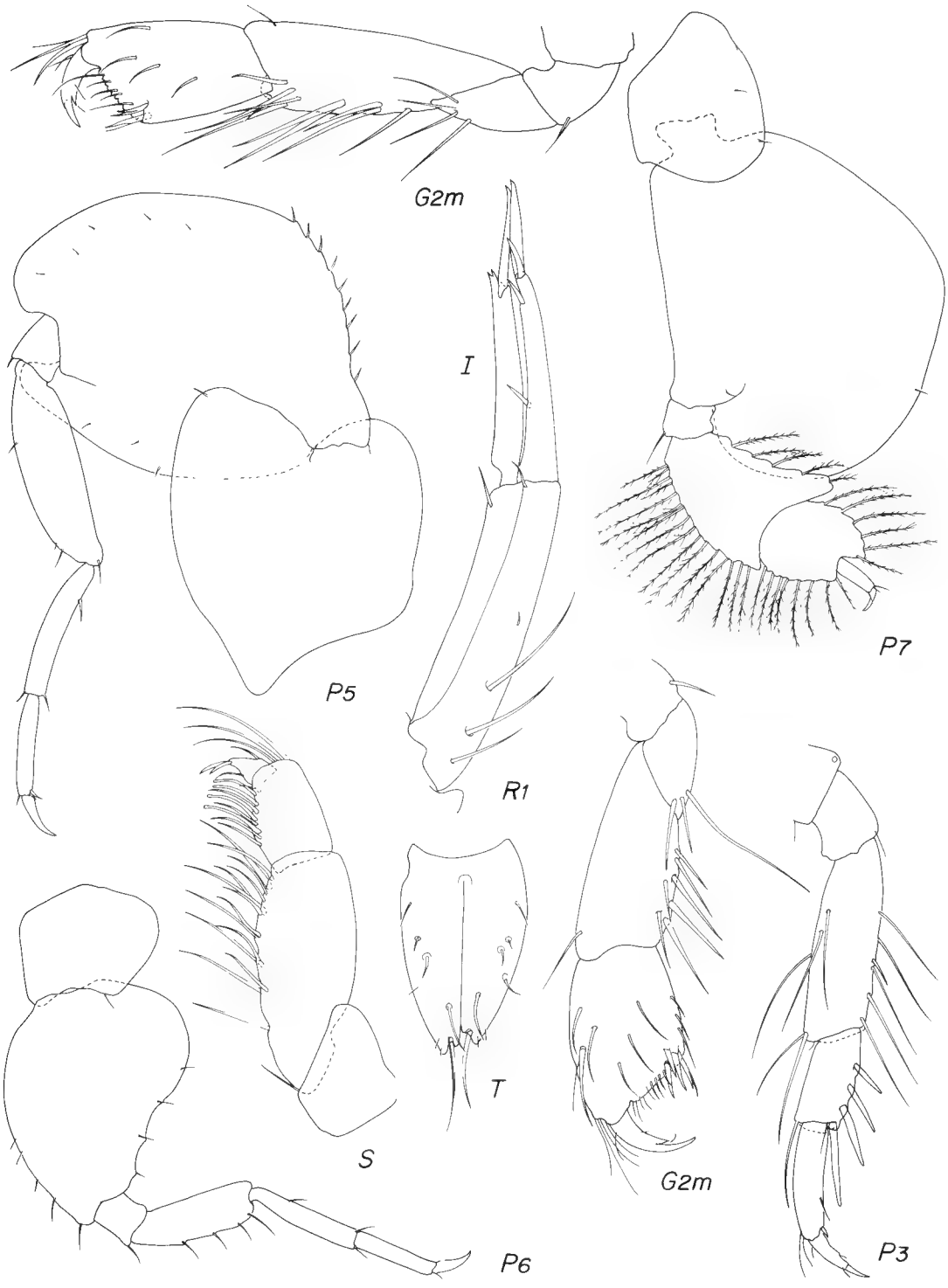

Figure 6. *Guernea yamminye*, holotype, male "a", 1.82 mm.

basofacial setae, uropods 1–2 with few spines, rami of uropod 3 setose; telson elongate and well armed.

Etymology. From an Australian Aboriginal word meaning "another", in reference to being "another" species from Lizard Island. Noun in apposition.

Distribution. Australia, Great Barrier Reef, Lizard Island, 1–2 m, rubble.

Relationship. This species is compared only to species with double humps on urosomites 1–2 and elongate apical spines on the rami of uropods 1–2.

It differs from *G. reticulata* in the lack of serrations on article 2 of pereopod 7 and in the weaker envelopment of article 6 by article 5 on pereopod 7. It differs from *G. coalita* in the broad formation of articles 4–5 on pereopod 7, with short article 6, the excavate posterior margin of article 2 on pereopod 6, and the more elongate carpi of gnathopods 1–2.

It differs from *G. longicornis* in the weak anterior lobe of coxa 5, shorter article 6 of pereopod 7 (possibly developmental), the concave posterior margin of article 2 on pereopod 6, and the presence on the outer ramus of uropod 1 of 1 marginal spine.

Acknowledgements

We thank the National Geographic Society (USA) for funds through grant 3723-87 to the first author to collect this material; and Jan Clark of Smithsonian Institution for assistance and who was supported in the field by the Research Opportunities Fund of the Smithsonian Institution. The laboratory work was supported by NSF Grants BSR-8515186 and BSR-8915688 to the first author; and Smithsonian's "Amphipod Grant" to the second author. We thank Elizabeth Harrison-Nelson of Smithsonian Institution for her assistance. We thank Mrs Linda B. Lutz of Vicksburg, Mississippi, for inking our drawings.

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KAMAKA TADITADI, A NEW MARINE SPECIES FROM PAPUA NEW GUINEA (CRUSTACEA: AMPHIPODA: COROPHIOIDEA)

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Abstract

Thomas, J.D. and Barnard, J.L., 1991. *Kamama taditadi*, a new marine species from Papua New Guinea (Crustacea: Amphipoda: Corophioidea). *Memoirs of the Museum of Victoria* 52: 311–318.

Kamaka taditadi is a new marine species of a genus heretofore found in fresh and brackish waters of Japan, eastern Siberia and Vietnam. Our species was found in almost fully saline seawater in an embayment near Madang, Papua New Guinea. The new species differs from the three previously known species in the thick male antenna 2 and the odd eusirid form of male gnathopod 2; it also is characterized, but not necessarily uniquely, in the short coxae 2–7, sparsity of spines on uropods 1–2, broad apex of mandibular palp and weak merus of pereopods 3–4.

Introduction

The discovery of *Kamaka taditadi* sp. nov. from marine waters of Papua New Guinea is remarkable because previous species of the genus have been found only in fresh to brackish waters of the Asian mainland from eastern Siberia through Japan to Vietnam. *Kamaka* is known primarily as a stream, river and lake genus. Our species was collected in almost fully saline seawaters in an embayment next to the dock at the Christensen Research Institute in Madang, Papua New Guinea.

We take the opportunity to modernize the diagnosis of the genus, provide a new key to the species and list the species and all of their literature citations. The distribution of each species is briefly stated and geographic codes from Barnard and Barnard (1983) are appended in brackets.

Corophiidae

Kamaka Derzhavin

Kamaka Derzhavin, 1923: 188 J.L. Barnard, 1973: 19.

Type species. Kamaka kuthae Derzhavin, 1923 (monotypy).

Description. Body subcylindrical, slightly depressed, smooth, urosomites 1–2 coalesced, 3 free from 2 but coalesced with telson, marked ventrally by sutures.

Rostrum short, supra-antennal line almost absent except in defining ocular lobes, ocular lobes elongate, very produced forward, blunt, antennal sinus deep. Head longer than pereonites 1–2 together. Eyes medium, on apices of stalked ocular lobes.

Antennae of medium length, 1 shorter than 2, both slender or antenna 2 stout in male in one species, peduncular article 3 of antenna 1 scarcely to slightly shorter than 1, either article 1 or 2 longest, accessory flagellum absent, main flagellar articles very few. Antenna 2 peduncular article 3 scarcely elongate, flagellar articles 3–7.

Epistome not produced anteriorly [new observation]. Labrum subrounded, incised, produced forward from epistome (lateral view). Mandible normal, palp strong, very slender, article 1 elongate, article 3 rectolinear or weakly clavate, shorter than 2. Labium with entire outer lobes, with well developed inner lobes, mandibular lobes short, pointed. Inner plate of maxilla 1 short, without setae, outer plate with 9–10 spines, palp 2-articulate. Plates of maxilla 2 ordinary, inner plate with only few or no mediomarginal setae. Inner plate of maxilliped with distal plumose setae, outer plate very long, with spines on medial margin, palp with 4 articles, article 2 long, article 3 unlobed, article 4 short, stubby, with medium nail and setae.

Coxae quite variable, either relatively long and lobuliform, or only coxa 1 large and coxae 2–7 short, weakly overlapping, of various sizes and shapes, progressively elongate from 2 to 4, coxa 1 dilated, produced forward, coxa 2 shorter than 1, coxa 4 longer or shorter than coxa 1, not lobed, coxa 5 at least as long as 4, coxa 7 smaller than anterior coxae.

Gnathopods 1–2 diverse, male gnathopod 2 greatly larger than 1, gnathopod 1 poorly subchelate, article 5 long, sublinear, unlobed, longer

than 6. Gnathopod 2 enlarged, weakly subchelate, propodochelate in male, with article 2 not dilated nor setose, article 5 very short, unlobed, article 6 dilated, with false chela or large process on posteroproximal margin, dactyl long.

Pereopods 3–4 normal, similar, with slender article 2, article 4 weakly dilated, dactyls short. Pereopods 5–7 similar to each other, progressively longer, with weakly expanded article 2, pereopod 5 much shorter than pereopod 7, dactyl of pereopods 5–7 short to medium in length, curved.

Sternal processes of thorax absent [new observation]. Coxal gills slender, present on segments 2-6 [new observation]. Pleopods normal. Epimeron 3 not bisinuate.

Uropods 1–2 biramous, stout, rami slightly unequal, shorter (1) or longer (2) than peduncle, peduncle of uropod 1 with ventrodistal process. Uropod 3 small, uniramous, single ramus short, with vestigial article 2, obtuse and setose distally, peduncle as long as or longer than ramus, but otherwise short and dilated medially. Telson entire, short, broader than long, semicircular, poorly armed.

Female. Antennae weaker. Coxae not different from male. Gnathopods small, gnathopod 2 slightly larger than 1, weakly subchelate, article 5 as long as or almost as long as 6, unlobed. Oostegites narrow, present on coxae 2–5.

Variables. Major deviations from the typical appearance of most species in this genus are: Male antenna 2 exceptionally long (type), very stout (*K. taditadi*), coxa 5 like coxa 4 and not lobed (*K. biwae*); peduncle of uropod 3 not dilated medially (*K. biwae*).

In constructing the key to species given below, we found few characters easy to express; there are various subtle differences among the species in shapes of various coxae and legs but we are uncertain as to the variability of these characters between the sexes and among instars. Firm identification continues to require examination of the original descriptions and figures of each species.

Distribution. Fresh and brackish waters, east Asia from Viet Nam to eastern Siberia, Kamchatka, Sakhalin, Kuriles, Japan, and New Guinea, 5 species.

Relationship. Even though *Chevalia* has coalesced urosomites 1–2 and *Rakiroa* has coalesced urosomites 2–3, *Kamaka* is unique in the Corophioidea: not only are urosomites 1–2 coalesced but the telson and urosomite 3 are coalesced.

Species. K. biwae Ueno, 1943 Lake Biwa, Japan [027]; *K. dershavini* Gurjanova, 1951 Kamchatka, marine littoral [279]; *K. kuthae* Dershavin, 1923b, 1930a (Ueno, 1935a, 1936, 1936b) (Gurjanova, 1951) east Siberia, Kamchatka, Sakhalin, Kuriles, northern Japan, freshwaters [013]; *K. palmata* Dang, 1968 Vietnam, freshwater [954]; *K. taditadi* Thomas and Barnard, herein, Papua New Guinea, marine sublittoral [597].

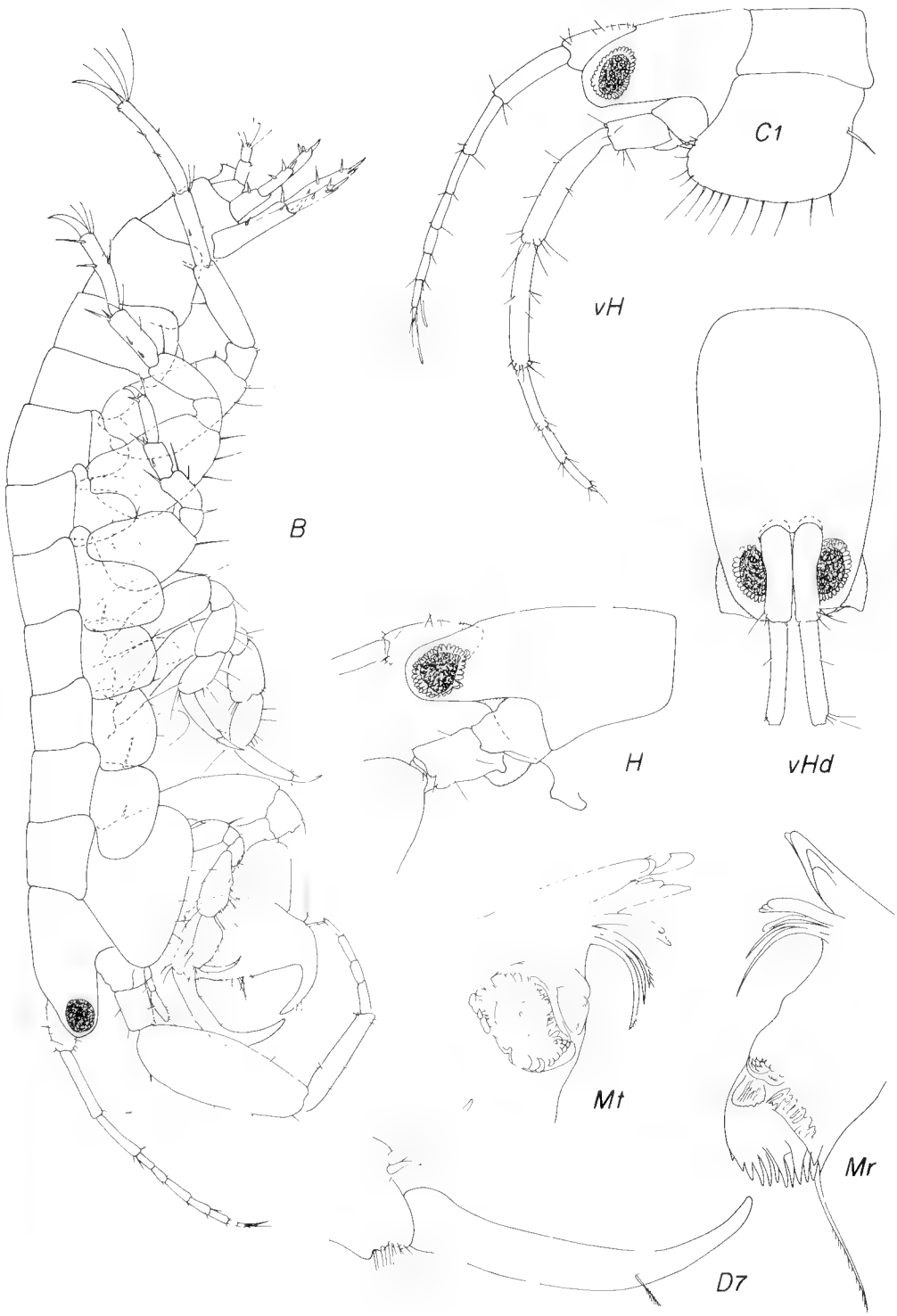
Key to the Species of *Kamaka*

Note: ? on carpus indicates our uncertainty on drawings in the literature

1. Male gnathopod 2 of eusirid form, palmar excavation broad and shallow, male antenna 2 stout ..... *K. taditadi*
— Male gnathopod 2 not of eusirid form, palmar excavation narrow and deep, male antenna 2 slender 2
2. Male gnathopod 2 with thumb strongly extending beyond apex of propodus to form true chela with dactyl, male coxa 1 twice as long (anteroposteriorly) as wide (dorsoventrally) ..... *K. palmata*
— Male gnathopod 2 with thumb not exceeding apex of propodus, male coxa 1 less than 1.5 times as long as wide 3

→

Figure 1. *Kamaka taditadi*, new species, unattributed figures = holotype, male "s", 1.93 mm; v = female "v", 2.96 mm. Legend: Capital letters in figures refer to parts; lower case letters to left of capital letters refer to specimens and to the right refer to adjectives as described below (unattributed main specimen of each plate is not labeled on left side of capital letters): B, body; C, coxa; D, dactyl; G, gnathopod; H, head; I, inner plate or ramus; J, urosome; L, labium; M, mandible; O, outer plate or ramus; P, pereopod; R, uropod; S, maxilliped; T, telson; V, palp; W, pleon; X, maxilla; Y, oostegite; Z, gill; d, dorsal; m, medial; r, right; s, setae removed; t, left.


C1
vH
B
H
vHd
Mt
Mr
D7

3. Inner rami of uropods 1–2 lacking dorsal marginal spines .... *K. dershavini*
— Inner rami of uropods 1–2 with dorsal marginal spines 4
4. Male antenna 2 as long as pereonites 1–6 together, article 4 of pereopods 3–4 poorly expanded apically, ?carpus of male gnathopod 1 extensively setose posteriorly ..... *K. biwae*
— Male antenna 2 as long as all body segments together, article 4 of pereopods 3–4 well expanded apically, ?carpus of male gnathopod 1 poorly setose posteriorly ..... *K. kuthae*

Kamaka taditadi sp. nov.

Figures 1–4

Material examined. Holotype: Papua New Guinea, Madang, sand sample near dock of Christensen Marine Institute adjacent to Nagada Harbour, 0.3 m, medium-fine quartz sand, J.D. Thomas and J. Clark, 14 Jan 1989, United States National Museum 253717 (male "s", 1.93 mm).

Paratypes: Type locality, USNM 253718 (female "u", 2.45 mm; female "v", 2.96 mm).

Diagnosis. Male antenna 2 very stout; coxae 2–7 of short form in genus (see *Variables*); male gnathopod 2 of eusirid-form, propodus suborbicular or weakly almond-shaped, palm very long and only weakly excavate compared with other known species; merus of pereopods 3–4 weak, poorly produced anterodistally; marginal (non-apical) spines on rami of uropods 1–2 not exceeding one per ramus; uropod 1 with well developed interramal tooth.

Female "v". With 8 eggs in brood pouch. Article 5 of pereopod 5 with 2 facial spines. Gills large on coxae 2–4, small on coxae 5–6, absent on coxa 7. Setae on oostegites 2–5 = 1–9–9–9. Outer ramus of uropod 2 with 2 dorsomarginal spines.

Additional descriptive notes. Pleopods ordinary; coupling hooks 2; length ratios of peduncle versus outer and inner rami for pleopods 1–3 = 39:78:67, 34:70:65, and 30:65:59; articles on outer and inner rami for pleopods 1–3 = 8–8, 8–6, and 7–5; setae on peduncles of pleopods 1–3 = 2–2–2.

Etymology. Taditadi, from Riwo language of New Guinea, "spotted" in reference to the purple-brown splotches typical of this species.

Relationship. See key above. This species differs from all other species in the strange eusirid form of male gnathopod 2. It differs from all but *K. biwae* in the thick and short male antenna 2, and from all but *K. palmata* in the short coxae 2–7. It differs from *K. palmata* and *K. biwae* in the much sparser spination on uropods 1–2.

This species is probably most similar to *K. palmata* from Vietnam but in addition to the above differences, it has article 4 of pereopods 3–4 less dominant. It is not clear whether or not *K. palmata* has an interramal tooth on uropod 1, a character positive for *K. taditadi.* The broad apex of the mandibular palp of the new species differs from the thin apex of *K. kuthae* and *K. biwae.*

This species is similar to *K. dershavini,* from Kamchatka, because the new species has only 1 fewer spine on the outer rami of uropods 1–2 and the presence of 1 spine on the inner rami of uropods 1–2; these spines on the inner rami are lacking in *K. dershavini.* Male antennae for *K. dershavini* apparently are unknown.

Acknowledgments

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We thank the National Geographic Society for funds through grant 3723-87 to the first author to collect this material; and, for assistance, Jan Clark of Smithsonian Institution who was supported in the field by the Research Opportunities Fund of the Smithsonian Institution. The laboratory work was supported by NSF Grants BSR-8515186 and BSR-8915688 to the first author; and Smithsonian's "Amphipod Grant" to the second author. Linda Lutz of Vicksburg, Mississippi, inked our drawings.

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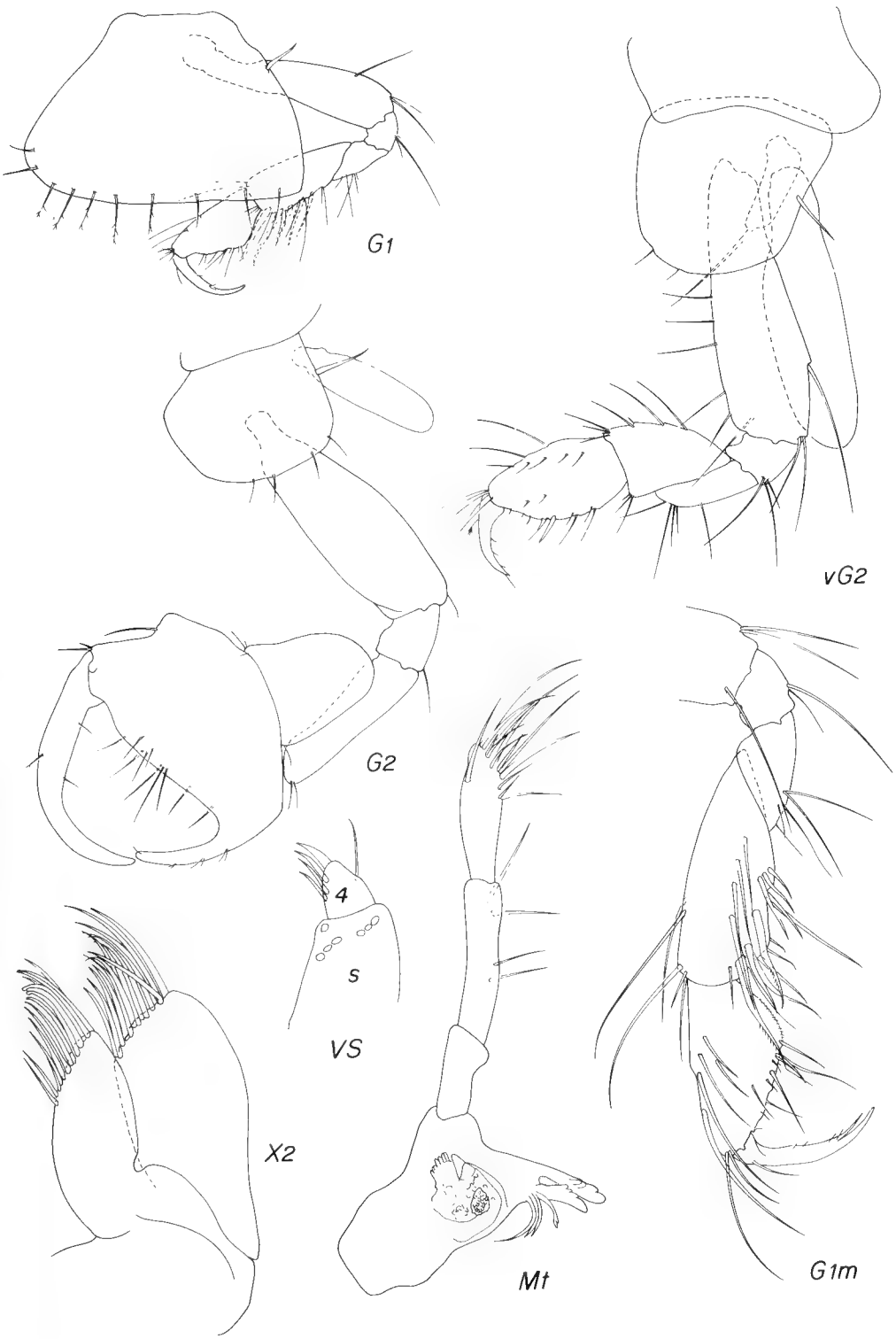

Figure 2. *Kamaka taditadi*, new species, unattributed figures = holotype, male "s", 1.93 mm; v = female "v", 2.96 mm.

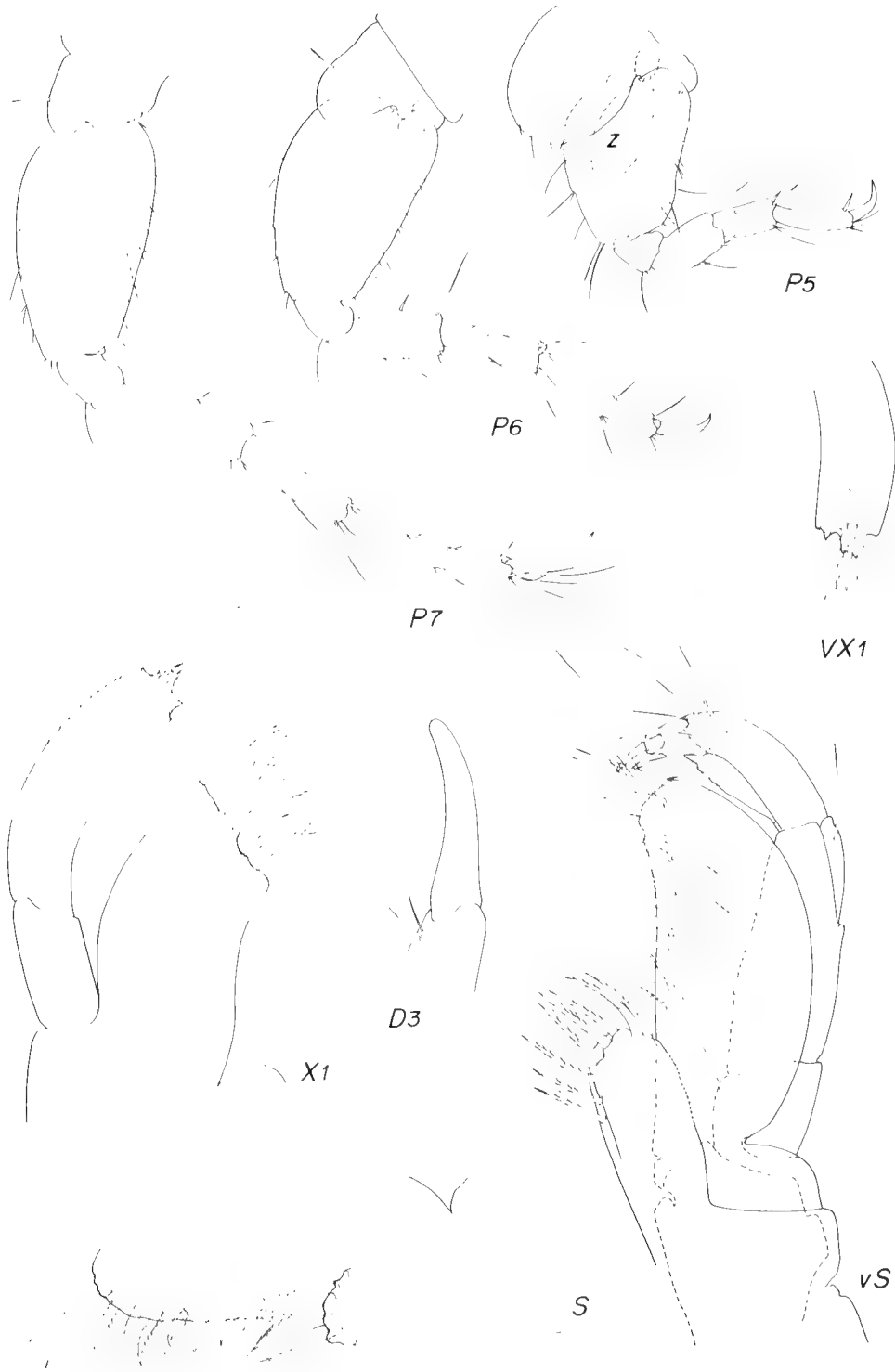

Figure 3. *Kamaka taditadi*, new species, unattributed figures = holotype, male "s", 1.93 mm; v = female "v", 2.96 mm.

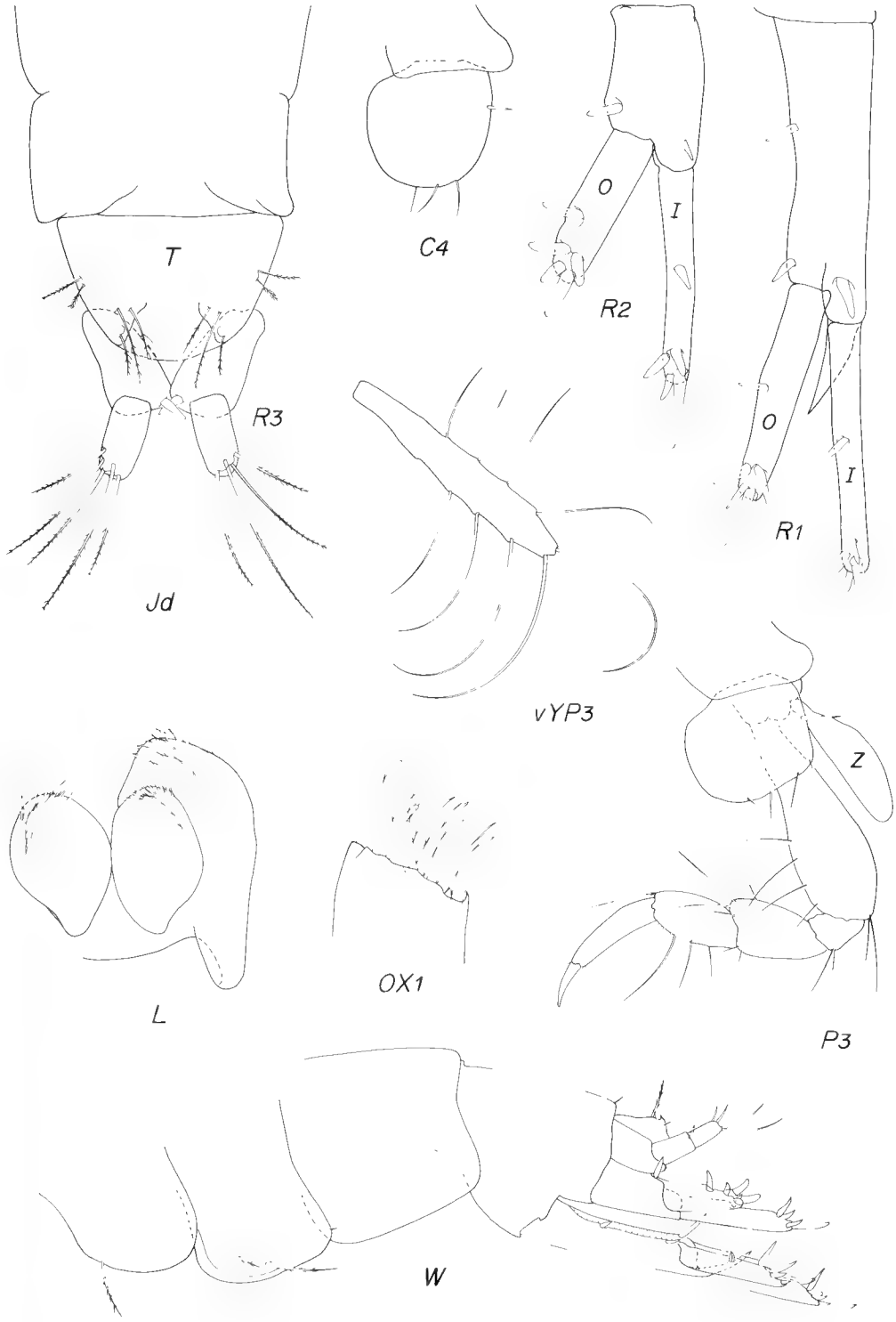

Figure 4. *Kamaka taditadi*, new species, unattributed figures = holotype, male "s", 1.93 mm; v = female "v", 2.96 mm.

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Memoirs of the Museum of Victoria 52(2): 319–324 (1991) ISSN 0814-1827

WOMBALANO YERANG, NEW GENUS AND SPECIES OF COROPHIOID (CRUSTACEA, AMPHIPODA) FROM THE GREAT BARRIER REEF, AUSTRALIA

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Abstract

Thomas, J.D. and Barnard, J.L., 1991. *Wombalano yerang*, new genus and species of corophioid (Crustacea, Amphipoda) from the Great Barrier Reef, Australia. *Memoirs of the Museum of Victoria* 52: 319–324.

Wombalano is characterized by having a interlocked basket of large spines on the bases of male gnathopod 2; these bases are curved inward to afford the interlocking capability.

This genus differs from *Lemboides* Stebbing in the even more shortened inner ramus of uropod 3, in the simple mandibular palp, the fused articles of the flagellum on antenna 2, and the immense basket-shovel formed of spines on article 2 of male gnathopod 2.

Introduction

Wombalano yerang is a new corophioid similar to *Lemboides* Stebbing. It was found on a shallow reef flat at Orpheus Island on the Great Barrier Reef. The male is characterized by the formation of a large basket of interlocked spines on the bases of gnathopod 2. The bases are enlarged, flattened and curved inward to form a hollow with the concavity facing forward. We assume the basket is used to gather food. *Wombalano yerang* was found on fine carbonate sands interspersed with fine algal strands.

Corophiidae Dana

Wombalano gen. nov.

Diagnosis. Body subcylindrical but weakly compressed laterally, smooth, urosomites free, urosomite 1 ordinary. Rostrum short, ocular lobes of medium size, sharp; antennal sinus moderate. Eyes medium.

Antennae short, of about equal length, both slender, though article 1 of antenna 1 slightly thickened; peduncular article 3 of antenna 1 shorter than article 1, article 2 longest, accessory flagellum 2-articulate. Antenna 2 peduncular article 3 short, articles 4 and 5 subequal, flagellum short, essentially uniarticulate (one main article tipped with 2 tiny apical articles).

Epistome unproduced anteriorly. Labrum subrounded, entire. Mandible normal, palp moderate, slender, article 3 linear, as long as 2, poorly setose. Labium with entire outer lobes, with well developed inner lobes, mandibular lobes long, pointed. Inner plate of maxilla 1 small, short, with 1 medial seta, outer plate with 10 spines, palp 2-articulate. Plates of maxilla 2 rather broad, inner plate with mediofacial row of setae. Inner plate of maxilliped without distal spines except for ventromedial locking spine (not shown in figure), outer plate normal, reaching apex of palp article 2, with spines on medial margin, palp with 4 articles, article 2 long, article 3 lobed, article 4 medium, with short nail and setae.

Coxae of medium size, short, weakly contiguous, anterior members of slightly diverse sizes and shapes, coxa 1 weakly expanded apically, not produced forward, coxa 4 not longer than coxa 1, not lobed, coxa 5 nearly as long as 4, coxa 7 smaller than anterior coxae.

Male gnathopods 1–2 different, large, gnathopod 2 apically narrower but basally broader than gnathopod 1, both subchelate, with thick articles, not densely setose, carpi of both elongate but thick, propodus of gnathopod 1 short, very broad, strongly chelate, of gnathopod 2 narrow, weakly chelate, second articles of gnathopod 2 immense, curving inward towards each other, forming interlocked scoop-basket by giant spines on dorsoposterior margin.

Pereopods 3–4 normal, similar, with weakly expanded article 2, article 4 scarcely dilated, dactyls of medium length. Pereopods 5–7 similar to each other, progressively longer, with weakly expanded unlobed article 2, pereopod 5 much shorter than pereopod 7, dactyl of pereopods 5–7 curved, of medium length.

Minute sternal process present on pereonite 1. Coxal gills present on pereopods 3–6 only. Pleopods ordinary. Epimeron 3 not bisinuate.

Uropods 1–2 biramous, normal, rami of uro-

pod 2 slightly unequal, longer than peduncle, peduncle of uropod 1 with ventrodistal process, that of uropod 2 absent. Uropod 3 of medium length, biramous, outer ramus moderately long, obtuse distally, with small article 2, peduncle expanded, shorter than outer ramus, inner ramus shortened, tapering and with single apical spine. Telson entire, short, broader than long, ovate, with 2 unequal medium apical setae on each side.

Female. Coxae not greatly different from male, coxa 2 especially longer. Gnathopods small, gnathopod 1 slightly larger than 2, 1 subchelate, 2 almost simple, article 5 long, linear, unlobed, dactyl ordinary, unlobed on both gnathopods 1–2. Oostegites narrow, present on coxae 3–5.

Type species. Wombalano yerang sp. nov.

Etymology. Wombalano, Aboriginal, beautiful, masculine, noun not Latinized; yerang, Aboriginal, thicket, in reference to the spine basket on gnathopod 2, noun in apposition, not Latinized.

Relationship. This genus differs from *Lemboides* Stebbing, 1895 (see Myers and Lyons, 1987) in the even more shortened inner ramus of uropod 3, in the simple mandibular palp, fused articles of the flagellum on antenna 2, and the immense basket-shovel formed of spines on article 2 of male gnathopod 2.

It differs from *Lemboides caecus* Ledoyer (1982) (said by Myers and Lyons, 1987 to be removed to a genus in Neomegamphopidae) in the much larger male gnathopods with their basket, the simple article 3 of the mandibular palp and the short inner ramus of uropod 3.

It differs from *Aorchoides* Ledoyer (1972) in the immensely enlarged male gnathopods with their basket, the feeble article 3 of the mandibular palp, the more uneven rami of uropod 3 and the fused articles of the flagellum on antenna 2.

Wombalano yerang sp. nov.

Figures 1–4

Material examined. 2 males, 1 female, 1 unsexed and unmeasured specimen (to preserve one unmanipulated, therefore undamaged, specimen).

Holotype: Orpheus Island, Great Barrier Reef, 4 m, in sediment sample from reef flat in front of Orpheus Island Research Station, at boat mooring area, gray carbonate sand with fine algal strands on surface, J.D. Thomas, 12 Feb 1989 (stn JDT OPH-4A), Museum of Victoria (NMV) J20493 (male "a", 2.93 mm).

Paratypes: Type locality, USNM 253542 (male "b", 2.63 mm); USNM 253541 (female "c", 3.25 mm; and one other unsexed and unmeasured specimen).

Description. Second article of male gnathopod 2 huge, bowing inward, dorsoposterior edges abutting, their spines interlocking, thus forming huge shovel-basket or nest, articles 5–7 flexed inward, first gnathopods contained within this nest; our illustrations showing gnathopod 2 flattened and unflexed.

Gills on coxae 3–6 long, thin sacs, those on coxae 5–6 slightly shortened. Pereonite 1 with small nipple-like sternal process.

Pleopods ordinary, dimensions as follows: length ratios of peduncle, outer and inner rami for pleopod 1 = 50:45:53, pleopod 2 = 55:39:49, pleopod 3 = 50:35:43, number of articles on outer and inner rami of pleopods 1, 2, 3 = 7–9, 7–8, 6–9.

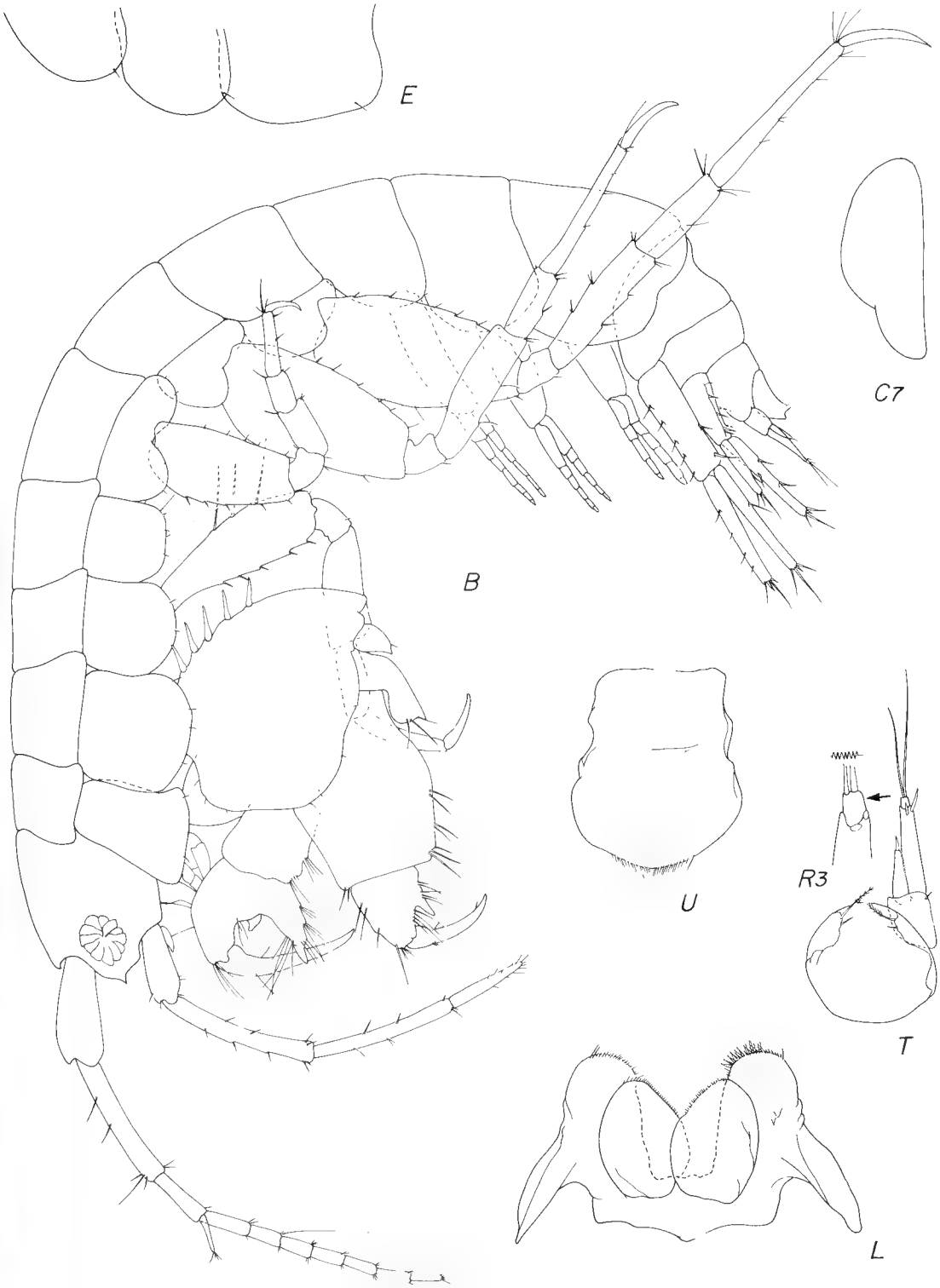
Female: Coxa 2 longer and narrower than in male, with 5 marginal setae; oostegites present on coxae 3–5, thin, elongate, marginally setose, all of similar size.

Distribution. Orpheus Island, Great Barrier Reef, Australia, 4 m.

Acknowledgements

We thank the National Geographic Society for funds through grant 3723-87 to the first author to collect this material; and Jan Clark of Smithsonian Institution who was supported in the field by the Research Opportunities Fund of the Smithsonian Institution. The laboratory work was supported by NSF Grants BSR-8515186 and BSR-8915688 to the first author; and Smithsonian's "Amphipod Grant" to the second author. We thank Geoff Charles of the Orpheus Island Research Station for his assistance. Linda Lutz of Vicksburg, Mississippi, inked our drawings.

Figure 1. *Wombalano yerang*, unattributed figures = holotype male "a"; b = male "b"; c = female "c". Capital letters in figures refer to parts; lower case letters to left of capital letters refer to specimens and to the right refer to adjectives as described below; unattributed specimens lack lower case letters to left of capital letters: B, body; C, coxa; E, epimera; G, gnathopod; I, inner plate or ramus; L, labium; M, mandible; O, outer plate or ramus; P, pereopod; R, uropod; S, maxilliped; T, telson; U, upper lip; X, maxilla; m = medial; r, right; s, setae removed; t, left.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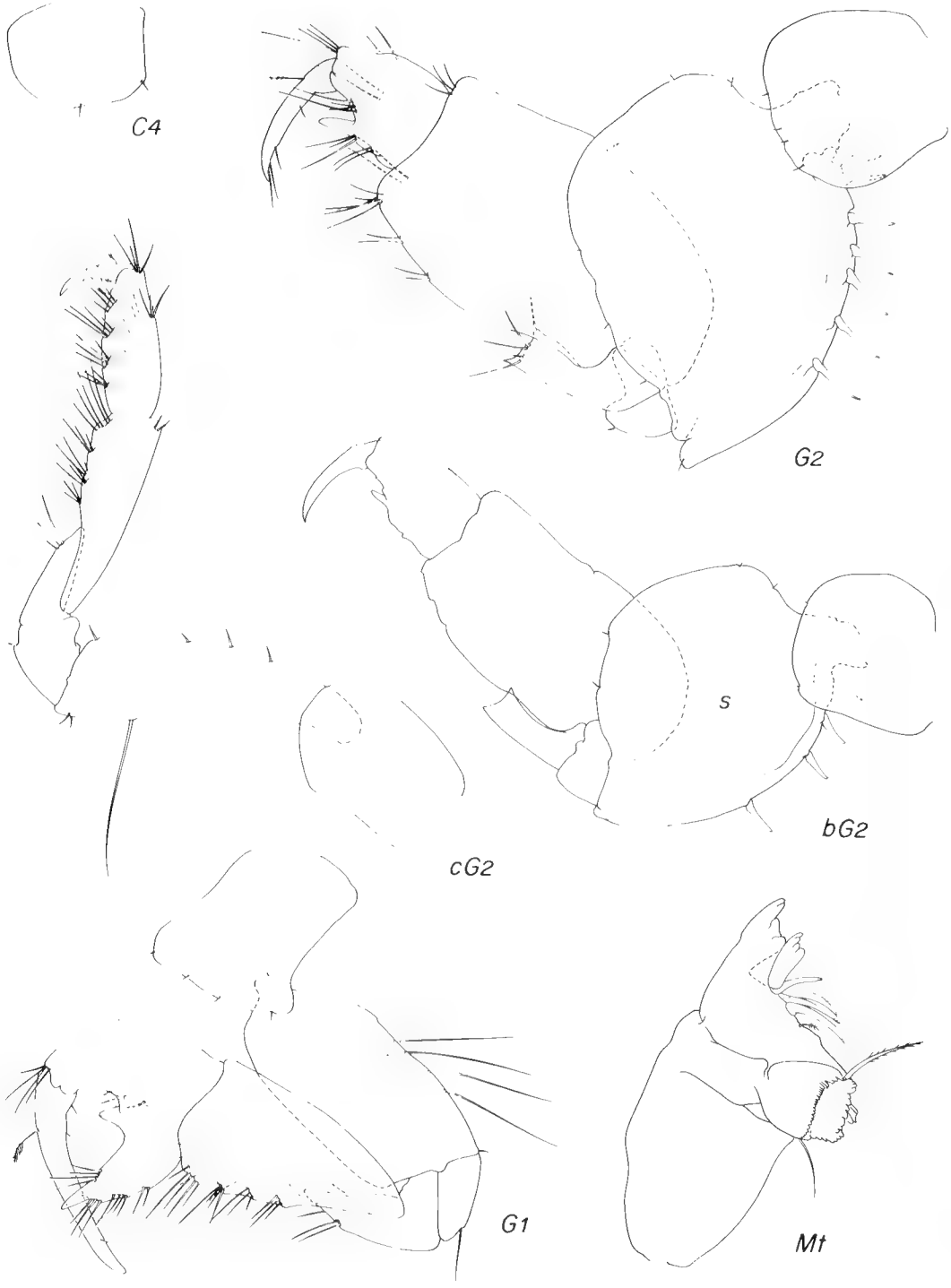

Figure 2. *Wombalano yerang*, unattributed figures = holotype male "a"; b = male "b"; c = female "c".

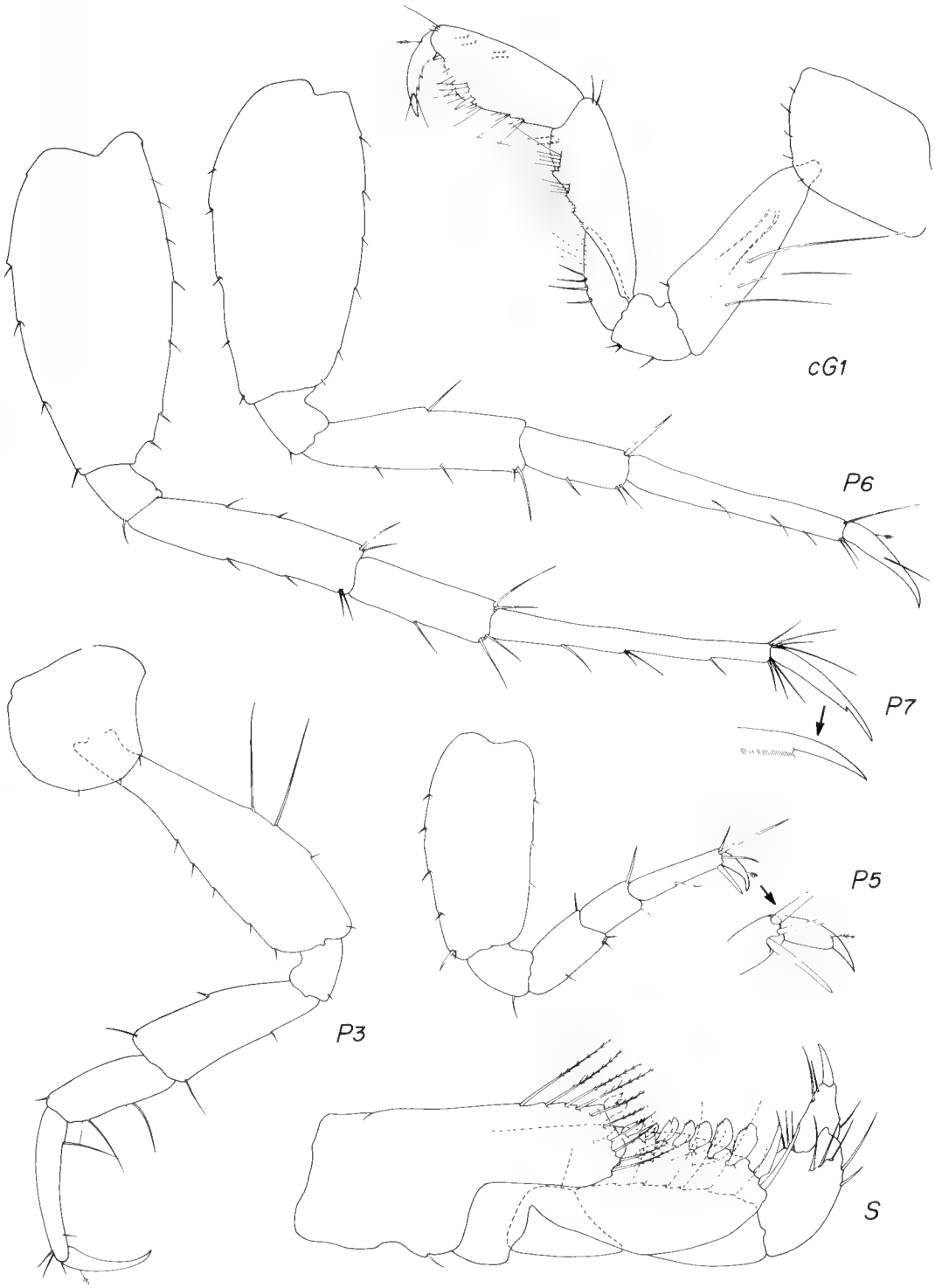

Figure 3. *Wombalano yerang*, unattributed figures = holotype male "a"; c = female "c".

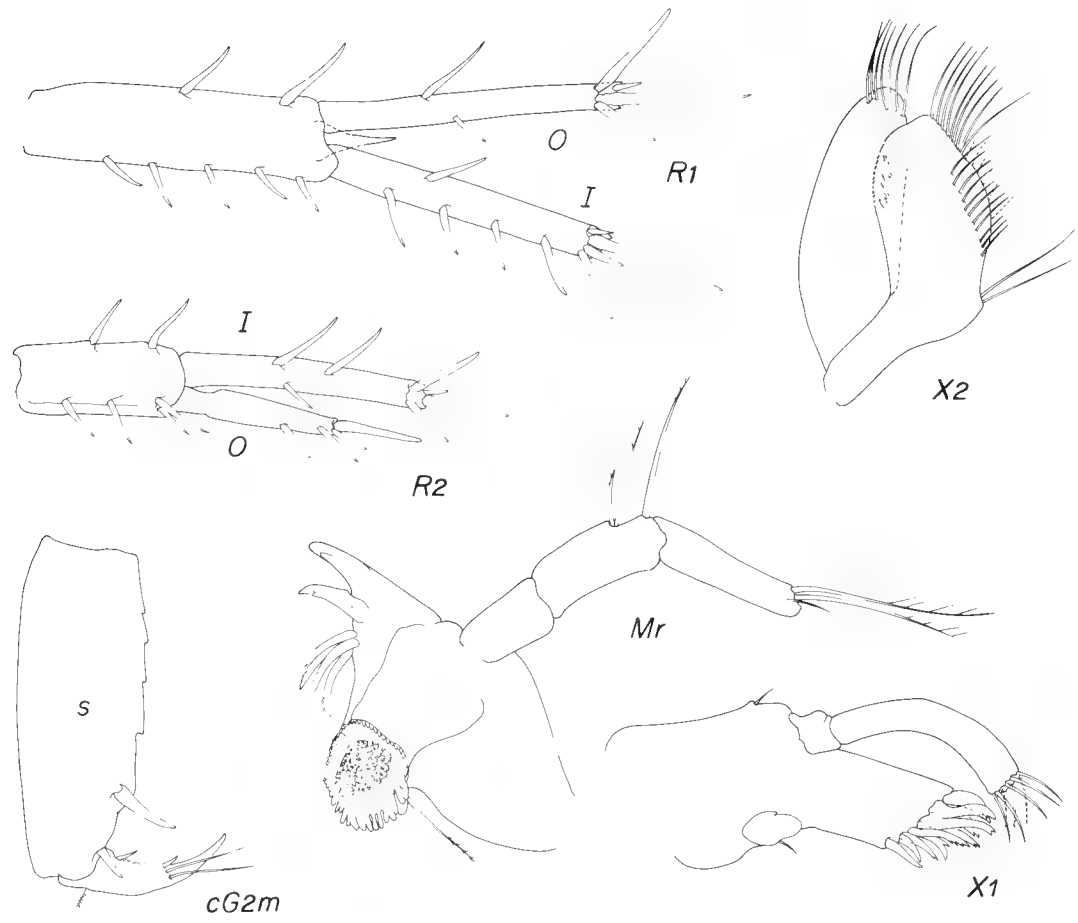

Figure 4. *Wombalano yerang*, unattributed figures = holotype male "a"; c = female "c".

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THREE NEW SPECIES OF *TENAGOMYSIS* FROM THE COASTAL WATERS OF SOUTH-EASTERN TASMANIA (CRUSTACEA: MYSIDAE: MYSINAE: LEPTOMYSINI)

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Abstract

Fenton, G.E., 1991. Three new species of *Tenagomysis* from the coastal waters of south-eastern Tasmania (Crustacea: Mysidae: Mysinae: Leptomysini). *Memoirs of the Museum of Victoria* 52: 325–335.

Tenagomysis australis sp. nov., *T. tasmaniae* sp. nov. and *T. bruniensis* sp. nov. from coastal south-eastern Tasmania are the first records of the genus from Tasmania and Australia. A key to differentiate them is presented. *Tenagomysis aseta*, previously described from Australia, is placed in the related genus *Australomysis*.

Introduction

During a study of Tasmanian coastal mysids three new species belonging to the genus *Tenagomysis* have been identified and are described here. This genus has not been recorded from Tasmanian waters before and the description of these new species is an important extension to the geographic range of the genus.

The following abbreviations are used for institutions where material is lodged: NMV, Museum of Victoria, Melbourne; TM, Tasmanian Museum, Hobart; QM, Queensland Museum, Brisbane; SAM, South Australian Museum, Adelaide. The abbreviation BSS refers to the Bass Strait Survey conducted by the Museum of Victoria.

Tenagomysis Thomson, 1900

Tenagomysis Thomson, 1900: 483–484.

Type species. Tenagomysis novaezealandiae Thomson, 1900.

Diagnosis. Carapace short, exposing at least last pereonite, produced anteriorly into moderate frontal plate. Eyes well developed, pigment black. Antennal scale narrowly lanceolate, setose along lateral and medial borders; with distal articulation. Labrum without spiniform process. Mandibles with well-developed masticatory surface. Terminal segment of maxilla longer than broad, armed with strong spines along distal margin of endopod; setiferous endites and exopod. Carpo-propodus of thoracic endopods 3–8 subdivided into 2–14 subsegments. Pleopods of female rudimentary. Male pleopods well-developed, pleopod 1 with endopod uniarticulate, exopod multiarticulate; pleopods 2–5 biramous, both rami multiarticulate. Exopod of pleopod 4 longer than endopod with modified setae on antepenultimate and penultimate articles. Telson triangular, lateral margins armed with spines throughout length, apical cleft armed with small closely-set spines and pair of plumose setae. Uropods: endopod with spines along inner margin; both endopod and exopod with setae along lateral and medial margins.

Remarks. This diagnosis combines the generic diagnoses given by Thomson (1900), Tattersall (1918, 1923) and Ii (1964), together with the modifications necessary after separation of two genera, *Iimysis* Nouvel, 1966 and *Nouvelia* Bacescu and Vasilescu, 1973, erected to accept species formerly included in *Tenagomysis*.

Although *Iimysis* and *Nouvelia* were diagnosed to reduce variability within *Tenagomysis* all three need extensive revision since most species descriptions, particularly of *Tenagomysis*, are incomplete. This needs to be carried out in conjunction with a revision of the closely allied genera *Doxomysis*, *Australomysis* Tattersall, 1927 and *Afromysis* Zimmer, 1916 with particular attention being given to the structure of the mouthparts, thoracic legs and male pleopods. For example, the shape of the terminal segment of the maxilla largely determines whether a species belongs in the genus *Tenagomysis* (longer than broad) or *Doxomysis* (broader than long) and yet this feature has not been described for many *Tenagomysis* species.

Iimysis is distinguished from *Tenagomysis* by the presence of a spinous process on the labrum and a 4-segmented tarsus (composed of 1 carpus,

2 propodal segments and 1 dactylus). *Iimysis* comprises two species formerly belonging to *Tenagomysis*: *I. orientalis* (Ii, 1937) and *I. atlantica* (Nouvel, 1942). *Nouvelia* is distinguished by the presence of a hiatus in the spination of the lateral margins of the telson and a 3-segmented tarsus (separate carpus, propodus and dactylus).

Nouvelia contains two former species of *Tenagomysis*: *N. natalensis* (Tattersall, 1952) and *N. nigeriensis* (Tattersall, 1957), and one previously in *Doxomysis* Hansen, *N. valdiviae* (Illig, 1906). Bacescu and Vasilescu (1973) also suggested that *T. similis*, a New Zealand species, may also belong to *Nouvelia* although the lateral margins of the telson have spines throughout their length. In 1975 Bacescu described a new species from Africa giving it only a subgeneric status, *Tenagomysis (Nouvelia) tanzaniana*. This species is however an unusual addition to either genus since it has a spine on the labrum, which is a diagnostic feature of the genus *Iimysis*. Therefore the status of this species needs to be reviewed.

Prior to the present study the genus *Tenagomysis* comprised nine species from New Zealand (a key for their identification is given by Tattersall, 1923) and *Tenagomysis (Nouvelia) tanzaniana* (discussed above) (Mauchline, 1980). In 1982 Bacescu and Udrescu described a new species, *T.aseta* from Queensland, Australia. The status of this species is revised here. The three new *Tenagomysis* species described here substantially increases the number of species known in the genus and provides an important extension to the geographic range of the genus.

The new species are easily distinguished from all other members of *Tenagomysis* by the presence of barbed spines on the terminal endopod of the maxilla. This feature has not been noted in other species but this may simply be due to the fact that the maxilla of many of the species in the genus has not been described, in spite of its taxonomic importance. In addition, it is worth noting that the penultimate article of the fourth male pleopod of the new species is very long in relation to the antepenultimate article. This has been noted in some but not all of the *Tenagomysis* species for which the fourth male pleopod has been described.

Key to the Australian species of *Tenagomysis*

1. Carpo-propodus of endopod of pereopod subdivided into 5 articles. Antennal scale very long, 15 times as long as broad ..... *T. australis* sp. nov.
— Carpo-propodus of endopod of pereopod subdivided into 3 articles. Antennal scale less than 10 times as long as broad 2
2. Lateral margins of telson with spines on distal half elongated. Exopod of male pleopod 4 of 9 articles. Carpo-propodus of endopod of pereopod with transverse articulations ..... *T. bruniensis* sp.nov.
— Lateral margins of telson with spines of uniform size. Exopod of male pleopod 4 of 7 articles. Carpo-propodus of endopod of pereopod with an oblique and transverse articulations ..... *T. tasmaniae* sp. nov.

Tenagomysis australis sp. nov.

Figures 1–9

Material examined. Holotype: One Tree Point, Bruny Island, Tasmania (43°07′S, 147°23′E), 3 m, R. Holmes and G. Fenton, 15 Nov 1982, TM G2806 (male, 12.3 mm long).

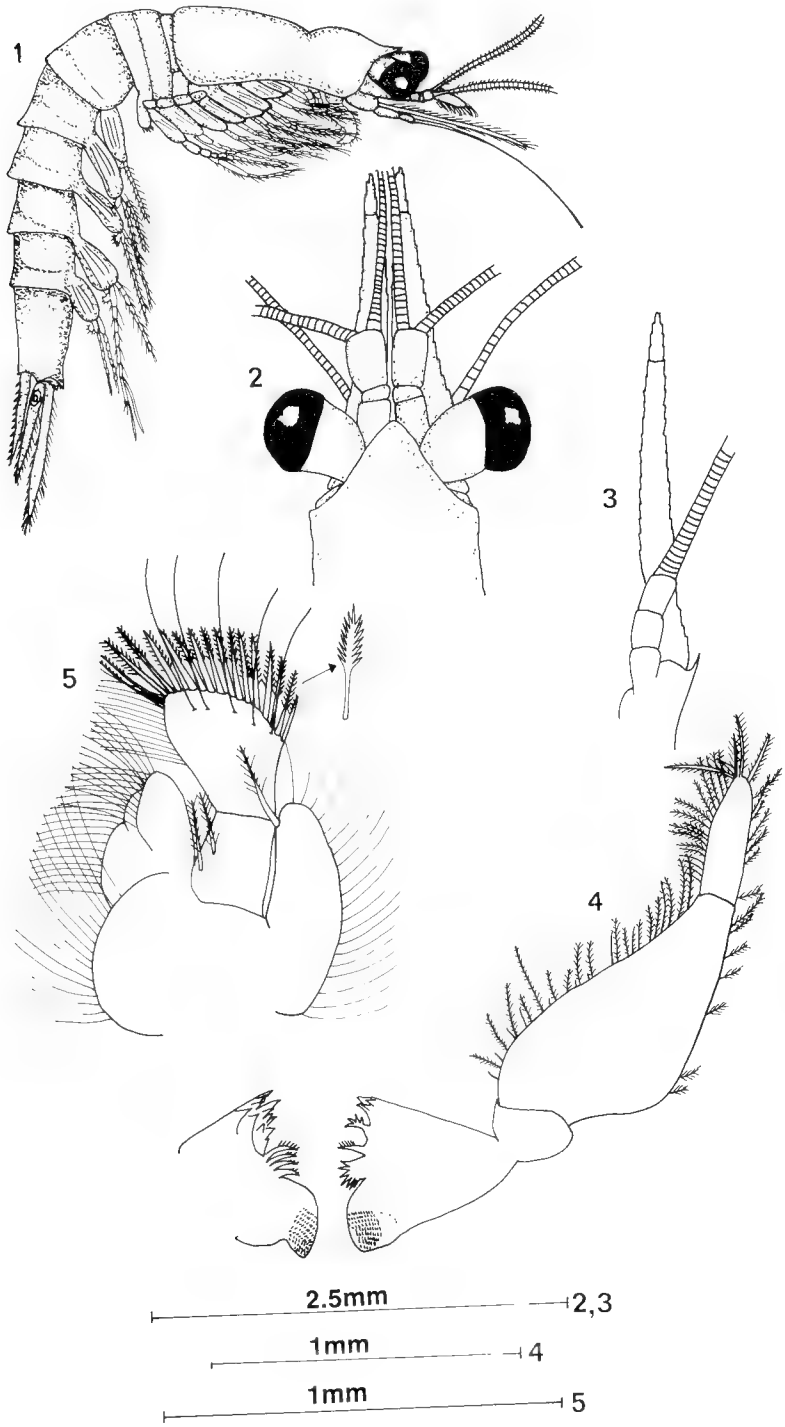
Paratypes: collection details as for holotype, TM G2807 (5 females, 5 males).

Other material. Tasmania. Granville Harbour, West Coast, R. Holmes, 14 Jan 1983, TM G3407. Hope Beach, South Arm, 43°03′S, 147°25′E, R. Mawbey, R. Holmes, G. Fenton, 12 Dec 1984, TM G3408. Variety Bay, Bruny Island, D. Cropp, 7 Mar 1983, 3 m, TM G3409.

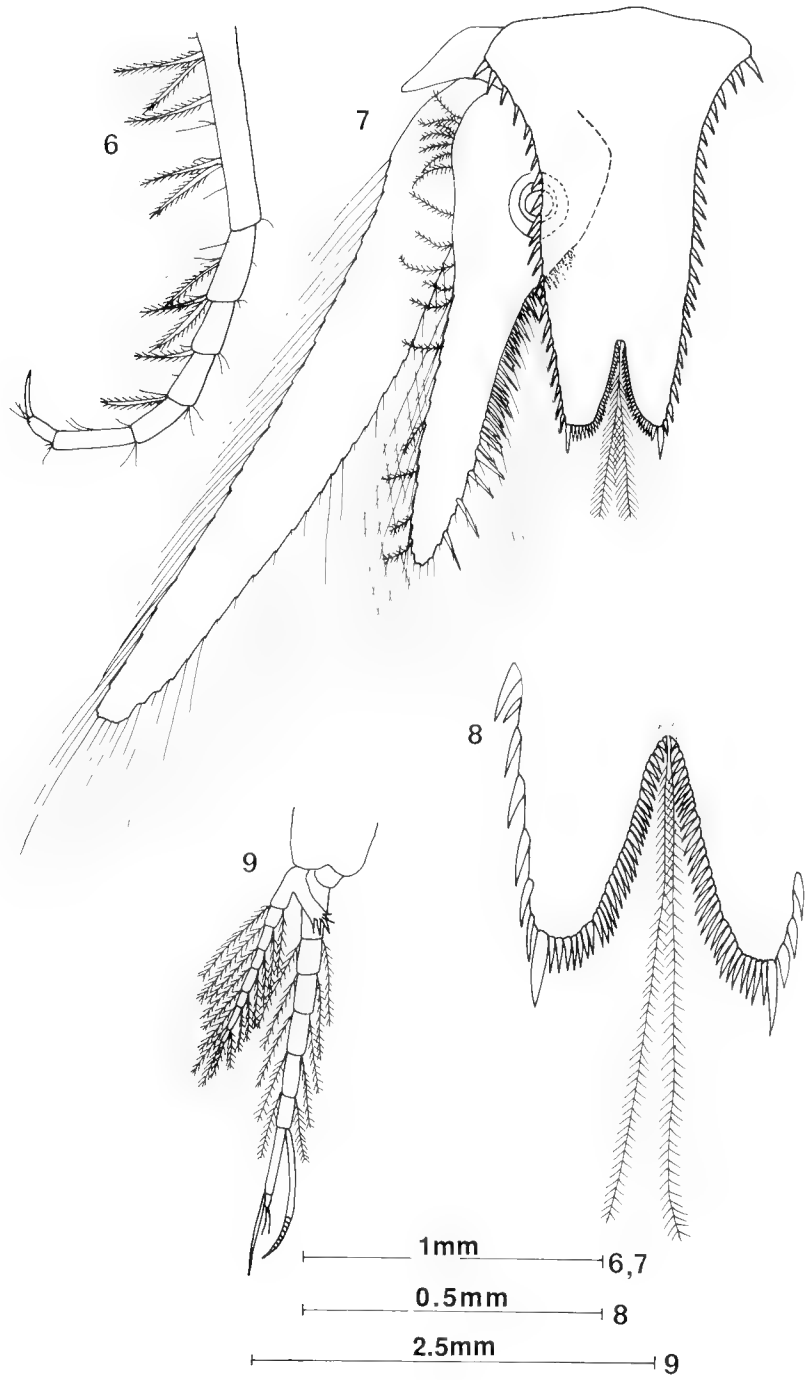
Bass Strait. 39°33′S, 144°21′E, 27 m, fine sand, epibenthic sled (stn BSS-108), NMV J5444. 40°31′S, 145°17′E, 40 m, sand, epibenthic sled (stn BSS-111), NMV J5403. 37°50′S, 148°40′E, 26 m, medium sand, epibenthic sled (stn BSS-208), NMV J9522. 38°15′S, 147°22′E, 16 m, clean sand with limestone reef outcrops, epibenthic sled (stn BSS-212), NMV J9510.

South Australia. Whiting ground off Outer Harbour, sand and weed, 6 m, SAM TC3985.

Description. (Description of male holotype with female characters from paratypes). Carapace short, leaving last 2 pereonites exposed; produced in front into acute rostrum extending almost to end of article 1 of antennular peduncle; anterolateral edges rounded (Fig. 1). Eyes elongate extending to article 3 of antennular peduncle (Fig. 2). Cornea black, occupying



Figures 1–5. *Tenagomysis australis* sp. nov. Holotype, adult male, 12.3 mm in length: 1, lateral view; 3, antennal scale; 4, mandibles and mandibular palp; 5, maxilla.
Adult female (paratype): 2, anterior region.



Figures 6–9. *Tenagomysis australis* sp. nov. Holotype, adult male, 12.3 mm in length: 6, carpo-propodus of endopod of pereopod 3; 7, telson and uropods; 8, apical cleft of telson; 9, male pleopod 4.

slightly less than half in dorsal view. Antennal scale narrow, 15 times as long as broad; lateral and medial borders setose (Fig. 3); twice as long as antennular peduncle.

Labrum rounded, no spiniform process present. Mandibles with well-developed masticatory surface (Fig. 4). Distal article of maxilla bears approximately 15 strong barbed spines; setiferous endites and exopod normal (Fig. 5).

Carpo-propodus of endopod of pereopods 3–8 subdivided into 5 articles, terminating in long slender nail (Fig. 6).

Telson subtriangular, twice as long as basal width; cleft occupying approximately one-quarter of total telson length (Fig. 7). Lateral borders of telson with at least 20 spines; each apical lobe bearing 1 large spine; cleft lined with approximately 30 spines and 2 long plumose setae at base of cleft (Fig. 8).

Uropods: endopod slightly longer than telson; 45 stout spines bordering inner edge, extending from statocyst nearly to apex (Fig. 7). Exopod approximately 1.75 times as long as telson. Both endopod and exopod setose along lateral and medial borders.

Male pleopods: Pleopod 1 uniramous, pleopods 2–5 biramous. Pleopod 4 elongate, extending backwards to distal end of telson, exopod long and modified, of 8 articles; article 6 bearing 1 strong seta, article 7 more than twice as long as article 6, bearing similar but smaller seta; article 8 small, terminating with 2 smaller curved setae (Fig. 9).

Female brood pouch of 3 pairs of lamellae.

Pigmentation of body: Dark brown–black in life, but fading in formalin leaving distinct pigmented areas between pleonites.

Body fairly robust. Adult length: 11–18 mm, measured from the tip of the rostrum to the end of the exopod of the uropod.

Ecology. This species has been the subject of an ecological and feeding study at One Tree Point, Bruny Island (Fenton, 1985). It has been recorded from several sites in Tasmania, Bass Strait and from at Outer Harbour, South Australia.

Etymology. For Australia.

Remarks. Tenagomysis australis is distinguished from all other species in the genus by the long antennal scales. Only *T. chiltoni* W.M. Tattersall, 1923 and *T. novaezealandiae* Thomson, 1900 also have very long antennal scales (twice the length of the antennular peduncle). However, both these species have an acute spine on each anterolateral margin of the carapace (Tattersall, 1923; Hodge, 1964), whereas in *T. australis* this margin is rounded. In addition, the carpo-propodus of the endopod of pereopods 3–8 is of 5 articles in *T. australis* and only 3 and 4 in *T. novaezealandiae* and *T. chiltoni* respectively. *T. chiltoni* is further distinguished by the presence of a prominent spine on the outer margin of the mandible beyond the base of the palp.

T. bruniensis sp. nov., described below, also has very long antennal scales but the armature of the telson, number of articles forming the pereopods and exopod of pleopod 4 clearly distinguish the two species.

Tenagomysis tasmaniae sp. nov.

Figures 10–18

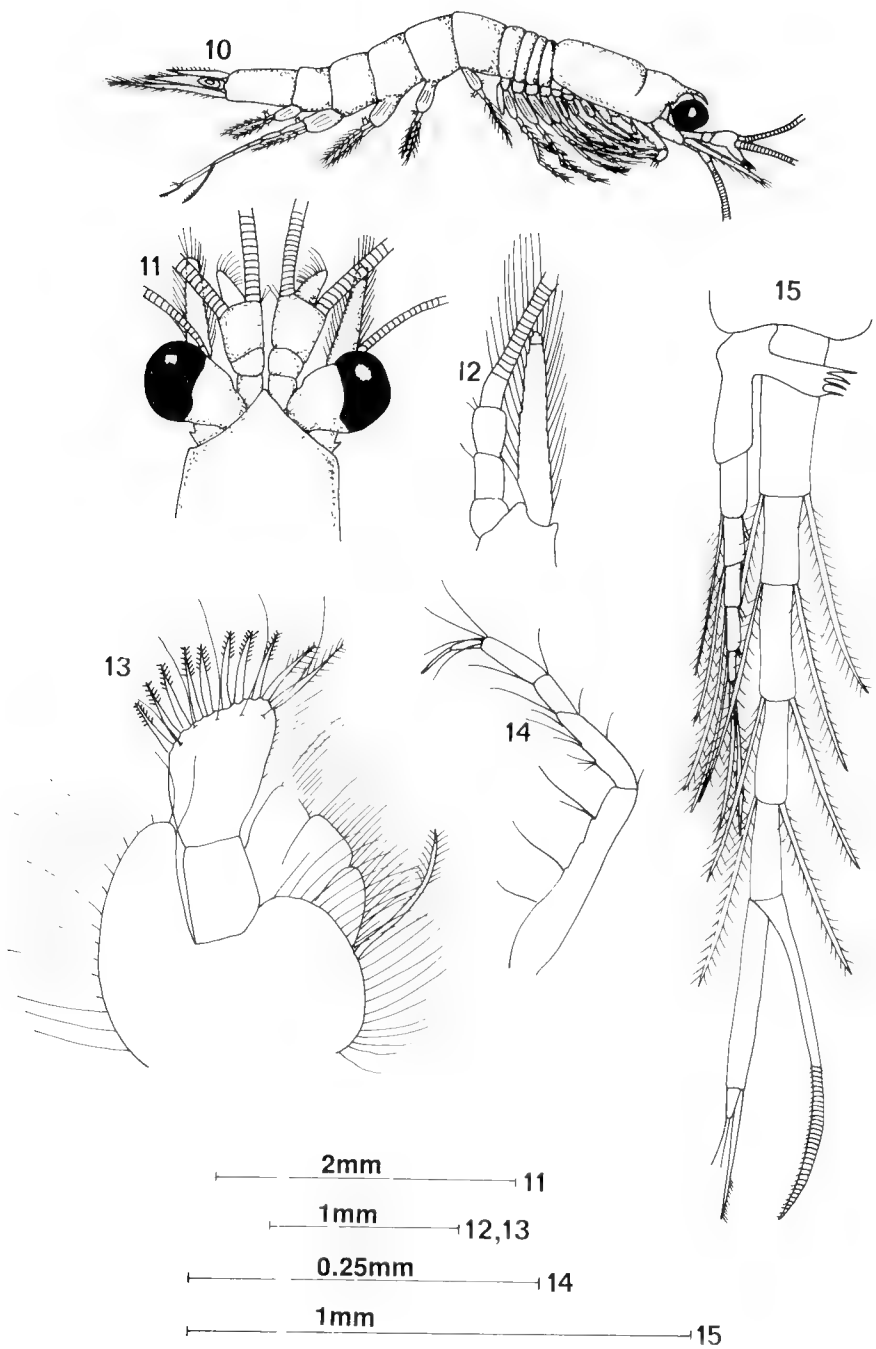
Material examined. Holotype: One Tree Point, Bruny Island, Tasmania (43°07′S, 147°23′E), 3 m, R. Mawbey and G. Fenton, 15 Nov 1982, TM G2808 (male, 9.3 mm long).

Paratypes: collection details as for holotype, TM G2809 (5 females, 5 males).

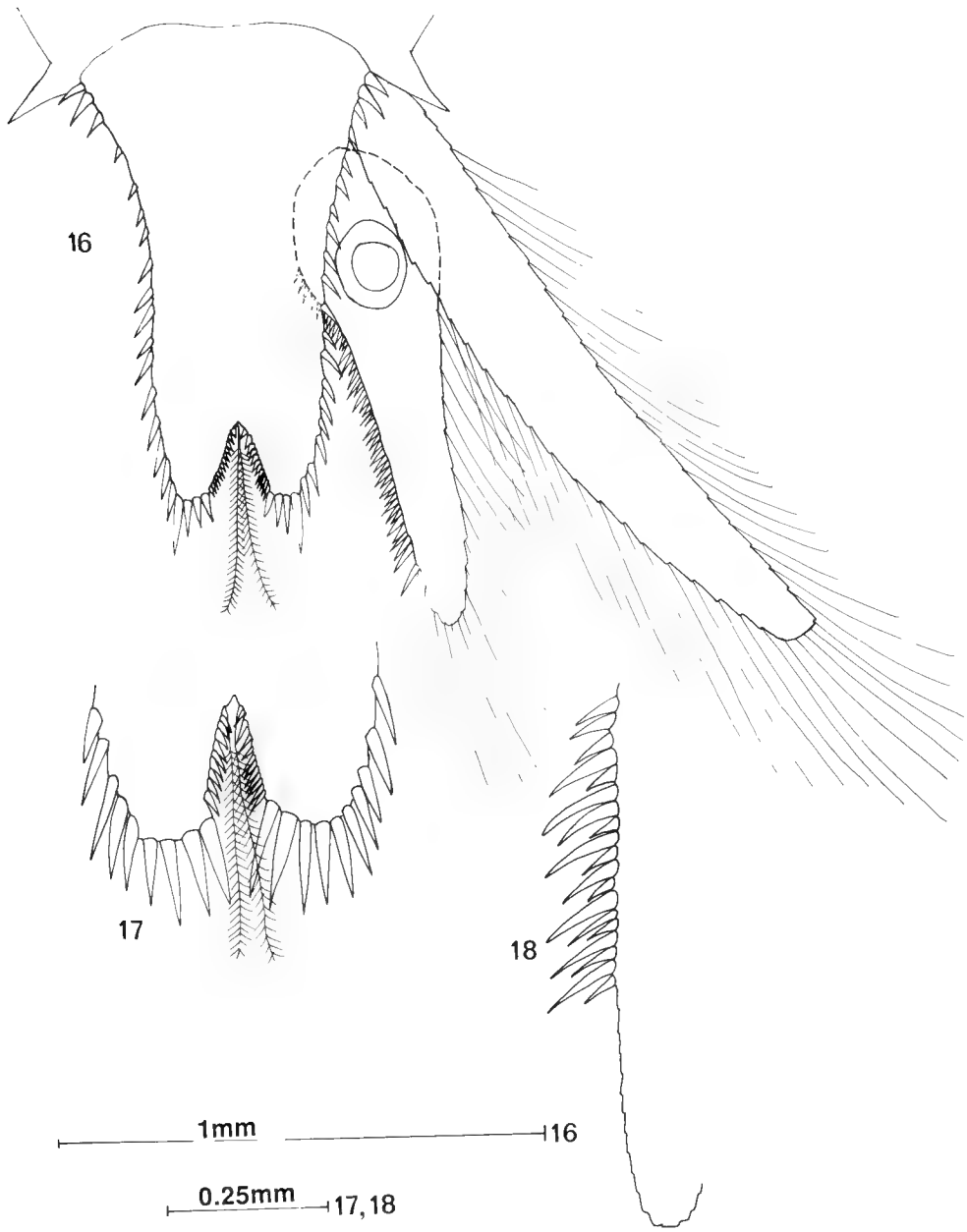
Other material. Tasmania: Partridge Island, D'Entrecasteaux Channel, 29 Nov 1983, R. Mawbey, R. Holmes and G. Fenton, TM G3410. Blow-hole, Tasman Peninsula, 27 Nov 1983, R. Mawbey, TM G3411. Greenhead, 28 Nov 1983, R. Mawbey, R. Holmes and G. Fenton, TM G3412. Sandspit Pt, Schouten Island, 11 Feb 1983, R. Mawbey, R. Holmes and G. Fenton, TM G3413. Tin Pot Pt, 22 Nov 1983, R. Mawbey, R. Holmes and G. Fenton, TM G3414. Spring Beach near Orford, 9 June 1977, 20 m, sandy bottom, A.J. Dartnall, Van Veen Grab, TM G 3334 (1 male). Little Swanport, sandy bottom off entrance, 8 June 1977, A.J. Dartnall, Van Veen Grab, TM G3333 (1 juv.).

Bass Strait: 40°40′S, 145°15′E, 32 m, medium shelly sand, epibenthic sled (stn BSS-115), NMV J5442. 39°48.6′S, 146°18.8′E, 82 m, shell bryozoa mud, epibenthic sled (stn BSS-158, NMV J5412. 39°46′S, 148°18.8′E, 80 m, shell bryozoa mud, (stn BSS-159), NMV J5417, J5446. 40°43.8′S, 148°37.2′E, 67 m, muddy very fine bryozoa shell, Smith-McIntyre Grab (stn BSS-164, NMV J5379. 40°13.8′S, 148°39.6′E, 60 m, muddy sand, epibenthic sled (stn BSS-165), NMV J5394. 39°49′S, 143°24′E, 56 m, fine sand, epibenthic sled (stn BSS-184), NMV J5411. 39°08.3′S, 144°43.9′E, 66 m, sandy shell, epibenthic sled (stn BSS-201), NMV J5404. 39°00.2′S, 144°33.9′E, 74 m, sandy shell, Smith-McIntyre Grab (stn BSS-202), NMV J5449.

Description. (Description of male holotype with female characters from paratypes). Carapace short leaving last 3 pereonites exposed; front margin produced into short acute rostrum (Fig. 10). Anterolateral margins of carapace rounded. Eyes extending to article 1 of antennular ped-



Figures 10–15. *Tenagomysis tasmaniae* sp. nov. Holotype, adult male, 9.3 mm in length: 10, lateral view; 11, dorsal view of anterior; 12, antennal scale; 13, maxilla; 14, carpo-propodus of endopod of pereopod 3; 15, male pleopod 4.



Figures 16–18. *Tenagomysis tasmaniae* sp. nov. Holotype, adult male, 9.3 mm in length: 16, telson and uropods; 18, arrangement at spines on inner margin of endopod of uropod.
Female paratype: 17, apex of telson.

uncle. Cornea black (Fig. 11). Antennal scale approximately 5 times as long as broad, setose all round and only slightly longer than antennular peduncle (Fig. 12). Male antennular peduncle with hirsute lobe.

Labrum rounded, spiniform process absent. Mandibles with well-developed masticatory surface. Maxillule simple bearing 3 long setae on proximal endite amongst smaller setae. Maxilla with approximately 8 large barbed spines at distal end of terminal endopod (Fig. 13).

Carpo-propodus of endopod of pereopods 3–8 subdivided into 3 articles by 2 transverse and 1 oblique articulation (Fig. 14).

Telson subtriangular in shape, 1.5 times longer than its basal width, apical cleft occupying approximately one-sixth of total telson length, more than 20 spines bordering lateral edges of telson. Apical lobes of telson armed with 1 long and 3–4 smaller spines in male (Fig. 16), but armed with 4–6 equal spines in female (Fig. 17). Each side of cleft armed with 10 smaller spines; 2 plumose setae at base of cleft.

Uropods: endopod longer than telson; 40 stout spines bordering inside edge, arranged in triplets extending from statocyst virtually to apex (Fig. 18). Exopod nearly twice as long as telson. Both endopod and exopod setose along lateral and medial borders.

Male pleopods: Pleopod 1 with exopod of 7 articles, pairs 2–5 biramous. Pleopod 4 elongate, extending posteriorly to distal end of telson; exopod long, of 7 articles, article 5 bearing 1 strong seta; article 6 twice as long as article 5, bearing a similar but smaller seta; article 7 small terminating with 2 simple setae (Fig. 15).

Female brood pouch of 3 pairs of lamellae.

Pigmentation of body: confined to small dots on ventral surface of abdomen, still present when preserved.

Adult length: 7–11 mm.

Ecology. This species has been the subject of an ecological and feeding study at One Tree Point, Bruny Island (Fenton, 1985). It has been recorded from several sites in Tasmania and from Bass Strait.

Etymology. For Tasmania.

Remarks. Tenagomysis tasmaniae can be distinguished from other species in the genus by the presence of an oblique articulation separating the carpus from the propodus. However, *T. tasmaniae* is allied to *T. novaezealandiae*, *T. macropsis* W.M. Tattersall, 1923, *T. robusta* W.M. Tattersall, 1923 and *T. bruniensis* sp. nov. on the basis of the number of articles forming the carpo-propodus. Nevertheless, the presence of spines on the anterolateral edges of the carapace of *T. novaezealandiae* and *T. macropsis* easily separate *T. tasmaniae* from these species. The robust body form and subequal length of the exopod and endopod of the uropod separate *T. robusta* and *T. tasmaniae*.

T. bruniensis sp. nov. (described below) is distinguished from *T. tasmaniae* by the armature of the telson, size of antennal scales and articulation of the fourth male pleopod. *T. tasmaniae* is also easily distinguished from the larger species *T. australis*, with which it often co-occurs, by the size of the antennal scales, and the articulation of the pereopods and fourth male pleopod.

Tenagomysis bruniensis sp. nov.

Figures 19–26

Material examined. Holotype: Moorina Bay, Bruny Island, Tasmania (43°14′S, 147°23′E), 3 m, R. Mawbey and R. Holmes, 30 June 1981, TM G3320 (male, 9.6 mm long).

Paratypes: collection details as for holotype, TM G 3321 (1 male, 1 female); Hope Beach, South Arm, Tasmania (43°03′S, 147°25′E), 3 m, R. Mawbey and G. Fenton, TM G3322 (5 males, 2 females).

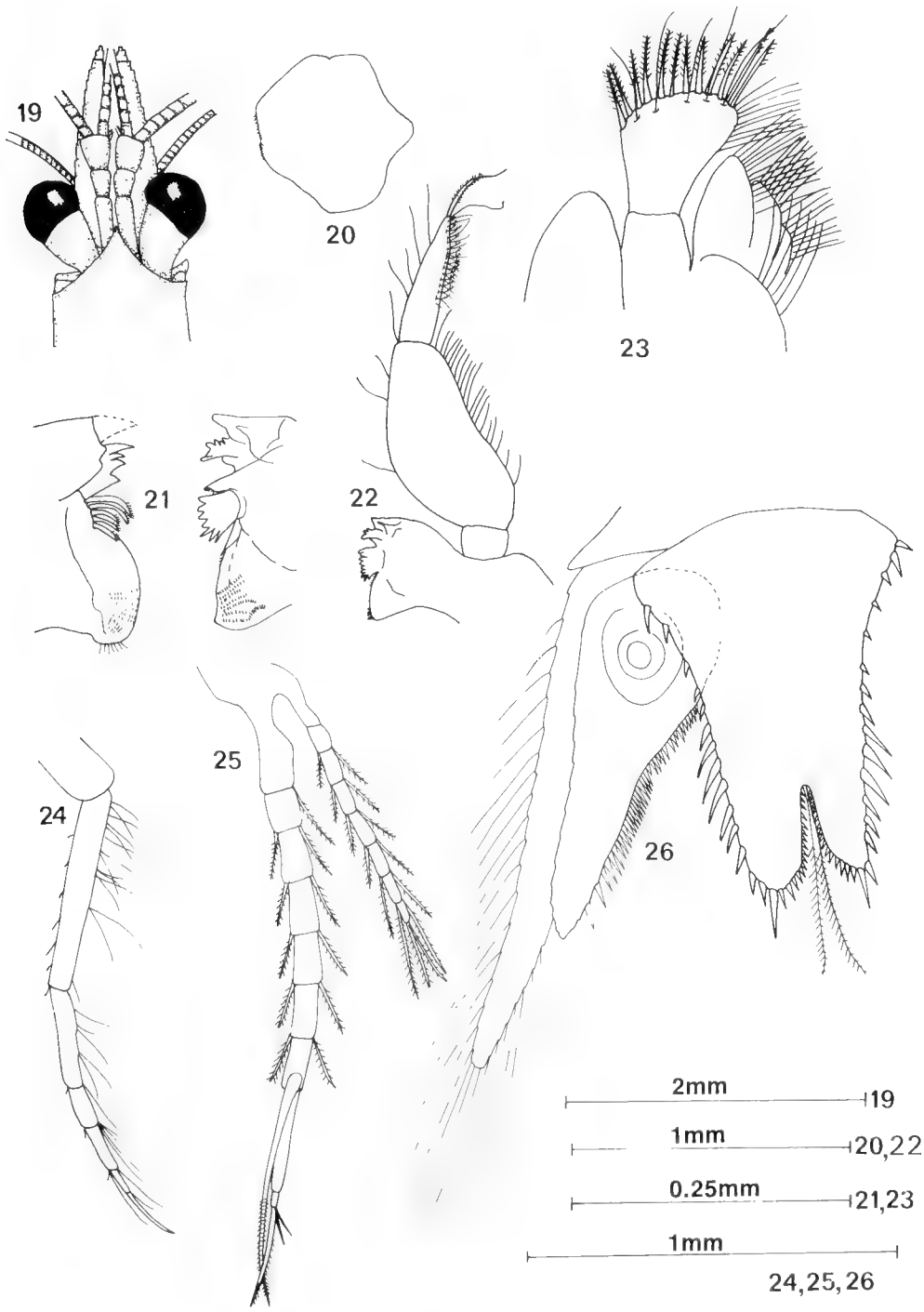
Other material. Tasmania: Little Swanport Bay, East coast, 16 Nov 1978, A.J. Dartnall, surface plankton haul at night with moonlight, TM G 3335 (1 male). Little Swanport Bay, East coast, 16 Nov 1978, A.J. Dartnall, surface plankton haul at night without moonlight, TM G 3336 (1 male).

Description. (Description of holotype with female characters from paratypes). Carapace exposing last pereonite; produced in front into acute rostrum, extending approximately half length of antennular peduncle (Fig. 19). Anterolateral margins of carapace rounded. Eyes elongated, cornea occupies one-third of eyestalk in dorsal view. Antennal scale approximately 10 times as long as broad; extending beyond antennular peduncle, almost twice as long as peduncle; with small terminal joint. Male appendage bears brush of setae.

Labrum rounded, spiniform process absent (Fig. 20). Mandible with well-developed masticatory surface (Figs 21, 22). Maxilla with 12 barbed spines and 5 elongated setae on distal end of terminal endopod (Fig. 23).

Carpo-propodus of endopod of pereopods 3–8 subdivided into 3 articles, dactylus terminating in long slender nail (Fig. 24).

Male pleopods: Pleopod 1 uniramous, pleopods 2–5 biramous. Pleopod 4 (Fig. 25) elongated, exopod almost twice as long as endopod.



Figures 19–26. *Tenagomysis bruniensis* sp. nov. Adult female paratype: 19, anterior region.
Holotype, male, 9.6 mm: 20, labrum; 21, mandibles; 22, mandible with mandibular palp; 23, maxilla; 24, carpo-propodus of endopod of pereopod 3; 25, male pleopod 4; 26, telson and uropods.

Exopod of 9 articles; article 7 bearing 1 strong seta; article 8 twice as long as article 7, bearing 1 similar but smaller seta; article 9 bearing 2 simple setae. Endopod of 8 articles.

Telson 1.5 times as long as broad, approximately same length as pleonite 6; spines on lower half of lateral edges unusually long. Each apical lobe bearing 1 large spine; 18 small spines lining cleft; 2 plumose setae at base of cleft (Fig. 26).

Uropods: exopod nearly twice length of telson. Endopod three-quarters length of exopod, approximately 40 stout spines bordering inside edge, extending from near apex to statocyst. Exopod and endopod setose along lateral and medial borders.

Adult length: 9–11 mm.

Ecology. This species has been recorded only from Tasmania.

Etymology. For Bruny Island.

Remarks. Tenagomysis bruniensis is easily distinguished from all other members of the genus by the elongated spines present on the lateral margins of the telson. The long antennal scales and number of articles forming the carpopropodus of the endopod of the pereopods 3–8 are similar to those found in *T. novaezealandiae*. However, the anterolateral edges of the carapace of the latter species are produced into acute spines, whereas they are rounded in *T. bruniensis*. The species *T. australis* and *T. tasmaniae* are distinguished from *T. bruniensis* for the reasons already discussed.

Australomysis Tattersall, 1927

Australomysis aseta (Băcescu and Udrescu)

Tenagomysis aseta Băcescu and Udrescu, 1982: 89–91.

Material examined. Holotype. Middle Banks, Moreton Bay, Queensland, 105 m, sandy mud, Sep 1973, QM W11248 (male).

Remarks. This species is excluded from *Tenagomysis* since it does not have plumose setae arising from the base of the cleft of the telson (hence the specific name). It is more correctly placed in *Australomysis* in which these setae are characteristically absent. Băcescu (pers. comm.) is in agreement with the decision to remove the species to *Australomysis*. As to whether *T. aseta* should be considered a distinct species of *Australomysis* is more difficult. It is clearly closely allied to, if not synonymous with, *A. incisa* (G.O. Sars, 1885). The facts that the holotype of *T. aseta* is in very poor condition and that both descriptions of *A. incisa* are incomplete (Sars, 1885; Tattersall, 1927) make it impossible to determine the status of *T. aseta* in the genus *Australomysis*.

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SCOLOPENDROMORPH AND GEOPHILOMORPH CENTIPEDES FROM THE KRAKATAU ISLANDS AND ADJACENT REGIONS, INDONESIA

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Abstract

Lewis, J.G.E., 1991. Scolopendromorph and geophilomorph centipedes from the Krakatau Islands and adjacent regions, Indonesia. *Memoirs of the Museum of Victoria* 52: 337–353.

Nine species of scolopendromorph and three species of geophilomorph centipedes are recorded from the Krakatau Islands and adjacent regions. None is new to science but some are poorly known and are here decribed in detail.

Introduction

The Krakatau Islands lie midway between Java and Sumatra in the Sunda Strait. All life on them was destroyed by an enormous volcanic eruption in 1883. The history of the archipelago, its present environment and details of previous surveys were given by Thornton and Rosengren (1988). There are currently four islands, Rakata, Sertung, Panyang and Anak Krakatau.

The first reference to the centipedes of the Krakatau Islands was made by Jacobson (1909). According to him the main island teemed with *Scolopendra subspinipes* which reached a length of 15 cm. Jacobson recorded a second unidentified scolopendrid from Rakata and an unidentified phosporescent species of "Geophilidae" was seen on the summit of the island.

Dammerman (1948) reported on the collections of 1921 and 1933. On Rakata *Scolopendra subspinipes* was still fairly plentiful in 1921 but by 1933 it had noticeably decreased in numbers. A slender species of the "Geophilidae" with a depressed rectangular head was found on Krakatau and Sertung, known to Dammerman as Verlaten Island, in 1921 and 1933. Dammerman sent material to R.V. Chamberlin but (Dammermam, 1948) received no information from him about the collection. Chamberlin had, in fact, published in 1944, listing *S. subspinipes* from Krakatau and *Mecistocephalus krakataunus* Chamberlin from Krakatau and Batavia, Java. Chamberlin deposited the material in the Academy of Natural Sciences of Philadelphia.

Details are here presented of centipedes collected from the Krakatau Islands, Sumatra and Java by the La Trobe University Zoological Expeditions in 1984 and 1985 and from Krakatau by Dr Seiki Yamana of Kagoshima University in 1982. Of the 38 specimens in the collection, 21 are from the Krakatau Islands, 15 from Liwa, Sumatra and two from Gunung Payung, Java. Twelve species were collected, five from the Krakatau Islands.

The collections contained no species new to science but some are poorly known so detailed descriptions and illustrations of the material are given where appropriate.

The specimens were kindly loaned by Professor I.W.B. Thornton and have been lodged in the Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB) and the Museum of Victoria, Melbourne, Australia (NMV).

Full synonymies have been given for the Geophilomorpha by Attems (1929) and for the Scolopendromorpha by Attems (1930a). The colour of specimens was described using the names given in Kornerup and Wanscher's (1967) Methuen handbook of colour.

Order Scolopendromorpha

Scolopendridae

Scolopendrinae

Scolopendra subspinipes subspinipes Leach

Scolopendra subspinipes Leach, 1815: 383.

Scolopendra subspinipes subspinipes.—Attems, 1930a: 29–30, fig. 43.

Material examined. Rakata, Zwarte Hoek, Krakatau Islands (6°09′S, 105°25′E), 15 Sep 1984, in tent, MZB (1 specimen, 35 mm). Rakata, Owl Bay, Krakatau Islands, 22 Sep 1984, NMV (1 specimen, 22 mm). Rakata, summit, 777 m, Krakatau Islands, 18–19 Sep 1984, NMV (1 specimen, 38 mm). Sertung, Forest I, Krakatau Islands, (6°05′S, 105°23′E) 18 Aug 1985, sweep, NMV (1 specimen, 23 mm). Rakata, Krakatau Islands, 18 Jul 1982, S. Yamane (1 specimen, 22 mm). Sertung, Krakatau Islands, 5 Jul 1982, from a tunnel made on tree trunk by termites, S. Yamane, NMV (1

specimen, 42 mm). Sertung, Krakatau Islands, 6 Jul 1982, forest, S. Yamane, MZB (1 specimen, 21 mm). Rakata, Krakatau Islands, 15–18 Jun 1982, 10–50 m, MZB (2 specimens, 115 mm and 118 mm).

Diagnosis. Tergite 1 without ring suture. Tergites with complete paramedian sutures. Prefemur of leg 20 without dorsal spines. Coxopleural process cone-like, usually with 2 end spines. End leg prefemur 2.5 times as long as wide, with 1–3 (4) not exceptionally long spines ventrally. End leg without tarsal spine.

Remarks. The specimens are typical. The species is widely distributed in the Indo-Australian region and the West Indies. It was collected on Rakata by both Jacobson (1909) and Dammerman (1948).

Otostigmus Porat

Otostigmus (O.) metallicus Haase

Figures 1–3

Otostigma metallicum Haase, 1887: 70.
Otostigmus metallicus.—Kraepelin, 1903: 121, fig. 58.
Otostigmus metallicus.—Attems, 1930a: 140.

Material examined. Forest, Liwa, Sumatra, 16 Sep 1984, MZB and NMV (4 specimens: 1, 20 mm; 2, 18 mm; 3, 12 mm and 4, in Hoyer's mountant, 10 mm).

Diagnosis. Antennae with 17–21 segments, basal 2–2¾ glabrous. Tergites marginate at least from 17, without keels or spines. Sternites without tubercles or spines. Each forcipular coxosternal tooth plate with 3–4 teeth. Coxopleural process without dorsal spine. Leg 21 prefemur with corner spine. A few anterior legs with 2 tarsal spines.

Description. Colour of preserved specimens: greyish brown. Antennae: with 17–21 segments, the basal 2½–2¾ segments glabrous dorsally. Tergites: with complete paramedian sutures from 5 or 6 and marginate from 6 or 7 in specimens 1 and 2, (not determined in specimens 3 and 4). Laterally corrugate from 6 or 7 in specimens 1 and 2, lacking spines and keels but with slight median ridge. Tergite 21 without median longitudinal suture but posterior median depression present. Sternites: with very short paramedian sutures in anterior segments, extending to two-thirds of length of sternite posteriorly (Fig. 1). Sternite 21 with sides converging posteriorly and posterior border concave or straight (Fig. 2). Forcipular coxosternal tooth plates: each with 3 main teeth, the first and third often with small subsidiary tooth (Fig. 3). End legs: coxopleural process short (Fig. 2) with 2 end and 1 lateral spine, without dorsal spine. Telopodites present in specimens 2 and 4 only. Prefemur with 4 ventrolateral, 2 ventromedial, 1 or 2 medial, 1 or 2 dorsomedial spines and a corner spine. Trunk legs: first with or without prefemoral spine but with 1 tibial and 2 tarsal spines. Legs 2 or 3 to 19 or 20 with 1 tarsal spine.

Remarks. This species has been recored from Sri Lanka, Bali and Flores, Sumatra, Sangir Island (N. Moluccas) and Sarawak. The material closely resembles the population described from Sarawak by Lewis (1982) but differs in that only the first one or two pairs of legs bear two tarsal spines (the first three or four pairs do in the Sarawak material) and that the twenty-first and sometimes the twentieth pairs lack tarsal spines. They are present in Sarawak material. Sarawak specimens have very short sternital paramedian sutures. In the type specimen (coll. no. 105, Sangereiland, Indische Archipel) in the Rijksmuseum, Leiden, Netherlands which I have examined, only the basal two antennal segments are glabrous, sternital paramedian sutures are absent and the first three or four pairs of legs have two tarsal spines. Such differences are to be expected in a widely distributed species.

Otostigmus (O.) oweni Pocock

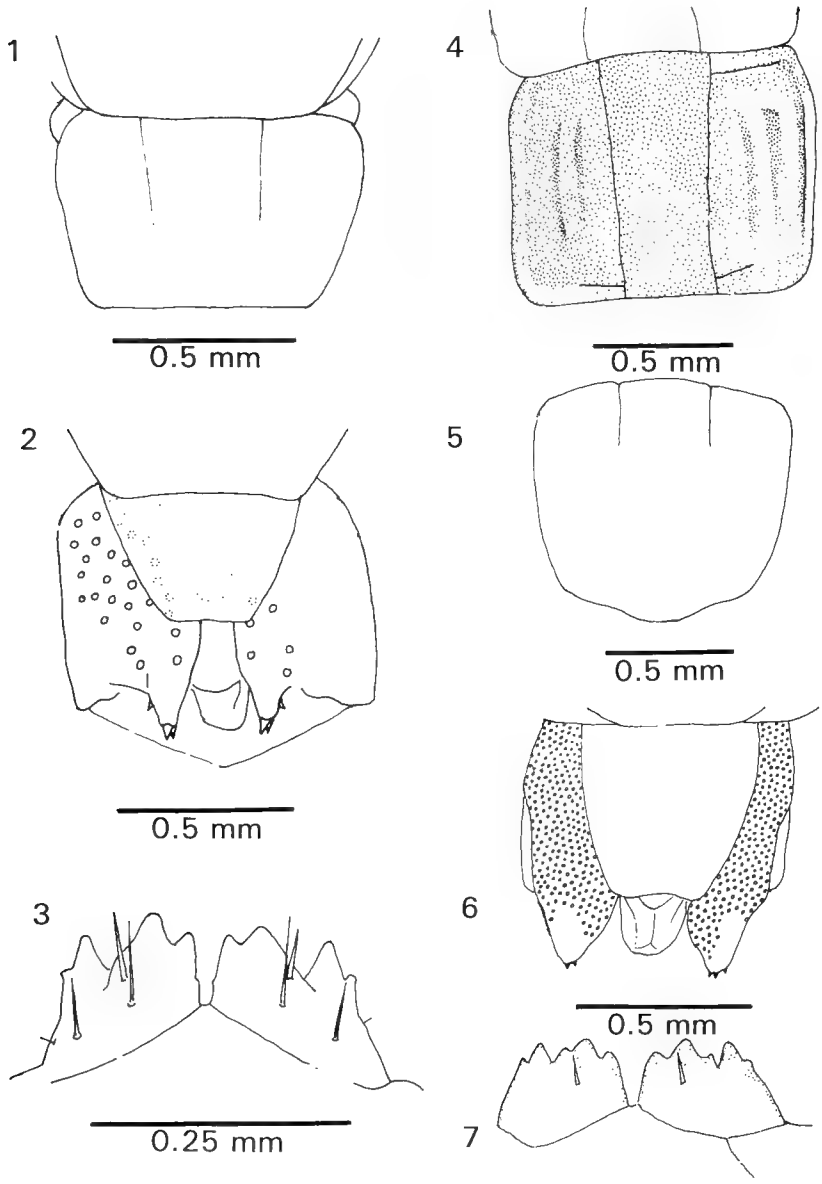
Figures 4–7

Otostigma oweni Pocock, 1892: 319.
Otostigmus oweni.—Kraepelin, 1903: 116.
Otostigmus oweni.—Attems, 1930a: 152.

Material examined. Disturbed forest, Liwa, Sumatra, 5–7 Sep 1984, pitfalls, MZB (1 specimen, 27.5 mm).

Diagnosis. Antennae with 18–23 segments, basal 2⅔ glabrous. Tergites marginate at least from 17, without keels or spines. Sternites without tubercles or spines. Each coxosternal tooth plate with 5 teeth. Coxopleural process with 2–3 end spines, 0–1 dorsal spines. Legs 1–18 with 2 tarsal spines.

Description. Colour of preserved specimen: bluish grey. Antennae with 22–23 segments, the basal 2⅔ glabrous dorsally. Tergites: with paramedian sutures complete from 6, marginate from 5, lateral corrugations present from 5, and without ridges or spines (Fig. 4). Tergite 21, with posterior median depression occupying about a third of its length. Sternites: with anterior para-



Figures 1–7. *Otostigmus metallicus* and *Otostigmus oweni*.
Otostigmus metallicus. Fig. 1, sternite 17, specimen 2. Fig. 2, ventral view of terminal segments, specimen 4. Fig. 3, forcipular coxosternal tooth plates, specimen 4.
Otostigmus oweni. Fig. 4, tergite 12. Fig. 5, sternite 16. Fig. 6, ventral view of terminal segments. Fig. 7, forcipular coxosternal tooth plates.

median sutures occupying about one-quarter to one-third their length, without pits or tubercles (Fig. 5). Sternite 21 with sides converging posteriorly, with slightly concave posterior margin (Fig. 6). Forcipule: median prefemoral process with 2 very low teeth or knobs. Each coxosternal tooth plate with 5 teeth consisting of inner group of 3 and outer group of 2. (Fig. 7). End legs: coxopleural process conical and rounded with 2–3 end spines, 0–1 lateral spines and 0–1 dorsal spines. Telopodites wanting. Trunk legs: first with 1 tarsal spine, legs 2 and 3 wanting, legs 4–

18 with 1 tibial and 2 tarsal spines, 19 and 20 with no tibial and 1 tarsal spine.

Remarks. This species was hitherto known from a single specimen from Owens Island, Mergui Archipelago in the Andaman Sea off the east coast of the most southerly part of Burma. The Sumatra specimen is very similar to the type specimen in The Natural History Museum, London (1891.10.15.8) which I have examined, but there some minor inaccuracies in Pocock's description. He described *O.oweni* as having the basal three antennal segments glabrous, in fact the basal 2⅔ are, and as having four sharp prehensorial coxosternal teeth; a small fifth tooth is present. I have little doubt that Pocock's specimen and the Sumatra specimen are conspecific.

Otostigmus (O.) multidens Haase

Figures 8–10

Otostigma multidens Haase, 1887: 75.
Otostigmus multidens.—Kraepelin, 1903: 121, fig. 59.
Otostigmus multidens.—Attems, 1930a: 141, fig. 172.

Material examined. Rakata, Krakatau Islands, Sep 1985, under logs, bark, litter, MZB (1 specimen, 34 mm).

Diagnosis. Antennae 20–22 segmented, basal 2¼–2½ glabrous. Tergites marginate at least from 17, without keels or spines. Sernites without tubercles or spines. Each coxosternal tooth plate with 6–10 teeth. Coxopleural process without dorsal spine. First 14–20 pairs of legs with 2 tarsal spines.

Description. Colour of preserved specimen: dark green. Antennae: incomplete, basal 2¼ segments glabrous dorsally. Tergites: with complete paramedian sutures from 6, weakly marginate from 14, lacking ridges or spines. Tergite 21 with a longitudinal median depression occupying posterior two-thirds of tergite. Sternites: with paramedian sutures occupying anterior one-third of anterior sternites and anterior half of posterior sternites, without pits or tubercles. Sternite 21 with sides converging posteriorly, posterior border slightly concave (Fig. 8). Forcipule: coxosternal toothplates each with 6 teeth (Fig. 9), median prefemoral process with 3 low teeth (Fig. 10). End legs: coxopleural process of moderate length with elongated ventral poreless strip (Fig.8), with 2 end spines and 1 lateral spine, dorsal spines lacking. Telopodites missing. Trunk legs: many missing. 1 tibial spine and 2 tarsal spines present from leg 2 to at least 18. Leg 20 lacks tarsal spines.

Remarks. Otostigmus multidens is a common species recorded from Java, Sumatra, Celebes, Sarawak, New Guinea, Mentaway Island and Tawarin Island. The species is similar to *O. oweni* from which it differs in having more forcipular coxopleural teeth and the characteristics of the coxopleural process of segment 21.

Otostigmus (O.) spinosus Porat

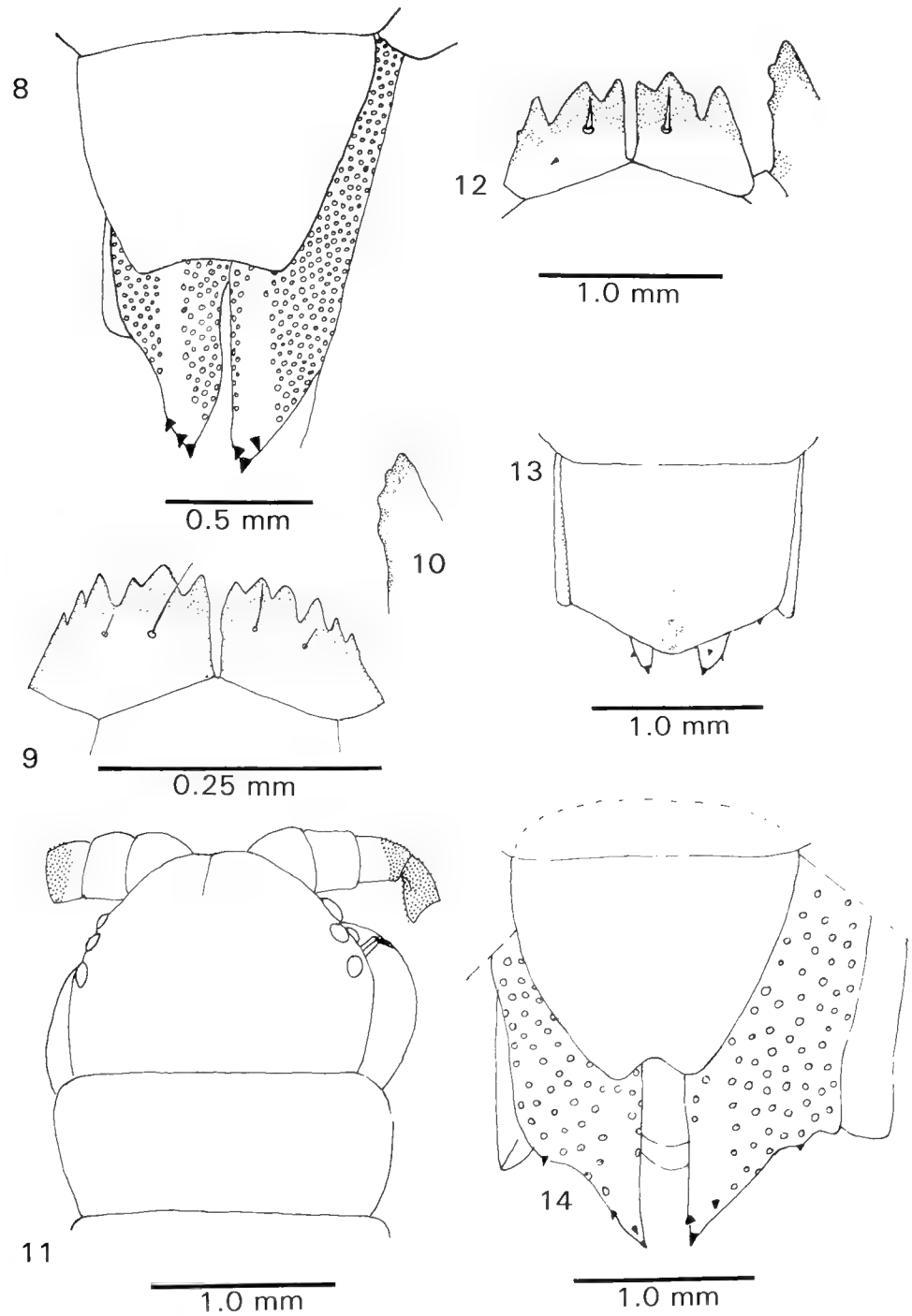
Figures 11–14

Otostigmus spinosus Porat, 1876: 22.
Otostigmus spinosus.—Attems, 1930a: 152, fig. 182.

Material examined. Panjang central, Krakatau Islands, 17 Aug 1985, MZB (1 specimen, 30 mm). Panjang, Krakatau Islands, litter, secondary rainforest, 14 Sep 1984, NMV (3 specimens, 26 mm, 26 mm, 24 mm). Rakata, Owl Bay, Krakatau Islands, 25 Aug 1985, NMV (1 specimen, 45 mm). Rakata, Krakatau Islands, under logs, bark, litter, Aug 1985, NMV (1 specimen, 29 mm). Rakata Camp, Krakatau Islands, 18 Jul 1982, S.Yamane, MZB (1 specimen, 22 mm). 1 km S of Panjang, Sumatra, under rocks, 3 Sep 1984, MZB (1 specimen, 38 mm).

Diagnosis. Antennae with 17–21 segments, basal 2½–3 glabrous. Tergites marginate at least from 17, without keels, with or without spines. Sternites without tubercles or spines, with short paramedian sutures. Coxopleural process with dorsal spine. Prefemur of leg 20 with dorsal end spine.

Description. Colour of preserved specimens: violet grey or turquoise grey with greyish blue legs. Antennae: with 17–21 segments, with basal 2½–2⅔ glabrous dorsally (Fig. 11). Tergites: with complete paramedian sutures from 5 or 6, margination beginning from 9 to 15, without keels, spines or lateral furrows. Tergite 21 as in Fig. 13. Sternites without spines, tubercles or pits, except for the specimen from Owl Bay, Rakata which has 3 feint depressions on sternites 15 and 16, with short anterior paramedian sutures on anterior sternites. Sternite 21 with sides converging posteriorly, posterior border concave (Fig. 14). Forcipular coxosternal toothplates: each with 4 or 5 teeth (Fig. 12). End legs: coxopleural process slender, (whether it be termed long or short is a very subjective matter), with 2 or 3 end spines, 1 or 2 lateral spines and 1 or 2 dorsal spines but never more than 5 spines in all. Lateral spines very near to or far from end spines. Terminal prefemur with ventrolateral



Figures 8–14. *Otostigmus multidens* and *Otostigmus spinosus*.
Otostigmus multidens. Fig. 8, ventral view of terminal segments. Fig. 9, forcipular coxosternal toothplates. Fig. 10, left forcipular prefemoral process.

Otostigmus spinosus, 24 mm specimen, Panjang Is. Fig. 11, dorsal view of head capsule. Fig. 12, forcipular coxosternal toothplates and left prefemoral process. Fig. 13, tergite 21. Fig. 14, ventral view of terminal segments.

row of 5, or, in one case 4 spines, ventromedially with 2, 3 or 4, medially with 3, 4 or 5 and dorsomedially with 1 or 2 plus corner spine. Telopodites missing in some specimens. Trunk legs: leg 1 with or without prefemoral spine, legs 1 or 1 and 2 or 1, 2 and 3 with tibial spine. Legs 1 to 3, 4 or 5 with 2 tarsal spines, succeeding legs to 18, 19, 20 or 21 with 1 tarsal spine, remainder without. Prefemur of leg 20 with typical distal dorsal spine, this not seen in 2 specimens from Panjang which lacked twentieth pair of legs.

Remarks. Otostigmus spinosus is a common species which has been recorded from Burma, Java, Sumatra, Borneo and New Guinea. The Krakatau specimens lack tergital spines and lateral tergal corrugations. Lewis (1982) suggested that tergital spines, present in some specimens from Sarawak were a female secondary sexual character. The figures for the number of prefemoral spines are similar to those given by Attems (1930a) but slightly more than those given by Lewis (1982) for Sarawak specimens.

Otostigmus (0.) politus Karsch

Figures 15–20

Otostigma politum Karsch, 1881: 62.
Otostigmus politus.—Attems, 1930a: 149–151.

Material examined: Sertung Forest II, Krakatau Islands, near spring (6°05′S, 105°23′E), 9 Aug 1985, MZB (1 specimen, 40 mm).

Diagnosis. Antennae with 17–19 segments, basal 3 glabrous. Tergites marginate, at least from 17, without keels or spines. Sternites without tubercles or spines, paramedian sutures almost complete. Tarsal spines present.

Description. Colour of preserved specimen: dark blue, head brownish, legs light blue. Antennae: damaged, basal 3 segments virtually glabrous dorsally (Fig. 15). Tergites: with paramedian sutures complete from 5, marginate from 8. Last tergite with slight median terminal depression (Fig. 17). Sternites: with short paramedian sutures (Fig. 18) on anterior segments, increasing in length in midbody region, with median pit or depression from tergites 5–18 and small pits marking termination of paramedian sutures (Fig. 19). Forcipules: each coxosternal toothplate with 3 teeth (Fig. 16) prefemoral process virtually without teeth. End legs: coxopleural complex (Fig. 20) with 2 end spines, 2 or 3 lateral spines and 2 or 3 dorsal spines. Telopodites wanting. Trunk legs: leg 1 with 1 tibial spine, 1 and 2 with 2 tarsal spines, 3–19 with 1 tarsal spine.

Remarks. The species is known from China, Burma, Sumatra, New Guinea, East Sumba, New Britain and Australia. The Krakatau specimen has fewer coxosternal teeth and more coxopleural spines than described in Attem's (1930a) monograph but is clearly referable to *O. politus*. A number of subspecies of *O. politus* have been described but their status is unclear. The problem requires a detailed study.

Otostiomus sp.

Figures 21–25

Material examined. Forest, Liwa, Sumatra, 1 Sep 1984, MZB (1 specimen, 12 mm).
Description. Antennae: with 17 segments, basal 2½ glabrous (Fig. 21). Tergites: with paramedian sutures complete from 5, pronounced longitudinal corrugations from 5 and median ridge but no spines or lateral ridges. Only tergite 21 marginate (Fig. 24) but this may be a juvenile character. Sternites: with complete paramedian sutures and anterior and posterior pits (Fig. 23), without spines or tubercles. Forcipules: coxopleural tooth plates each with 4 teeth (Fig. 22), prefemoral process with 1 tooth. End legs: coxopleural complex short (Fig. 25), with 2 end spines but no lateral or dorsal spines. Prefemur with 3 ventrolateral, 2 ventromedial, 2 medial, 2 dorsomedial and a corner spine. Trunk legs: 1–19 with 1 tarsal spine, 20 and 21 without.

Remarks. This specimen is immature and I am unable to assign it to a species but it is described here since there is little information about *Otostiomus*. The specimen resembles *O. metallicus* but has complete sternital paramedian sutures and ventral pits. It is unlikely that these are juvenile characters.

Rhysida H. C. Wood

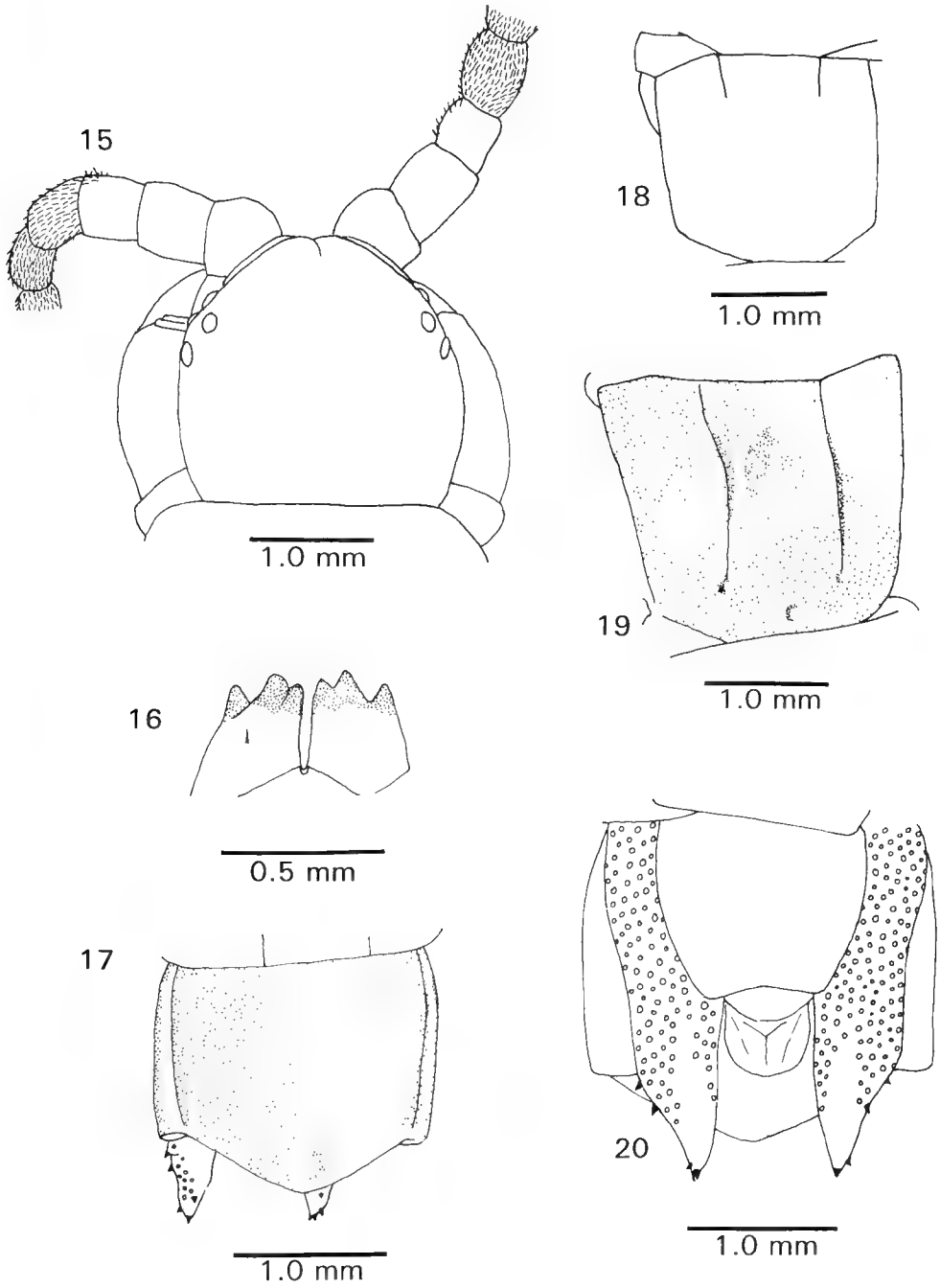
Rhysida immarginata (Porat)

Figures 26–30

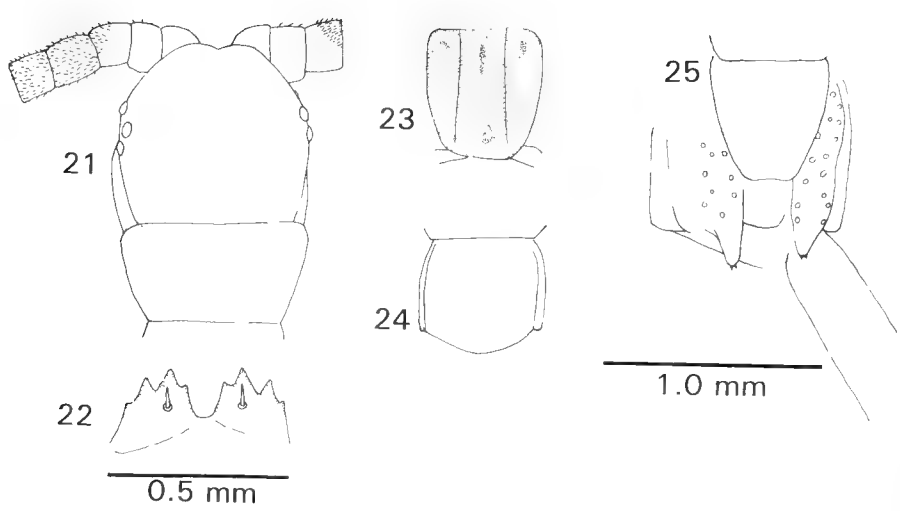
Branchiostoma immarginata Porat, 1876: 24.
Rhysida nuda immarginata.—Attems, 1930a: 190.
Rhysida immarginata.—L.E. Koch, 1986: 212.

Material examined. Sertung, Krakatau Islands, 16 Sep 1984, A. Saim, MZB (specimen 1, 44 mm). Sertung Forest, Krakatau Islands, (6°05′S, 105°23′E), 18 Sep 1986, under log, Sertung Spring Valley, NMV (specimen 2, 47 mm, lacks end legs).

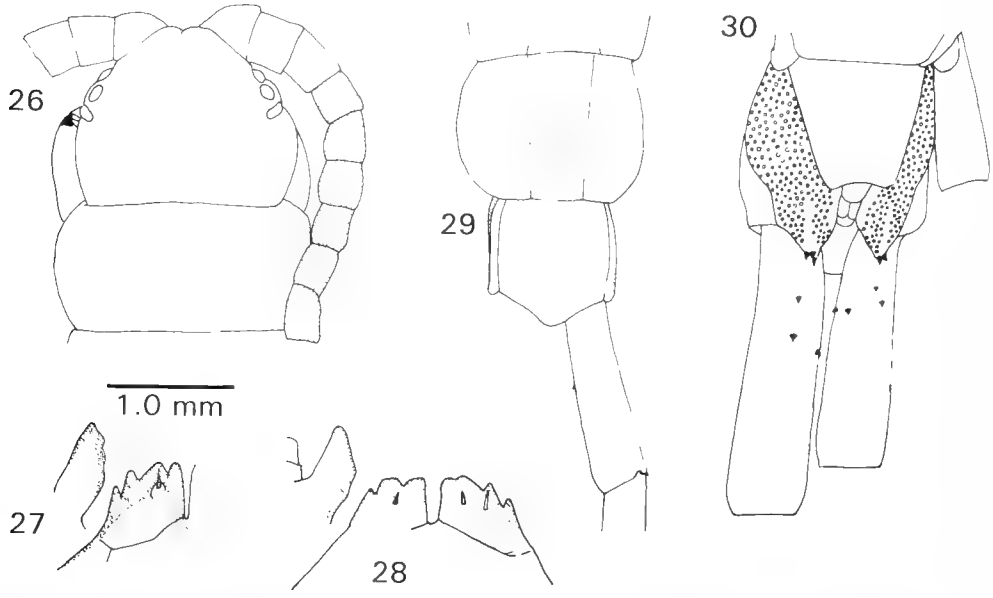
Diagnosis. Most tergites with complete paramedian sutures, only tergite 21 marginate. First 15–18 pairs of legs with 2 tarsal spines. Coxopleural process with 3 end spines.



Figures 15–20. *Otostigmus politus.* Fig. 15, dorsal view of head capsule and basal antennal segments. Fig. 16, forcipular coxosternal tooth plates. Fig. 17, tergite 21. Fig. 18, sternite 3. Fig. 19, sternite 9. Fig. 20, ventral view of terminal segments.



Figures 21–25. *Otostigmus* sp. Fig. 21, dorsal view of head capsule and tergite 1. Fig. 22, forcipular coxosternal tooth plates. Fig. 23, sternite 11. Fig. 24, tergite 21. Fig. 25, ventral view of terminal segments.



Figures 26–30. *Rhysida immarginata*. Fig. 26, dorsal view of head capsule and tergite 1 specimen 1. Fig. 27, forcipular coxosternal toothplate and prefemoral process specimen 1. Fig. 28, forcipular coxopleural tooth plates and prefemoral process specimen 2. Fig. 29, tergites 20 and 21 and prefemur of right terminal leg. Fig. 30, ventral view of terminal segments and prefemora of the terminal legs.

Description. Colour of preserved specimens: dark blue or dark green with yellowish white legs. Antennae with 19 segments, basal 3 glabrous. Head capsule as in Fig. 26. Forcipules: coxopleural tooth plates each with 3 or 4 teeth (Figs 27, 28), median prefemoral process with 2 slight teeth. Tergites: with complete paramedian sutures from 4 or 6, without lateral corrugtions, spines or keels. Only tergite 21 marginate (Fig. 29), lacking median suture and virtually without median posterior depression. Sternites: with short anterior paramedian sutures occupying

quarter of their length, without pits or tubercles. Last sternite with sides converging posteriorly, with slightly concave posterior margin (Fig. 30). End legs: coxopleural process stout, with 3–2 end spines and 0–1 lateral spines in specimen 1 and 3–3 end spines in specimen 2. Dorsal spines absent. Right prefemur of first specimen (Fig. 30) with 2 ventromedial and 1 medial spine, left (which is regenerated) with 3 ventrolateral, 1 ventromedial and 1 medial. Without dorsomedial spines or corner spines. Trunk legs: leg 1 with 0 or 1 prefemoral spines and 1 or 2 tarsal spines, tibial spines present on legs 1 and 2. Legs 2–18 (specimen 1) or 1–15 (specimen 2) with 2 tarsal spines, 1 tarsal spine on 19 or on 16–18, 19 with or without, 20 and 21 without tarsal spines.

Remarks. The species has been recorded from Sudan, India, Burma, Brunei, Philippines, Venezuela and Guatemala. It is possibly even more widely distributed as Koch (1985) suggested that the name *Rhysida immarginata* may be applicable to some or even most of the non-Australian forms previously recorded as *R. nuda* (Newport).

Crytopodidae

Cryptops Leach

Cryptops sp.

Material examined. Gunung Pajung, summit, 12–13 Sep 1984, beating (1 specimen, 9.5 mm, in Hoyer's Mountant).

Description. Colour: yellowish grey, specimen may be newly moulted. Antennae: of 17 segments. Head capsule: without sutures. Clypeus: with 5 rows of 2, 1, 2, 2 and 8 setae, last immediately in front of the labrum. Labral side pieces not notched. Second maxillae: hooked apical claw of telopodite with rounded lobe at its base. Forcipules: anterior margin of coxosternum virtually straight with 3 setae on each side, fourth large seta on each side just behind anterior margin. Tergites: first overlying posterior border of head capsule, lacking ring or other sutures. Trunk tergites without paramedian or other sutures. Tergite 21 semicircular, without median longitudinal suture, overlapped by pleural region. Sternites without paramedian sutures but with median longitudinal sulcus, not seen after prepared in Hoyer's Mountant. No transverse suture but weak transverse skeletal thickening between coxae. Sternite 21 posteriorly rounded, wider than long (1.5:1). End legs: coxae each with 10 gland pores in anterior two-thirds of coxa. About 6 setae in pore-field. Telopodites missing. Trunk legs: tarsi of legs 1–19 not divided, those of leg 20 clearly so.

Remarks. In Attems' (1930a) key the specimen runs down to the region of *C. modiglianii* Silvestri from Sumatra, *C. audax* Attems from South Africa and *C. patagonicus* Meinert from Argentina. It appears to be related to the poorly described *C. stabilis* Chamberlin from Gunung Malabar, Java but as the specimen lacks the terminal legs it cannot at this stage be assigned to a definite species. Two further specimens of *Cryptops* in poor condition were collected in litter in forest at Liwa, Sumatra, on 6 Sep 1984.

Order **Geophilomorpha**

Mecistocephalidae

Mecistocepalus Newport

Mecistocephalus (M.) verrucosus Verhoeff

Figures 31–41

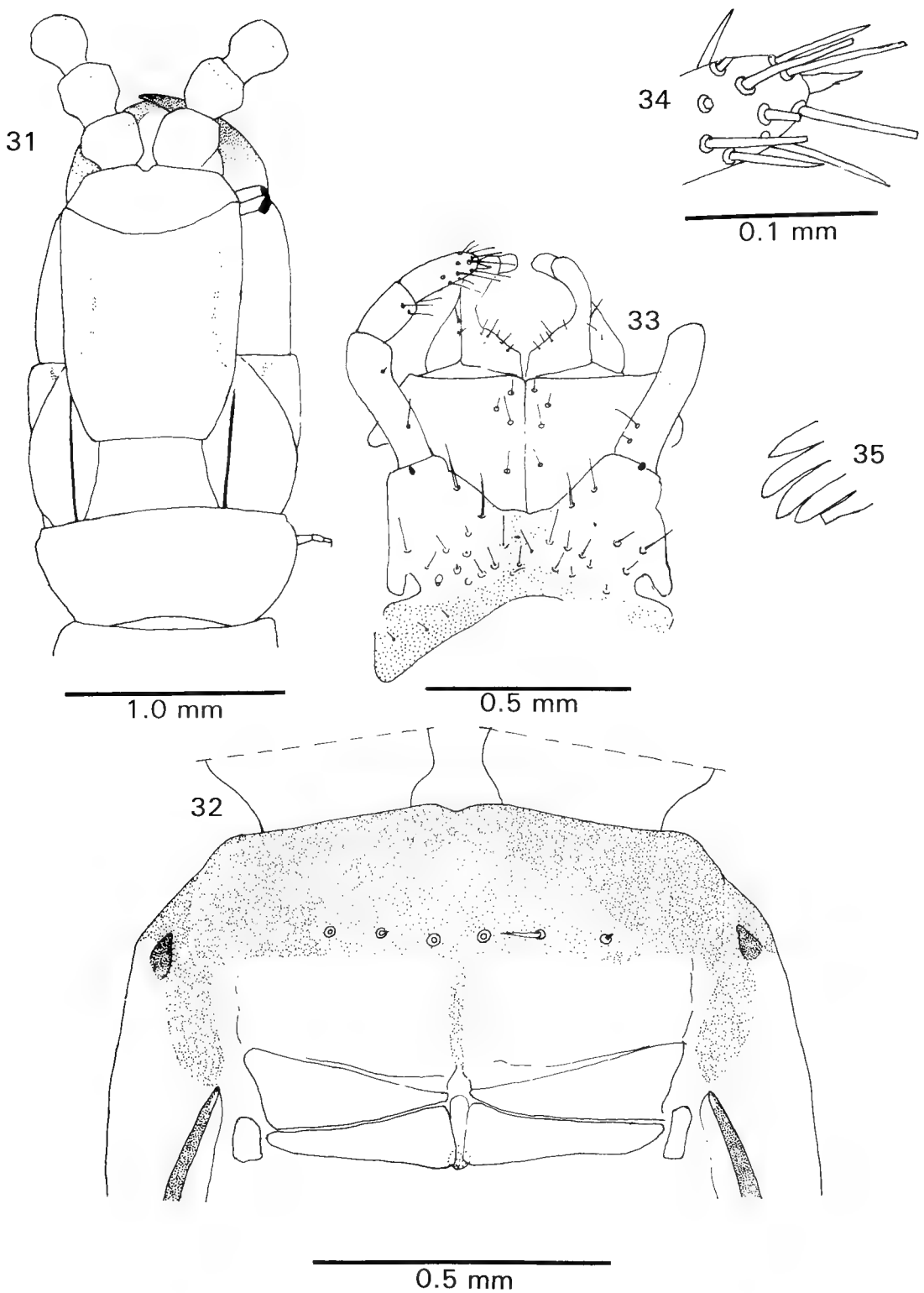
Mecistocephalus verrucosus Verhoeff, 1937: 231, figs 32–33.

Mecistocephalus (*Mecistocephalus*) *verrucosus*.— Attems, 1947: 101.

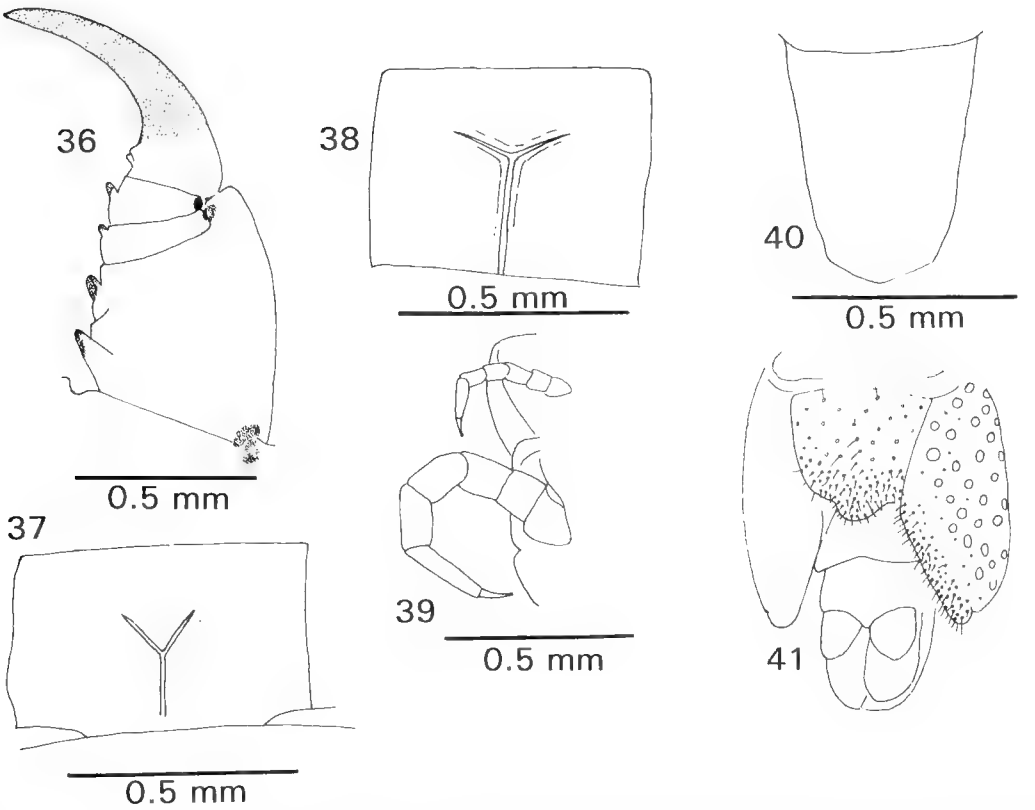
Material examined. Disturbed forest, Liwa, Sumatra, 5 Sep 1984, litter, MZB (specimen 1, female, 31 mm, head removed, 1st and 2nd maxillae in Hoyer's Mountant). Forest, Liwa, Sumatra, 6 Sep 1984, litter, NMV (specimen 2, female, 33 mm, head removed, 1st and 2nd maxillae in Hoyer's Mountant). Liwa, Sumatra, as above, (specimen 3, adolescens I, about 10 mm).

Diagnosis. 49 pairs of legs. Anterior sternites with obtusely angled Y-shaped median thickenings. Areolate region of clypeus without smooth areas. Midpart of labrum very narrow, mandibular tooth plates with teeth of approximately equal size. Posterior half of head pleurite setose. Leg 1 about half length of leg 2.

Description of specimens 1 and 2. Colour: Head capsule and forcipular segment brown red, trunk dull yellow, without pigment flecks. Pairs of legs: 49. Antennae: with sparse large setae on basal segments increasing in number and becoming shorter on segments 8 and 9, densely setose from segment 10. Segments relatively short, sharply incurved at their bases. Head capsule: ratio of length to width 1.6:1 in specimen 1, 1.52:1 in specimen 2. Widest in anterior third, tapering slightly posteriorly (Fig. 31). Frontal suture well marked. Clypeal region: paraclypeal sutures complete. Head pleurite areolate anterior to buccal spiculum (tooth), posterior region



Figures 31–35. *Mecistocephalus verrucosus* specimen 1. Fig. 31, dorsal view of head capsule and tergite 1. Fig. 32, clypeus and labrum. Fig. 33, first and second maxillae. Fig. 34, claw of second maxilla. Fig. 35, a mandibular tooth plate.



Figures 36–41. *Mecistocephalus verrucosus*. Fig. 36, right forcipule, specimen 2. Fig. 37, sternite 2, specimen 1. Fig. 38, sternite 7, specimen 1. Fig. 39, left legs 1 and 2, specimen 2. Fig. 40, last tergite specimen 2. Fig. 41, ventral view of terminal segments, specimen 1.

smooth (Fig. 32). Buccal spiculum pointed and incurved. Anterior part of head pleurite (bucca) glabrous, posterior half with strong setae. Clypeus: anterior areolate region (fore-clypeus) with broad based triangle of more finely areolate cuticle adjacent to hind clypeus (clypeal plagula). Setae 3+3. Anterior border of hind clypeus straight. Ratio of fore- to hind-clypeus about 1:1. Labrum: midpiece not projecting beyond side pieces but overlapped by them in its posterior half (Fig. 32). Posterior border of side pieces smooth and not notched. First maxilla: coxosternum with prominent midlongitudinal suture (Fig. 33) with anterior margin more or less straight, without blunt projection at outer corner or curved suture behind corner. Median lobes of more or less equal length, each inner lobe with 5 or 6 setae, each outer with 3. Coxosternum with 4+4 setae. Second maxilla: without median suture, median areolate strip with 3 or 5 setae (Fig. 33). Terminal claw of telopodite spine-like with minute lateral spicule (Fig. 34). Metameric pores lateral. Mandible: obscured in preparation of specimen 1, partly visible in specimen 2; with about 6 tooth plates each with 6–12 more or less equal-sized teeth (Fig. 35); general appearance much as in *M. insularis*. Forcipules: coxosternum (prosternum) without chitin lines; with 2 prominent median anterior teeth in specimen 1, these obscured in specimen 2. Telopodite reaching in front of head (Fig. 31); basal article with 2 large teeth, femuroid and tibioid each with large tooth; claw not serrate and without noticeable basal tooth (Fig. 36). Basal plate: without median groove, setae not set in pale areas of cuticle. Tergites: with thin longitudinal strips of areolate cuticle from 2 in position normally occupied by paramedian sutures. Sternites: with Y-shaped median thickenings (rhachides) from 2 to 31 or 32. Obtuse: 80° on tergite 2 (Fig. 37), 130° on tergite 7 (Fig. 38); simple on tergites 32 and 33 in specimen 1. First pair of legs: about half length of second pair (Fig. 39). Last leg-bearing segment: tergite with sides converging posteriorly (Fig. 40) with hind border more or less rounded. Ratio of length to width 1.61:1. Sternite with converging sides and strongly setose semicircular bulge on posterior border but not divided into anterior and posterior regions (Fig. 41). Ventromedial edge of coxopleu-

ron raised, swollen and densely setose. Coxal pores large and evenly distributed. Female gonopods: 1-segmented and widely separated (Fig. 41). Anal gland pores apparently absent.

Specimen 3: (Presumed to be *M. verrucosus*.) Differs from other specimens in: Head capsule relatively shorter (ratio of length to width 1.38:1). Posterior region of head pleurite with relatively few setae. Triangular area of finely areolate cuticle not developed on fore-clypeus. Tergital paramedian sutures not visible. Ratio of length to width of tergite of last leg-bearing segment 0.95:1, sides barely converging, hind border obtusely angled. Sternite virtually triangular, less setose than in adult as are raised edges of coxopleura. Coxopleura without gland pores but well developed anal glands and pores present. (Clypeus, labrum and mouthparts not examined in detail.)

Remarks. Crabill's (1959) terminology has been adopted for a number of characters.

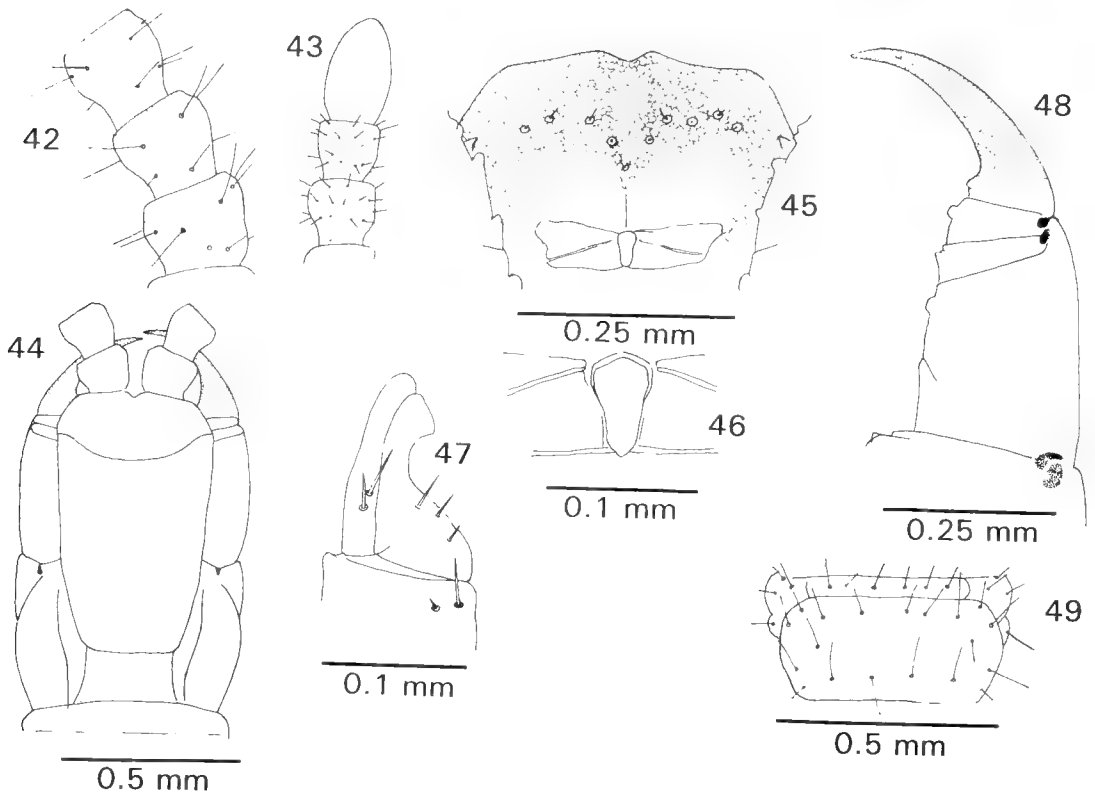
Verhoeff described *M. verrucosus* on the basis of a single male from Kuala Legap, Plus Valley, Perak, Malaya. He gave some characters in the description, others in a key to related species. He described the triangular fore-clypeus as having thick wart-like structure with two pairs of setae. I presume that this is the finely areolate region of the Liwa specimens. Although the description is brief, I have little doubt that the two females here described are of the same species.

Mecistocephalus (M.) cf. conspicuus Attems

Mecistocephalus conspicuus Attems, 1938: 327, figs 287–292.

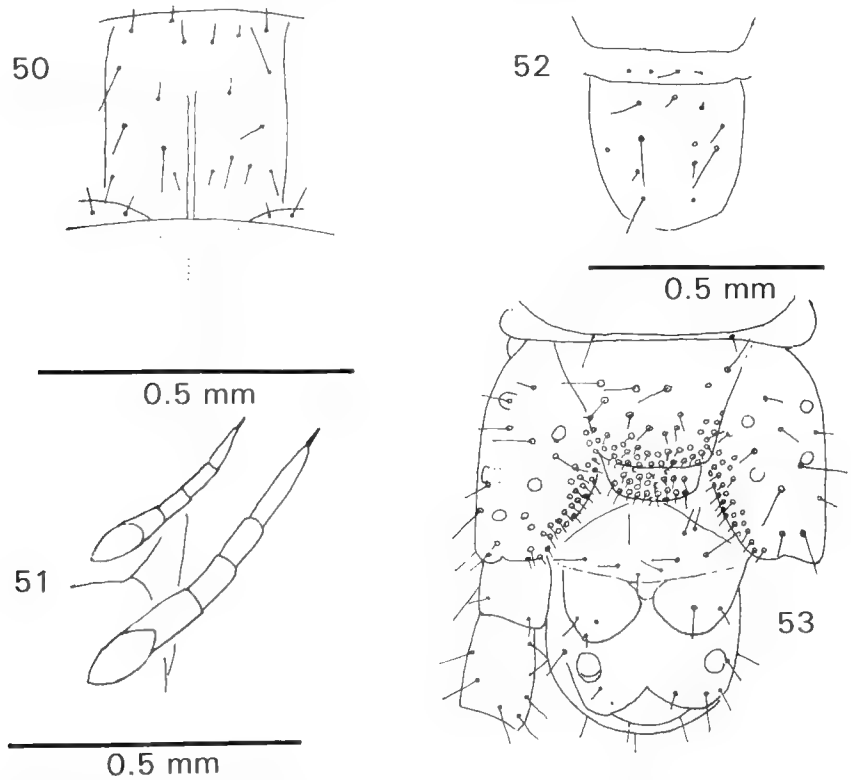
Material examined. West Java, Gunung Payung, 300 m, 13 Sep 1984, MZB (1 specimen, immature female, 17 mm).

Description. Colour: head capsule and forcipular segment dark brown (tan), antennae yellowish brown, trunk greyish orange with brown pigment (fat body?) seen through cuticle on either



Figures 42–49. *Mecistocephalus* cf. *conspicuus*. Fig. 42, basal three segments of right antenna. Fig. 43, terminal three segments of right antenna, setae of terminal segment omitted. Fig. 44, dorsal view of head capsule. Fig. 45, clypeus and labrum. Fig. 46, midpiece of labrum. Fig. 47, left side of first maxilla. Fig. 48, right forcipule. Fig. 49, tergite 3.

side of midline. Pairs of legs: 49. Antennae: with sparse large setae on basal segments, increasing in number and becoming shorter and more dense distally (Figs 42, 43). Segments relatively short, not sharply incurved at bases. Head capsule: ratio of length to width 1.67:1. Widest in anterior eighth, tapering slightly posteriorly (Fig. 44). Frontal suture well marked. Clypeal region: paraclypeal sutures complete. Buccal spiculum pointed, inward pointing and not well sclerotised (Fig.45). Clypeus: with anterior areolate region with longitudinal median strip of more finely areolate cuticle with 3+4 fine setae posterior to which is pair of posterior geminate setae (Fig. 45). Ratio of anteroposterior length of fore- to hind-clypeus about 1:1. Labrum: broad midpiece (Fig. 46) not projecting beyond side pieces but its posterior half overlapped by them. Posterior border of side pieces smooth, not notched. First maxilla: coxosternum with prominent midlongitudinal suture (Fig. 47) with anterior margin more or less straight, without blunt projection at outer corner or curved suture behind corner. Telopodites and median lobes of more or less equal length, latter crotchet-like. Telopodites with 3 setae, median lobes with 1 or 2, coxosternum with 2+2 setae. Second maxilla: without median suture, median areolate strip with 2 or 3 setae. Metameric pores not observed. Mandible: not seen as this sole specimen was not dissected. Forcipules: coxosternum (prosternum) without chitin lines with 2 small nipple-like projections on midanterior border. Telopodite reaching in front of head (Fig. 44), basal article with anterior wart-like tooth, second posterior tooth barely present. Femuroid with small tooth, tibioid with large wart-like tooth (Fig. 48). Claw not serrate and with small basal tooth. Basal plate: without median groove: setae not set in pale areas of cuticle (Fig. 44). Tergites without paramedian sutures, with long setae (Fig. 49). Sternites with long setae and with simple median longitudinal sternital thickening (rhachides) from sternite 1 (obscured by tergite 2) to 21 (Fig. 50). First pair of legs: about half length of second pair (Fig. 51). Last leg-bearing segment: tergite as in Fig. 52 with hind border more or less rounded. Ratio of length to width 1.1:1. Sternite with converging sides and semicircular bulge on posterior border which is



Figures 50–53. *Mecistocephalus* cf. *conspicuus*. Fig. 50, sternite 7. Fig. 51, right legs 1 and 2. Fig. 52, tergite of last leg-bearing segment. Fig. 53, ventral view of terminal segments.

strongly setose and divided into anterior and posterior regions (Fig. 53). Ventromedial edge of coxopleuron raised, swollen and densely setose. Coxal pores 4–5. Female gonopods: 1-segmented and widely separated (Fig.53). Anal gland pores present.

Remarks. M. conspicuus was described from Poulo Dama Isles, Gulf of Vietnam. The immature specimen here described runs down to *M. parvidentatus* Verhoeff from Mauritius in Attems' (1947) key. It is, however, not this species which has a very narrow labral middle piece and much smaller buccal spicula. It appears to be similar to *M. monticolens* Chamberlin from Java, *M. rubriceps* H. C. Wood from Japan and the Lesser Sunda Islands, *M. modestus* Silvestri from West Sumba and West Flores, Java, New Guinea and Ethiopia, *M. apator* Chamberlin from Celebes and *M. mossambicus* Lawrence from Mozambique and Zimbabwe. I think it is most likely an immature *M. conspicuus*. These species are poorly characterised and Attems (1930b) regarded *M. modestus* as an immature *M. rubriceps* and did not distinguish *M. modestus* from *M. apator* in his 1947 key.

Schendylidae

Ballophilinae

Ballophilus Cook

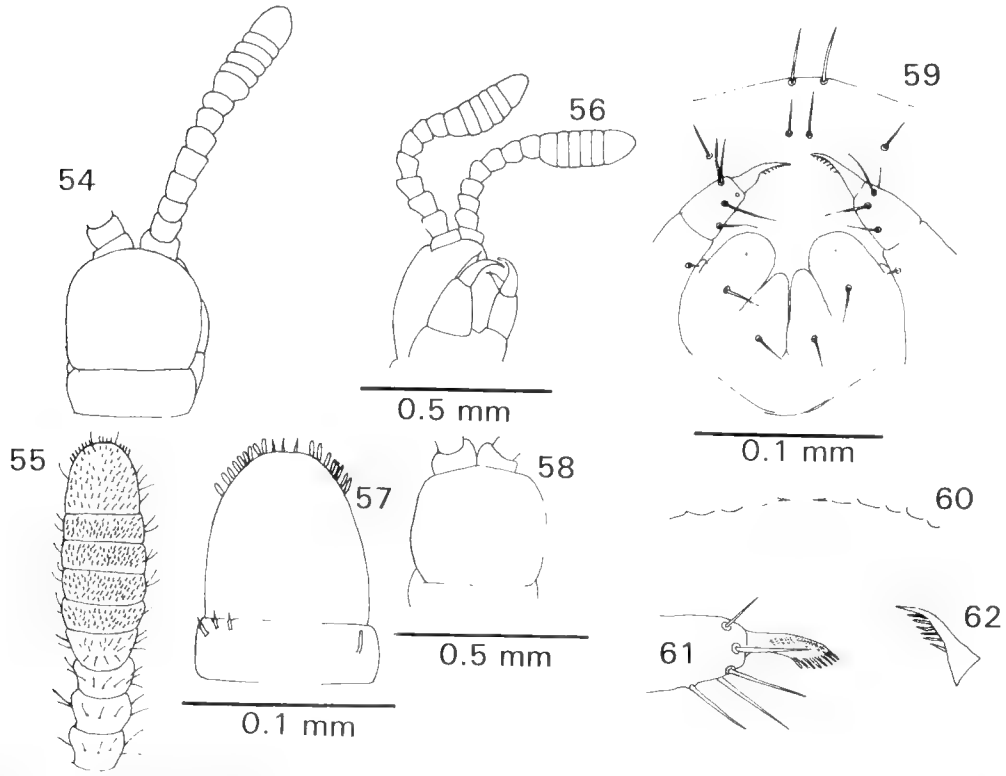
Ballophilus pedadanus Chamberlin

Figures 54–68

Ballophilus pedadanus Chamberlin, 1944: 5, fig. 1.

Material examined. Disturbed forest, Liwa, Sumatra, 5 Sep 1984, litter, NMV (specimen 1, male, 13 mm). Forest, Liwa, Sumatra, 6 Sep 1984, litter, MZB (specimen 2, male, 14 mm and specimen 3, female, 12 mm).

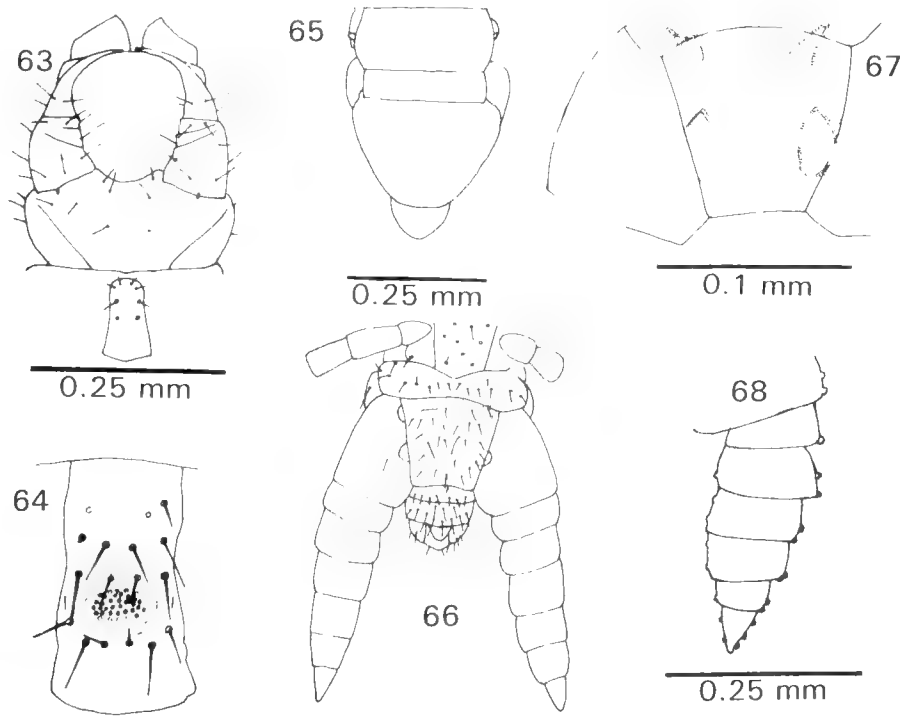
Diagnosis. 47–51 pairs of legs. Last antennal segment conically narrowed. Claw of second max-



Figures 54–62. *Ballophilus pedadanus*. Fig. 54, head and forcipular tergite specimen 2. Fig. 55, ventral view of distal 9 antennal segments, specimen 2. Fig. 56, ventrolateral view of head, specimen 2. Fig. 57, dorsal view of segments 13 and 14 of right antenna, specimen 2. Fig. 58, dorsal view of head capsule, specimen 1. Fig. 59, clypeus and parts of first and second maxillae, specimen 2. Fig. 60, labrum, specimen 2. Fig. 61, part of terminal segment and claw of second maxillary telopodite, specimen 1, viewed obliquely. Fig. 62, claw of second maxillary telopodite, specimen 2.

illa pectinate along both edges. Pore fields on all sternites except first and last four. Tergites not granulate. Coxopleuron of end leg with 2 pores.

Description. Body anteriorly attenuate, narrowest between segments 3–6. Colour of specimen 2: trunk brownish orange, head reddish brown, ventral glands greyish magenta, this colour disappearing after clearing in 60% lactic acid. Antennae: clavate (Fig. 54), last 6 segments expanded and very densely setose ventrally (Fig. 55); not strongly geniculate (Fig. 56). Specimens 1 and 2 with numerous thin-walled basiconic sensilla anterolaterally on segment 14 and a few spine-like sensilla distally (Fig. 57). On other segments sensilla dorsal. Segment 13 with 2 or 3 thick-walled basiconic sensilla anteroexternally and 1–3 brown sensilla anterointernally. On segment 9, 1 or 2 thick-walled basiconic sensilla and 2 or 3 brown sensilla. In specimen 1 very few antennal sensilla (this may be a sexual difference but distal antennal segments have most setae missing and absence of sensilla could be related to this). Head capsule: about as long as wide (Fig. 54) or wider than long (Fig. 58), posterior border covered by forcipular tergite. No discernible frontal suture. Clypeus: paraclypeal sutures not discernible. Row of 4 setae behind 2 anteroclypeal setae (Fig. 61). Labrum: midpiece apparently atrophied, side pieces with 4 or 5 low teeth and medially directed seta (Fig. 60). First maxillae: median lobes small, far exceeded by telopodites (Fig. 61). Small telopodal lappet present, larger in specimen 3 than in specimen 2. Second maxillae: with robust telopodite with broad spoon-shaped claw, finely pectinate along inner and outer borders (Figs 61, 62). Forcipules: not extending beyond anterior border of head capsule (Fig. 63). Without teeth. Poison calyx small, cordiform, situated in tibia/tarsus. Chitin lines (pleurograms) absent. Tergites: not granulate and without paramedian sutures. Sternites: much wider than long, posterocentrally with elliptically transverse raised pore field (Fig. 64) on all tergites except first and last 4. Last leg-bearing segment: pretergite distinct from pleurites (Fig. 65), tergite wider than long (ratio 1.4:1 in specimen 1) with sides converging posteriorly and hind border rounded. Presternite constricted centrally but not obviously divided.



Figures 63–68. *Ballophilus pedadanus*. Fig. 63. ventral view of head capsule and forcipular tergite, specimen 2. Fig. 64, sternite 4, specimen 2. Fig. 65, dorsal view of terminal segments, specimen 1. Fig. 66, ventral view of terminal segments, specimen 1. Fig. 67, ventral view of sternite and right coxopleuron of last leg-bearing segment, specimen 3. Fig. 68, lateral view of end leg, specimen 2. Setae are not shown.

Sternite about as wide as long (Fig. 66) with sides converging posteriorly and hind border more or less straight. Coxopleuron with 2 pores, round and equal in specimen 1 (Fig. 66) but anterior pore smaller in specimens 2 and 3 and pores somewhat compressed and elliptical (Fig. 67). End legs inflated, tarsus double, large setigerous alveoli as in Fig. 68. Postpedal segments: male (Fig. 66) and female gonopods 1-segmented. No discernible anal gland pores.

Remarks. Chamberlin (1944) gave a very brief description of *B. pedadanus* based on a single specimen from Lampongs, Sumatra. It is very similar to *B. sabesinus* Chamberlin from Sebesi Island in the Sunda Strait from which it differs in having antennae that are not truly geniculate with the terminal segment more conically narrowed distally. The specimens may prove to be conspecific. The Liwa specimens are provisionally allocated to *B. pedadanus*. A revision of the genus is clearly necessary.

Discussion

Of the twelve species, nine scolopendromorphs and three geophilomorphs here recorded, five, all scolopendromorphs, are from the Krakatau Islands. *Scolopendra subspinipes subspinipes* which has previously been recorded from the islands is widely distributed in the Indo-Australian region and the West Indies. Lewis (1988) noted that it seems to be a wandering species and that its behaviour favours distribution through trading. *Otostigmus multidens*, *O. spinosus* and *O. politus* are widely distributed in the far east and *Rhysida immarginata* is found in central and south America, Africa, India and the far east. The geophilomorph *Mecistocephalus (M.) krakataunus* Chamberlin recorded from Rakata, Krakatau Islands and Batavia, Java (Chamberlin, 1944) was incompletely described. It has 47 pairs of legs and a simple median longitudinal sternital thickening. It is not represented in the present collection.

Acknowledgements

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THREE NEW SPECIES OF *GMINATELLUS* MILLER FROM NORTHERN AUSTRALIA (HETEROPTERA: REDUVIIDAE)

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Abstract

Malipatil, M.B., 1991. Three new species of *Gminatellus* Miller from northern Australia (Heteroptera: Reduviidae). *Memoirs of the Museum of Victoria* 52: 355–359.

Three new species of *Gminatellus* Miller are described: *G. elegans* sp. nov. (Northern Territory and Queensland including the Torres Strait Islands), *G. fasciatus* sp. nov. (Queensland) and *G. maculatus* sp. nov. (Queensland). A key to the species of *Gminatellus* is given.

Introduction

The harpactorine reduviid genus *Gminatellus* was described by Miller (1957) to include his new species, *G. debilis* from Queensland. The present paper describes three new species from the Northern Territory and Queensland including the Torres Strait Islands.

Unless otherwise indicated measurements, in millimetres, are of the holotype male followed by ranges for paratypes in parentheses. Specimens are lodged in the Australian Museum, Sydney (AM), Australian National Insect Collection, Canberra (ANIC), the Natural History Museum, London (BMNH), Queensland Museum, Brisbane (QM), South Australian Museum, Adelaide (SAM), and the University of Queensland Insect Collection (UQIC).

Gminatellus Miller

Gminatellus Miller, 1957: 70–71.

Type species. Gminatellus debilis Miller, 1957, by original designation.

Remarks. The following minor alterations to the original generic description and redescription (Malipatil, 1991) must be made to accommodate the new species:

Body length 8.0–13.0.

Head subequal to or slightly longer than pronotum. Antennal segment 1 subequal to or shorter than head and pronotum together. Labial segment 1 shorter than 2 and 3 together.

The genus is related to *Gminatus* Stal from which it differs in having the abdominal margin with its posterior area of at least the fourth visible segment produced to a point.

Key to *Gminatellus* species

1. Corium with a conspicuous circular, white, wax-covered spot ..... *G. maculatus* sp. nov.
— Corium without a white spot 2
2. Femora and dorsum of abdomen without fuscous areas ..... *G. debilis* Miller, 1957
— Femora and dorsum of abdomen with fuscous areas 3
3. Dorsum of visible abdominal segments 2–6 fuscous ..... *G. elegans* sp. nov.
— Dorsum of lateral margins of only fourth and fifth visible abdominal segments fuscous ..... *G. fasciatus* sp. nov.

Gminatellus debilis Miller

Gminatellus debilis Miller, 1957: 70–71.

Type. Holotype male, Australia, Queensland (no precise locality), F.P.Dodd (B.M.1904-284), in BMNH.

Other material examined. Northern Territory, Port Darwin, W.D. Dodd (SAM 1 male, 1 female).

Remarks. Nothing needs to be added to the original description.

Gminatellus elegans sp. nov.

Figures 1–3, 10–14

Types. Holotype male, Dividing range, 15 km W of Captain Billy Creek, Cape York Peninsula, Queensland, 5–12 Feb 1976, G. Monteith (QM T11875).

Paratypes. Queensland, same data as holotype (QM 1 male); Iron Range, Cape York Peninsula, 13 Apr 1961, I.F.B. Common and M.S. Upton (ANIC 1 female); same locality, 5–10 May 1968, G.B. Monteith (UQIC 1 female); same locality, 11–17 May 1968 (UQIC 2 males, 1 female); same locality and collector, 26–31 May 1971 (UQIC 1 female); same locality and collector, 1–9 Jun 1971 (UQIC 1 female); Lockerbie Area, Cape York, 13–27 Apr 1973, G.B. Monteith (QM 2 males); West Claudie River, Iron Range, rainforest, 50 m, 3–10 Dec 1985, G. Monteith and D. Cook (QM 1 female).

Other material examined. Torres Straits, Moa Is., J.W. Schomberg (SAM 1 female); Eet Hill vicinity, Moa (Banks) Is., 9–13 Jun 1977, G. Monteith and D. Cook (QM 1 female).

Northern Territory, Radon Creek (12°45′S, 132°53′E), rainforest, 14–16 Jul 1979, G. Monteith and D. Cook (QM 1 female).

Description. Ground colour orange with red tinge, with following fuscous: eyes, most of antenna, apices of labium, tarsi and tibia, hind femur, distal half–two-thirds of fore- and mid-femora, apices of pronotal spines, distal five-sixths of hemelytra, wings and most of distal five-sixths of abdominal dorsum.

Body and legs subshiny, densely covered with short, golden yellow setal hairs.

Body 11.20 (11.20–12.60); maximum width 3.50 (2.60–3.78).

Head. Length 2.50 (2.38–2.58), width across eyes 1.12 (1.18–1.25), interocular space 0.63 (0.60–0.68), interocellar space 0.42 (0.38–0.45), eye-ocellar space 0.28 (0.22–0.23); eye length 0.57 (0.52–0.54), eye width 0.30. Length of antennal segments: I, 4.12 (3.98–4.48); II, 1.33 (1.26–1.33); III, 1.47 (1.40–1.47); IV, strongly curved. Labium extending to anterior quarter of prosternum, length of segments: I, 1.33 (1.19–1.33); II, 1.26 (1.12–1.15); III, 0.42 (0.35–0.36), labrum short, one-eighth as long as first labial segment.

Thorax. Pronotum with dorsal spines long and acutely produced (fFig. 1), length 2.52 (2.24–2.52), width anterior margin 1.26 (1.12–1.26), maximum width 2.74 (2.55–2.94). Scutellum with apex acutely pointed and upcurved, length 0.84 (0.88–0.98), width 1.12 (1.32–1.40). Legs with tarsi 3 segmented, distal segment subequal to proximal 2 segments together. Hemelytra exceeding abdomen by one-quarter their length, length 7.28 (6.72–8.26), length corium 5.18 (4.48–5.46), width membrane 2.38 (2.20–2.80).

Abdomen. Lateral margins gradually widened to posterior margin of fourth visible segment and gradually narrowed to posterior end; connexiva at posterior margins of third and fourth visible segments produced to point, those of latter segment more prominent (e.g., fig. 8). Three minute dorsal scent gland scars distinct between visible terga II–III, III–IV and IV–V.

Genitalia. Male: Pygophore posterior margin produced medially (fig. 10). Paramere (fig. 11) slender, slightly curved in middle. Aedeagus with flap on dorsal surface sclerotised (fig. 12), ventral surface with 2 opposable median rows of long spines and 2 batches of lateral sclerotised spinules exterior to spines in pattern (fig. 13), and distal end of endosoma with numerous fine setal spines.

Female: First valvula (VI1) and first valvifer (Vf1) (fig. 14), styloid apically modified to a tube like structure, tergite 9 (t9) (fig. 14), tergite 10 (t10) narrow, flap-like, folded under.

Remarks. Gminatellus elegans can be easily distinguished from the type species, *G. debilis*, by the presence of fuscous areas on the femur and the dorsum of abdomen, and the more acutely produced apex of scutellum.

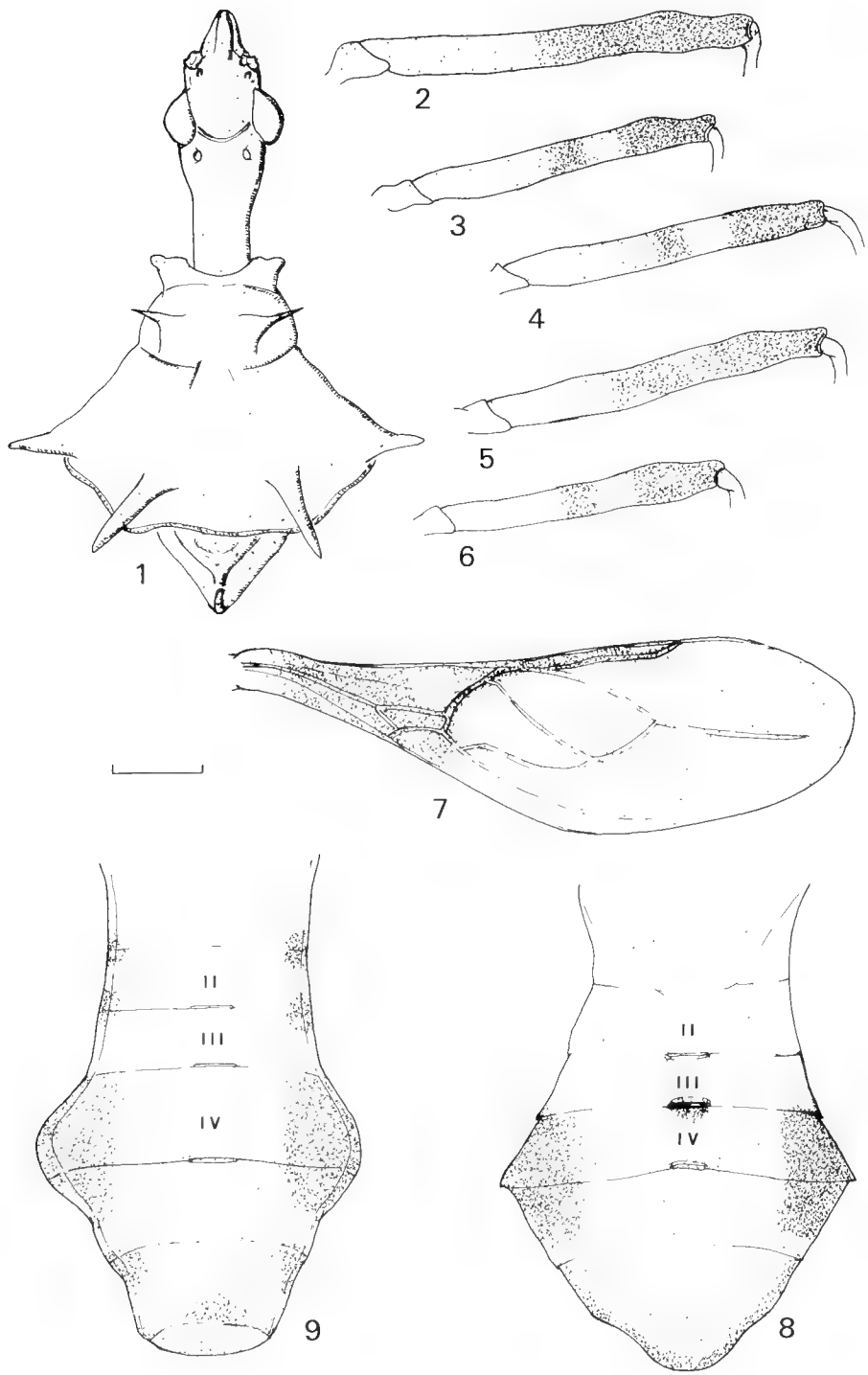
There is considerable variation in coloration in the type series. In some paratypes (e.g., Iron Range, 5–10 and 11–17 May 1968) most of the mid-femur is fuscous. The Northern Territory specimen is small (8.96) and narrow (2.10) and has fore- and mid-femora with narrow annular fuscous band at about midlength and about distal quarter uniformly fuscous (fig. 3).

→

Figures 1–3. *Gminatellus elegans* sp. nov. Holotype: 1, head, pronotum and scutellum, dorsal view; 2, fore-femur. Specimen from Radon Creek, N.T.: 3, fore-femur.

Figures 4, 5, 8. *Gminatellus fasciatus* sp.nov. Paratype male, Kuranda, Qld: 4, fore-femur; 8, abdomen, dorsal view. Specimen from West Normanby River, Qld: 5, fore-femur.

Figures 6, 7, 9. *Gminatellus maculatus* sp.nov. Paratype female: 6, fore-femur; 7, hemelytra; 9, abdomen, dorsal view. Abbreviations: II, III, IV, etc., abdominal segments. Scale line 1.0 mm.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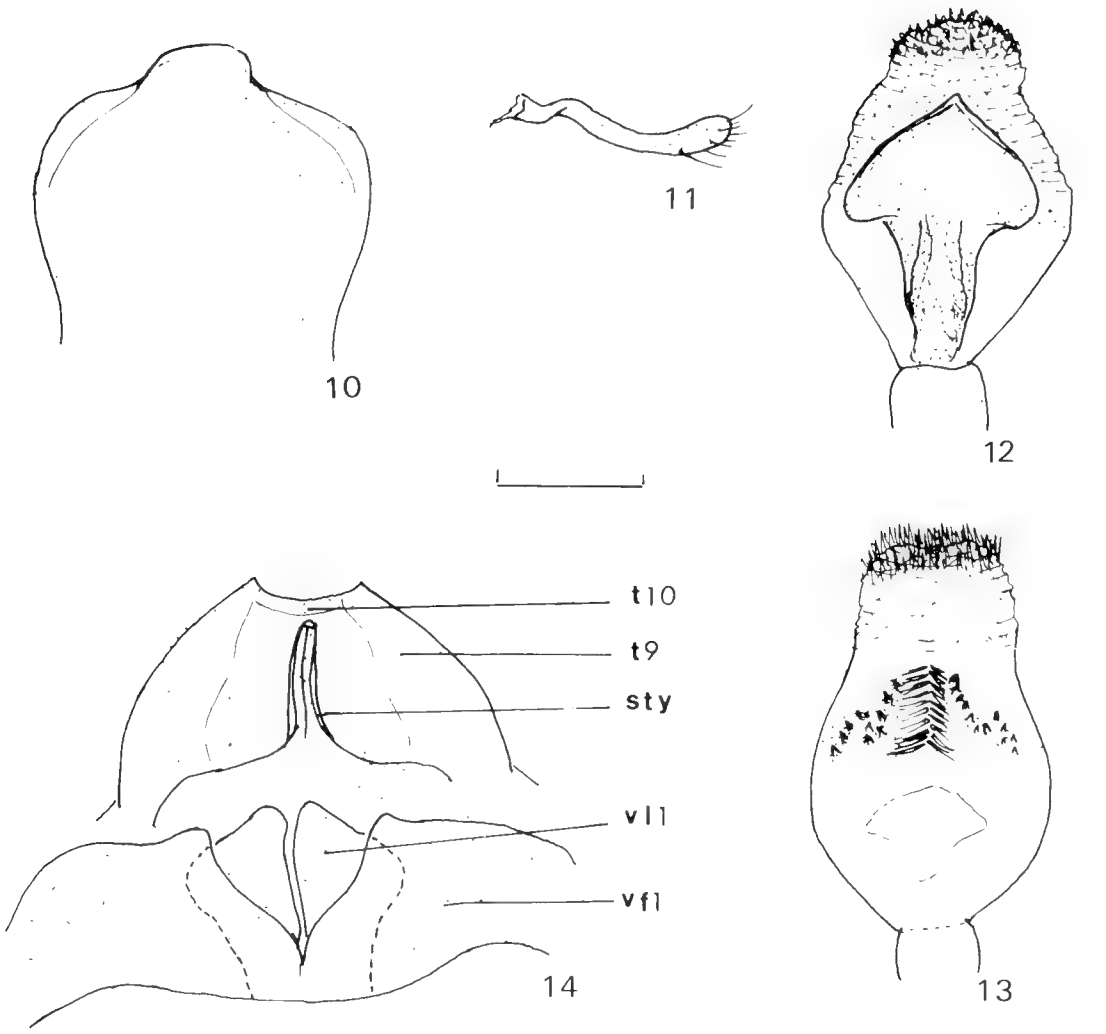

Figures 10–13. *Gminatellus elegans* sp. nov. Paratype male: 10, pygophore, dorsal view of posterior part; 11, right paramere, lateral view; 12, aedeagus, dorsal aspect; 13, same, ventral aspect.

Figure 14. *Gminatellus elegans* sp. nov. Paratype female genitalia, posterior view. Abbreviations: sty, styloids; t9, t10, tergites 9 and 10; vf1, first valvifer; vl1, first valvula. Scale line 0.5 mm.

Gminatellus fasciatus sp.nov.

Figures 4, 5, 8

Types. Holotype male, Kuranda, Queensland, 18 Sep 1955, J.G.Brooks, AM.

Paratypes. Queensland, same data as holotype (AM 1 male); Almaden, Chillagoe district, Jun–Sep 1929, W.D. Campbell, K60927 (AM 1 male, 1 female); West Normanby River, 40 mi (64 km) W of Cooktown, 5 May 1970, G.B. Monteith (UQIC 1 male, 1 female); same locality and collector, 7 May 1970 (UQIC 1 female).

Description. Ground colour dirty yellow, with the following fuscous: apex of labium, broad proximal, middle and distal areas of first, distal half of second, and third and fourth segments of antennae; distal quarter and narrow annular ring near middle of femora (fig. 4), and tibiae and tarsi; inner margin and distal third excluding apex of corium, basal area of membrane, and wings; broad lateral areas of visible abdominal terga IV and V, and narrow margin of VI, as in fig. 8.

Body 9.80 (10.22–11.48); maximum width 3.36 (2.94–3.65).

Head. Length 2.24 (2.24–2.45), width across eyes 1.10 (1.00–1.17), interocular space 0.53 (0.52–0.64), interocellar space 0.41 (0.41–0.53), eye–ocellar space 0.23 (0.19–0.23), eye length 0.49 (0.46–0.52), eye width 0.30 (0.23–0.30). Length of antennal segments: I, 3.49 (3.90–4.06); II, 1.14 (1.19–1.33); III, 1.06 (1.12–1.25); IV, strongly curved. Length of labial segments: I, 1.21 (1.25–1.33); II, 1.14 (1.17–1.19); III, 0.41 (0.38–0.55).

Thorax. Pronotum length 2.03 (2.10–2.45), width anterior margin 0.90 (0.98–1.05), maximum width 2.38 (2.45–2.80). Scutellum length 0.56 (0.59–0.81); width 0.90 (1.19–1.40). Length hemelytra 5.88 (6.44–7.42), length corium 4.20 (4.34–5.04). Width membrane 2.20 (2.10–2.66).

All other details as in *G. elegans.*

Etymology. Fascia (Latin) band or stripe, alludes to the fuscous bands on visible abdominal tergites IV and V.

Remarks. Gminatellus fasciatus may be readily distinguished from *G. elegans* by its conspicuous broad fuscous lateral bands on visible abdominal tergites IV and V (fig. 8).

The West Normanby River specimens exhibit considerable colour variations, particularly in having the distal half of the femora uniformly fuscous (fig. 5) and the postocular part of the head dorsally also lightly fuscous.

Gminatellus maculatus sp.nov.

Figures 6, 7, 9

Types. Holotype female, Clermont, Queensland, 29 Sep 1929, Dr K.K. Spence, K 62425, AM. Distal 3 segments of right and fourth segment of left antennae missing.

Paratypes. Same data as holotype (AM 3 females).

Description. Ground colour orange with brown tinge, with the following fuscous: most of head dorsally including eyes, broad proximal, middle and distal areas of first, second and part of third antennal segments; apices of pronotal spines, small area near base of spines on disc of anterior lobe; distal quarter and small indistinct annular band near middle of femora, in addition mid- and hind-femora with an additional indistinct proximal band, and tibia and tarsi; most of corium except for a circular white spot near middle (fig. 7); dorsum of abdomen (fig. 9), contiguous subventral areas of visible segments IV and V, connexiva; abdominal venter irregularly lightly fuscous except for sutural areas and small circular spots which are pale.

Body shiny, without conspicuous hairs

Measurements are of holotype female.

Body 9.95; maximum width 2.80.

Head: Length 2.10, width across eyes 1.10, interocular space 0.57, interocellar space 0.45, eye–ocellar space 0.30, eye length 0.52, eye width 0.34. Length of antennal segments: I, 3.29; II, 0.98; III, 1.19; IV, strongly curved. Labium just reaching to anterior third of prosternal groove, length of segments: I, 1.32; II, 0.95; III, 0.41.

Thorax. Pronotum length 2.03, width anterior margin 0.98, width posterior margin 2.38. Scutellum apex less acutely pointed than in other species, length 0.63, width 1.05. Hemelytra well exceeding abdomen, length 6.30, corium with conspicuous circular white wax covered area (fig. 7), length 4.40, width membrane 2.10.

Abdomen. Lateral margins conspicuously explanately produced (fig. 9).

Genitalia. Male unavailable. Female as in *G. elegans.*

Etymology. Macula (Latin) spot or mark, alludes to the white circular spot on the corium.

Remarks. *Gminatellus maculatus* can be readily distinguished from all other species of the genus by the white circular wax covered spot on the corium, and the conspicuously explanate margins on the visible abdominal terga IV and V.

Acknowledgements

I thank the curators of the above-mentioned institutions for the loan of the material, and Dr G. B. Monteith for commenting on the manuscript.

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A REVISION OF THE TEMPERATE AUSTRALIAN GOBIID (GOBIOIDEI) FISH GENUS *TASMANOGOBIUS* WITH A COMMENT ON THE GENUS *KIMBERLEYELEOTRIS*

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Abstract

Hoese, D.F., 1991. A revision of the temperate Australian gobiid (Gobioidei) fish genus *Tasmanogobius* with a comment on the genus *Kimberleyeleotris*. *Memoirs of the Museum of Victoria* 52: 361–376.

Two new species of the genus *Tasmanogobius* are described from Tasmania, Victoria and South Australia. The type species, *T. lordi*, known only from Tasmania, is redescribed. The three species are separated on the basis of fin-ray counts, colour and scale coverage. The species live in estuarine and sometimes freshwater environments, typically over mud or sand. At least one species occupies burrows. One species shows considerable variability in coloration and meristic features.

Introduction

Only a small percentage of gobioid fishes occurs in temperate regions. The largest concentration of gobioid genera, restricted to temperate regions, occurs in the north Pacific from California to Japan, Korea and China, with about 20 genera (of 270 recognised genera within the suborder) confined to this region. Few genera are restricted to temperate regions of South America and northern Europe. In Australia only three genera (*Nesogobius*, *Tasmanogobius* and the eleotridid *Thalasseleotris*) have their greatest concentration of species in extreme southern Australia (Victoria, Tasmania, South Australia and south-western Western Australia). Although about 30 of the 400 gobioid fishes known from Australia occur in this region, over half belong to widespread tropical Indo-Pacific genera, such as *Favonigobius* and *Pseudogobius*. These tropical genera have only one or two species each occurring in the region, although most of these species are restricted to temperate Australia.

The three species of *Tasmanogobius* are known only from Tasmania, Victoria and South Australia. Of the nine known species of *Nesogobius*, all occur in Victoria and only two range to New South Wales and Western Australia. Relationships of *Tasmanogobius* are uncertain, but the genus is superficially similar to the sympatric genus *Nesogobius*, which differs from the former in having 13 segmented caudal rays.

Hoese and Allen (1987) illustrated the papilla pattern of *Tasmanogobius lordi*. The captions had been mixed (incorrectly labelled *Kimberleyeleotris hutchinsi*). The correct figure for that species is illustrated here (Fig. 1). It should also be noted that the genus was incorrectly spelled as *Kimberleotris* on page 36 of the same publication.

Methods

Counts and measurements largely follow those given by Hubbs and Lagler (1958). The longitudinal scale count was taken from behind the pectoral base to the end of the caudal peduncle and is a count of scale rows, rather than a straight line count since the scales are irregularly developed anteriorly. In *Tasmanogobius* the anal spine and spine in the second dorsal fin may be present or absent. Total elements in these fins refers to rays and spine (if present). Vertebral counts were determined from radiographs and cleared and stained material and include the urostyle. In descriptions, data are presented as the count followed by its frequency in parentheses. The osteology was studied from trypsin-prepared cleared material stained with alizarin. Much of the material was in poor condition and data are given only from those specimens where accurate data could be obtained. The papilla patterns were drawn from well preserved material and cleared and stained material, using a camera lucida for basic drawings. The patterns are a composite of several specimens, since all papillae are rarely discernible on a single specimen. All fish sizes refer to standard length (SL). Sex was determined from the shape of the urogenital papilla.

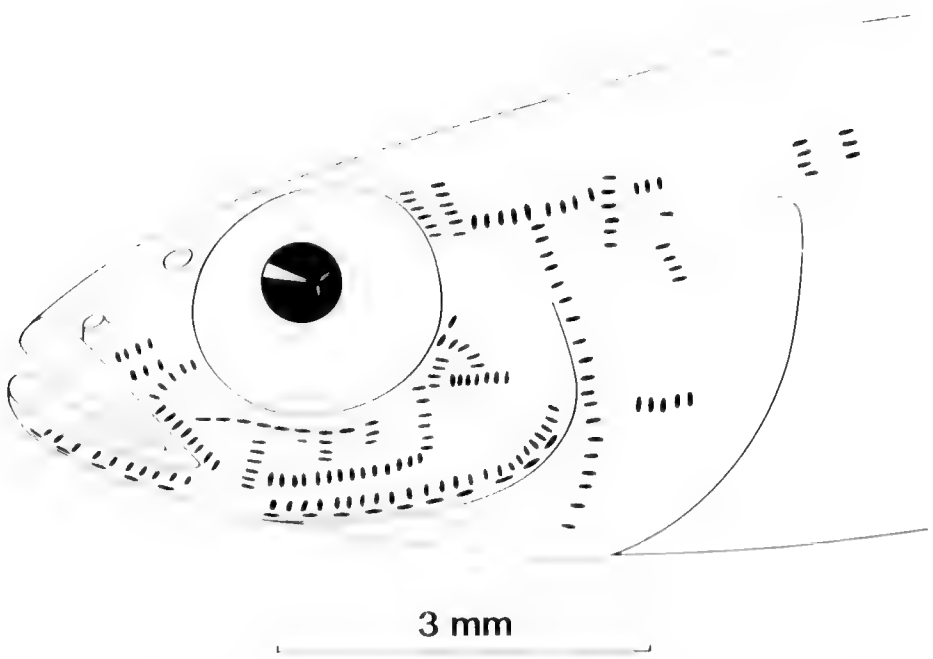

Figure 1. Head papilla pattern of *Kimberleyeleotris hutchinsi*, based on holotype and several paratypes.

The pterygiophore formula follows Birdsong (1975). The papilla pattern terminology follows Hoese (1983). The type of lines is designated by two letters, the first giving the orientation of the line (V = vertical, L = longitudinal, T = transverse) and the second the orientation of the papilla axes in relation to the axis of the line (L = axis along the papilla line, T = axis at right angles to axis of line).

Tasmanogobius

Diagnosis. General. Head more-or-less rounded. Snout rounded in dorsal view; steep in side view. Gill opening restricted to pectoral base. Rakers on inner face of first arch and other arches unossified, short and papillate. Pelvic fins fused into a large cup-shaped disc. Tongue tip truncate to slightly emarginate. Head canals, when present, fused between eyes. No anterior interorbital pore. Scales on sides of belly vertically elongate. Second dorsal and anal fins long based, much longer than caudal peduncle length. First dorsal spines VI–VIII; second dorsal elements 0–1, 13–16; anal elements 0–1, 12–16; pectoral fin-rays 16–21; segmented caudal rays 17; vertebrae 26–32.

Osteology. No bony connection between symplectic and preoperculum; metapterygoid elongate without ventral process extending over quadrate; basihyal broad and spatulate; a single epural; neural arches reduced, without a posterior connection to centra (Fig. 2) in *T. lordi* and juveniles of other species, posterior connection of neural arch to central, when developed, usually confined to precaudal vertebrae; 2 pterygiophores precede first haemal arch.

Head Papilla Pattern. (Figs 3, 5 and 8). Cheek with 5 (in *T. lasti* and *T. gloveri*) or 6 (in *T. lordi*) VT lines extending ventrally from eye; second and third lines not reaching dorsally to eye; first, fourth and fifth (in *T. lasti* and *T. gloveri*) or fifth and sixth (in *T. lordi*) reaching eye; last 1 or 2 lines incomplete, interrupted by upper longitudinal (LT) line. Preopercular-mandibular series composed of an inner LL line and an outer LT line, both normally interrupted just below posterior end of jaws. Behind eye 2 transverse (TT) lines (in *T. lasti* and *T. gloveri*) or 1 (in *T. gloveri*); 2 longitudinal (LT) lines dorso-medial to transverse lines. Anteriorly on operculum a VT line dorsally disjunct from ventral VT line. LT line above dorsal margin of preoperculum and operculum, interrupted by 2 short transverse lines; short LL line developed above posteriodorsal margin of operculum.

Remarks. Vertically elongate scales and reduc-

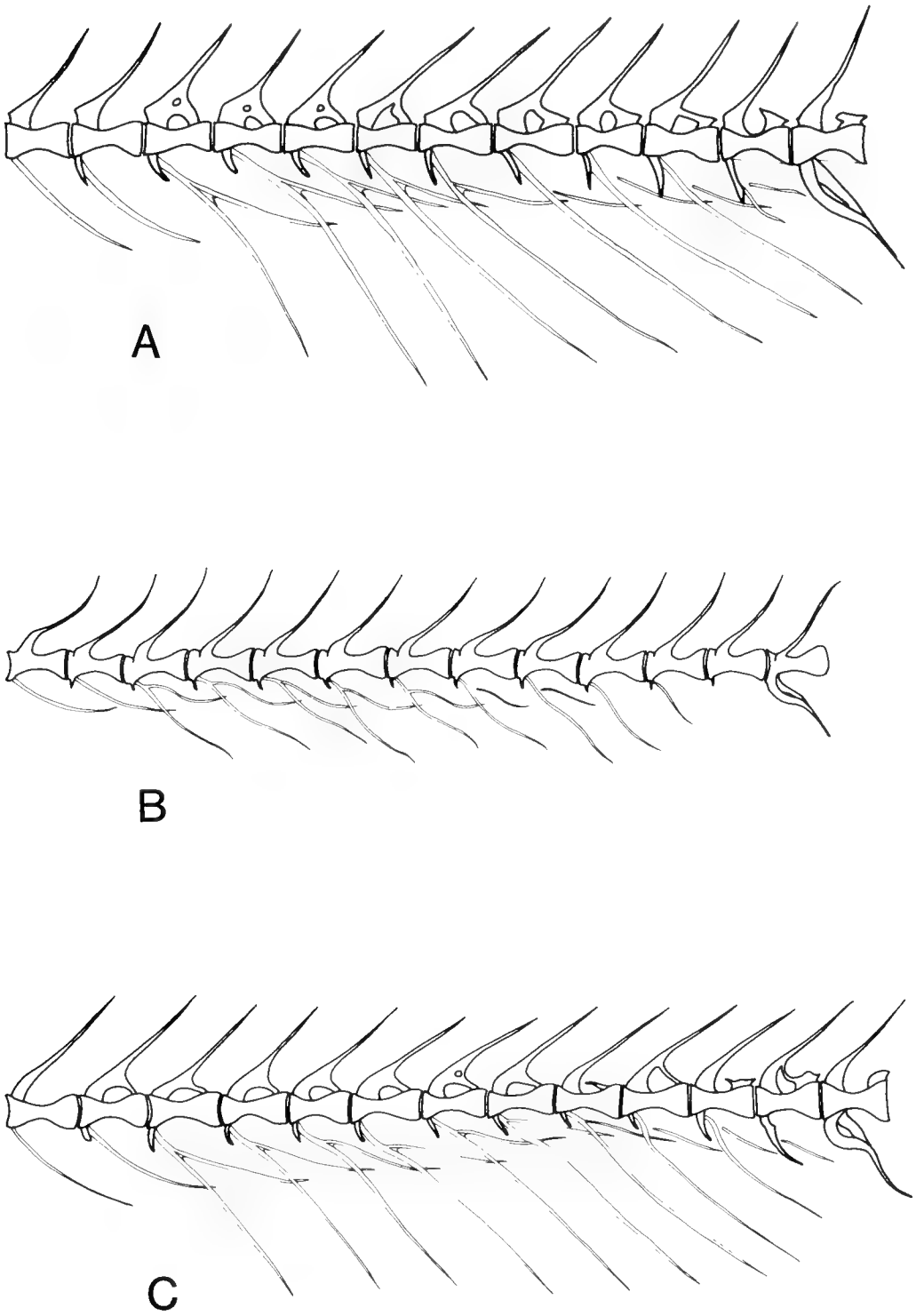

Figure 2. Section of vertebral column of 3 species of *Tasmanogobius*, based on cleared and stained specimens. A = *T. gloveri*, 26 mm SL; B = *T. lordi*, 27 mm SL; C = *T. lasti*, 21 mm SL.

tion of neural arches are also common to at least some species of *Nesogobius*.

Several meristic features of the species are given in Tables 1–5. Sexual dimorphism was found only in the shape of the urogenital papilla. In males the papilla is slender and elongate, and in females it is short and rounded.

Key to species of Tasmanogobius

1. First dorsal fin VI; pectoral rays 19–21; total anal elements usually 12–13; body with a whitish longitudinal stripe, interrupted by short vertical bars ..... *T. gloveri* sp. nov.
— First dorsal usually VII–VIII; pectoral rays 16–20 (rarely 20); total anal elements usually 14–15; body without stripe, but with thin vertical bars 2
2. Head pores present; first dorsal usually VIII; second dorsal and anal spine frequently present; body extensively scaled, scales usually continuous, sometimes broken into a patch behind pectoral fin and a second patch on body; posterior scales extending forward at least to just behind second dorsal origin ..... *T. lasti* sp. nov.
— No head pores; first dorsal usually VII; second dorsal and anal spine rarely present; scales confined to a patch behind pectoral fin and a patch on caudal peduncle ..... *T. lordi*

Tasmanogobius gloveri sp. nov.

Figures 3 and 4

Tasmanogobius sp. 1.—Last, Scott and Talbot, 1983: 453, fig. 30.132 (Tasmania and South Australia).

Material examined. Holotype. South Australia, American River, Kangaroo Island, D. Hoese and party, 8 and 10 Mar 1978 (AMS I.20179-025, 34 mm SL).

Paratypes. South Australia. Type locality, AMS I.20179-003, 14(21–34) and AMS I.20179-026, 2(23–26), cleared and stained. Pelican Lagoon, Kangaroo Island, SAM F.5082, 1(34), H.M. Cooper, Apr 1954; SAM F.5083, 1(32), H.M. Cooper, 4 Aug 1957; SAM F.5084, 1(40), H.M. Cooper; SAM F.5085, 4(32–42), H.M. Cooper, 13–18 Aug 1958; SAM F.5086, 6(33–44), H.M Cooper, 13 Aug 1958; SAM F.5087, 13(24–34), H.M. Cooper, 14 Apr 1959.

Tasmania. Parsons Bay, AMS I.28791-001, 2(40–40), P. Last, Nov 1978. D'Encastreaux Channel, NMV A.7770, 1(39), P. Last, 1974. Greens Beach to Kelso, QVM 439, 5(15–22), R. Green, 28 Jan 1967. Green Island, TM D.2052–D.2053, 2(28-29), D.F. Turner, 21 Jul 1948.

Victoria. Crib Point, Western Port, AMS I.19783-001, 1(34), A. Robertson, 30 May 1975.

Diagnosis. First dorsal fin usually VI. Vertebrae usually 12 + 15. Pectoral rays usually 19–21. No head pores. Body partly scaled with cycloid scales; no scales ventrally on belly, narrow area immediately behind pectoral base and area before a line from behind middle of pectoral base to below posterior end of first dorsal fin; scales on sides of belly vertically elongate. Gill rakers on outer face of first arch triangular, raker at angle of first gill arch slightly shorter than upper gill filaments. First dorsal fin long based, with membrane connecting to base of second dorsal fin origin. Body moderately robust, depth at anal origin 14.4–18% SL; depth at pelvic origin 16.2–20.5% SL. Body light brown with a whitish midlateral stripe, broken by short vertical brown bars. Five vertical (VT) papilla lines on cheek.

Description. First dorsal fin VI(46), pterygiophore formula 3(12210) in 9 specimens. Second dorsal fin with 13–15 elements, (usually 14), all rays segmented. Anal fin with 12–14 elements (usually 13), all rays segmented. Longitudinal scale count 38–47. Gill rakers on outer face of first arch 1–4 + 6–7 = 5–10; lower rakers 6(3), 7(1); total rakers 8(1), 9(1), 10(2). Segmented caudal rays 17(45). Branched caudal rays 12–15, usually 13–15; upper unsegmented caudal rays 7(2), 8(3), 9(4), 10(2); lower unsegmented caudal rays 8(2), 9(3), 10(6). Vertebrae 11 + 15 (20).

Head length 26.5–34.0% SL. Eye about equal to snout in adult. Anterior nostril at end of short tube, about midway between upper margin of upper lip and eye, about 2 nostril diameters above upper lip. Posterior nostril with raised rim, immediately before anterior margin of eye and above anterior nostril. Gill opening restricted to pectoral base. Teeth in upper jaw conical and close-set in outer row, 1–2 inner rows of smaller teeth anteriorly; lower jaw teeth

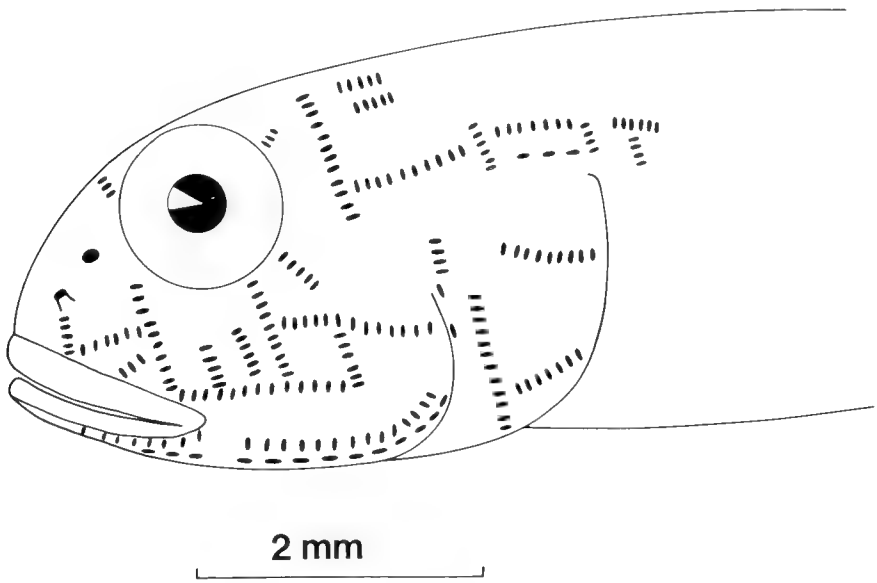

Figure 3. Head papilla pattern of *Tasmanogobius gloveri*, based on holotype and several paratypes.

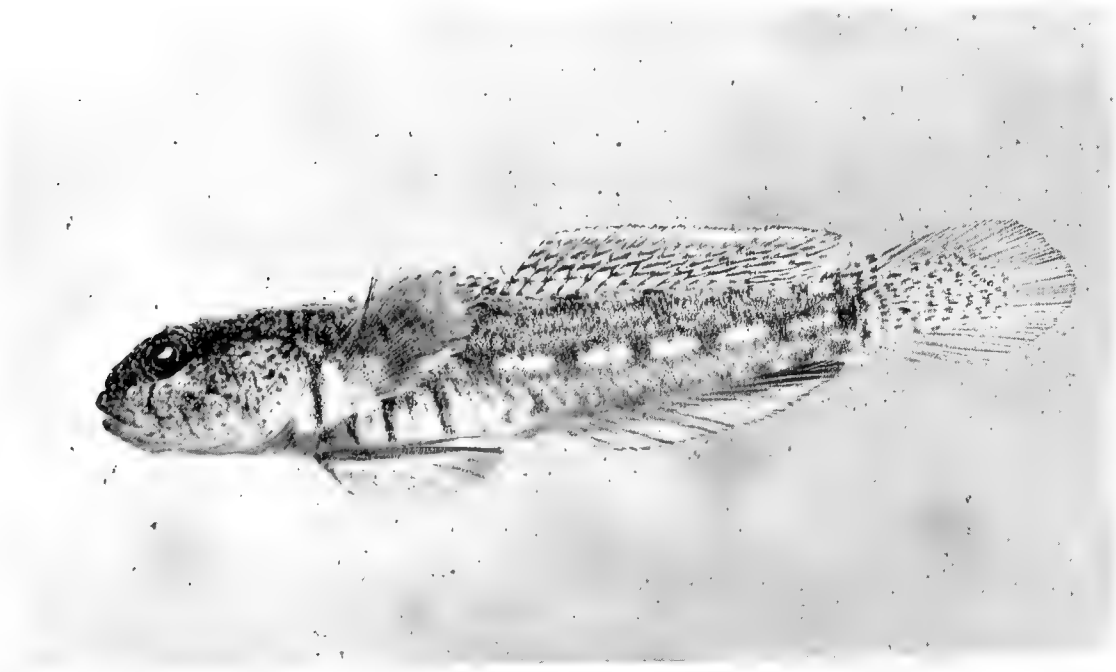

Figure 4. Holotype of *Tasmanogobius gloveri*, AMS I.20179-025, 34 mm SL.

similar to upper jaw teeth, but with outer row teeth more wide-set. Mental frenum low and rounded. Mouth small and oblique; reaching to below middle of eye in adult; jaws forming an angle of 20–25° with body axis; upper margin of upper jaw in line with or below lower margin of eye. Tongue tip emarginate. Upper part of gill arches with numerous small fleshy bumps extending onto pharyngeals; gill rakers on outer face of first arch with slender ossified rod anter-

iorly, with slightly expanded posterior fleshy section; rakers curving into oral cavity; rakers slightly shorter than filament length. Body scales ctenoid. Pectoral base, prepelvic area and midbelly naked. First dorsal fin with low rounded margin. Pectoral fin with rounded margin, reaching to point below or just beyond second dorsal origin. Pelvic fins fused to form large cup-shaped disc, reaching anus.

Colour of fresh material. Head and body whitish to grey. Head with scattered white flecks and thin grey lines and minute spots. Often prominent black stripe extending posteriorly from mideye to caudal peduncle above midside. Pectoral base with distinct vertical brown or grey bar. Body with 3–5 thin vertical grey to brown bars below pectoral fin, ventrally on belly. Midline of body with distinct subcutaneous white stripe, bordered by thin grey to brown margins; white stripe interrupted by thin vertical gray to brown bars; first below second dorsal origin, second below anterior part of second dorsal fin, third below middle of second dorsal fin, fourth near end of second dorsal fin, fifth on middle of caudal peduncle and last at end of caudal peduncle. Two thin horizontal grey lines above midside. Dorsal fins transparent to translucent with thin black distal margin and broader submarginal white stripe; below white stripe series of elongate black spots forming 4–5 dark longitudinal lines, alternating with narrow white stripes. Caudal fin translucent to grey with scattered small black spots centrally and basally. Anal fin largely white, often with grey stripe basally, expanding onto whole fin posteriorly; margin black to grey. Pectoral and pelvic fins translucent with scattered minute white spots.

Colour in alcohol as in fresh material, but head, body and fins becoming brown and opaque.

Distribution and ecology. *Tasmanogobius glovcri* occurs in estuarine and marine muddy environments from Kangaroo Island, Victoria and Tasmania. The species was observed in burrows over soft mud.

Etymology. For J. Glover, Curator of Fishes at the South Australian Museum.

Tasmanogobius lasti sp. nov.

Figures 5–7

Tasmanogobius sp. 2. –Last, Scott and Talbot, 1983: 454, fig. 30.133 (Tasmania and South Australia).

Material examined. Holotype. Victoria, Princetown, G. Backhouse, 1981 (AMS I.22950-001, 28.7 mm SL).

Paratypes. South Australia. Vivonne Bay, Kangaroo Island, AMS I.20158–002, 4(19–24), D. Hoese and party, 2 Mar 1978; AMS I.20159–004, 1(26), D. Hoese and party, 2 Mar 1978; Southwest River, Kangaroo Island, AMS I.20170–005, 4(19–24), D. Hoese and party, 6 Mar 1978.

Tasmania. Southern region, AMS I.28971–001, 1(27), cleared and stained, P. Last. Browns River estuary, AMS I.17546–004, 3(22–28), D. Hoese and W. Ivantsoff, 30 Nov 1972. Gawler estuary, AMS I.22535–001, 70(16–28) and AMS I.22535–007, 9(16–21), cleared and stained), D. Hoese and G. Allen, 19 Feb 1981. Moulting Lagoon, AMS I.22563–001, 2(36–40), P. Last, 5 Jul, Camerons Inlet, Flinders Island, AMS I.22567–001, 2(38–39), P. Last, 25 Jun 1978. Arthurs River, AMS I.22568–001, 3(40–41), P. Last, Oct 1979. Nierinna Creek, AMS I.22570–001, 1(38), T. Walker, 26 Aug 1974. Huon River, AMS I.28794–001, 1(31), R. Buttermore, 19 Jul 1977. Duck River, AMS I.28795–001, 2(26–27), P. Last, 17 Feb 1978. Big Waterhouse Lagoon, AMS I.28796–001, 3(20–25), R. Mawbey, 2 May 1979. Patriachs Inlet, Flinders Island, AMS I.28797–001, 2(22–35), P. Last, 5 Feb 1977; AMS I.28798–001, 9(22–28), P. Last, 29 Jan 1978. Yellow Rock River, King Island, AMS I.28799–001, 1(32), P. Last, 9 Aug 1978; AMS I.28800–001, 3(30–39), P. Last, 23 Feb 1978. Andersons Creek, Tamar River, AMS I.28870–001, 12(12–27), Andersons Creek, 23 Apr 1975; NTM S.12580–001, 10(18–23); QVM 440, 29(17–26), 23 Apr 1975; SAM F.6676, 10(17–25), 23 Apr 1975; WAM P.30008–001, 10(20–27), 23 Apr 1975. Davey River, CSIRO H1982–01, 1(33), P. Last, Mar 1979. Derwent River, CSIRO H1983–01–02, 2(28–33), P. Last, 30 May 1978. Opposite Berriedale Reserve, Derwent River, TM D.2057, 1(25), 7 Dec 1960.

Victoria. Hollands Landing, AMS I.16975–010, 1(26), D. Hoese, 2 Mar 1972. Bruthen Creek estuary, south-east Gippsland, AMS I.22944–002, 19(30–39), J. Beumer, 3–9 Aug 1979; AMS I.22946–005, 2(32–36), J. Beumer, 12 Aug 1979; NMV A.3255, 2(31–33), J. Beumer, 20 Jul 1979; NMV A.3256, 20(22–41), J. Beumer, 5–19 Jul 1979. Princetown, AMS I.22950–001, 8(26–32), G. Backhouse, 1981. Lower Barwon River, NMV A.7691, 1(21), Victorian Fisheries and Wildlife Department, 3 Jul 1987. Hobsons Bay, Port Phillip, NMV A.3253, 1(31), J. Watson, 1 May 1972. Lake Monibeong, NMV A.3568, 17(25–28), Victorian Fisheries and Wildlife Department, 25 Mar 1980. Barham River, NMV A.3569, 5(34–36), Victorian Fisheries and Wildlife Department, 15 Jun 1976.

Non-type material. Tasmania. Big Lagoon, AMS I.28793–001, 2(23–30), Big Lagoon, P. Gaymer, 15 Apr 1973.

Victoria. Estuary at Petersborough, AMS I.16987–009, 1(33), D. Hoese and W. Congleton, 21 Mar 1972. Barham River, NMV A.3567, 1(29). Glenelg River, NMV A.3583, 1(31), J. Kudenov. Greens Beach, QVM 1972/5/454, 1(33), R.H. Green, 11 Nov 1963.

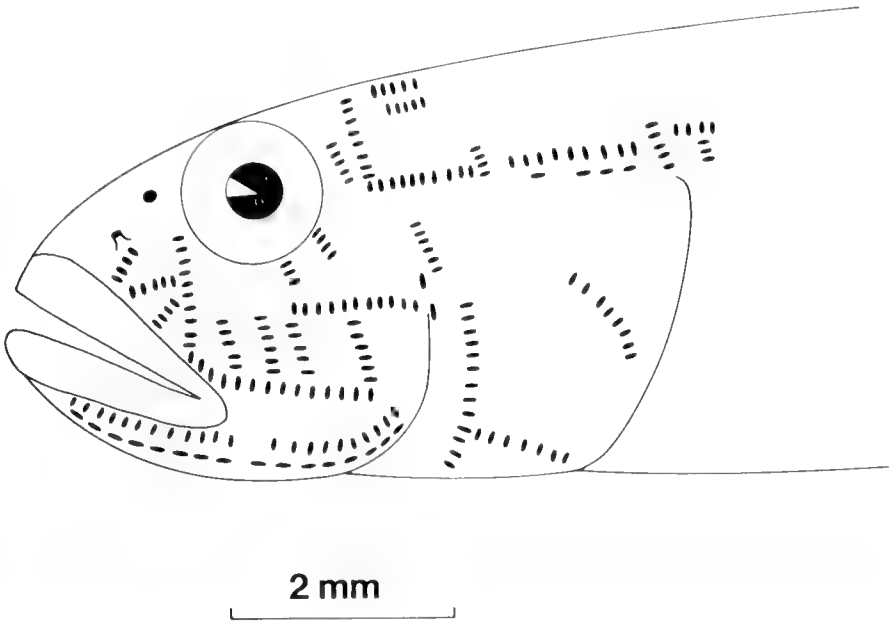

Figure 5. Head papilla pattern of *Tasmanogobius lasti*, based on holotype and several paratypes.

Figure 6. Holotype of *Tasmanogobius lasti*, AMS I.22950–002, 28.7 mm SL.

Diagnosis. First dorsal fin usually VIII. Vertebrae usually 12 + 19. Pectoral rays usually 17–18. At least 5 lateralis system open head pores. Body partly scaled; vertically elongate scales behind pectoral base on sides of belly usually continuous with posterior body scales; posterior scale patch tapering anteriorly, always reaching well forward of middle of second dorsal fin; rest of body naked. Gill rakers short, outer raker at angle of first gill arch much shorter than upper gill filaments. First dorsal fin long based, membrane from end of first dorsal fin reaching near, but not to second dorsal origin. Body slender, depth at anal origin 13.5–15% SL; depth at pelvic origin 15.3–16.4% SL. Body light brown with a series of dark spots, usually vertically elongated on midsides; usually with a small black median transverse bar or spot just before first dorsal fin. Five vertical (VT) papilla cheek lines.

Description. First dorsal fin VII(9), VIII(90), IX(1); pterygiophore formula variable, 3(122110) in 2 specimens, 3(1221100) in 1, 3(1221101) in 1, 3(1221110) in 15, 3(12211110) in 1, spine often missing from last or penultimate pterygiophore. Second dorsal with 13–16 elements, (usually 14–15), typically with first ray

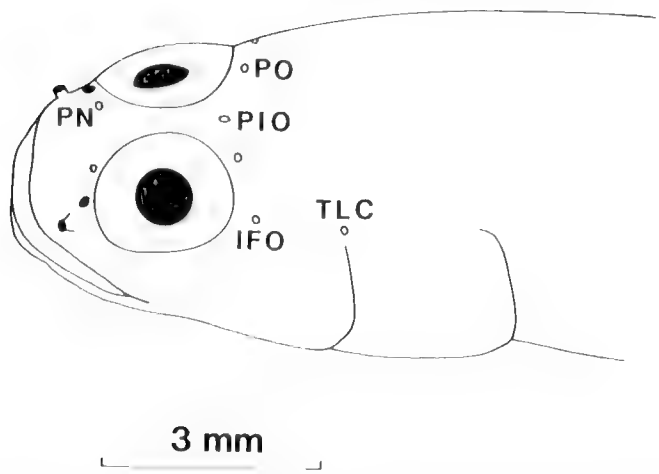

Figure 7. Composite head pore pattern in *Tasmanogobius lasti*. PN = posterior nasal pore, PIO = posterior interorbital pore, PO = postorbital pore, IFO = infraorbital pore, TLC = terminal lateral canal pore.

unsegmented. Anal ray elements 12–16 (usually 14), typically with first ray unsegmented. Longitudinal scale count 29–47. Gill rakers on outer face of first arch 1–3 + 4–7 = 5–10; lower rakers 4(1), 5(7), 6(5), 7(2); total rakers 5(1), 6(1), 7(2), 8(5), 9(2), 10(3). Segmented caudal rays 16(2), 17(108); branched caudal rays 13–17, usually 14–15; upper unsegmented caudal rays 8(5), 9(11), 10(4); lower unsegmented caudal rays 7(2), 8(8), 9(9), 10(1). Vertebrae 12 + 18(11), 12 + 19(67), 12 + 20(1), 13 + 18(1), 13 + 19(2).

Head length 25.7–28.1% SL. Eye about equal to snout in adult. Anterior nostril at end of short tube, about midway between upper margin of upper lip and eye, about 2 nostril diameters above upper lip. Posterior nostril with raised rim, immediately before anterior margin of eye and above and behind anterior nostril. Gill opening restricted to pectoral base. Teeth in upper jaw conical, outer row teeth close-set; second row of smaller teeth anteriorly; lower jaw teeth similar to upper jaw teeth, but with outer row teeth more wide-set. Mental frenum indistinct. Mouth small and oblique; reaching to below middle of eye in male and below anterior quarter of pupil in female; jaws forming an angle of 35-40° with body axis; upper margin of upper jaw in line with middle of eye to lower quarter of eye. Tongue tip truncate to slightly emarginate. Upper part of gill arches with numerous small fleshy bumps extending onto pharyngeals; gill rakers on outer face of first arch with slender ossified rod anteriorly, and with slightly expanded posterior fleshy section; rakers much shorter than filament length (about one-third length). Body scales largely ctenoid. Pectoral base, prepelvic area and midline of belly naked; posterior portion of body completely scaled; anteriorly scale coverage becoming reduced, with naked patch beginning below and near front of second dorsal fin, with scale coverage narrowest between dorsal fins and below posterior end of first dorsal fin, coverage broadening anteriorly near pectoral insertion; belly naked or sometimes scaled on sides. First dorsal fin with low rounded margin. Pectoral fin with rounded margin, reaching to a point below middle of first dorsal fin. Pelvic fins fused to form large cup-shaped disc reaching to below point just beyond middle of first dorsal fin, well short of anus.

Colour of fresh material from Kangaroo Island. Head and body translucent light brown. Head with numerous scattered melanophores; thin black bar from ventral margin of eye to posterior end of jaws. A diffuse grey spot behind eye and similar diffuse spot at dorsoposterior margin of operculum; cranium behind eye with dense subcutaneous concentration of melanophores. Body with scattered, irregularly shaped black spots dorsally; 2–3 vertical black bars below first dorsal fin, extending onto sides of belly; midside with 4 more-or-less rectangular large black spots, first below second dorsal origin, second below middle of second dorsal fin, third below posterior end of second dorsal fin and fourth at posterior end of caudal peduncle; smaller, vertically elongate or rounded black spot, midway between each pair of rectangular spots; belly white to silvery. Pectoral

base light brown to yellow, with small black spot dorsally near base of fin rays. Fins transparent. First dorsal fin with small dark spots forming 2–3 horizontal black stripes; second dorsal with dark spots forming 3–5 oblique stripes; caudal fin with 2–4 wavy black bars; anal fin without pigment; pelvic and pectoral fin with scattered black flecks.

Colour in alcohol similar to fresh coloration, except that dorsal irregularly shaped spots become faint or obscure; back often with scattered dense concentrations of melanophores. The more-or-less rectangular spots on side often oval or vertically elongate. Intensity of dark markings variable.

Variation. Tasmanogobius lasti shows considerable variation in several characteristics. Females reach and tend to average a larger size than males (Table 4). The largest male examined is 36 mm SL, while the largest female is 41 mm SL. Males average 23.5 mm, with 31 of the 37 examined smaller than 29 mm SL, while females average 29 mm SL, with 33 of the 63 examined larger than 27 mm SL. The greater number of females is probably related to sampling bias, since collectors and seine nets generally select for largest individuals. Males have intense black pigment, usually forming a black bar between last 2–3 dorsal spines. The first dorsal is pale to grey posteriorly in females.

Head pores also vary considerably. Juveniles of other gobioid species often have reduced pore patterns, but the variation is high in adults of this species. The following discussion is based only on specimens greater than 24 mm SL. A composite head pore pattern is shown in Figure 7. In the most common pattern, individuals have a posterior nasal pore on each side of the snout just above the posterior nostril, a median posterior interorbital pore just behind the eyes and an infraorbital pore behind each eye. This pattern was found in 24 of 50 specimens examined. The pattern was found in almost all specimens below 24 mm SL. In the other 26 adult specimens the typical pores are sometimes absent, or more frequently extra pores were found (Table 7). In two specimens the posterior interorbital pore is absent. In some individuals a lateral canal extends from the infraorbital pore above the preoperculum, ending in a terminal lateral canal pore. In others the lateral canal is restricted to a short tube above the preoperculum, with a pore at each end (not shown in Fig. 7). In two individuals there is a postorbital pore behind the eye above the infraorbital pore. Of the 26 variant specimens, 15 are asymmetrical, with different number of pores of the two sides of the head.

This species differs from other species of *Tasmanogobius* in frequently having a distinct anal spine and a spine at the beginning of the second dorsal fin. About 80–83% of specimens have the spines (Tables 1, 2).

The scale pattern also varies considerably. In most individuals, the body scales extend from behind the pectoral base to the caudal peduncle. In juveniles, below 20 mm SL and some adults, the scales on the sides of the belly are isolated into a separate patch from the posterior body scales.

Geographical variation is also apparent. Analysis of variance was carried out on 6 populations (5 for scale counts): Kangaroo Island, South Australia; Bruthen Creek, Victoria; Lake Monibeong, Victoria; Flinders Island, Bass Strait; Tamar River, Tasmania and Gawler Estuary, Tasmania. Specimens from Lake Monibeong, Victoria, are unusual in having the scales reduced in size and in having less extensive scale coverage, with the posterior scale patch extending forward to just behind the second dorsal origin, and an extensive naked area below the anterior half of the first dorsal fin and a similar naked patch above the anterior two-thirds of the anal fin. The anterior scale patch has a few non-imbricate scales. Most scales are missing in the specimens, preventing accurate scale counts to be made. All specimens have large dermal parasite cysts and the scale pattern may not be normal. The scales on the caudal peduncle in this population are approximately half the height of scales in specimens from Kangaroo Island. Specimens from Kangaroo Island have the largest scales, hence the lowest longitudinal scale counts (Table 4). Analysis of variance comparing scale counts of the five specific localities, indicated that specimens from Kangaroo Island differed significantly from specimens from these other localities ($P < 0.001$). Comparison of other features gave mixed results. Second dorsal-ray counts (Table 1) showed significant geographical variation ($p < 0.05$), but with no single population being significantly different from any other, although the lowest counts were found in the few specimens from Kangaroo Island. No significant differences were noted in anal ray counts (Table 2). Pectoral ray counts also indicated significant geographical variation ($p < 0.05$), with Flinders Island specimens averaging highest counts and Kangaroo Island the lowest. Branched caudal ray counts also showed significant geographical variation ($p < 0.01$),

with Flinders Island specimens averaging significantly higher counts than other populations, with the exception of Lake Monibeong and Kangaroo Island.

While there was some variability in the meristic features for various populations the most distinctive population was that of Flinders Island. Specimens from Flinders Island averaged higher branched caudal-ray and pectoral-ray counts (Tables 3, 5). Similarly about half of the specimens from Flinders Island had anal and second dorsal spines. In most other populations the spines were present in about 80–90% of the specimens. However, about half the specimens from Kangaroo Island also had the spines.

Distribution. *Tasmanogobius lasti* is known from estuarine and muddy marine areas from Kangaroo Island, South Australia, Victoria and throughout Tasmania.

Etymology. For Peter Last, CSIRO Division of Fisheries, Hobart, who supplied much of the Tasmanian material of this species.

Remarks. Although superficially similar to *T. lordi*, the species differs in several features in addition to those given in the key. For example *T. lasti* is deeper bodied and has fewer VT cheek papilla lines. Although it is possible that more than one species is included here, the high variability within populations suggests a single highly variable species.

Tasmanogobius lordi Scott, 1935

Figures 8 and 9

Tasmanogobius lordi Scott, 1935: 56, figs 1, 2, pl. 4 fig. 2 (type locality: mouth of Leven River, Tasmania).

Material examined. Tasmania. Rubicon River, AMS I.28970–002, 7(26–31) and AMS I.28970–002, 4(25–27), cleared and stained. Duck River, AMS I.22561–001, 2(27–28). Inglis River, AMS I.22564–001, 3(25–29). Rubicon River, AMS I.27505–001, 27(25–29); TM D.2054–2056, 3(27–28). Forth River, AMS I.28792–001, 1(30). Greens Beach to Kelso, QVM 1972/5/421B, 1(28). Greens Beach, QVM 1972/5/488C, 2(27–28); QVM 1972/5/695B, 1(27).

Diagnosis. First dorsal fin usually VII. Vertebrae usually 12 + 18. Pectoral rays usually 18–19. No head pores. Body partly scaled; small patch of vertically elongate scales behind pectoral base on sides of belly and isolated patch of few scales on caudal peduncle, sometimes extending forward in narrow wedge to under end of second dorsal fin; rest of body naked. Gill rakers short, outer raker at angle of first gill arch shorter than upper gill filaments. First dorsal fin short based,

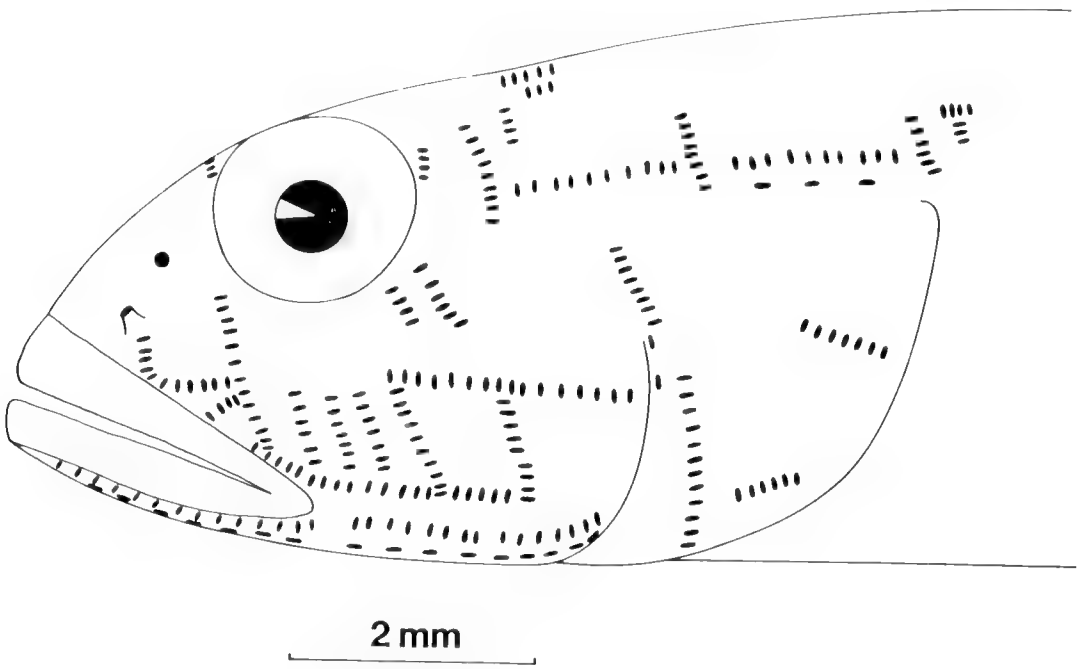

Figure 8. Head papilla pattern of *Tasmanogobius lordi*, based on several specimens.

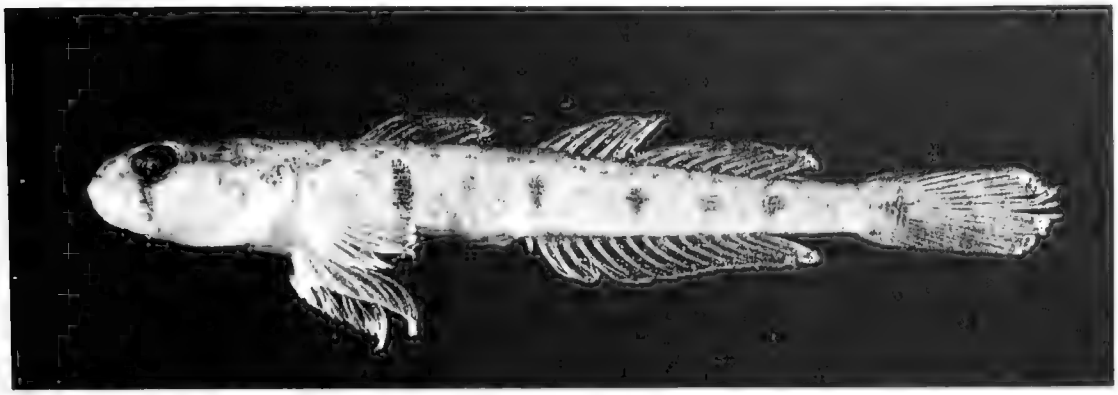

Figure 9. *Tasmanogobius lordi*, AMS I.22564—001, 29 mm SL.

base subequal to distance from last dorsal spine of first dorsal fin to second dorsal origin. Body light brown with series of dark brown spots, usually vertically elongate on midsides. Body slender, depth at anal origin 9.4–10.3% SL; depth at pelvic origin 10.2–11.4% SL. Six vertical (VT) cheek papilla lines.

Description. First dorsal fin VI(3), VII(18), VIII(3). Second dorsal fin with 13–16 elements, (usually 15), typically all rays segmented. Anal fin with 12–14 elements, (usually 12–13), typically with all rays segmented. Longitudinal scale count 10–24; longitudinal count of anterior scale patch 6(3), 7(1), 8(3), 9(1), 10(1); posterior scale patch 3(2), 4(2), 5(2), 8(1), 9(1). 14(1). Gill rakers on outer face of first arch 1–2 + 6–8 = 8–10; lower rakers 6(2), 8(2); total rakers 8(2), 9(1), 10(1). Segmented caudal rays 17(28); branched caudal rays 12–14, usually 13; upper unsegmented caudal rays 8(1), 9(5), 10(3), 11(2); lower unsegmented caudal rays 8(3), 9(4), 10(2), 11(2). Vertebrae 12 + 17(2), 12 + 18(19), 12 + 19(3).

Head length 23.9–25.6% SL. Eye about equal to snout in adult. Anterior nostril at end of short tube, about midway between upper margin of upper lip and eye, about 2 nostril diameters above upper lip. Posterior nostril with raised rim, immediately before anterior margin of eye. Gill opening restricted to pectoral base. Teeth in upper jaw conical, an outer row of close-set teeth; few smaller teeth anteriorly in second row; lower jaw teeth similar to upper jaw teeth, but with outer row teeth more wide-set. Mental frenum indistinct. Mouth small and oblique; reaching to below middle of eye in male and below anterior quarter of eye in female; jaws forming angle of 35–40° with body axis; upper margin of upper jaw in line with middle of eye. Tongue tip truncate to slightly emarginate. Upper part of gill arches with numerous small fleshy bumps extending onto pharyngeals; gill rakers on outer face of first arch with slender ossified rod anteriorly, and slightly expanded posterior fleshy section; rakers much shorter than filament length (about half length). Body scales largely ctenoid. Pectoral base, prepelvic area and belly naked. First dorsal fin with low rounded margin. Pectoral fin with rounded margin, reaching to point below middle of first dorsal fin. Pelvic fins fused to form large cup-shaped disc reaching to below end of first dorsal fin, well short of anus.

Colour of preserved material. Head and body light brown. A thin black vertical bar from ventral margin of eye to posterior end of jaws; diffuse black spot behind posterior margin of eye and similar diffuse black mark on dorsoposterior margin of operculum. Body with scattered brown to black spots dorsally; single vertical bar below anterior quarter of first dorsal fin; shorter and fainter bar below end of first dorsal fin and series (4–6) of short, vertically elongate, more-or-less evenly spaced black spots on midside below second dorsal fin, first below second dorsal origin and last at posterior end of caudal peduncle. Fins largely opaque; dorsal fins usually with black spots forming oblique lines, caudal fin sometimes with wavy vertical grey bars.

Distribution. Tasmanogobius lordi is known from scattered localities in fresh water and estuaries in Tasmania.

Remarks. Live colour was described (Scott, 1935) as transparent, with a row of about nine small fawn markings along the midlateral line, many being vertically elongate, and with other fawn markings dorsally.

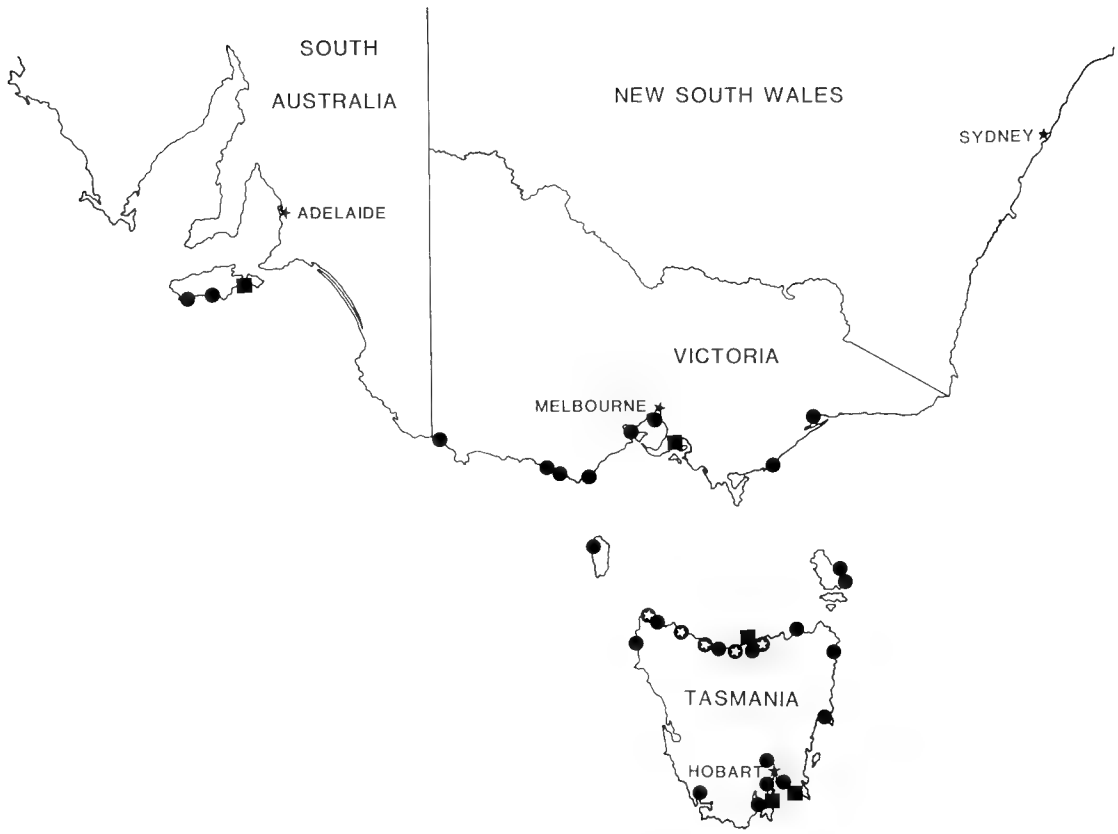

Figure 10. Distribution of species of *Tasmanogobius*. squares = *T. gloveri*, circles = *T. lasti*, white stars = *T. lordi*. Black stars indicate capital cities in southern states.

Table 1. Second dorsal fin rays in *Tasmanogobius*.

Species/Locality	Total Dorsal Elements					Dorsal spine	
	13	14	15	16	Mean	0	1
T. lordi	2	4	28	1	14.8	29	6
T. gloveri	3	39	3	—	14.0	45	—
T. lasti							
Total	6	60	58	5	14.5	26	103
Kangaroo Is., SA	2	6	—	—	13.8	3	5
Bruther Creek, Vic.	1	10	9	—	14.4	6	14
Lake Monibeong, Vic.	—	7	9	1	14.6	4	13
Other Victoria	—	10	3	—	14.2	2	11
Flinders Is., Tas.	—	5	6	1	14.7	5	7
King Is., Tas.	1	1	2	—	14.3	2	2
Tamar R., Tas.	—	9	11	—	14.6	—	20
Gawler Estuary, Tas.	—	9	11	—	14.6	2	18
Other Tasmania	2	3	7	3	14.7	2	13

Table 2. Anal fin rays in *Tasmanogobius*.

Species/Locality	Total Anal Elements						Anal spine	
	12	13	14	15	16	Mean	0	1
T. lordi	—	2	19	12	1	14.4	33	1
T. gloveri	8	36	1	—	—	12.8	45	—
T. lasti								
Total	1	10	102	16	3	14.1	32	100
Kangaroo Is., SA	—	2	6	—	—	13.8	6	2
Bruther Creek, Vic.	—	—	15	5	—	14.3	2	18
Lake Monibeong, Vic.	—	2	12	2	1	14.1	4	13
Other Victoria	—	—	12	1	—	14.1	3	10
Flinders Is., Tas.	1	—	9	3	—	14.1	6	7
King Is., Tas.	—	2	1	1	—	13.8	2	2
Tamar R., Tas.	—	2	15	2	1	14.1	1	19
Gawler Estuary, Tas.	—	1	18	1	—	14.2	5	15
Other Tasmania	—	1	14	1	1	14.1	3	14

Table 3. Pectoral-fin rays in *Tasmanogobius*.

Species/Locality	Pectoral Rays						
	16	17	18	19	20	21	Mean
T. lordi	—	4	22	8	—	—	18.2
T. gloveri	—	—	—	17	26	3	19.7
T. lasti							
Total	11	53	58	9	1	—	17.5
Kangaroo Is., SA	2	5	1	—	—	—	16.9
Bruther Creek, Vic.	2	6	20	1	—	—	17.7
Lake Monibeong, Vic.	1	10	3	3	—	—	17.5
Other Victoria	1	5	7	—	—	—	17.4
Flinders Is., Tas.	—	3	4	4	1	—	18.3
King Is., Tas.	—	3	1	—	—	—	17.3
Tamar R., Tas.	1	6	12	1	—	—	17.7
Gawler Estuary, Tas.	3	12	5	—	—	—	17.1
Other Tasmania	3	8	6	—	—	—	17.1

Table 4. Longitudinal scale counts in species of *Tasmanogobius*.

Species/Locality	Scale count																						
	10	11	13	16	18	24	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	47
T.lordi	3	2	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T.gloveri																							
Kangaroo Is., SA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	2
Vic. and Tas.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	4	1	1	—	—
T. lasti																							
Total	—	—	—	—	—	—	2	2	2	2	4	6	8	12	12	14	5	3	2	1	1	1	—
Kangaroo Is., SA	—	—	—	—	—	—	2	2	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Bruther Creek, Vic.	—	—	—	—	—	—	—	—	—	—	—	1	1	2	—	4	1	—	1	—	—	—	—
Other Victoria	—	—	—	—	—	—	—	—	—	2	1	1	2	2	—	2	—	—	—	—	—	—	—
Flinders Is., Tas.	—	—	—	—	—	—	—	—	—	—	—	1	2	1	2	—	1	2	—	—	1	1	—
King Is., Tas	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	—	—	—	—	—	—	—	—
Tamar R., Tas.	—	—	—	—	—	—	—	—	—	—	—	2	1	3	2	2	—	—	—	—	—	—	—
Gawler Estuary, Tas.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	3	2	3	—	1	—	—	—	—
Other Tasmania	—	—	—	—	—	—	—	—	—	—	2	1	1	2	3	4	—	1	—	1	—	—	

Table 5. Branched caudal-fin rays in *Tasmanogobius*.

Species/Locality	Caudal Rays						
	12	13	14	15	16	17	Mean
T. lordi	1	16	1	—	—	—	13.0
T. gloveri	2	7	17	19	—	—	14.2
T. lasti							
Total	—	9	38	55	6	4	14.6
Kangaroo Is., SA	—	—	2	5	1	—	15.0
Bruther Creek, Vic.	—	1	7	8	—	—	14.4
Lake Monibeong, Vic.	—	—	2	9	2	1	15.1
Other Victoria	—	1	3	7	—	—	14.5
Flinders Is., Tas.	—	—	—	7	2	3	15.7
King Is., Tas.	—	—	1	2	1	—	15.0
Tamar R, Tas.	—	4	9	6	—	—	14.1
Gawler Estuary, Tas.	—	1	11	8	—	—	14.4
Other Tasmania	—	2	3	3	—	—	14.1

Table 6. Size distribution of males and females of *Tasmanogobius lasti*.

Sex	Size Class (mm SL)					
	17–22	23–27	28–32	33–37	38–42	43–49
Males	20	6	9	2	—	—
Females	12	20	9	14	8	1

Table 7. Head pore variation in 50 specimens of *Tasmanogobius lasti*. Numbers indicate number of specimens with or without pore.

Pore/canal	Present			Absent		
	Left	Right	Median	Left	Right	Median
Posterior nasal	50	50	48	—	—	2
Posterior interorbital						
Postorbital	1	2		49	48	
Infraorbital	50	50		—	—	
Terminal lateral canal	9	11		41	39	
Lateral canal tube	5	6		45	44	

Individuals with normal pattern = 24; variants = 26; number of asymmetrical variants = 15.

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