CHAPTER 1

General introduction

The cypridinid (Myodocopida: Myodocopina) ostracods are a diverse group of crustaceans, present in marine environments world-wide, at all depths (Cohen, 1982). They bear seven pairs of limbs on an externally unsegmented body which is completely enclosed by a bivalved carapace (Figure 1). Myodocopids in general have lacked the scientific attention of podocopid ostracods. This is because of the economic significance of fossilized podocopids as important indicators of past environmental conditions (stratigraphic markers) for oil exploration. Unfortunately, myodocopids do not preserve well as fossils because they possess amorphous calcium carbonate in their carapaces as opposed to the crystalline calcium carbonate of podocopid carapaces (Sohn & Kornicker, 1969). Our poor understanding of the Myodocopida, and the benefits of further study of this group, has been emphasized (Kornicker, 1958).

Cypridinids are mainly known from direct benthic and pelagic sampling. From studies of their appendages and gut contents, it has been generally concluded that they are either collectors or predators (Cannon, 1940; Kornicker, 1975). However, a few cypridinid species have been reported as scavengers, entering baited traps (Sars, 1922; Cohen, 1983; Collins *et al.*, 1984; Stepien & Brusca, 1985; Vannier & Abe,

1993).

Between 1986 and 1995, the Australian Museum conducted an extensive trapping program along the east coast of Australia, from Cairns in the north to Hobart in the south, known as the SEAS (Scavengers of Eastern Australian Seas) Project. This included setting baited traps (7.5 mm entrance hole, single chamber trap; Keable, 1995) overnight, from 25 to 1000 m depths. Lysianassoid amphipods and cirolanid isopods (Crustacea) comprised a significant component of the scavenging guild from the majority of sites. However, against expectations, cypridinid ostracods numerically dominated the scavenging guilds at many sites sampled at depths of less than 100 m (Figure 2) (J.K. Lowry, pers. comm.).

Over 60 undescribed species of cypridinids, from 13 genera (some undescribed), have been identified from this study. Therefore, at least in east Australian seas, scavenging is a major mode of feeding within the Cypridinidae. This contrasts with the situation in the Caribbean (Cohen & Morin, 1990), where most of the over 50 species of cypridinids recorded from this area do not enter baited traps and, therefore, are probably not scavengers (A.C. Cohen, pers. comm.). Because of the absence of any large scale trapping outside Australian and Caribbean waters, it is still unknown whether scavenging among cypridinids is an Australian phenomenon, or whether it occurs in other global regions.

In 1990, I began preliminary studies on the taxonomy and ecology of southeastern Australian scavenging cypridinids. Taxonomic, behavioural, anatomical, and phylogenetic discoveries followed. Many of these discoveries also relate to

other members of the Myodocopina, and even other crustaceans.

The aim of this thesis is to document the above findings, made between 1990 and 1995. This is achieved as a series of chapters, each a very separate study, but continuing from the theme of the previous chapter. The chapters are written for publication in specific journals, hence there is variation in style. Figures and tables for each chapter/sub-chapter are positioned at the end of the relevant chapter/sub-chapter. At the time of submitting this thesis, Chapter 6 is in press in *Proceedings of the Royal Society of London: Biological Sciences* (December 1995 issue).

The thesis begins with the taxonomy of some Australian scavenging cypridinids, establishing two new genera, and includes the development of a DELTA (descriptive language for taxonomy) database for the family Cypridinidae (Dallwitz *et al.*, 1993). The functional morphology of the previously unknown carapace sensilla present in one of the above new genera, and the furcae, central adductor muscles, sclerotized plate of the dorsal body wall, and finely ringed setules on the first antennae of scavenging and other ostracod types is subsequently reported. The finely ringed setules of the first antenna were found to produce highly efficient iridescence, which was observed to have a function in courtship of some cypridinids. From video recordings, the first accurate account of myodocopid mating is also presented. The development of characters involved in visual systems (including photoreceptors and light reflectors) within the Cypridinidae has revealed important phylogenetic implications within the group, and also provides evidence for an independent evolution

of the ostracod compound eye. Finally, iridescence is introduced as a widespread phenomenon within the Crustacea, indicating that it should be considered as an important mechanism of communication within this group, as are bioluminescence and pigmentation.

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Figure 1. Generalized diagram of *Doloria levis* (Skogsberg) (Myodocopina: Cypridinidae), left carapace valve removed.

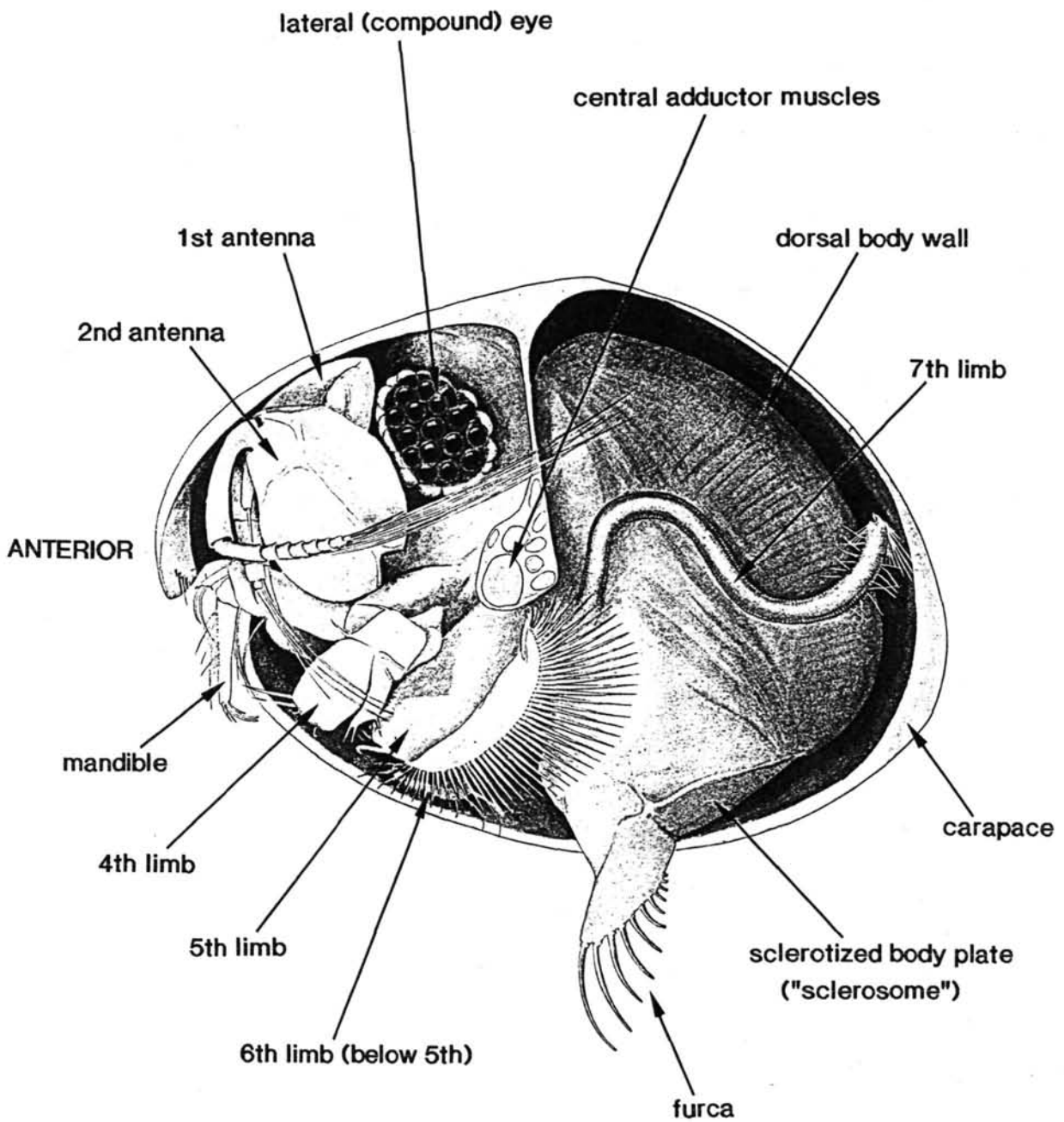
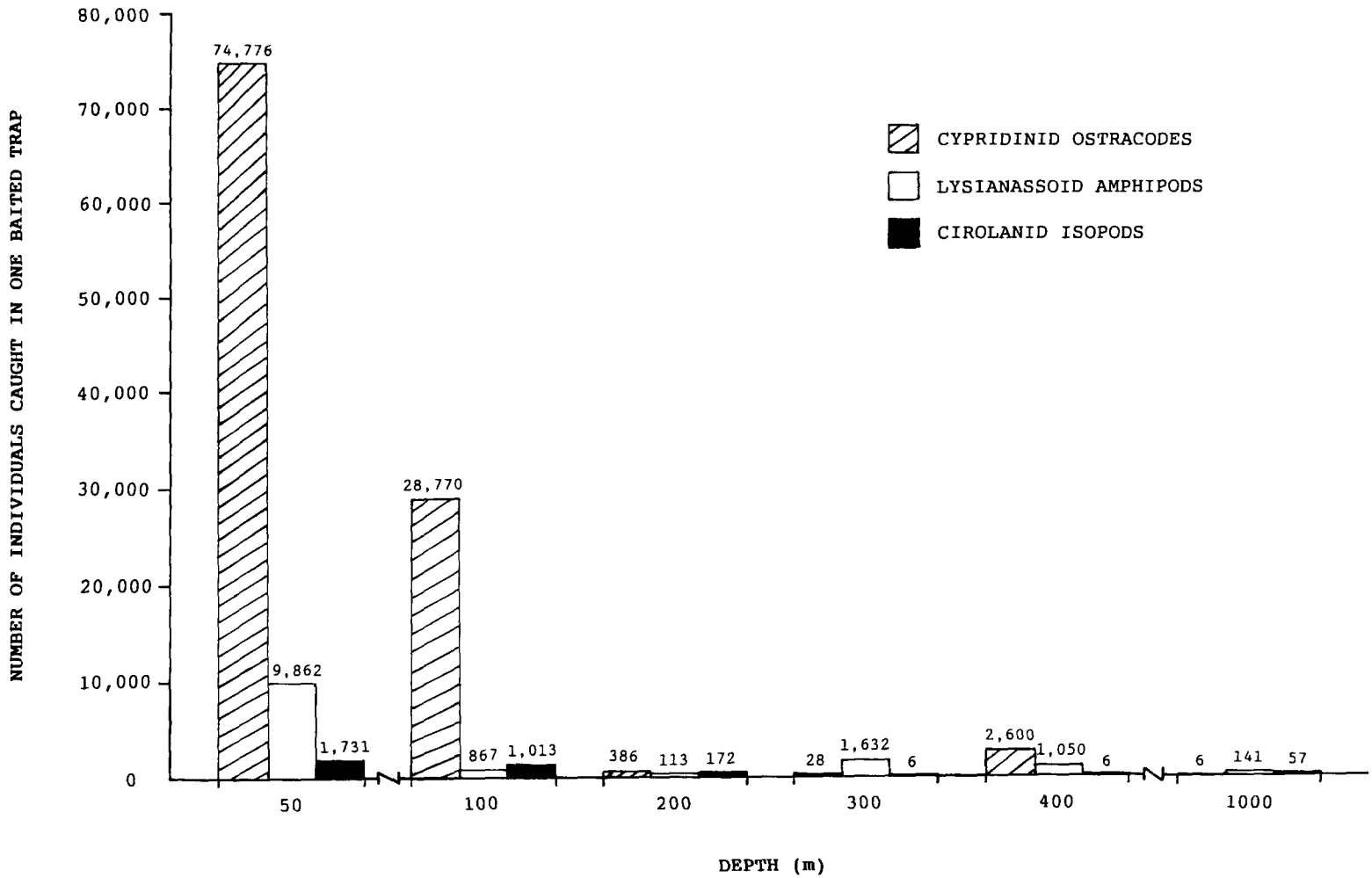

lateral (compound) eye
central adductor muscles
1st antenna
dorsal body wall
2nd antenna
7th limb
ANTERIOR
mandible
carapace
4th limb
5th limb
sclerotized body plate
("sclerosome")
6th limb (below 5th)
furca
VENTRAL

Figure 2. Graph showing number of small scavenging crustaceans caught per baited trap against depth along a transect off South East Tasmania (Australia), 1994.


80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
NUMBER OF INDIVIDUALS CAUGHT IN ONE BAITED TRAP
74,776
9,862
1,731
28,770
867
1,013
386
113
172
28
1,632
6
2,600
1,050
6
6
141
57
50
100
200
300
400
1000
DEPTH (m)
CYPRIDINID OSTRACODES
LYSIANASSOID AMPHIPODS
CIROLANID ISOPODS

CHAPTER 2

Systematics of Cypridinidae (Ostracoda: Myodocopina)

2.1 Introduction

Literature review

Subclass OSTRACODA Latreille, 1806

Baird (1850) originally named three ostracod families (Cypridinidae, Cypridae and Cytheridae). This was amended by Dana (1852) who grouped the Cypridae (Cyprinae) and Cytheridae (Cytherinae) as subfamilies under the family Cypridae and formed the family Halocyprídae to include the subfamilies Cypridininae (Baird's Cypridinidae) and Halocyprinae. However, the first major division of the Ostracoda was into four divisions of equal rank (Sars, 1866); Myodocopa, Cladocopa, Podocopa and Platycopa. This system was used by Brady & Norman (1896) and Calman (1909), although Calman designated each rank to be an order. Müller (1894) grouped the divisions Myodocopa and Cladocopa into a suborder Myodocopa, and the divisions Podocopa and Platycopa into a suborder Podocopa. Skogsberg (1920) further divided the Myodocopa into the suborders Cypridiniformes and Halocypriformes. Within the

Cypridiniformes were the families Cypridinidae, Rutidermatidae, Sarsiellidae and Asteropidae. Kornicker (1968) recognized five extant families of the suborder Myodocopina, within the order Myodocopida. These were the Cypridinidae, Philomedidae, Cylindroleberididae, Sarsiellidae and Rutidermatidae. The Cypridinidae were divided into the subfamilies Cypridininae and Azygocypridininae.

A large taxonomic study of the Cypridinidae, using Skogsberg's classification, was made by Poulsen (1962). Poulsen described 34 species of Cypridinidae in addition to 24 supplementary descriptions, and designated nine new genera (also supplementary descriptions for eight existing genera) from world-wide trawled collections. This included 11 species, from seven genera, from southern and/or eastern Australian seas.

Probably the most comprehensive study of myodocopid ostracods was made by Kornicker (1975). Kornicker described benthic collections of myodocopids between Antarctica and 35°S using the classification of Kornicker (1968). In this Antarctic monograph, Kornicker (1975) described 15 new species and designated three new genera belonging to the family Cypridinidae, in addition to supplementary descriptions for 16 cypridinid species and nine cypridinid genera. This included nine species, in five genera, from southern Australia.

Kornicker's Antarctic monograph (1975) is the only thorough taxonomic study of cypridinids from one large geographic area. Kornicker also described cypridinids from many smaller areas such as New Zealand (1979), Enewetak and Bikini Atolls (1991), and the North East Mozambique Channel

(1992), and has recently described cypridinids from the Australian continental slope (1994).

Two additional cypridinids described from eastern Australia are Sheina orri Harding and Azygocypridina lowryi Kornicker.

Cohen and Morin have recently described over 50 new species, and one new genus (1993), of closely related bioluminescent cypridinids (1989) from the Caribbean Sea.

Taxonomic methodology used in this thesis

The ostracod classification system used in this thesis is as follows, after the advice of an unknown reviewer (to be included in the forthcoming Treatise on Ostracoda):

Order: Myodocopida
Suborder: Myodocopina
Families: Cypridinidae, Cylindroleberididae, Philomedidae, Sarsiellidae, Rutidermatidae

Here the Myodocopida is divided into two suborders: Myodocopina and Halocyprina. The orders Myodocopida and Podocopida comprise the majority of ostracods.

In Chapter 2.2, a new species of Vargula (Skogsberg) (Cypridinidae) from a baited trap from Tasmania (Australia) is described, following the methodology of previous workers (Kornicker, 1993). This description was used to provide the format for a DELTA database for cypridinid ostracods.

Among other things, DELTA (descriptive language for taxonomy) enables accurate and consistent taxonomic descriptions to be produced, on completion of an initial database (Dallwitz *et al.*, 1993). I developed such a DELTA database for the Cypridinidae in this project. The descriptions of two new species of cypridinids in Chapter 2.3, each from new genera (from Australian baited trap samples), were formulated using this cypridinid DELTA database. Setal terminology used in this chapter is based on the classification system of Watling (1989).

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2.2 *Vargula karamu*, a new species of luminescent ostracod (Cypridinidae, Myodocopina) from a baited trap off Tasmania, Australia

(Prepared for Invertebrate Taxonomy)

Abstract

A new species of cypridinid (Myodocopina) ostracod, *Vargula karamu*, is described. This species, from off the west coast of Tasmania, is a scavenger and produces bioluminescence. It occurs in an area of a relatively high diversity of scavenging crustaceans, and exhibits feeding limbs well equipped for scavenging.

Introduction

There are 16 species of *Vargula* (Myodocopina: Cypridinidae) (Müller, 1890 & 1908; Poulsen, 1962; Kornicker, 1975 & 1994) described from Australian seas, mostly from deep water. Recently, the SEAS (Scavengers of Eastern Australian Seas) Project of the Australian Museum has revealed a further 16 species of *Vargula*, mostly from shallow water (J.K. Lowry, personal communication). However, most of the latter are from off New South Wales. Here, a new species of *Vargula* from shallow water off Tasmania is described.

The new species of *Vargula* was caught off the west coast of Tasmania in a trap containing a dead fish bait. Other cypridinid ostracods (in the genus *Vargula*), lysianassoid amphipods (in the genera *Stephonyx*, *Tryphosella* and *Waldeckia*) and cirolanid isopods (in the genus *Natatolana*) constituted nearly all of the total number of animals caught in the baited trap from this site.

It was noted from the living specimens that this new species of *Vargula* produced a bright blue luminescence in captivity, i.e. under stressful conditions (J.K. Lowry & S.J. Keable, personal communication).

Abbreviations used in the following descriptions and figures are: D = dorsal, V = ventral, L = length, H = height, RT = right, LT = left, M = medial, Lat = lateral, DM = dorsomedial, VM = ventromedial, DLat = dorsolateral, VLat = ventrolateral, N = number of specimens examined, x = times, AM = Australian Museum, BMNH = The Natural History Museum, London.

Family CYPRIDINIDAE Baird

Sub-family CYPRIDININAE Brady and Norman

Vargula karamu, sp. nov.

(Figures 1 and 2)

Type Locality

Vargula karamu was caught in a baited trap (TAS-281) about 50 m offshore, and just to the east of Hannants Bight, north side of Cape Sorell, Tasmania, 42°11.5'S 145°11.4'E,

J.K. Lowry and S.J. Keable on the *Flying Scud*, 26-27 April, 1991. The trap lay on a sand substrate at a depth of 18 m.

Material Examined

Holotype. AM P41841 adult male, L 2.51 mm, H 1.54 mm. Valves and body in alcohol, appendages on slide.

Paratypes. AM P41842, 1 adult female, L 2.62 mm, H 1.69 mm. Valves and body in alcohol, appendages on slide. AM P41843, 2 adult males, 1 adult female, 7 juveniles. Whole specimens in alcohol. BMNH 1993.427-429, 1 adult male, 1 adult female, 1 juvenile. Whole specimens in alcohol.

Etymology. The type species of *Vargula karamu* is named after the steam ship "Karamu", which sank on 4 September 1925 off South West Cape, Tasmania (on a sand bar very near the type locality).

Morphological diagnosis:

Valve size: relatively small [male L = 2.18-2.51 mm, female L = 2.53-2.83 mm (N = 7)]. *First antenna*: V seta and D seta of male 4th article of similar L; about 4% of valve L; males with total of 24-26 smaller "suckers", distal "sucker"-bearing setule of b-seta with 7 "suckers", b- and c-setae unusually long. *Second antenna*: seta of male 2nd exopodial article with 7 stout V spines (all visible at 250 x magnification). *Mandible*: distal sclerotized finger of 2nd article shorter than DM and VLat claws of terminal article and only slightly longer than DLat claw, about same L as other terminal claws. Terminal article with DM terminal claw

slightly curved distally and with few basal M spines; c-seta about 0.5 x L of DM claw. *Fourth limb*: 4 a-setae on both limbs; male a-3 seta more than 6.5% of valve L; b-2 seta less than 44% L of alpha-1 seta and 70% L of b-1 seta. *Fifth limb*: smallest tooth of 1st exopodial article with about 9 cusps; male peg seta more than 8% of valve L. *Sixth limb*: terminal article slightly square shaped with a rounded V corner. *Seventh limb*: total of 22-23 setae; 7 long broad spines and 5 short spines in terminal comb; single sclerotized peg. *Male eighth "limb"*: tip of hood narrowed; V margin of hood with a pronounced hump. *Upper lip*: single ventral field with total of about 27-30 glandular nozzles arranged in rows of 3 or 4 across; 1 pair of lateral tusks with distal thin setae. *Bellonci organ* cylindrical. *Frontal knob* large and rounded with two pointed processes just ventral to knob. *Furca* with 9 or 10 claws on each lamella; claws 2, 3 and 4 fused to lamella in males, claws 2 and 4 in females.

DESCRIPTION OF ADULT MALE CHARACTERS:

Colour of the Living Ostracods: reddish to brownish pigments anterodorsally on valve infold and limbs; gut grey to reddish brown above and yellow-white below; light organ bar-shaped, yellow-brown.

Carapace: [N = 4]

Length (L) = 2.51 mm (Range = 2.81-2.51 mm)

Height (H) = 1.54 mm (Range = 1.40-1.50 mm)

L/H = 1.63 (Range = 1.47-1.63)

Oval with deep incisure and protruding keel; margins broadly rounded, posterodorsal margin more steeply sloped than anterodorsal margin; keel abruptly joined by conspicuous D concave curve to curved posterior margin of valve; D edge of keel slightly above midheight of valve. D edge of incisure slightly overlapping V edge at inner end; faint line on outer surface of valve curving from inner D edge of incisure to anterior margin of valve, V to incisure. Rostrum tip with few minute inconspicuous anterior bumps. Valve surface smooth at low magnification, but with faint scale-like pattern visible on anterior margins with light microscope at 100 x magnification, pattern producing few very minute points on anteroventral margin of valves; minute scattered setae on valve surface rather evenly spread; muscle scars variable, but typical for family; usually about 12 forming triangle, about 3 smaller scars inside triangle; sometimes a circle or a cluster without pattern.

Infold: posterior to rostrum with row of 21-23 double setae parallel to valve margin (5-11 D to incisure), 1-6 double setae posterior to row; 2 very unequal double setae on posterodorsal edge of incisure and 1 double seta posterior to D inner corner of incisure; sclerotized ridge (list) at angle D to incisure. Anteroventral infold with 2 short double setae near inner corner of incisure and 1 double seta near posterior edge of infold; row of 46-56 double setae parallel to margin (2-3 V to incisure), diminishing in L posteriorly; 1 seta anterior to row, no setae posterior to row. Left valve with 5 setae on V margin and 3 setae posteroventral to caudal list. List becoming broader, forming shallowly curved narrow smooth

ridge in vicinity of keel, ridge unornamented except minute short setae or papillae emerging from unrimmed pores; list of LT valve ending in small faint D knob, minute anterior facing indistinct process on list of LT valve (and possibly RT valve), of RT valve in D bar; few minute setae or papillae emerging from pores on posterior margin of keel, D margin of keel with small bump.

Selvage: lamellar prolongation of selvage narrow along rostrum, broad and striated along lower margin of incisure, narrower and with fainter striations along V margin, terminating on V margin of keel.

First Antenna:

1st article with spines on V margin. *2nd article* with M spines forming rows and spines near and on V and D margins. *3rd article* short with M spines forming rows. Setae of 3rd and 4th articles with short spines. Third article with 1 terminal V seta and 1 D seta near centre, setae approximately same L. *4th article* with 1 terminal D seta (longer than that of 3rd article) and 1 terminal V seta (longer than that of 3rd article). *5th article*: s-seta (formerly the sensory seta, Chapter 5) with bifurcate tip and 10 long bare proximal (10th separated from first 9) and 2 more slender and shorter distal halophores (setules, Chapter 5). *6th article* with short apparently bare M seta near D margin. *7th article*: bare a-seta approximately the same size as seta of 6th article; b-seta with proximal setule (with bulbous base) bearing large "sucker" and large bulbous distal process and pointed tip, 2 distal setules each bearing 6-8 small "suckers" (distal setule

extending far beyond tip of seta, with small process just proximal to most proximal "sucker", distal seta about 1.6 x L of middle "sucker" bearing setule); c-seta similar to b-seta but about 1.5 x as long, with slightly larger basal setule, "sucker" and distal process, with 2 more distal slender setules, each bearing 5-6 small "suckers" (with small process just proximal to most proximal "sucker"), with 3-6 bare halophores between "sucker" bearing setules (tip of seta extending beyond proximal setule) and 6 long, slender, bare distal halophores. *8th article*: d- and e-setae longer than b-seta, bare, filamentous; long g-seta, f- and g-setae with slender halophores (f-seta with 8, g-seta with 10) increasing in L distally, some with a few spines. c-, f- and g-setae tapering, becoming filamentous distally, longer (g- and c-setae longest) than s-seta; each of these 4 setae with bifurcate tips.

Second Antenna:

Protopodite with medium-short seta with short spines. *Endopodite* with 3 articles: *1st article* with 4 proximal setae (1 long and about twice L of 3 shorter setae) and 1 long distal spinous seta (longer than longest proximal seta and extending to near end of 2nd article); *2nd article* elongate with terminal seta extending to about L of 3rd article; *3rd article* about 0.5 x L of 2nd article, with long terminal seta. *Exopodite*: *2nd article* with seta with tip reaching to about 6-7th article, with 7-8 V spines; *articles 3-8* with basal spines becoming longer distally and each with 1 seta with natatory setules; *9th article* lateral spine about same size as spine of

8th article; 9th article with 4 setae (3 long with natatory setules, 1 shorter and bare).

Mandible:

Coxal endite spinous, with ringed seta near base and terminal ringed seta. *Basis*: Broad relative to 2nd endopodial article (about 3 x); b-seta (closer to a-seta than c-seta), 1 long spinous and 1 short spinous (about 0.5 x L of longer seta) M a-setae, 1 short bare Lat b-seta (close to a-setae), 1 long bare and 1 short spinose c-setae and 2 d-setae near distal end of margin (space between c- and d-setae much larger than space between c-setae; shortest a-, b- and c-setae all about same L; proximal d-seta medium long with short spines, distal d-seta very long with long proximal and short distal spines); distal quarter to third of D margin with 3 long setae with short spines (1 distal and 2 unequal, subterminal), none with long spines or setules (spines slightly longer on M [or distal] seta; M [or distal] seta proximally unringed). *Exopodite* extending slightly beyond D end of 1st endopodial article, with M wrinkled and hirsute D process extending to pointed tip and 2 V setae (longer proximal seta with short spines, distal seta about 0.5 x L of proximal seta, with short spines). *Endopodite*: *1st article* with 4 V setae (1 minute bare a-seta, 1 medium short spinous b-seta, c-seta long with long central spines and short distal spines [similar to longest d-seta of basis], d-setae much longer than c-seta with spines and long setules (similar to longest d-seta of basis). *2nd article*: article elongate and tapered with straight or slightly crescent-shaped rows of short M and V spines; D

margin with 16-18 setae: 1 a-, 1 b-, 1 c-, 2 d-setae (long, ringed, with short spines, d-setae longest, about equal L and extend to distal V seta or just to 3rd article), 10-14 M shorter setae (stout partially ringed M seta distal to b-seta and with long stout spines), 1-2 medium L ringed setae (with short spines) distal to d-setae plus 0-1 short setae. V margin with 2 short single setae proximal to finger (setae not overlapping and about 60% L of finger), 1 equally long finger-seta with base on Lat side of subterminal finger; finger long, stout, curved and unringed (L shorter than terminal claws of 3rd article). *3rd article* with 3 long basally stout claws; DM (middle) claw shortest and thinnest, tapered, bearing few proximal M spines, tip evenly curved; VLat claw (bearing 4-5 minute proximal Lat spines) abruptly narrowed, ventral claw tips more bent; 4 ringed setae: VM c-seta 70% L of DM claw; 1 longer VLat b-seta with stout base bearing short spines on base and slightly shorter than claws, 1 very short VM a-seta, and 1 DLat d-seta extending to about 90% L of DLat claw and with thin pointed tip and subterminal papilla or opening; DM (middle) claw L = 4% valve L.

Fourth Limb:

Endite setae: *I* = 11 long stout setae (some setae partially unringed with bare pointed or trifid tip). *Coxa* with stout D seta bearing many setules. *Basis* with 2 long thin bare Lat setae (1 near base of exopodite and shorter than exopodial setae) and 1 distal M seta with short spines (distal on basis although sometimes appears to be on 1st endopodial article). *Exopodite* with many fine setae, with 1 long proximal seta with

many setules and 2 long terminal setae (outer seta with many setules and few short spines, bare distally, and inner seta with short spines). *Endopodite* rather rectangular; cutting tooth large, bifid with squarish cusps (proximal cusp sometimes rounded), with proximal part separated from rest by partial suture on cutting edge; small inconspicuous terminal Lat sclerotized tooth; 2 alpha-setae, one medium long with proximal setules and one long and with many setules, 3 beta-setae, one long, pectinate and ringed (beta-3), 2 short, thin, ringed beta-setae (beta-2 with a few triangular spines and longer than the bare beta-1 seta) shorter than alpha-setae; 1st article with rows of M thin setae; *2nd article* much narrower than 1st endopodial article with 4 thin, distally ringed a-setae; a-3 and a-4 with few spines in central region; a-1, 2 and 4 with pointed tips and a subterminal papilla or opening, a-3 with a terminal tubular opening; 3 stout, ringed and pectinate b-setae; b-1 long with long thin spines, b-2 medium L with long thinner spines, b-3 (most posterior) shorter, somewhat claw-like, distally ringed and tapering, with 5-6 large stout spines on anterior side and one small spine on posterior side; 3 ringed c-setae with long thin spines; c-1 seta (most anterior) short and slender, c-2 and c-3 setae medium L (with medium sized spines); 3 long stout pectinate d-setae with long spines (d-1 and d-2 setae shorter unringed, claw-like, with curved tips and stout spines, d-3 distally ringed with thinner spines).

Fifth Limb:

36 *epipodial setae*. *Protopodite* with anterior distal

tooth. *Endite setae*: *I* = 9-10 stout, unequal, distally ringed, with long stout setules or spines, 1 thin, distally ringed and bare; *II* = 5 stout with proximal setules (some with many setules), all distally ringed; setae #1 distally pectinate, seta #3 partially ringed with distal spines, seta #5 with long distal spines; *III* = 7 (inner [posterior] seta [#1] with large base and proximal setules, distally pectinate; adjacent seta [#2] partially ringed and bare; seta #3 longer and stout, unringed with distal spines; setae #4 and 5 very thin, unringed, pointed and rather claw-like; seta #6 with long setules and long distal spines; last [anterior] seta [#7] longest, with long proximal and short distal setules, distally ringed. *Exopodite* with 2 prominent sclerites; 1st article sclerite rather right angle-shaped, shorter, broader part of right angle underlying 6 teeth of article, longer part of right angle underlying anterior setal row; 2nd article sclerite large, irregular, occupying setal portion of article. *1st exopodial article*: posterior row of 6 pectinate teeth and 1 proximal smooth triangular peg, with 1 large stout peg-seta with few (about 6) proximal setules, distally ringed with about 2 central triangular spines, proximal to peg (peg about 2 x longer than wide); peg-seta same L as longest tooth, peg same L as shortest tooth, shortest tooth with total of about 9 tiny cusps (with 2 slightly offset proximal groups of 3-4 cusps, then 2 thinner distal spines) preceding small triangular tip; anterior row of 3 setae (1 medium L with many setules and often very faint, 2 very long [1st seta longest] with long proximal stout setules or spines and distal rings and pectination [spines much longer and stouter on first

seta]), and 4th anterior seta on proximal margin of article over sclerite (may be on protopodite), faint, medium L, with many setules and distal short spines. *2nd exopodial article* with total of 16 setae: 4 short to long unringed pectinate (with large spines) posterior claw-like a-seta (# 1-4, decreasing in size posteriorly), 7 long to medium-long ringed pectinate (with long spines) b-setae, row of 3 b'- setae, anterior row of 4 longer b"- setae; 1 posterior ringed c-seta with proximal setules and distal short spines, 1 anterior ringed d-seta with proximal setules and short distal spines. Inner lobe of *3rd exopodial article* with 3 ringed setae (shorter more proximal seta with long proximal setules and distal short spines, longer subterminal seta with short spines, shorter terminal seta partly ringed with few spines; outer lobe with many very fine setae, with 2 terminal medium-broad setae, outer seta with proximal setules and both with distal short spines. *4th* and *5th exopodial articles* separated by faint suture, with many very fine setae; 4th exopodial article with 4 medium broad setae; 2 medium L (anterior) and 1 shorter narrow ringed spinous terminal setae, 1 posterior subterminal medium L seta with large base, distal rings and medium L spines; 5th exopodial article with 2 subequal terminal setae with short spines (both setae longer than setae of 3rd article); process present terminally on inner 5th article with small stout terminal spines.

Sixth limb:

Endites separated from each other and rest of limb by grooves or sutures; with many very fine M setae. 4-5 bare

setae in place of *epipodite*. *Protopodite* with rows of very fine M setae. *Endite* setae: *I* = 3 with long spines (1 long and ringed, 2 short, stout and ringed); *II* = 5 (2 long with long central spines and distal rings and medium short spines, 3 short and stout ringed, with long spines [one with distal medium L spines]); *III* = 4 (3 with long proximal or central spines and distal rings, sometimes some with distal short spines, and 1 shorter ringed, with long central spines); *IV* = 3 (2 long and ringed with long central [or groups of] spines and distal short spines, 1 shorter [medium long] with long proximal spines and rings. *Terminal article* square-shaped, basally separated by suture or groove from rest of limb; ventral rows of long stout setae on M surface, Lat surface with many long very fine setae; total of 8-10 anterior V terminal setae (number may vary on opposite limbs) long with long proximal spines and medium-short distal spines, setae L reducing evenly from long [3rd most anterior seta] to medium [last] (2 most anterior setae long and narrow) followed by a long space (gap = about 30-50% V L of terminal article with a rounded corner [sometimes slightly dented] at anterior end) between anterior setae and 3 posterior ringed setae (setae increasing in L from anterior to posterior end, shorter more anterior seta with long setules and medium short distal spines).

Seventh limb:

Total of 22-23 setae. *Comb side* with 5-6 nonterminal and 6 terminal setae (each with 2-6 bells), bells consist of encircling fringe; *peg side* with 6-8 nonterminal (each with 4

bells), and 4 terminal setae (each with 4-6 bells). *Comb* of 7 long tapered minutely fringed teeth with pointed tips (central tooth longest) and 5 short blunt teeth, with grooves, on each side. Single sclerotized *peg* straight, thin, shorter than short comb teeth, tip expanded with at least 5 minute pointed terminal or lateral spines, base of peg recessed from outer limb edge.

Eighth (Copulatory) "limb":

Basal part of *1st article* with prominent *Y-sclerite* with *strut* so that sclerite forms irregular rectangular loop with M distal inner extension (*finger*) terminating near distal tip of *finger branch* of *inner lobe*; loop broader distally and slightly elongated at outer distal corner. *Inner lobe* with 2 branches, *finger branch* and *setal branch*, separated by terminal cleft. Tip of *finger branch* bears many minute triangular spines (more prominent on inner side of finger branch). *Setal branch* bears tiny spines on terminal and cleft region; external surface with 5 or 6 ringed bare nonterminal setae with expanded bases. *Outer lobe* of limb has *thumb sclerite* articulating with distal corner of strut of Y-sclerite of 1st article. Distally, sclerite of 2nd article emerges as a small bare *thumb* at inner D base of hood; 5 ringed bare *thumb setae* grouped near the thumb. *Hood* is distal extension of 2nd article and is folded over the distal inner lobe in preserved specimens (probably retracted position). Tip of hood is narrowed and extends as an elongate finger-like tip and bears subterminal minute spines. Outer lobe bears 2 *proximal* anterior bare ringed *setae*. A third lobe, the *central*

lobe, lies between inner and outer lobes, rather posterior and M to outer lobe, tip not reaching thumb setae of outer lobe but reaching to about 75% L of inner lobe. Central lobe bears 3 or 4 unringed terminal setae with short spines.

Furca:

Each lamella with 9 claws; claws 2, 3 and 4 fused to lamella; claw 3 more slender than, but slightly longer than claw 4; all claws with 2 rows of posterior spines (1 M row, 1 Lat row) and a row of thin anterior spines (visible at 1000 x magnification). Anterior lamella with few tiny spines.

Bellonci organ:

Cylindrical, L (= 0.12 mm) slightly more than twice width, tip blunt with bump, without pigment, attached to V cup of naupliar eye.

Eyes:

Medial eye small (L = 0.17 mm) with some maroon pigment. *Lateral eye* (L = 0.30 mm) larger (about 1.8 x) than medial eye with at least 14 ommatidia (slightly larger posteriorly). Eye pigment dark brown in reflected and transmitted light.

Upper lip:

Anteroventral field: single, oval flat field of about 27-30 nozzles arranged in about 3-4 rows. Pair of long *tusks* Lat and posterior to anterior field, tusks tapered from broader base, with nozzles (step-like) along distal 80% of posterior margin and tip, few long thin distal setae, tusks with at

least 13 posterior nozzles plus 1-2 nozzles at tip. *Posterior* part of upper lip paired with many thin setae. Upper lip pigmented proximally in preserved specimens.

Anterior of body: large frontal knob, dorsal to group of minute projections (1 round, 2 triangular pointed), and more ventral minute round knob.

Posterior of body: 8 or 9 dorsal folds.

DESCRIPTION OF ADULT FEMALE CHARACTERS:

Most characters common to both sexes have been omitted from the following description.

Carapace: [N = 4]

Length (L) = 2.62 mm (Range = 2.53-2.83 mm)

Height (H) = 1.69 mm (Range = 1.64-1.83 mm)

L/H = 1.55 (Range = 1.54-1.55)

Oval; keel jointed less abruptly and at higher point on valve than in male, D edge > 0.5 valve H, but projecting a little less than in male.

Infold:

Anteroventral row with 59-61 setae. Row of double setae of infold dorsoposterior to rostrum more S-shaped.

Size:

Larger (L about 1.04 x) than males.

First antenna:

Setae of 3rd and 4th articles with short spines. 7th article: a-seta bare; b- and c-setae without "suckers"; b-seta stout basally, tapering gradually, about 1.5 x L of a-seta; c-seta with 7 or 8 halophores.

Second antenna:

Protopodite: seta bare. Exopodite: seta of 2nd article reaching to 8th article, with 8 V spines (most proximal spine small and very close to adjacent spine); small spine on 2nd article at base of seta.

Mandible:

Endopodite: D margin of 2nd article with only 14-16 setae (1 or 2 spiny setae, i.e. setae bearing stouter long spines); b- and c-setae with short setules along middle third of length. Terminal article: DLat claw proximally pectinate with 2 or 3 large spines and smaller more proximal spines.

Sixth limb:

Endite setae: I = 8 (3 short); II = 7 (5 short); all setae without spines. Terminal article: 9 anterior V terminal setae (2nd most anterior seta shorter and thinner with spines and without setules).

Seventh limb:

Total of 23 setae; peg side with 7 nonterminal setae.

Eighth (Copulatory) "limb":

Much smaller than in male: 2 round lobes (1 on each side), each with a spermatophore attached.

Furca:

Right lamella with 9 claws, left lamella with 10 claws. Claws 2 and 4 only fused to lamella, claws slightly shorter and stouter than in male.

Eyes:

Lateral eye (L = 0.23 mm) smaller (0.76 x) in actual size, and in relation to value L, than in male.

Anterior of body:

Similar profile to male except slightly more protruding frontal knob and more rounded minute single ventral process (less tooth-like).

Upper lip:

Posterior part with distal longer spines as well as short ones.

Posterior of body:

No pigment observed. 15 "muscle bands" in place of dorsal folds (smaller than folds).

Eggs:

About 18 eggs/side (0.08 mm diameter), in carapace cavity.

Discussion

Habitat

The contents of baited traps from around Tasmania were examined. These traps included nine which were set in an area of radius 5 km, including the type locality, and twenty-four traps from different localities and depths along the eastern coast of Tasmania. The shallower depths (below 50 m) showed the greatest diversity of scavenging crustacea, including cypridinid ostracods in the genera *Cypridinodes* and *Vargula*. However, *Vargula karamu* was only found in the trap set at the type locality (TAS-281).

The trap containing *V. karamu* (TAS-281) also caught lysianassoid amphipods, cirolanid isopods, leptostracans, cumaceans, natantians and other cypridinid ostracods. The remaining eight traps set off the western coast of Tasmania caught mainly lysianassoid amphipods and cirolanid isopods. Therefore, the trap in which *V. karamu* was found also contained a high diversity of other crustaceans.

Generic Classification

This new species belongs in the genus *Vargula* (Skogsberg, 1920) because: the endopodite of the second antenna possesses three articles, the first article has five setae, the second article has one distal seta; the longest alpha-seta of the fourth limb has abundant marginal setules; the furca has nine to ten claws on each lamella, the second and fourth claws are united to the lamella on the female, the second to fourth claws are united to the lamella on the male, the third most posterior claw is more slender and shorter than the fourth; the upper lip has a single anteroventral field of nozzles and

a long tusk on each side (Poulsen, 1962; Kornicker, 1975).

Vargula karamu shows many similarities with the monotypic genus *Sheina* Harding, but differs foremost in the shape of the upper lip, the shape and relative size of the furcal claws, and the shape of the tip of the lateral seta of the third article of the mandible.

Related Species

Vargula karamu is similar to *V. plicata* Poulsen, although on examination of all limbs and carapace there are many obvious differences. For example, *V. plicata* has: an elongated terminal article of the sixth limb, with fewer (four) anteroventral setae; seven claws on each furcal lamella, with only the second and fourth fused with the lamella in both sexes, and fewer (two) "suckers" on each setule of the b- and c-setae of the male first antenna. *Vargula karamu* is also similar to *V. subantarctica* Kornicker. However, *V. subantarctica* has: a longer and thinner Bellonci organ, only seven anteroventral terminal setae on the terminal article of the sixth limb; eleven spines on the seta of the second article of the second antennal exopodite, only nine or ten ommatidia in the lateral eye, and a much narrower dorsomedial mandibular claw. One diagnostic character of *V. karamu* is the presence of a hump on the hood of the eighth limb. This character is also shared with: *V. parasitica* Wilson, which has a less square-shaped terminal article of the sixth limb, with only anteroventral terminal setae; *V. shulmanae* Cohen & Morin, which has a distinct and characteristic keel present on the male and female carapace; *V. graminicola* Cohen & Morin, which

has many anterior setae dorsal to anterior rows on the internal carapace surface; *V. harveyi* Kornicker & King, which has a large spine on the third to fifth most distal rings of the seventh limb which forms a dorsal jaw; *V. puppis* Poulsen, which has a smaller hump on the hood of the eighth limb, only eight claws on each furcal lamella, tusks of the upper lip with a large medial tooth on the proximal posterior margin, a more rounded Bellonci organ, and a pronounced caudal process on the female carapace. Other similar species of *Vargula* are: *V. hamata* Kornicker, which has a hook-shaped process within the terminal comb of the seventh limb, a longer and thinner Bellonci organ, and a distinctly shaped caudal process on the male carapace; *V. lusca* Kornicker, which lacks lateral eyes; *V. norvegica*, which has nine or more spines on the seta of the second exopodite article of the second antenna. The *Vargula* species with the most similar carapace size is *V. subantarctica*, although there is greater sexual dimorphism in this species.

Scavenging Ecology

Kornicker (1975) suggested that within the Ostracoda, it is species within the family Cypridinidae that have the most suitable limbs for scavenging. *Vargula karamu* exhibits such adaptations, with strong claw-like setae on the fourth and fifth limbs, and well articulated mandibles with stout terminal claws. Species of *Vargula* have been found buried neatly into the flesh of dead fish baits from scavenger traps set off Australia (A. Parker, personal observation), and although one individual could not cause much damage to a dead

or restrained fish, their sheer numbers (up to 75,000 individuals caught per trap; J.K. Lowry, personal communication) make cypridinid ostracods important scavengers off eastern Australia.

Bioluminescence

Vargula karamu produces bioluminescence when under stressful conditions. However, it is not known whether the bioluminescence of this species is used only as an antipredatory response (Morin 1983), or whether it is alternatively/also employed during courtship (Morin & Cohen, 1991), or for some other function. Currently, the courtship function of cypridinid bioluminescence is only known to occur in the Caribbean, although the bioluminescent cypridinids in other geographical regions require more detailed study.

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FIGURE 1. *Vargula karamu*: A, male LT valve, medial view; B, female complete specimen; C, male anterior LT valve, M view; D, male right furcal lamella, Lat view (LT lamella also with 9 claws); E, female, RT furcal lamella, Lat view (LT lamella with 10 claws); F, male dorsoposterior of body showing weak segmentation and Y-sclerite, Lat view; G, male muscle scars, LT valve, M view; H, male anterior of body showing lateral eye (l.e.), medial eye (m.e.), Bellonci organ (b.o.), frontal knob (f.k.), and upper lip with V view of single anteroventral field (limbs removed); I, male LT second antenna, M view; J, male LT first antenna, M view.

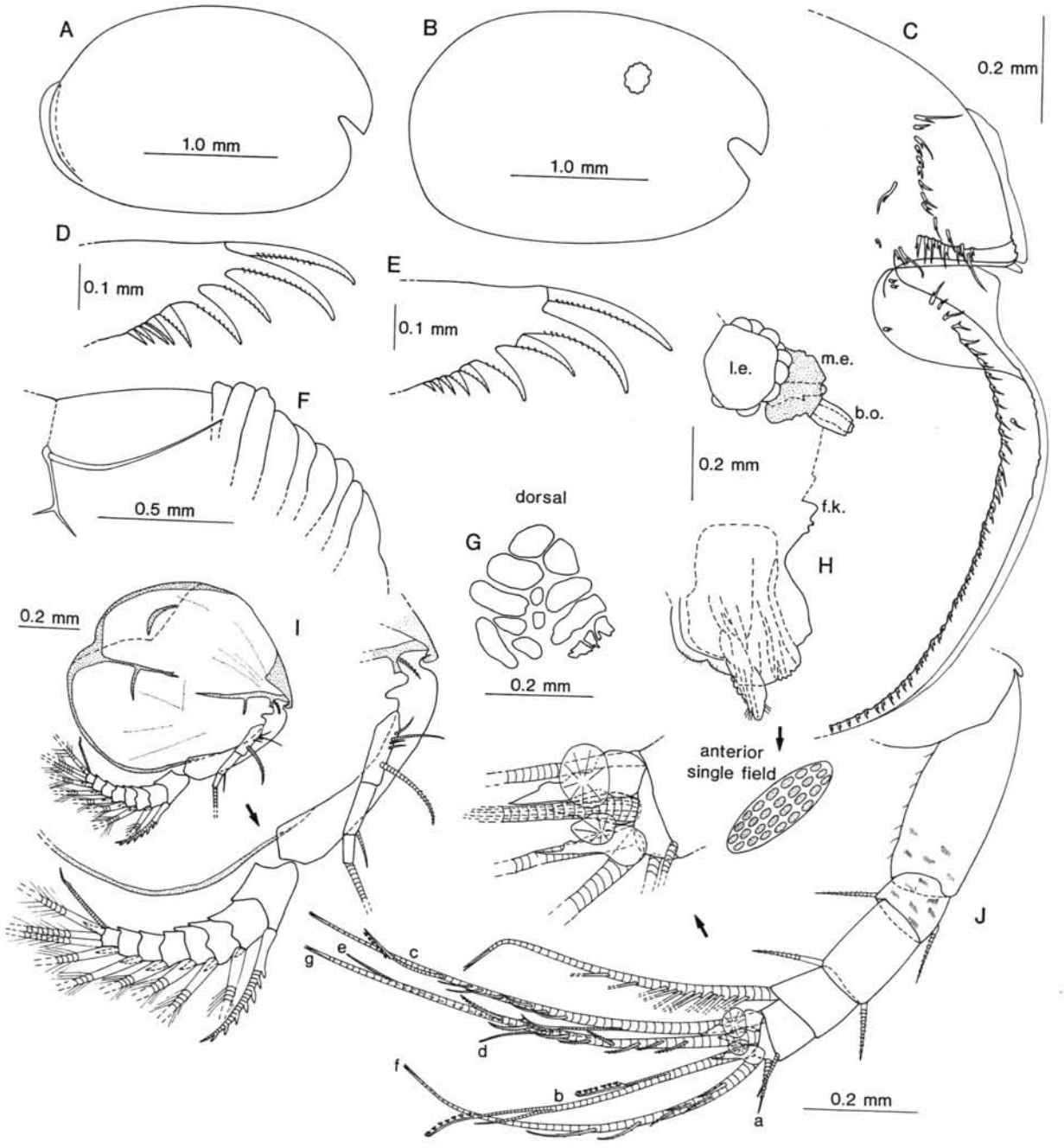
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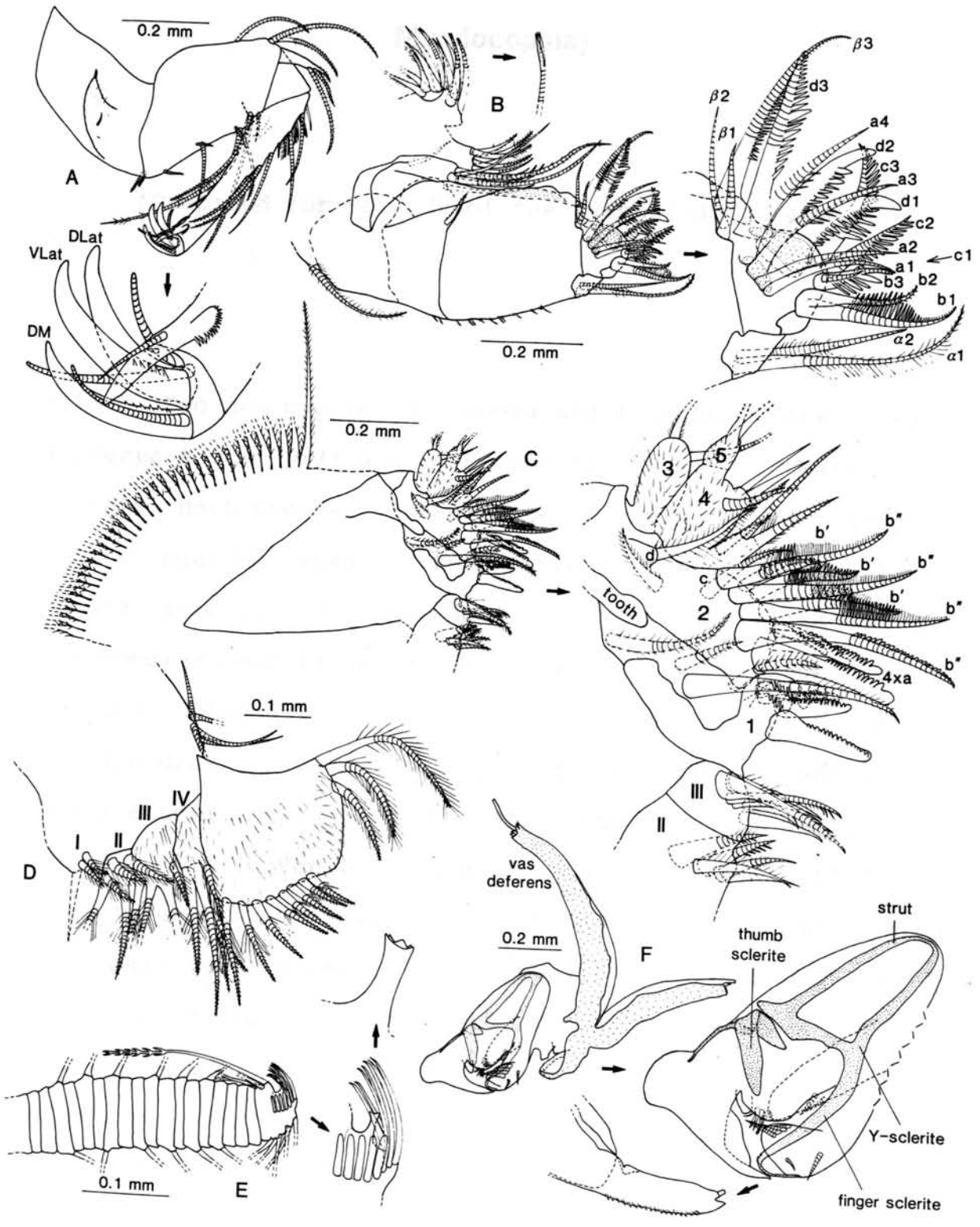
FIGURE 2. *Vargula karamu*: A, male LT mandible, M view (a-seta of third endopodial article not shown); B, female LT fourth limb, Lat view (not all endite setae shown); C, female LT fifth limb, anterior view (endite I not shown); D, male RT sixth limb, M view; E, tip of male seventh limb (setae with 2-6 bells) showing comb teeth and peg; F, male copulatory apparatus, posterior view, showing LT eighth "limb" and tip of hood.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2.3 Two new cypridinid genera and species from New South Wales, Australia (Crustacea: Ostracoda: Myodocopina)

(Prepared for Records of the Australian Museum)

ABSTRACT. Two new cypridinid genera and species (*Cohenia taiti* and *Lowrya kornickeri*) are described from New South Wales, Australia. Both species are scavengers. They bear very large "suckers" near the base of the c-setae of the adult male first antennae, arising from cup-shaped processes. The males of these species bear large compound eyes with very large dorsal ommatidia. *Cohenia* is defined by the presence of trichocoels, which are unusual concave sensilla of the carapace, and a concave anterior margin of the left rostrum only. *Lowrya* is defined by the presence of an additional small "sucker" distal to the large basal "sucker" on the basal setule of the b-seta of the male first antenna. The possession of exceptionally large male "suckers", and their locations between the long setae and setules of the first antennae, in *Cohenia* and, in particular, *Lowrya*, provides evidence against their previously regarded function as suctorial organs.

Introduction

Cypridinids dominate, at the species level, the modern myodocopin (Ostracoda) fauna. Cohen (1982) reported 24 genera and about 100 species worldwide in the Cypridinidae. Since 1982 about 60 additional species of cypridinids have been described. About a third of the world's known cypridinids are from Australian seas.

Only a few species of cypridinids have previously been reported as scavengers (Sars, 1922; Collins *et al.*, 1984; Stepien & Brusca, 1985; Cohen, 1983; Vannier & Abe, 1993).

The Australian Museum has conducted extensive trapping of scavenging crustaceans in eastern Australian seas from 1986 to 1995 (the SEAS, Scavengers of Eastern Australian Seas, Project). Scavenging cypridinids were present at all depths, and down to about 100 m depth they numerically dominate the scavenging guild, with numbers of individuals reaching to 75,000 per trap (J.K. Lowry, personal communication). The two species described herein were caught during the above trapping program, using single chamber traps designed by Keable (1995). These taxa belong to the family Cypridinidae because: they have seven pairs of limbs, the seventh limbs are vermiform; they bear compound eyes, a well-developed mandibular exopodite, and strong pectinate setae on the exopodite of the fifth limb; adult males possess large and small "suckers" on their first antennae; they lack gills, a large squarish tooth on the second article of the fifth limb exopodite, and male mandibular pincers. They belong in the subfamily Cypridininae because the number of claws on each furcal lamella falls

between 4 and 15, and they bear lateral eyes with ommatidia. Within the Cypridininae, they belong in the tribe Cypridinini, because their carapace valves are united only along their dorsal and posterodorsal margins and are less than 8 mm long. The distribution of small "suckers" on the non-basal setules of the b- and c-setae of the adult male first antennae of both *Cohenia* and *Lowrya* indicates that these genera belong in the *Cypridina* group within the Cypridinini.

Skogsberg (1920) considered the "suckers" (although possibly olfactory organs; Kornicker, 1983) of the adult male first antennae, and the endopodite of the adult male second antenna, to be "the most noteworthy" in classifying the Cypridinidae. Kornicker (1983) illustrated the different types of "sucker" arrangements on the first antennae of adult male cypridinids, and their use in grouping genera. The exceptionally large size of the basal "suckers", and their extrusion from a separate cup-like basal section, of the c-setae on the adult male first antennae, are characters unique to *Cohenia* and *Lowrya* (*Lowrya* bears the largest "sucker").

Cohenia and *Lowrya* have an unique rectangular carapace shape, with a red colouration on the rostrum due to strong sclerotization, and also bear some halophores (setules on the first antennae; Chapter 5) with spines, and some mandibular claws with very long spines. A very broad fourth furcal claw, and elongate frontal knob are also present in both genera.

Cohenia is distinguished from *Lowrya* by the presence of trichocoels (Chapter 3); concave sensilla forming a row on the external carapace surface parallel with the anterior, ventral and posterior carapace margins. *Cohenia* also uniquely exhibits

a concave margin of the left carapace rostrum only, with strong sclerotization in the corresponding supplementary region of the right carapace rostrum. *Lowrya* is characterized by the presence of a small "sucker" distal to the larger, usual "sucker" of the basal setule of the b-seta of the male first antenna.

Descriptions have been generated from the taxonomic data base program DELTA (Dallwitz *et al.*, 1993). Material is lodged in the Australian Museum, Sydney (AM), the National Museum of Natural History, Washington D.C. (NMNH) and the Natural History Museum, London (BMNH).

Abbreviations used in the following descriptions and figures are: D = dorsal, V = ventral, L = length, H = height, RT = right, LT = left, M = medial, Lat = lateral, DM = dorsomedial, VM = ventromedial, DLat = dorsolateral, VLat = ventrolateral, N = number of specimens examined, x = times.

Systematics

Myodocopina

Cypridinidae

Cohenia n.gen.

Diagnosis. Almost rectangular carapace (with rounded corners); red colouration on rostrum due to strong sclerotization. Presence of trichocoels (concave sensilla, Chapter 3), forming row on the external carapace surface parallel with anterior,

ventral and posterior carapace margins. Concave anterior margin of left carapace rostrum; anterior margin of right carapace rostrum convex, strongly sclerotized in supplementary region. First antenna: relatively short b-, c-, f- and g-setae; very large basal "sucker" of c-seta on adult male first antennae, arising from separate cup-like basal section; only non-terminal halophores (setules on first antennae, Chapter 5) of male f-seta with small spines. Second antenna: endopodite with 3 articles, second article with long distal seta; second exopodial article with medium-short, thin spine mid-way along ventral margin; large ventral spines and small distal medial spine on seta of second exopodial article; third exopodial article seta with broad proximal spines. Mandible with three broad terminal claws (of similar length), dorsolateral and ventrolateral mandibular claws with very long spines. Fourth and fifth limbs: many terminal setae with large spines. Fourth limb: 1 α-seta (with many setules) and 2 β-setae. Fifth limb: medium sized terminal process on fifth exopodial article, with long terminal spines forming a triangular process. Sixth limb: terminal article short and approximately triangular. Seventh limb: few non-terminal and terminal setae; few terminal long and short teeth; base of peg recessed from edge of limb. Male copulatory "limb": hood with medium-broad peak with an abrupt joint near inner edge of limb. Furca: very broad fourth claw; claws 2 and 4 fused to lamella. Frontal knob: elongate. Upper lip: single unpaired field of nozzles; short tusks. Posterior of male body: without dorsal folds.

Type species. *Cohenia taiti* n.sp.

Species composition. *Cohenia* contains only *C. taiti* n.sp.

Etymology. In honour of Anne C. Cohen, myodocopid ostracod expert, who introduced ostracod taxonomic techniques to the author.

Remarks. *Cohenia* is most closely related to *Lowrya* (*Cohenia* bears trichocoels and a concave margin of the rostrum of the left carapace valve, and *Lowrya* bears a hump on the ventral margin of its furcal lamellae and an additional sclerite in the outer lobe of the male copulatory "limb"). Apart from the above diagnostic characters, *Cohenia* is similar to *Vargula* Skogsberg, 1920, which has an upper lip with tusks without lobes, s-seta (formerly the sensory seta of the fifth article, Chapter 5) of first antenna with longest halophores positioned proximally, endopodite of second antenna with three articles, the second article with a seta, and a small process on the fifth article of the fifth limb. It can be noted that *Vargula subantarctica* Kornicker, 1975, for example, also bears some halophores with spines, and males of *V. psydrax* Kornicker, 1994, bear a first antenna with an almost cup-like process at the base of the c-seta, although the "sucker", which is not as well developed as in *Cohenia*, does not arise from this process. However, *Vargula* is polyphyletic and requires reorganisation (Cohen & Morin, 1990). *Cohenia* bears only one α-seta on its fourth limb, a character shared with *Kornickeria* Cohen & Morin, 1993, although these two genera have very different carapace shapes. The sclerotization of the rostrum, forming lateral processes, and the concave anterior rostral

margin, although only on one valve in *Cohenia*, are most similar to those of *Paracypridina* Poulsen, 1962, and to some extent *Heterodesmus* Brady, 1866, although *Cohenia* is separated from these genera by the possession of an endopodite of the second antenna with three articles. *Cohenia* is most similar to the monotypic genus *Sheina* Harding, 1966. Both genera bear very large "suckers" on the c-setae of the male first antennae, which appear to be morphologically similar (arising from a basal cup-like process). These two genera are only known from eastern Australia. *Cohenia* differs from *Sheina* in its carapace and furca shapes, and in that it bears a well-developed coxal endite on its mandibles, the c-seta (lateral seta) of the terminal endopodial article of the mandible lacks a dorsal hirsute pad.

Cohenia taiti n.sp.

(Figures 1-4)

Type locality. Off Providential Head, Bate Bay, NSW, Australia (34°07'S 151°10'E); baited trap set overnight at 46 m depth. Collected by J.K. Lowry, S.J. Keable and A.R. Parker on M.V. Krista, 14-15 January 1991. Total of 70 *Cohenia* sp. caught in trap (62 males), in addition to 11 other species of cypridinid ostracods, 3 species of cirolanid isopods, 3 species of lysianassoid amphipods, and 1 species each of a nebaliacean, gastropod and a polychaete. Undescribed species of the cypridinid ostracods *Paradoloria* (926 individuals), *Vargula*

(860) and *Cypridinodes* (464) constituted the dominant scavenging species.

Type material. HOLOTYPE: AM P44618, adult female. PARATYPES: AM P44619, adult male; AM P45529, adult female; AM P45530, adult male; AM P45531, 3 adult males (undissected); BMNH 1995:1601-1602, 2 adult males (undissected); NMNH, 2 adult males (undissected).

Other material examined. AM P45532, adult male, cleaned using ultrasound, critical point dried, mounted on a scanning electron microscope (SEM) stub, and coated with gold (examined in a SEM).

Description of adult female characters.

COLOUR OF LIVING OSTRACODS. Beige with a red area above the incisure.

CARAPACE. Holotype: L = 1.27 mm, H = 0.81 mm; L/H = 1.57. Paratype: L = 1.36 mm, H = 0.91 mm; L/H = 1.49.

Shape: almost rectangular with rounded corners, very slightly protruding keel; margins straight for much of length dorsally, slightly rounded ventrally. Keel joined by slight D concave curve to curved posterior margin of valve; D edge of keel at about midheight of valve; D edge of incisure slightly overlapping V edge at inner end, line on outer surface of valve curving from inner D edge of incisure to anterior margin of valve (V to incisure) is faint. Tip of rostrum rounded; with smooth adjacent margins.

Valve surface smooth at low magnification, but with scale-like pattern visible on anterior margins with light

microscope at 100 x; setae on valve surface medium sized and scattered evenly; 9 *muscle scars*, forming a triangle with smaller scars inside triangle.

Infold: infold posterior to rostrum with row of 11 setae, double type, parallel to valve margin, 9 of these setae are D to incisure; 1 seta posterior to carapace infold row, double type; 4 setae anterior to carapace infold row, double type. Posterodorsal edge of incisure without setae. Posterior to D inner corner of incisure with 1 seta, double type. Sclerotized ridge (list) D to incisure forming an angular shape within rostrum (point of angle near rostral tip), more strongly sclerotized section nearest incisure. Sclerotization of rostrum very strong, resulting in external Lat processes on rostrum. Anteroventral infold, near inner corner of incisure, with 6, medium L, double setae; posterior edge of carapace infold without setae. Infold parallel to anteroventral/ventral margin with 26 setae, double type, 4 of these setae in the region V to incisure, diminishing in L posteriorly; 1 seta anterior to anteroventral/ventral row, no setae posterior to row. LT valve with 30 setae parallel to anteroventral/ventral margin. In vicinity of keel, list remains constant in width, forming a shallowly curved narrow smooth ridge; keel infold simple. Ridge of keel unornamented except for minute short setae or papillae emerging from unrimmed pores, and without setae; list of LT valve ending in pronounced D knob, without processes. RT valve with posterior margin of keel possessing no setae, with few minute setae or papillae emerging from pores; D margin of keel with pronounced projection.

Lamellar prolongation of *selvage*: narrow along rostrum;

along lower margin of incisure selvage is broad and striated; along V margin selvage is narrower, terminating posteroventrally. Trichocoels forming rows near carapace margins present: 5-6 in rostral row, 4-5 in incisure row, 32-34 in V row, 5-6 in keel row; total of 46-51.

FIRST ANTENNA. *First article* bare. *Second article* with M spines forming rows, and spines on V and D margins. *Third article* very short and slightly trapezoid, without M spines, setae of 3rd and 4th articles ringed with short spines; third article with 1 slightly longer and stouter V seta, distally, and 1 D seta, just proximal to middle. *Fourth article* with 1 D seta, longer than D seta of 3rd article, and 1 V seta, sub-terminally, longer than V seta of 3rd article. *Fifth article*: s-seta with 10 proximal halophores, halophores long and bare; distally 2 non-terminal halophores, more slender and shorter. *Sixth article* with short bare and ringed M seta near D margin. *Seventh article*: a-seta short (shorter than seta of 6th article), stout and ringed with few distal spines; b-seta short, thin, ringed and bare; c-seta long and ringed, with 6 non-terminal halophores, halophores slender and bare. *Eighth article*: d- and e-setae (including terminal halophores) much longer than b-seta, bare and filamentous; f-seta shorter than c-seta, with 4 non-terminal halophores, halophores without ornamentation; g-seta of similar length to c-seta, with 3 non-terminal halophores, halophores without ornamentation. Bifurcate tips (2 terminal halophores) present on c-, f-, g- and s-setae.

SECOND ANTENNA. *Endopodite* with 3 articles. *First article* with 4 proximal setae; 2 short, 2 long. *Second article*

elongate, with terminal long bare seta. *Third article* longer than 2nd article; terminal seta very long. *Exopodite*: *second article* bearing seta with tip reaching to about article number 8, bearing 9 V spines, of which most proximal spine is much smaller than others, and no D spines; medium-short thin spine on V margin of article. *Articles 3-8* with basal spines becoming longer centrally, and with plumose natatory setae, spines present on seta of 3rd article only; V spines of seta of 3rd article short and stout proximally, becoming thin distally. Lat spine of *ninth article* of similar length to that of fifth article. Ninth article with 4 setae; 2 long with natatory setules; 1 thinner, shorter and bare; 1 very short, thin and bare.

MANDIBLE. *Coxal endite* spinous; seta near base short, ringed and bare; 2 terminal setae, ringed and bare. Setae on V margin of *basis*: longest M a-seta short-medium long and bare, and about 2 x longer than shortest seta; shortest a-seta bare; Lat b-seta medium length and bare, positioned closer to c-setae than a-setae; longest c-seta long and bare; shortest c-seta short and bare; longest d-seta much longer than basis, with rings of long spines; shortest d-seta much less than 0.5 x L of basis, and bare; space between c- and d-setae much larger than space between c-setae. Distal part of D margin of basis with 3 setae; 1 more proximal seta, medium length and bare, and 2 subterminal setae, subequal in L, long with short spines. *Exopodite* of similar length as 1st endopodial article; M surface smooth; D process with few short spines, extending to a rounded tip, and with 2 V setae, of which the longest seta is long, with short spines. *Endopodite*: *First endopodial*

article with 3 V setae; a-seta absent, b-seta medium length and spinous, c-seta long and bare, d-seta long with rings of long spines. *Second endopodial article* long, thin, and slightly tapered; spines (in rows) on M surface are short and straight or slightly crescent shaped; D margin with 11 setae; 1 a-, 1 b-, 1 c-, 2 d-setae; d-setae longest; d-setae long with short spines; 5 DM shorter setae, of which there are no short, stout and unringed M setae with long stout spines; and 1 seta distal to d-setae. V margin with few short spines, and 3 setae proximal to finger; no very short fine setae on V margin at base of finger. Finger seta about 60% L of finger. Finger long, slender with wide base, curved with rounded tip and unringed. *End article* with 3 claws; claws all similarly curved and of approximately equal L; longest claw longer than finger; DM (middle) claw shortest and thinnest, tapered, with an almost pointed tip, without spines; VLat claw longest, proximally stout, distally tapered, with a rounded tip, bearing 1 minute spine; DLat claw slightly shorter than VLat claw, proximally stout, distally tapered, with a rounded tip, bearing 5 very long spines. End article with 4 setae; VM a-seta short, tapered, with an almost pointed tip; VLat b-seta medium L, broad and slightly tapered, with a rounded tip; VM c-seta very long, untapered, with a rounded tip; DLat d-seta long, tapered, with an almost pointed tip; c-seta longest; a-seta shortest.

FOURTH LIMB. *Endite I* with 9 setae; *endite II* with 5 setae; *endite III* with 4 setae; trifid tips present on a few endite setae. *Coxa* with long D seta with many setules. *Basis* with no Lat setae, and 2 M setae. *Exopodite* bare, with 1

proximal seta, which is long with many setules; and 2 terminal setae, which are long with proximal spines. *Endopodite*: *first endopodial article* approximately rectangular, and bare; cutting tooth large, with 3 cusps, cusps squarish in shape, partial suture or cutting edge separating proximal part from rest of cutting tooth present. 1 α-seta; α1-seta very long with distal setules. 2 β-setae; β2-seta medium length and bare, β3-seta very long and denticulate. *Second endopodial article* much narrower than 1st article, with 4 a-setae, dissimilarly curved: a1-seta thin with a widened base, medium length and bare, distally ringed; a2-seta thin with a widened base, long and bare, ringed throughout most of length; a3-seta thin with a widened base, long and bare, ringed throughout most of length; a4-seta thin with a widened base, long and bare, distally ringed. 3 b-setae: b1-seta medium width, medium L and denticulate, ringed throughout most of length, with 6 teeth, teeth medium broad, of medium length and present distally; b2-seta medium width with a widened base, medium L and denticulate, unringed, with 11 teeth, teeth narrow, short and present distally; b3-seta (most posterior) claw-like, medium L and denticulate, unringed, with 2 teeth, teeth very broad, long and present centrally. 3 c-setae: c1-seta (most anterior) very thin, short and bare, ringed throughout most of length; c2-seta broad, medium L and denticulate, ringed throughout most of length, with 10 teeth, teeth medium broad, long and present along most of setal length; c3-seta broad, long and spinous, ringed throughout most of length, with 10 teeth, teeth medium broad, long and present along most of setal length. 3 d-setae: d1-seta claw-like, long and

denticulate, unringed, with 3 teeth, teeth very broad, of medium L and present centrally; d2-seta claw-like, long and denticulate, unringed, with 5 teeth, teeth broad, long and present centrally, of these teeth 2 are large, and positioned distally on the anterior side of the d2-seta; d3-seta thin with a widened base, long and denticulate, distally ringed, with 10 teeth, teeth medium broad, long and present distally, of these teeth 2 are large, and positioned proximally on the anterior side of the d3-seta.

FIFTH LIMB. With 40 *epipodial setae*. Anterior distal tooth of *Protopodite* with rounded tip. *Endite I* with 6 setae; *endite II* with 6 setae; *endite III* with 6 setae. *First exopodial article*: posterior row of 6 pectinate teeth; tooth 1 (smallest, most posterior) with 7 cusps, tooth 2 with 7 cusps, tooth 3 with 8 cusps, tooth 4 with 9 cusps, tooth 5 with 10 cusps, tooth 6 with 12 cusps; peg large, and triangular; peg-seta medium L, stout, and with setules throughout length, peg-seta about same L as longest tooth. Anterior side of article with row of 3 setae; 1st-seta (inner) medium length, medium width, and with setules throughout length; 2nd-seta long, medium width, and with distal setules; 3rd-seta long, medium width with a broadened base, with many setules and distal spines. Additionally 1 more proximal anterior seta on 1st exopodial article, close to protopodite; proximal anterior seta medium L, thin, and with setules throughout length. *Second exopodial article*: with 4 a-setae, a-setae claw-like, and coarsely pectinate; 7 b-setae, b-setae medium L to long, and most ringed (posterior row of 3 b'-setae, anterior row of 4 b"-setae); posterior c-seta ringed throughout most of

length, and with distal spines; anterior d-seta unringed, and setose. Inner lobe of *third exopodial article* with 3 setae; most proximal seta very short, unringed, and bare; subterminal seta long, distally ringed, and bare; terminal seta medium L, distally ringed, and bare. Outer lobe of 3rd exopodial article hirsute, with 2 setae; outer seta medium L, unringed, and with proximal setules. *Fourth* and *fifth exopodial articles* fused, with many very fine setae. Fourth article with 1 medium broad seta. Fifth article with 2 medium broad setae, subequal in L, unringed, and spinous. Terminal process on inner 5th article medium sized with long spines and a group of spines forming a triangular sub-process.

SIXTH LIMB. With 5 setae in place of *epipodite*, these setae are bare and ringed. *Endites* with M setae. Endite setae: *I* = 3; 1 long, distally ringed, with short distal setules, and without spines; 2 very short, medium width, ringed, with short setules, without spines. *II* = 5 setae; 2 long, distally ringed, with long proximal setules and short distal spines; 3 medium short, medium width with broad base, ringed, with long setules, without spines. *III* = 3 setae; 2 long, distally ringed, with long proximal setules and short distal spines; 1 medium short, thin with broad base, ringed, with long proximal setules and without spines. *IV* = 2 setae; 1 very long, distally ringed, with long central setules and short distal spines; 1 medium long, thin with broad base, ringed, with long central setules and without spines. Endites separated from each other and rest of limb by sutures or grooves. *Terminal article* slightly triangular, basally separated by suture or groove from rest of limb; M surface with many long fine setae;

Lat surface with rows of stout long setae along V margin. 5 anterior V terminal setae, with broad bases abruptly constricting to a narrow distal width, distally ringed, with long proximal setules and long distal spines; setae of terminal article reducing evenly in length from most anterior seta to most posterior, with bases on margin of article; gap posterior to anterior V terminal setae long, including a rounded corner and a small anterior recess, gap = about 35% V L of terminal article, followed by 3 posterior setae, mostly unringed, some with bases on edge of article, some with bases set back from edge, the longest is the most posterior; the most anterior is medium L, with a broad base abruptly constricting to a narrow distal width, with long proximal setules and long distal spines.

SEVENTH LIMB. Total of 9 setae. *Comb side* with 1 nonterminal seta, and 3 terminal setae; minimum number of bells on setae = 4, maximum number of bells on setae = 6. *Peg side* with 2 nonterminal setae, and 3 terminal setae; minimum number of bells on setae = 4, maximum number of bells on setae = 6. *Comb* of 3 long teeth on each side, coarsely biserrate, with rounded tips, central tooth slightly longer than others; 2 short teeth on each side, medium L, with square tips, and deep grooves. *Peg* medium L, slightly curved, narrow; tip of peg similar width to centre of peg, with many points; base of peg recessed from outer limb edge.

FURCA. Left lamella with 7 claws, RT lamella with 7 claws; claws 2 and 4 fused to lamella; claw 3 shorter and thinner than claw 4; claw 1 long and medium wide; claw 4 exceptionally broad; claw 5 short and thin; anterior claws

short and thin; claws generally increasing in size posteriorly (with exception). Claws generally evenly curved, four most posterior claws with spines; distal M spines of most posterior claw absent. Lamellae elongate, tapered and bare.

ANTERIOR OF BODY. *Bellonci organ*: shape (non-extended) is square; L (non-extended) = 0.03 mm; width similar to length; slightly pigmented.

Eyes: *medial eye* medium sized; L = 0.04 mm; pigmented. *Lateral eye*: L = 0.18 mm; large (about 20 x size of medial eye); broadest dorsally; with at least 16 ommatidia, largest ommatidia located dorsally; ommatidia light amber in transmitted light, matrix between ommatidia maroon in transmitted light.

Upper lip: single undivided process directed anteroventrally, V field of process pear-shaped, with about 18 valves; valves large, and arranged in about 3-5 anterior-posterior rows on a single plane; anterior process bare. Pair of L *tusks* short, medium width with parallel margins, each with 1 valve, valves medium sized, positioned terminally; tusks without setae and without spines; spurs on tusks absent; tusks terminating at a rounded posterior corner. Upper lip pigmented.

Frontal knob very large, rounded, width less than L; without projections V to frontal knob.

POSTERIOR OF BODY. Dorsal folds replaced by muscle bands. *Y-sclerite* with V branch shorter than 50% L of D branch.

Description of adult male characters.

Most characters common to both sexes have been omitted

from the following description.

CARAPACE. L = 1.12 - 1.20 mm (N = 9), H = 0.80 mm; L/H = 1.5. Trichocoels: 4 in rostral row, 3 in incisure row, 27 in ventral row, 4 in keel row; total of 38.

FIRST ANTENNA. *Fifth article*: s-seta with 7-9 bare proximal halophores (most proximal 5-7 halophores longest and separated by a small gap from more central 2 halophores), and 2 shorter, bare, distal non-terminal halophores. *Seventh article*: b-seta with basal setule with bulbous base, large proximal "sucker" (transparent), without non-terminal halophores, additionally 2 setules present, each bearing 7 small "suckers", small process just proximal to most proximal "sucker" present; c-seta with bulbous base with large basal setule with sub-terminal process, and additional cup-shaped basal process from which a large "sucker" (diameter greater than width of each of the distal five articles; transparent) arises, 6 short and slender non-terminal halophores, additionally 2 proximal setules, each bearing 6-7 small "suckers", small process just proximal to most proximal "sucker" present. *Eighth article*: f-seta with 5 non-terminal halophores, with short spines; g-seta with 11 non-terminal bare halophores.

COPULATORY "LIMB". *First article*: *Y-sclerite* prominent; *strut* present so that the sclerite forms an irregular rectangular loop; loop broader distally; *finger sclerite* medium wide, terminating at distal tip of finger branch. *Inner lobe* elongate with rounded tip. *Finger branch* and *setal branch* separated by a deep terminal cleft; tip of finger branch with many minute scales. Terminal and cleft region of setal branch

bears minute scales; external surface of setal branch with 6 setae, ringed and bare. *Outer lobe* with *thumb sclerite* terminating at D hood edge; *thumb* big and bare, located proximally on thumb sclerite, near hood; thumb with 3 ringed, bare setae, located proximal to tip of thumb sclerite. *Hood*: dorsoventral margin medium L, distally triangular, with an anterior step-like constriction, becoming a finger-like lobe; L anterior peak small; tip of hood complete, with few minute scales or spines. Hood extends less than half way over inner lobe. *Central lobe*: width > 50% and L = about 50% of that of inner lobe. The central lobe bears 3 terminal setae, which are ringed and spinous.

ANTERIOR OF BODY. *Lateral eye*: very large, L = 0.20 mm; broadest dorsally; at least 16 ommatidia (7 large, of approximately equal size; about 9 small, of approximately equal size), largest ommatidia located dorsally.

Etymology. This species is named in honour of Noel N. Tait, invertebrate zoologist, who provided the author with much invaluable advice on zoological subjects.

Myodocopina

Cypridinidae

***Lowrya* n.gen.**

Diagnosis. Almost rectangular carapace (with rounded corners), red colouration on rostrum due to strong sclerotization. Trichocoels (Chapter 3) absent. Anterior margins of rostrum of

left and right carapace valve similar. First antenna: relatively short b-, c-, f- and g-setae; basal setule of b-seta of adult male with a small "sucker" distal to larger "sucker"; extremely large basal "sucker" of c-seta of adult male, arising from separate cup-like basal section; small "suckers" of non-basal setules of adult male b- and c-setae bear widened, almost cone-shaped, shafts; male with many halophores (setules on the first antennae, Chapter 5) of the f- and g-setae, and most proximal halophores of the c-seta, bearing small spines, most proximal five halophores of the s-setae (formerly the sensory seta of the fifth article, Chapter 5) bearing large proximal spines. Second antenna: endopodite with three articles, second article with a long distal seta, third article very narrow; second exopodial article with a medium-short, thin spine mid-way along ventral margin; large ventral spines on seta of second exopodial article; seta of third exopodial article with long, thin, proximal spines; ninth exopodial article with two setae. Mandible: with distal spines on ventral margin of second endopodial article; 3 broad terminal claws (of similar length) on third endopodial article, dorsolateral and ventrolateral mandibular claws with very long spines, dorsomedial claw with few short spines. Fourth and fifth limbs: many terminal setae with large spines. Fourth limb: one α-seta, with many setules, and two β-setae. Fifth limb: large terminal process on fifth exopodial article, with long terminal spines. Sixth limb: terminal article short and approximately square. Seventh limb: few non-terminal and terminal setae; few terminal long and short teeth; base of peg recessed from edge of limb. Male copulatory "limb": hood with

narrow peak with an abrupt joint near outer edge of limb; outer lobe bears a thumb sclerite forming the edge of a triangle, with an extended tip, along with an additional sclerite. Furca: very broad fourth claw; claws 2 and 4 fused to lamella; claw 1 with broad distal medial spines; lamellae with a hump along ventral margins. Frontal knob: elongate. Upper lip: single unpaired anteroventral field; short tusks. Posterior of male body: without dorsal folds.

Type species. *Lowrya kornickeri* n.sp.

Species composition. *Lowrya* contains only *L. kornickeri* n.sp.

Etymology. In honour of James K. Lowry, carcinologist, who discovered new guilds of scavenging crustaceans off Australia with unusual compositions, including high proportions of cypridinids.

Remarks. *Lowrya* is most closely related to *Cohenia* (see remarks for *Cohenia*). *Lowrya* is similar to *Vargula* (for reasons similar to those of *Cohenia*), although differs in that it bears only two setae on the ninth exopodial article of the second antenna. *Lowrya* also has the characters which *Cohenia* shares with *Kornickeria*, *Paracypridina*, *Sheina* and *Heterodesmus*, but again *Lowrya* is separated from these genera for similar reasons as *Cohenia*. Additionally, the b-seta of the third endopodial article of the left female *Lowrya kornickeri* mandible (paratype), curves in the opposite direction to that of the male and right female limb, forming a

"pincer" with the other terminal mandibular claws and setae. This arrangement is shared with species of *Kornickeria*, for example, but also *Sheina*, which has a developed tip of this b-seta. However, this arrangement in *Lowrya* is either variable, or a consequence of mounting on a slide (only found on one limb of one specimen, although this was the only female examined).

Lowrya kornickeri n.sp.

(figures 5-7)

Type locality. Collected from east of Grotto Point, Port Jackson, NSW, Australia (33°49.05'S 151°15.92'E); baited trap set overnight at 11 m depth. Collected by P. Berents, A.R. Parker, K.B. Attwood and A. Murray on M.V. Sula, 25-26 November 1993. In addition to *Lowrya kornickeri*, a second species of *Lowrya* (AM P45071, significantly larger in size and both males and females with a smaller compound eye) and an undescribed species of *Skogsbergia* (AM P45070) (Cypridinidae), and unidentified cirolanid isopods and lysianassoid amphipods were caught. Only a small (representative) proportion of this trap sample was made available (this study was not the primary purpose of the trapping), therefore relative abundances are unknown.

Type material. HOLOTYPE: AM P45463, adult male. PARATYPES: AM P45465, adult male; AM P45464, adult female; AM P42244, adult

male; BMNH 1995:1603, adult male (undissected); NMNH, adult male (undissected).

Description of adult male characters.

COLOUR OF LIVING OSTRACODS. Beige with a red area above the incisure.

CARAPACE. L = 1.24 mm, H = 0.82 mm; L/H = 1.51. Range of L = 1.22 - 1.28 mm (N = 4).

Shape: almost rectangular with rounded corners, very slightly protruding keel; margins slightly rounded, posterodorsal margin more steeply sloped than anterodorsal margin. Keel joined to curved posterior margin of valve by smooth convex curve; D edge of keel slightly below midheight of valve; D edge of incisure slightly overlapping V edge at inner end, prominent line on outer surface of valve curving from inner D edge of incisure to anterior margin of valve (V to incisure). Tip of rostrum rounded, with few small anterior bumps.

Valve surface: smooth at low magnification, but with faint scale-like pattern visible on anterior margins with light microscope at 100 x; setae on valve surface medium sized and scattered evenly; 9 *muscle scars*, forming a circle.

Infold: infold posterior to rostrum with row of 8 setae, double type, at an angle to valve margin, all D to incisure; no setae anterior or posterior to carapace infold row. Dorsal edge of incisure with 4 single setae. Dorsal to D inner corner of incisure with 1 double seta, at an angle with incisure margin. Sclerotized ridge (list) D to incisure at an angle with incisure margin; sclerotization strong, causing red

colouration (after preservation) of D incisure margin. Anteroventral infold, near inner corner of incisure, with 5 double setae (2 medium length, 3 short); posterior edge of carapace infold without setae. Infold parallel to anteroventral/ventral margin with 21 double setae; 3 in the region V to incisure; diminishing in length posteriorly; no setae anterior or posterior to anteroventral/ventral row. List becomes broader in vicinity of keel, forming a shallowly curved wide smooth ridge; keel infold simple. Ridge of keel unornamented except for minute short setae or papillae emerging from unrimmed pores, without setae; list of LT valve without D knob, and without processes. RT valve with posterior margin of keel without setae, with few papillae emerging from pores; D margin of keel without process.

Lamellar prolongation of *selvage*: medium width along rostrum; very broad and striated along lower margin of incisure; narrower along V margin; terminating anteroventrally. Trichocoels (Chapter 3) absent.

FIRST ANTENNA. *First article* bare. *Second article*: many M spines forming rows, and spines on V and D margins. *Third article*: short, without M spines; with V seta of approximately equal L to D seta, positioned distally; 1 D seta at base of article. *Fourth article*: 1 D seta, of approximately equal L to D seta of 3rd article; 1 V setae, positioned terminally, shorter than V seta of 3rd article; setae of 3rd and 4th articles ringed with short spines. *Fifth article*: s-seta with 7 long proximal halophores, some with proximal spines; distally 2 non-terminal halophores, more slender and shorter. *Sixth article*: short, bare and ringed M seta near D margin.

Seventh article: a-seta medium length, stout and ringed with few distal spines; b-seta short, with basal setule with bulbous base, large proximal "sucker" (transparent) and small distal "sucker", without non-terminal halophores, additionally 2 setules present, each bearing 8-9 small "suckers", small process just proximal to most proximal "suckers" absent; c-seta long and ringed with bulbous base with large basal setule with sub-terminal process, and additional cup-shaped basal process from which a very large "sucker" (diameter > width of each of the distal five articles; transparent) arises, with 7 short and slender non-terminal halophores, most proximal halophore with few short spines, additionally 2 proximal setules present, each bearing 8 small "suckers", small process proximal to most proximal "sucker" absent. Small "suckers" on the non-basal setules of the b- and c-setae bear widened, almost cone-shaped, shafts. *Eighth article* (very reduced or absent): d- and e-setae (including terminal halophores) longer than b-seta, bare and filamentous; f-seta shorter than c-seta, with 8 short non-terminal halophores, most with small proximal spines; g-seta shorter than c-seta and longer than f-seta, with 9 short non-terminal halophores, some with small proximal spines. Bifurcate tips (2 terminal halophores) present on c-, f-, g- and s-setae.

SECOND ANTENNA. *Protopodite*: long, bare seta. *Endopodite*: 3 articles. *First article*: 3 proximal setae; 2 short, 1 long, and no distal setae. *Second article*: elongate, with terminal long bare seta. *Third article*: longer than 2nd article and narrow; terminal seta long and unringed. *Exopodite*: *second article*: bearing seta with tip reaching to about 8th article,

bearing 7 V spines, most proximal spine is similar size to others, no D spines; medium-short thin spine on V margin of article. *Articles 3-8*: with basal spines becoming longer distally; natatory setae with many setules, thin spines present on seta of 3rd article only. *Ninth article*: Lat spine of similar L to that of 8th article; 2 setae, both long with natatory setules.

MANDIBLE. *Coxal endite*: spinous; seta near base short, ringed and bare; 2 terminal setae, unringed and bare. Setae on V margin of *basis*: longest M a-seta short-medium L, spinous, about 3 x longer than shortest seta; shortest a-seta bare; Lat b-seta short and bare, positioned very close to a-setae; longest c-seta long and bare; shortest c-seta short and bare; longest d-seta much longer than basis, with rings of long spines; shortest d-seta much less than 0.5 x L of basis, and bare; space between c- and d-setae much larger than space between c-setae. Distal part of D margin of basis: 3 setae; 1 more proximal seta, medium L and bare; 2 subterminal setae, subequal in L, with short spines. *Exopodite*: similar L as 1st endopodial article; M surface wrinkled; D process with many fine setae, extending to a pointed tip; with 2 V medium-broad setae, longest with short spines. *Endopodite*: *First endopodial article*: 3 V setae; a-seta absent, b-seta medium length and spinous, c-seta long and spinous, d-seta long with rings of long spines. *Second endopodial article*: long, very thin, and slightly tapered; spines (in rows) on M surface are long and straight; D margin with 11 setae; 1 a-, 1 b-, 1 c-, 2 d-setae; c-seta longest; d-setae long with short spines; 5 DM shorter setae (1 short, stout and unringed with long stout spines); 1

seta distal to d-setae; V margin with few long spines and 3 setae proximal to finger; no very short fine setae on V margin at base of finger. Finger seta about 60% L of finger; finger long, slender with wide base, curved with pointed tip and unringed. *Terminal article*: with 3 claws; claws all similarly curved and of approximately equal L; longest claw longer than finger; DM (middle) claw shortest and thinnest, tapered, with an almost pointed tip, bearing 5 spines of medium L; VLat claw midsize, proximally stout, distally tapered, with rounded tip, bearing 12 spines (6 medium length and proximal, 6 long and more distal); DLat claw slightly longer than VLat claw, proximally stout, distally tapered, with a rounded tip, bearing 12 spines (6 medium length and proximal, 6 long and more distal); 4 setae; VM a-seta short, tapered, with an almost pointed tip; VLat b-seta medium L, tapered, with rounded tip; VM c-seta very long, almost bulbous proximally, distally tapered, with unevenly curved tip, bearing many short spines; DLat d-seta long, tapered, with almost pointed tip; c-seta longest; a-seta shortest.

FOURTH LIMB. *Endite I* with 6 setae; *endite II* with 5 setae; *endite III* with 5 setae; trifid tips present on a few endite setae. *Coxa*: long hirsute D seta. *Basis*: no Lat setae, 3 M setae. *Exopodite*: bare; 1 proximal seta, long with many setules; 2 terminal setae, long with many setules. *Endopodite*: *first endopodial article*: approximately rectangular, uniformly spinous; cutting tooth large, with 2 squarish cusps, partial suture or cutting edge separating proximal part from rest of cutting tooth; 1 α-seta (α1), very long with many setules; 2 β-setae: β2-seta medium L and bare, β3-seta very long and

denticulate. *Second endopodial article*: much narrower than 1st article; 4 a-setae, dissimilarly curved; a1-seta broad with widened base, long with proximal spines, ringed throughout most of length; a2-seta thin with widened base, long with proximal spines, ringed throughout most of length; a3-seta thin with widened base, long with proximal spines, ringed throughout most of length; a4-seta very thin with widened base, medium L and bare, ringed throughout most of length; 3 b-setae; b1-seta medium width with widened base, long and denticulate, ringed throughout most of length, with 7 long medium-broad teeth, present proximally, and about 9 smaller distal spines; b2-seta medium width with a widened base, medium L and denticulate, ringed throughout most of length, with 6 broad teeth of medium length and present centrally; b3-seta (most posterior) claw-like, medium L, unringed, with 2 long, broad teeth, present centrally; 3 c-setae; c1-seta (most anterior) very thin, short and bare, ringed throughout most of length; c2-seta medium width with widened base, medium L, ringed throughout most of length, with 16 proximal broad teeth, longer proximally; c3-seta broad, long, ringed throughout most of length, with 15 long, broad teeth, present distally; 3 d-setae; d1-seta claw-like, medium L, unringed, with 6 long, broad teeth, present centrally; d2-seta claw-like, long, unringed, with 9 long, broad teeth, present centrally; d3-seta medium width with widened base, very long, distally ringed, with 35 medium-broad teeth, medium L proximally, decreasing in L distally, present along most of setal length.

FIFTH LIMB. 38 *epipodial setae*. *Protopodite*: anterior

distal tooth with rounded tip. *Endite I* with 6 setae; *endite II* with 6 setae; *endite III* with 7 setae. *First exopodial article*: posterior row of 6 pectinate teeth; tooth 1 (smallest, most posterior) with 5 cusps, tooth 2 with 8 cusps, tooth 3 with 8 cusps, tooth 4 with 9 cusps, tooth 5 with 9 cusps, tooth 6 with 10 cusps; peg large, triangular; peg-seta medium L, stout, with very long, thin proximal spines, peg-seta shorter than longest tooth; anterior side with row of 3 setae; 1st-seta (inner) very long, medium width with broadened base and distal spines; 2nd-seta very long, medium width with broadened base, very long, thin proximal spines and long and broad distal spines; 3rd-seta short, thin with broadened base, and with very long, thin proximal spines and long, broad distal spines; additionally 1 proximal anterior bare seta, very short, medium width with broadened base, close to protopodite. *Second exopodial article*: 4 a-setae, claw-like and coarsely pectinate; 5 b-setae, medium-long to very long, ringed, posterior row of 3 b'-setae, anterior row of 2 b"-setae; posterior c-seta unringed and bare; anterior d-seta distally ringed, with very long, thin proximal spines. Inner lobe of *third exopodial article* with 3 setae; most proximal seta short, unringed, with distal spines; subterminal seta long, ringed and bare; terminal seta medium-long, distally ringed, with distal spines. Outer lobe of 3rd exopodial article: with many very fine setae, 2 medium-broad setae; outer seta medium-long, distally ringed, with long thin proximal spines and short thin distal spines along outer margin only. *Fourth* and *fifth exopodial articles* fused, with many very fine setae. *Fifth article*: 2 setae, subequal in

length, ringed, spinous; terminal process large with long spines. *Fourth article*: 1 seta.

SIXTH LIMB. 3 bare and ringed setae in place of *epipodite*. *Endites* with M setae, separated from each other and rest of limb by sutures or grooves (except endites I and II, which are fused to rest of limb). Endite setae: *I* = 3; 1 very long, distally ringed, with long setules; 2 very short, medium width, ringed, with long setules and without spines; *II* = 5; 2 long, distally ringed, with long central setules and short distal spines; 3 medium short, medium width with broad base, ringed, with long setules; longest with short distal spines; *III* = 3; 2 long, distally ringed, with long central setules and with short distal spines; 1 medium short, medium width, ringed, without setules and with short spines; *IV* = 2, 1 very long, ringed, with long central setules and with short distal spines; 1 short seta, medium long, thin with broad base, distally ringed, with long central setules and without spines. *Terminal article*: square shaped, basally separated by suture or groove from rest of limb; M surface with many long very fine setae; Lat surface with rows of long spines; 5 anterior V terminal setae, with broad base abruptly constricting to narrow distal width, distally ringed, with long central setules and long distal spines, reducing evenly in length from most anterior seta to most posterior, with bases on margin of article; gap posterior to anterior V terminal setae medium L, including rounded corner, gap = about 20% V L of terminal article, followed by 3 ringed posterior setae, some with bases on edge of article, some with bases set back from edge, longest is posterior, most anterior setae long, with broad

base abruptly constricting to a narrow distal width, with long central setules and long distal spines.

SEVENTH LIMB. Total of 10 setae. *Comb side*: 1 nonterminal seta, 4 terminal setae; minimum number of bells on setae = 4, maximum number of bells on setae = 7. *Peg side*: 2 nonterminal setae, 3 terminal setae; minimum number of bells on setae = 4, maximum number of bells on setae = 6. *Comb*: 3 long teeth on each side, long teeth long, coarsely biserrate, with pointed tips, central tooth longer than others; 2 short teeth on each side, short teeth medium long, with square tips, and deep grooves. *Peg*: long, slightly curved, very narrow; tip of peg similar width to centre of peg, and with many points; base of peg recessed from outer limb edge.

COPULATORY "LIMB". *First article*: *Y-sclerite* prominent; *strut* present so that sclerite forms an irregular rectangular loop; loop broader distally; *finger sclerite* broad proximally, becoming narrow distally, forming a continuous section along inner margin of inner lobe, terminating near base of inner lobe. *Inner lobe*: elongate with rounded tip. *Finger branch* and *setal branch* separated by a deep terminal cleft. *Finger branch*: tip with stout spines; terminal and cleft region bare; external surface with 2 bare, ringed setae. *Outer lobe*: *thumb sclerite* forming edge of a triangle with an extended tip; *thumb* big and bare, located proximally on thumb sclerite, near hood; 2 bare, ringed setae located proximal to tip of thumb sclerite. *Hood*: dorsoventral L medium long; distally triangular becoming a finger-like lobe; anterior peak short; tip of hood complete, with few minute scales or spines; hood extends less than half way over inner lobe. *Central lobe*:

width > 50% and L = about 50% of that of inner lobe; 3 terminal ringed and spinous setae.

FURCA. Left lamella with 9 claws, RT lamella with 9 claws; claws 2 and 4 fused to lamella; claw 3 longer but thinner than claw 4; claw 1 long and medium wide; claw 4 exceptionally broad; claw 5 short and broad; anterior claws short and broad; claws generally increasing in size posteriorly; claws generally slightly curved; all claws with spines; distal M spines of most posterior claw broad; lamellae with concave posterior part of V margin, leading to an anterior V hump; LT lamella bare, RT lamella with M long thin setae near distal V margin.

ANTERIOR OF BODY. *Bellonci organ*: (non-extended) is trapezoid (terminal margin longer than basal margin); L (non-extended) = 0.03 mm; width greater than length; tip (extended) bluntly rounded; without pigment.

Eyes: *medial eye* large, L = 0.06 mm; pigmented. *Lateral eye*: very large, L = 0.27 mm; about 10 x size of medial eye; broadest dorsally; with at least 16 ommatidia (7 large, of approximately equal size; 9 small, of approximately equal size), largest ommatidia located dorsally; ommatidia light amber in transmitted light, matrix between ommatidia maroon in transmitted light.

Upper lip: pigmented. *Anterior*: single undivided process directed anteroventrally; V field of process pear-shaped, with about 16 large valves, arranged in about 3-5 anterior-posterior rows on a single plane; anterior process bare. *Posterior*: with very fine setae posteriorly. *Tusks*: short, consistently medium width; each with 2 valves, valves

medium sized, forming a step-like profile of posterior tusk margin; tusks without setae or spines; spurs on tusks absent.

Frontal knob: large, rounded, width < length; no projections V to frontal knob.

POSTERIOR OF BODY. *Dorsal folds*: replaced by muscle bands. *Y-sclerite*: V branch < 50% L of D branch.

Description of adult female characters.

Most characters common to both sexes have been omitted from the following description.

CARAPACE. L = 1.14 mm, H = 0.70 mm; L/H = 1.63.

FIRST ANTENNA. Without "suckers" and basal setules of b- and c-setae; all halophores without spines.

MANDIBLE. All setae generally less spinous than male. *Second endopodial article*: D margin with 7 bare setae; 1 a-, 1 b-, 2 shorter-, 1 c-, 2 d-setae (no setae distal to d-setae). *Third endopodial article*: b-seta of left limb curves in opposite direction to claws and c- and d-setae, forming a "pincer"; b-seta of right limb similar to that of the male.

SIXTH LIMB. *Terminal article*: row of 4 anteroventral setae.

SEVENTH LIMB. Total of 8 setae. *Comb side*: without non-terminal setae; 3 terminal setae.

FURCA. Left lamella with 7 claws, RT lamella with 8 claws; claws 2 and 4 proximally broader than in male; large medial spines of claw 1 (most posterior claw) present along almost complete length of claw; lamellae irregularly shaped, with very prominent hump midway along ventral margin.

ANTERIOR OF BODY. *Lateral eye*: large, L = 0.27 mm;

broadest centrally (dorsal side similar size to ventral side); with at least 16 equally sized ommatidia.

Etymology. This species is named in honour of Louis S. Kornicker, myodocopid ostracod expert, who has described a large proportion of the known myodocopins, and taught the author important techniques for working with ostracods.

Discussion

Species of *Cohenia* and *Lowrya* are scavengers. This is reflected in the well-developed "armature" of their fourth and fifth limbs (many terminal setae with large spines), large spines on most mandibular claws, and the broad fourth claw of their furcae; these parts are all used in the scavenging feeding process (Chapter 4).

Although the species described herein only occurred in trap samples in relatively low numbers, other species belonging to *Cohenia* and *Lowrya* have been identified from eastern Australian trap samples, between southern Queensland and Tasmania, often in very large numbers. A preliminary analysis of these species indicates that they are relatively small cypridinids, all with a similar, almost rectangular, carapace shape, with a red colouration of a section of the rostrum (indicating strong sclerotization in this region). These characters make specimens of *Cohenia* and *Lowrya* relatively easy to identify under a dissecting microscope by non-ostracod specialists, without making dissections.

Specimens of *Cohenia* can be further separated under a dissecting microscope by the presence of trichocoels.

The unusually large basal "suckers" of the c-setae of the first antennae of *Cohenia* and *Lowryi*, and the intriguing cup-shaped sections from which they arise, justify a functional morphology study of these, and all other male first antennal "suckers" within the Cypridinidae and Halocyprina (Myodocopida). These "suckers" are supposedly suctorial organs used by the adult male to grasp the female during copulation (Kornicker, 1983). However, from video recordings of a *Skogsbergia* species, a cypridinid with male first antennal "suckers", during mating, it was observed that these "suckers", or any part of the male first antenna, did not make contact with the female (Chapter 7). Therefore, the possibility that these "suckers" have a sensory function (Kornicker, 1983) should be investigated. The cup-shaped basal sections, and the bulbous proximal parts, of the basal setules of the c- and b-setae of the male first antennae of *Cohenia* and *Lowrya* species, provide evidence for a functional mechanism for the whole "sucker" system which is more complex than one required for a "simple" suctorial organ. Additionally, the large "sucker" of the c-seta of the male first antenna of *Lowrya kornickeri*, at least, is located "slotted" between the s-seta and the c- (shaft) and g-setae (Figure 5, J). The s-seta may therefore provide a physical obstacle for this large "sucker" to function as a suctorial organ. It can be noted that the large "suckers" (at least) bear a close resemblance to the calceoli of certain amphipods; the calceolus is a presumed sensory receptor (Lincoln &

Hurley, 1981). Lincoln (1985) suggests, with evidence, that the calceoli may function as phonoreceptors, sensitive to water borne pressure waves.

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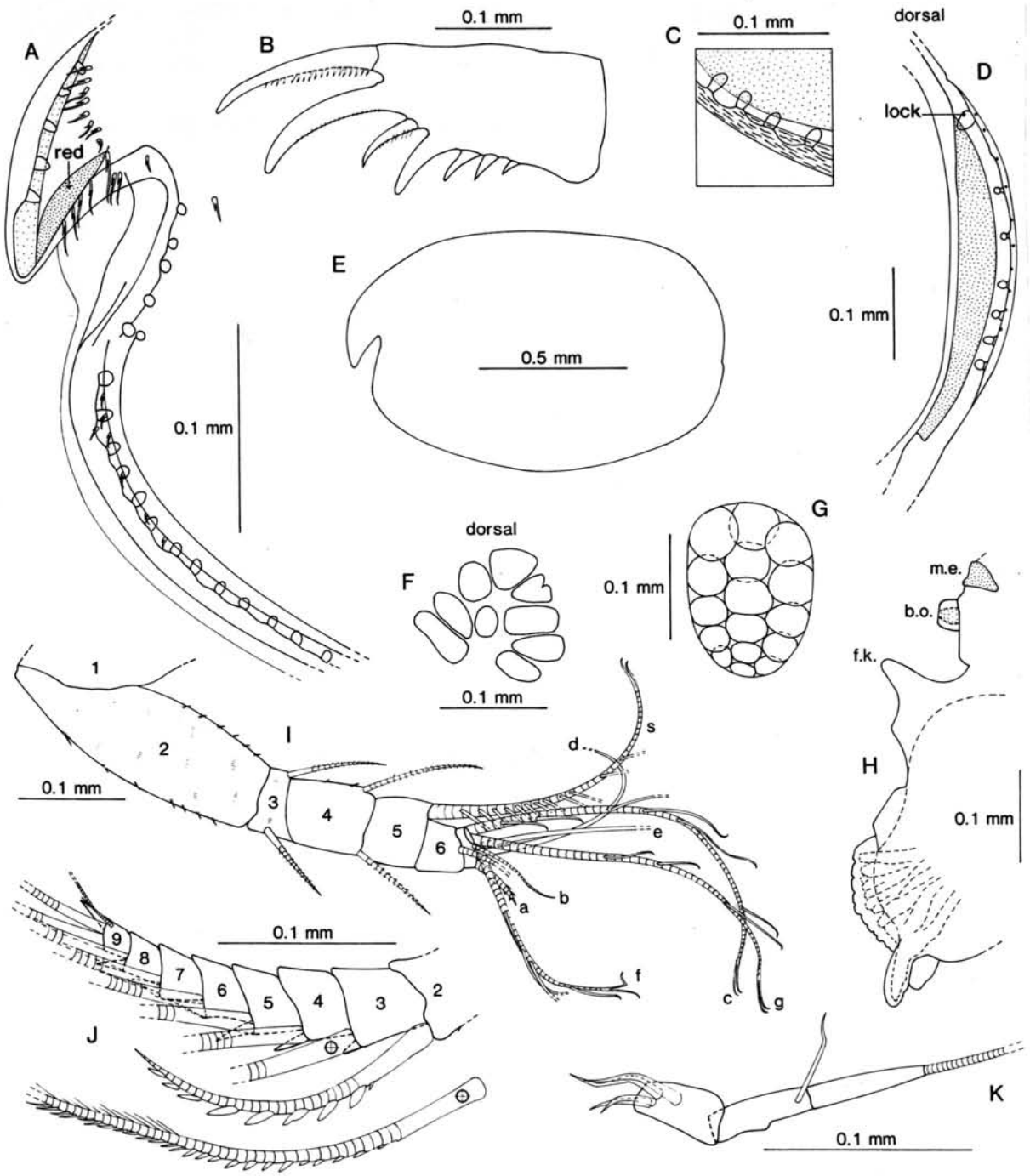
Figure 1. *Cohenia taiti*, adult female (AM P44618). **A**, anterior of RT carapace valve, M view (area of sclerotization shaded). **B**, LT furcal lamella, Lat view. **C**, appearance of trichocoels (in anteroventral section of LT carapace valve) at 200 x magnification, Lat view (setae not visible). **D**, posterior (keel) of RT carapace valve, M view. **E**, RT carapace valve, M view. **F**, central adductor muscle scars of RT carapace valve, M view. **G**, LT lateral (compound) eye, Lat view (dorsal above). **H**, anterior of body, limbs removed, showing medial eye (m.e.), Bellonci organ (b.o.), frontal knob (f.k.), and upper lip. **I**, RT 1st antenna, M view. **J**, exopodial articles 2-9 of LT 2nd antenna, including seta of 3rd article, M view. **K**, endopodite of RT 2nd antenna, M view.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0.1 mm

Figure 2. *Cohenia taiti* adult female (AM P44618). **A**, RT mandible, M view. **B**, terminal part of 5th limb, anterior view, showing endites (I, II and III), and exopodial articles (1-5). **B(i)**, terminal process of 5th exopodial article. **B(ii)**, terminal part of 2nd b"-seta. **B(iii)**, longest a-seta. **B(iv)**, longest "tooth". **B(v)**, peg. **C**, RT 4th limb, M view. **D**, RT 6th limb, Lat view, showing endites (I-IV). **E**, terminal part of 7th limb, showing peg.

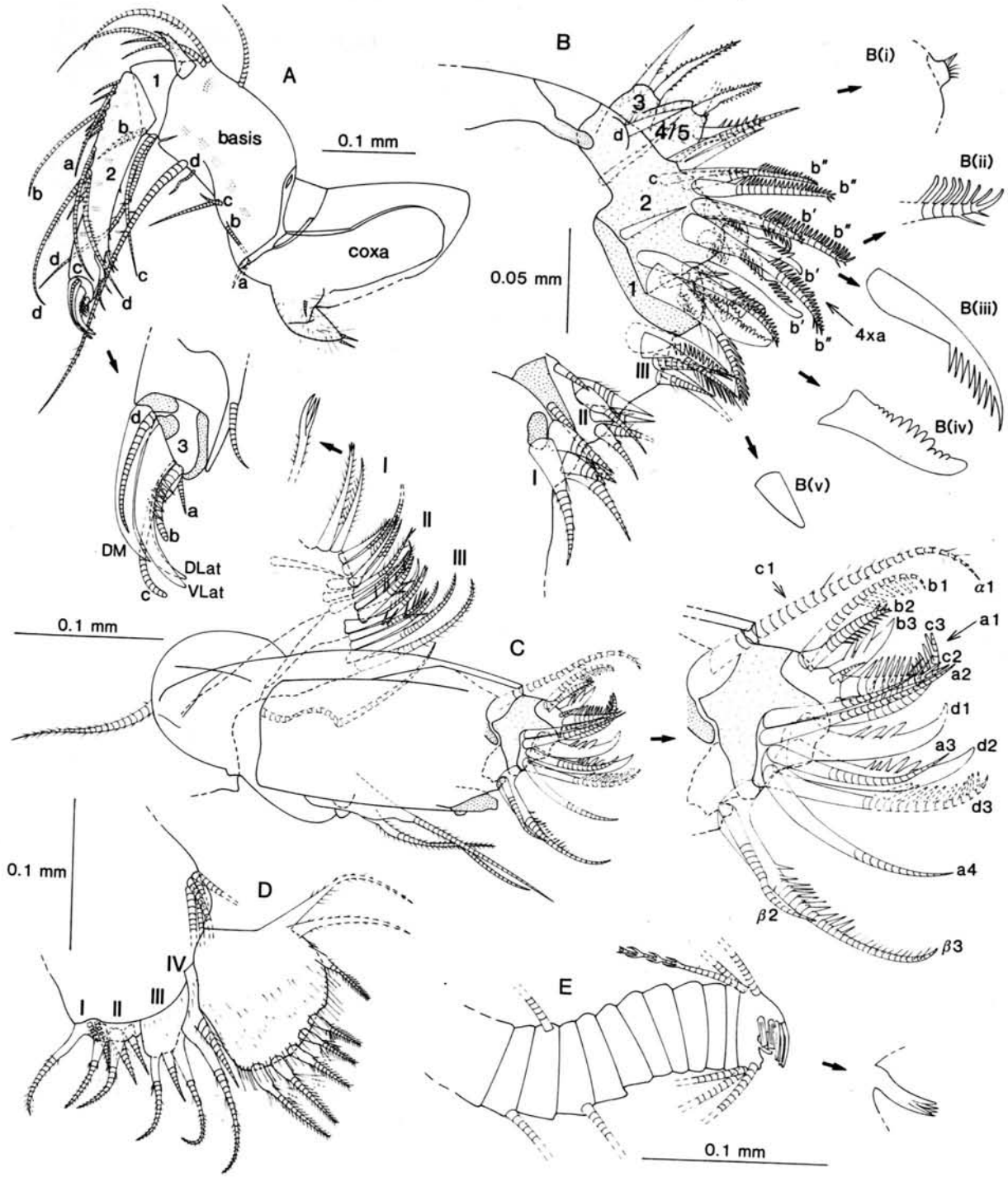

A
basis
coxa
0.1 mm
B
B(i)
B(ii)
B(iii)
B(iv)
B(v)
4xa
0.05 mm
DM
DLat
VLat
0.1 mm
C
c1
b1
α1
b2
b3
c3
a1
c2
a2
d1
a3
d2
d3
a4
β2
β3
0.1 mm
D
IV
E
0.1 mm

Figure 3. *Cohenia taiti* adult male (AM P44619). **A**, LT carapace valve, M view, showing rows of trichocoels. **B**, anterior of RT carapace valve, M view. **C**, smallest "tooth" and peg of LT 5th limb, anterior view. **D**, terminal part of RT first antenna, Lat view, shaft of b-seta missing. **D(i)**, 3rd most proximal halophore of the f-seta. **E**, LT copulatory "limb", V view, showing internal sclerites. **F**, terminal part of LT copulatory "limb", V view. **G**, VLat claw of RT mandible, Lat view. **H**, DLat claw of RT mandible, Lat view. **I**, terminal part of seta of 2nd exopodial article of the RT 2nd antenna, Lat view, showing small M spine.

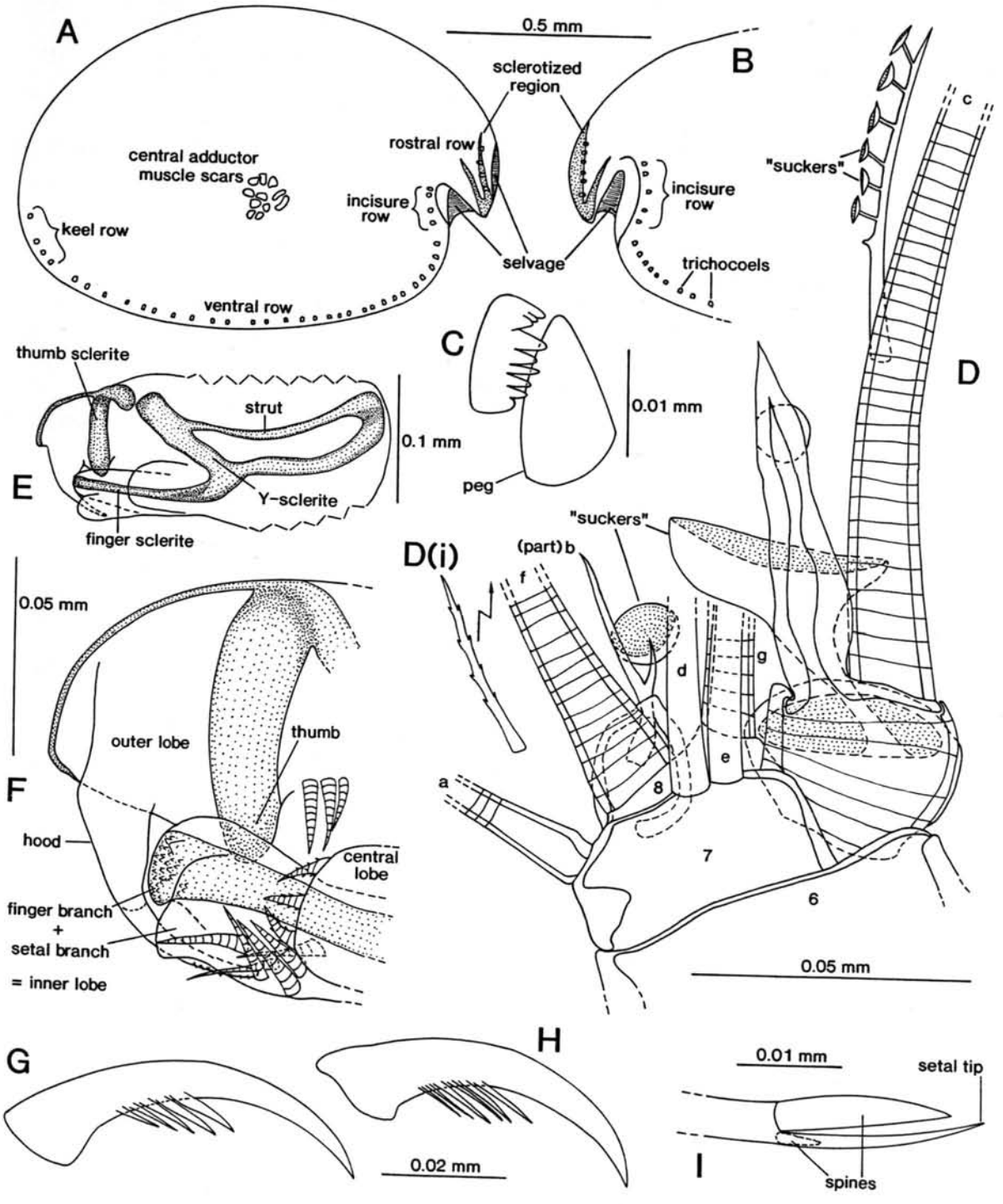

A
0.5 mm
B
sclerotized region
rostral row
central adductor muscle scars
incisure row
keel row
selvage
incisure row
trichocoels
ventral row
C
0.01 mm
peg
D
c
"suckers"
thumb sclerite
strut
0.1 mm
E
Y-sclerite
finger sclerite
D(i)
"suckers"
(part) b
f
d
g
e
a
8
7
6
0.05 mm
0.05 mm
outer lobe
thumb
F
hood
central lobe
finger branch + setal branch = inner lobe
G
H
0.02 mm
0.01 mm
setal tip
I
spines

Figure 4. *Cohenia taiti* Scanning electron micrographs, adult male (AM P45532). **A**, anterior of body, limbs removed, showing upper lip (ul) and compound eye (ce); RT tusk arrowed, LT tusk broken. **B**, upper lip, V view (RT tusk arrowed). **C**, surface of RT carapace valve, central region (anterior to the right), Lat view. **D**, rostrum (r) and incisure (i) of the right carapace valve, Lat view; examples of trichocoels arrowed. **E**, rostrum of RT carapace valve, M view, showing internal setae, selvage (s) and sclerotized region (inner edge of "angle" arrowed); sclerotized region remains rigid while remaining carapace curls after drying. **F**, three trichocoels (arrowed) of the ventral row (anterior part) of the LT carapace valve, also showing recessed "lip" near edge of valve (l), and a more common type of external carapace seta (distributed randomly over entire surface). Scales: **A** = 0.2 mm; **B** and **C** = 50 μm; **D** and **E** = 0.1 mm; **F** = 20 μm.

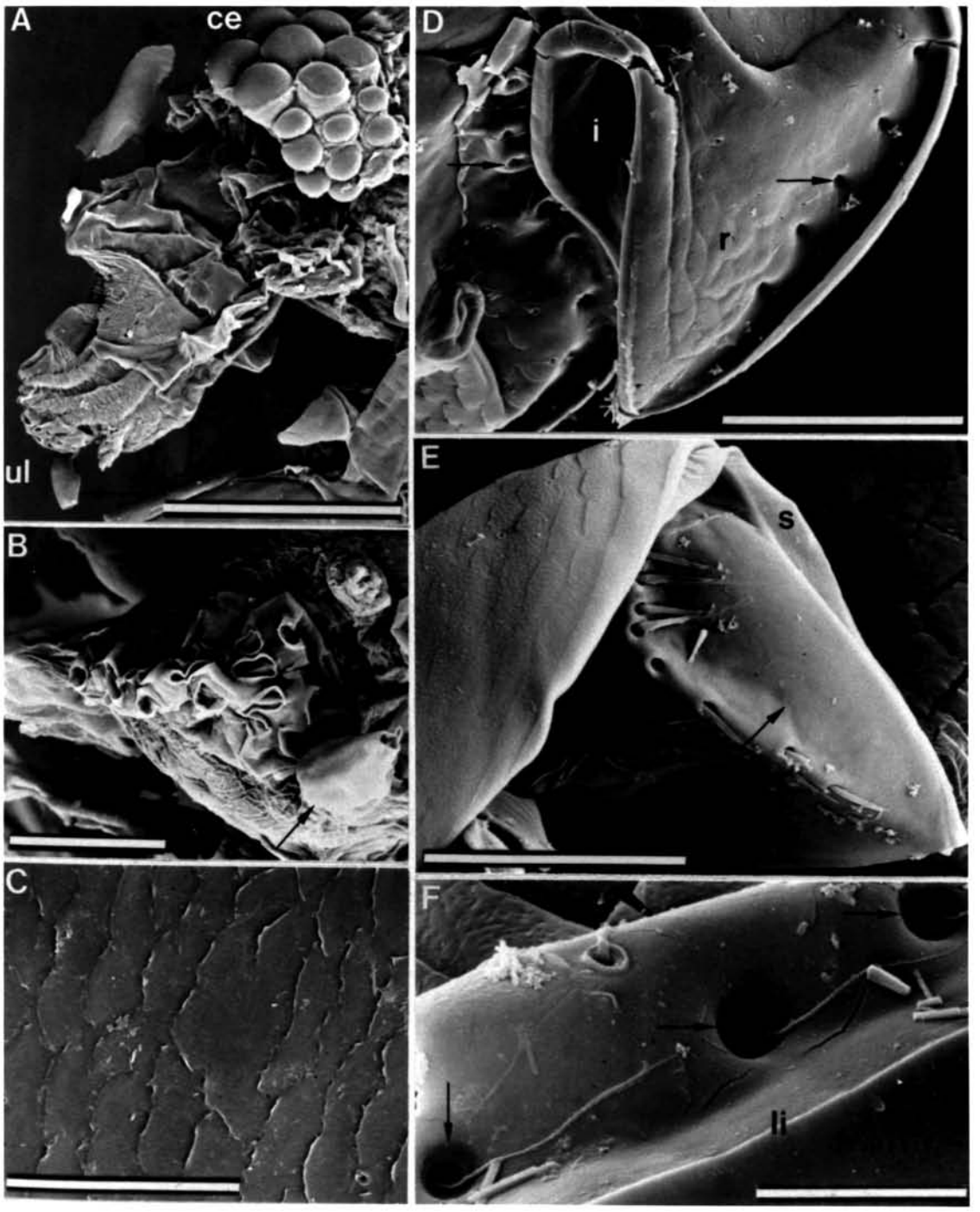

A
ce
ul
B
C
D
i
r
E
s
F
li

Figure 5. *Lowrya kornickeri* adult male (AM P45463). **A**, whole animal, Lat view. **B**, anterior of LT carapace valve, M view. **C**, LT furcal lamella, Lat view. **D**, central adductor muscle scars of RT carapace valve, M view. **E**, anterior of body, limbs removed, showing medial eye (m.e.), lateral eye (l.e.), Bellonci organ (b.o.), frontal knob (f.k.), and upper lip (u.l.) including left tusk (t.), areas of maroon pigmentation shaded. **F**, endopodite (dashed) and exopodite of LT 2nd antenna, Lat view. **G**, basal setule of b-seta of RT 1st antenna, bearing 2 "suckers", M view. **H**, terminal articles of LT 1st antenna, s-seta not illustrated, 8th article not visible, Lat view. **H (i)**, proximal section of 7th most proximal halophore of the f-seta of the LT 1st antenna, Lat view. **I**, proximal halophores arising from shaft of s-seta of RT 1st antenna, M view. **J**, RT 1st antenna, M view. **K**, 2nd most proximal setule of the c-seta of the LT 1st antenna, showing "suckers", Lat view. **L**, distal part of 2nd most proximal setule of the b-seta of the LT 1st antenna, showing "suckers", DLat view.

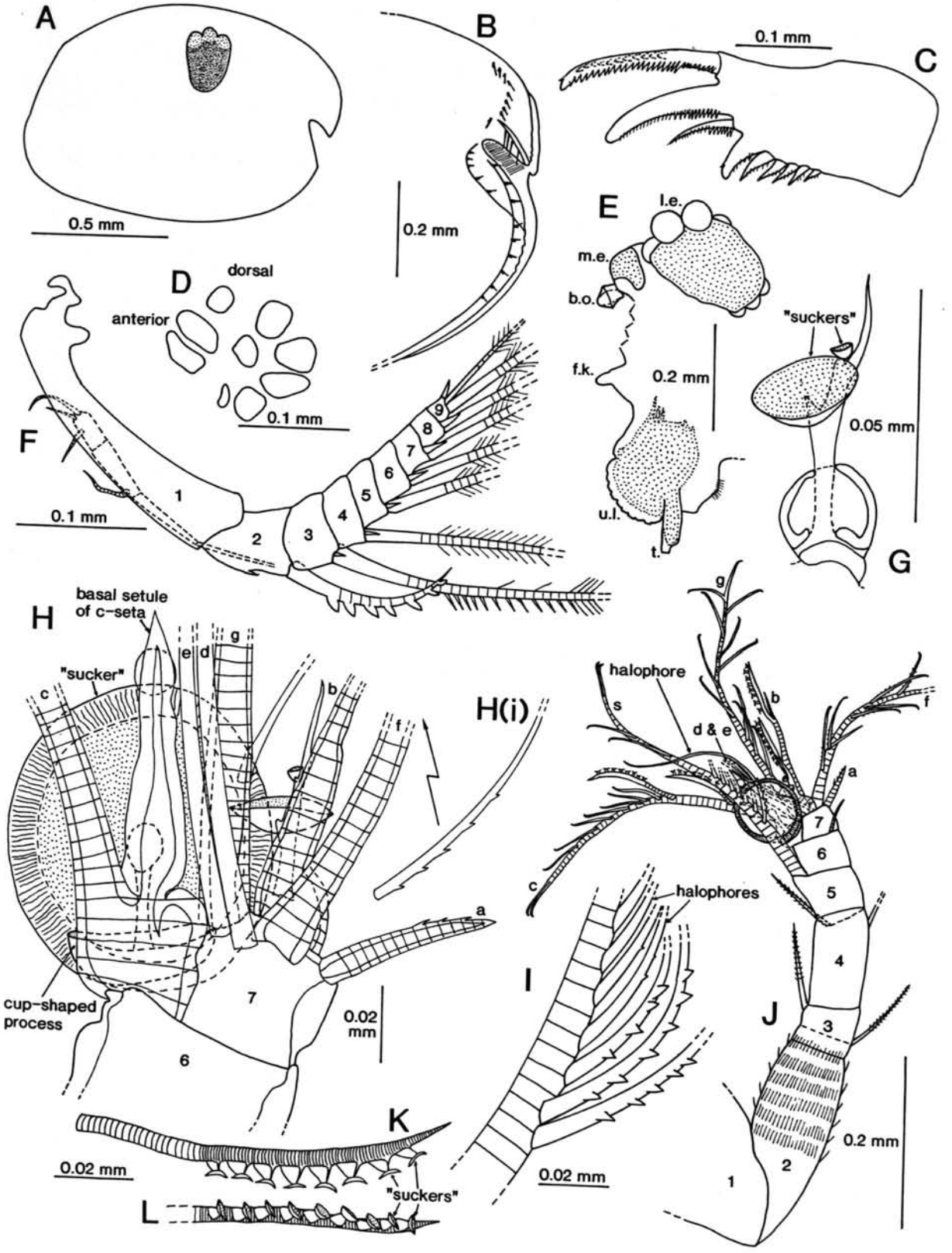

A
0.5 mm
B
0.2 mm
C
0.1 mm
D
dorsal
anterior
0.1 mm
E
l.e.
m.e.
b.o.
f.k.
u.l.
t.
0.2 mm
"suckers"
0.05 mm
G
F
1
2
3
4
5
6
7
8
9
0.1 mm
H
basal setule of c-seta
"sucker"
c
e
d
g
b
f
a
cup-shaped process
7
6
0.02 mm
H(i)
g
halophore
s
b
f
d & e
a
7
6
5
4
3
2
1
c
halophores
I
0.02 mm
J
0.2 mm
K
0.02 mm
L
"suckers"

Figure 6. *Lowrya kornickeri* adult male (AM P45463). **A**, RT mandible, M view. **B**, LT 4th limb, showing some terminal endopodial setae, Lat view. **C**, terminal endopodial setae of RT 4th limb excluded from **B**, M view. **D**, terminal section of exopodite of RT 5th limb, anterior view (the spines of many setae are longer than appear in this illustration, due to the angle of observation). **E**, LT copulatory "limb", D view. **F**, RT 6th limb, Lat view. **G**, terminal section of 7th limb.

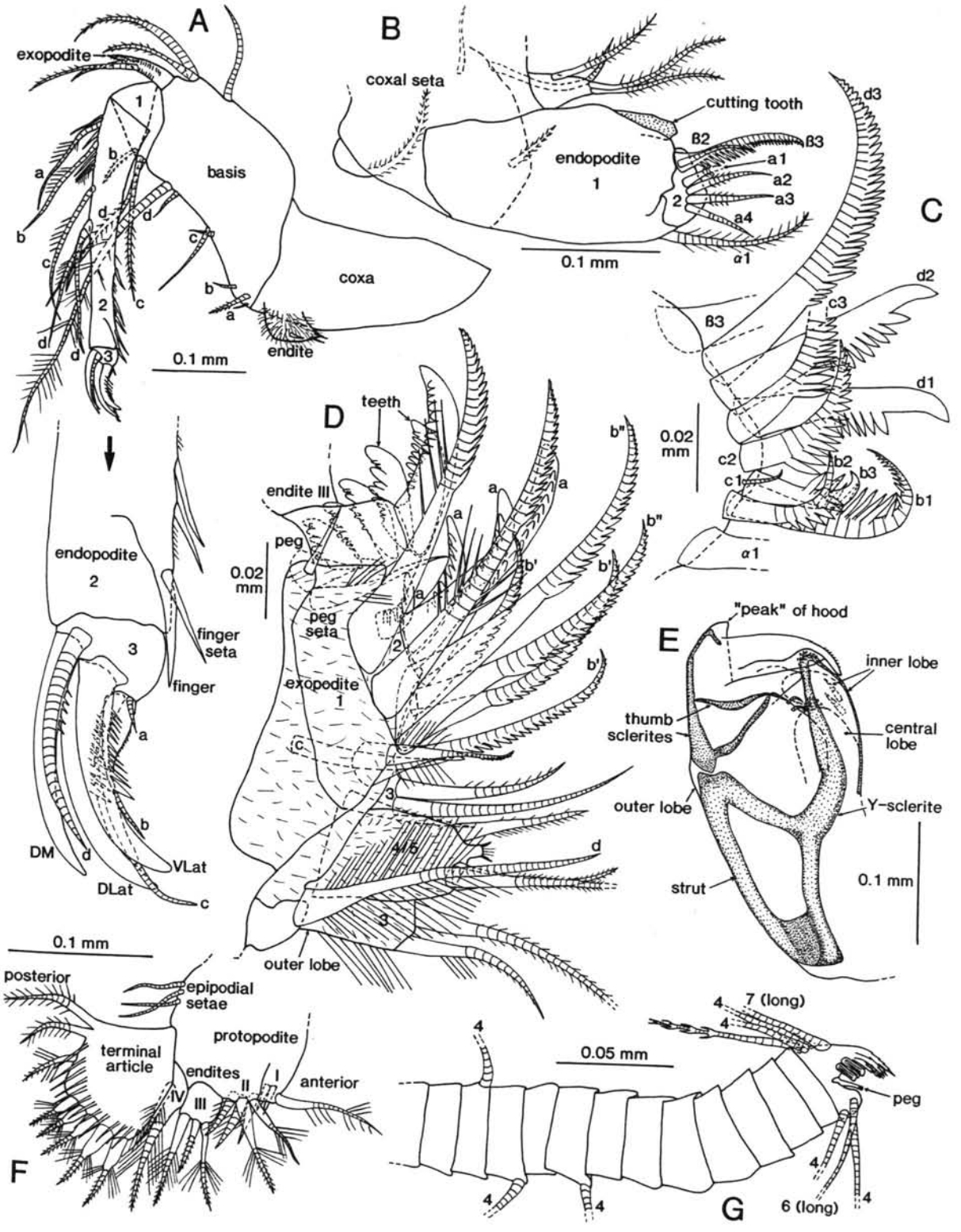
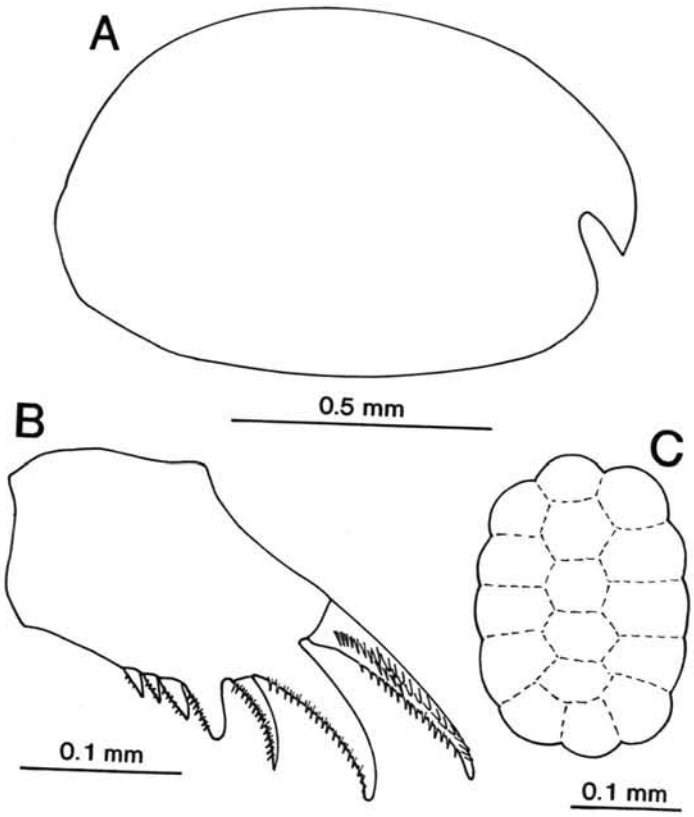

A
exopodite
basis
coxa
endite
0.1 mm
B
coxal seta
cutting tooth
endopodite
1
0.1 mm
C
0.02
mm
D
teeth
endite III
peg
peg
seta
exopodite
1
outer lobe
0.02
mm
endopodite
2
finger
seta
finger
DM
VLat
DLat
E
"peak" of hood
inner lobe
thumb
sclerites
central
lobe
outer lobe
Y-sclerite
strut
0.1 mm
F
0.1 mm
posterior
epipodial
setae
terminal
article
protopodite
endites
anterior
G
0.05 mm
7 (long)
peg
6 (long)

Figure 7. *Lowrya kornickeri* adult female (AM P45464). **A**, RT carapace valve, Lat view. **B**, LT furcal lamella, M view (RT lamella with 8 claws). **C**, LT lateral (compound) eye, Lat view (dorsal above).


A
0.5 mm
B
0.1 mm
C
0.1 mm